HIGHWAY TWINNING FEASIBILITY STUDY

for the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR)

Project No. 151046.01

Detailed Feasibility Study
PROJECT SUMMARY (FINAL)

January 2017

CBCL LIMITED
Consulting Engineers

Prepared for:

NOVA SCOTIA
Transportation and Infrastructure Renewal

ISO 9001
Registered Company

CBCL Limited
1489 Hollis Street
PO Box 606
Halifax, NS B3J 2R7

Corporate Website:
www.cbcl.ca

Contact Person:
Audrey Muir
Tel: 902-421-7241, Ext. 2286
Fax: 902-423-3938
E-Mail: amuir@cbcl.ca

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Project Summary (Draft)	Andrew Gates	2016/12/23	Audrey Muir
Issue or Revision	***Reviewed By:***	***Date***	***Issued By:***

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Consulting Engineers

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REGISTERED PROFESSIONAL ENGINEER
DATE JAN 20/17
A. W. Gates
5455
PROVINCE OF NOVA SCOTIA

CBCL LIMITED
Consulting Engineers

January 20, 2017

Mr. Brian Ward, P.Eng.
Director, Highway Engineering and Capital Programs
Nova Scotia Department of Transportation and Infrastructure Renewal
4th Floor, Johnston Building
1672 Granville Street, PO Box 186
Halifax, NS B3J 2N2

Dear Mr. Ward:

RE: Highway Twinning Feasibility Study – Detailed Feasibility Study Phase, Project Summary (Final)

1489 Hollis Street
PO Box 606
Halifax, Nova Scotia
Canada B3J 2R7

Telephone: 902 421 7241
Fax: 902 423 3938
E-mail: info@cbcl.ca
www.cbcl.ca

Thank you for giving us the opportunity to undertake this important study on your behalf. As you know we have been carrying out a significant amount of work to update the Preliminary Screening/Assessment phase to the Detailed Feasibility Study, including the refinement of highway alignments, the development of Class C cost estimates, updating toll revenue calculations and also the indicative financial viability.

We hope that this report provides you with all that you need at this stage, however, please do not hesitate to contact us should you require any further information.

We look forward to continuing to work with you on this landmark project.

Yours truly,

CBCL Limited

Audrey Muir, MITE, AFMCSCE
Project Manager
Direct: (902) 421-7241, Ext. 2286
E-Mail: amuir@cbcl.ca

Project No: 151046.01

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CHAPTER 1 PROJECT BACKGROUND

1.1 Background

Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR), Highway Engineering Services, appointed CBCL Limited and their sub-consultants HDR Corporation, Ernst & Young Orenda Corporate Finance Inc., and R.A. Malatest & Associates Ltd, through a competitive proposal process to undertake the ***Highway Twinning Feasibility Study*** on their behalf. The project was initiated to look at the cost to design, construct, operate, maintain and finance eight sections of 100-series highways within the Province, and to determine viable options to fund these projects either through tolls, and/or available PPP Canada funding models, and/or government subsidies.

The eight highway sections identified as part of the study are:

- Corridor 1: Highway 101 – Three Mile Plains to Falmouth (10.8 km);
- Corridor 2: Highway 101 – Hortonville to Coldbrook (23.7 km);
- Corridor 3: Highway 103 – Exit 5 at Tantallon to Exit 12 Bridgewater (68.1 km);
- Corridor 4: Highway 104 – Sutherlands River to Antigonish (37.8 km);
- Corridor 5: Highway 104 – Taylor's Road to Auld's Cove (39.5 km);
- Corridor 6: Highway 104 – Port Hastings to Port Hawkesbury (7.0 km);
- Corridor 7: Highway 104 – St. Peter's to Sydney (83.9 km); and
- Corridor 8: Highway 107 – Porter's Lake to Duke Street, Bedford (33.3 km).

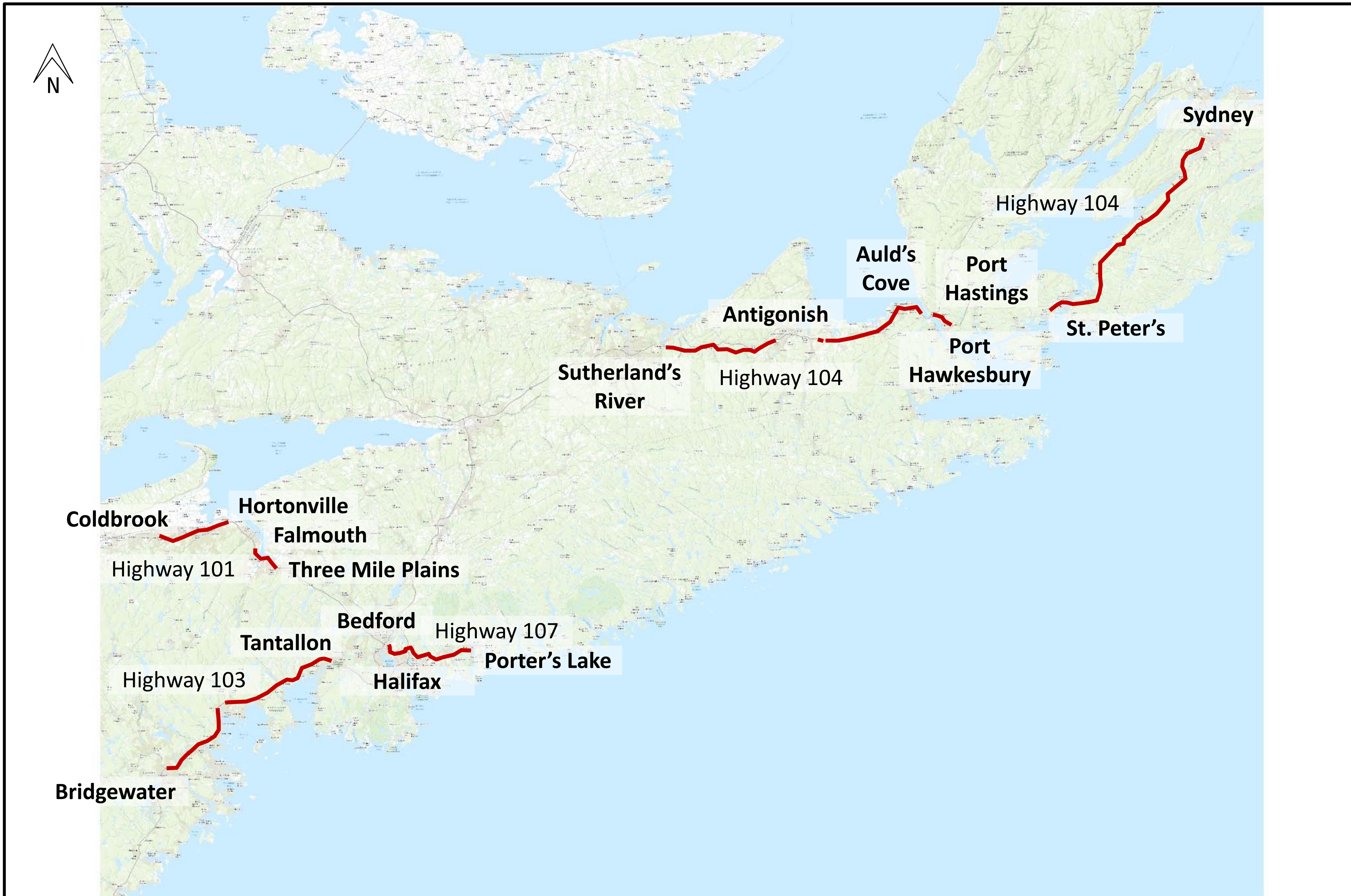
In general, the study is examining the costs and potential revenue associated with constructing the highways and operating a tolling system on the proposed corridors to determine whether the highways are indicatively financially feasible. Most of these corridors have been extensively reviewed in the past as candidate sections for twinning, upgrading, or new construction due to increases in traffic volumes since the existing two-lane highways were constructed during the 1960's, 1970's and 1980's. More recently, NSTIR commissioned operational and safety reviews of Highways 101, 103 and 104, and the results of these studies indicated that twinning be considered as the ultimate improvement.

The project has been sub-divided into two main phases, the Preliminary Screening/Assessment (PSA) phase, and the Detailed Feasibility Study (DFS). The Preliminary Screening/Assessment was completed in July 2016. The Detailed Feasibility Study expanded on the work undertaken for the PSA and involved much more detailed methodologies for determining optimum revenues, estimating costs and subsidies required, recommending a toll collection system, and preparing a Class C cost estimate and schematic design.

Our approach during the Detailed Feasibility Study phase of the work has been to update the costs associated with implementing the highway upgrades to Class C cost estimates, based on more refined highway alignments and environmental work undertaken, and the associated revenue generation potential from tolling. The matrix assessment has been updated to show the results obtained for each of the eight sections of highway being compared against each other using a weighted ranking system. Fundamentally, highway projects that are able to generate tolling revenue to offset capital costs and the 30 year operation, maintenance and replacement (OMR) cost (after consideration of federal and provincial lump sum grants, along with other key assumptions), and/or provide significant reductions in collisions and improvements in road safety, have been ranked higher, while those that are not have been ranked lower.

The project team has also held a number of meetings, workshops and presentations with NSTIR's Working Committee, and Steering Committee during the DFS, and have continued to receive valuable and timely input during the course of the study.

The general location of the study area, as defined by NSTIR, is shown in **Figure 1.1**.



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Highway Twinning Feasibility Study
Detailed Feasibility Study

Project No.: 151046.01
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Figure 1.1
General Location of Study Area

CHAPTER 2 TRAFFIC ANALYSIS AND FORECASTS

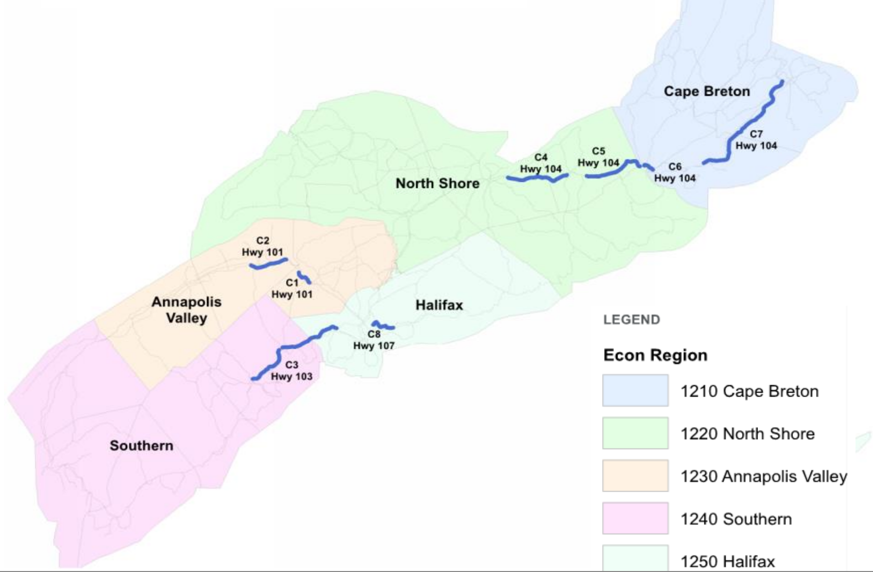
2.1 Data Review and Analysis

The data reviewed for the traffic analysis and forecasts were also completed in the two major stages: Preliminary Screening / Assessment (PSA) phase, and the Detailed Feasibility Study (DFS). During each stage, refinements to the forecasting methodology were made based on input and feedback from NSTIR, as well as accounting for new data that were made available as the study progressed.

The data input for the PSA phase consisted mainly of historic traffic data and major economic indicators. NSTIR provided data on auto and truck traffic counts, collision data, background studies and reports, population projections. Historic economic trends on tourism, motor vehicle registrations, and GDP outlook were also assembled by the project team. For the DFS phase, origin-destination pattern data and survey data on travel characteristics as well as additional counts were collected and analyzed for each corridor.

Since population forecasts, socio-economic projections, and historic traffic data trends are key factors in predicting traffic growth, we discuss these categories separately in the sub-sections below. Based on available data, economic forecasts were reviewed on a provincial basis, while population forecasts were examined at both the provincial and regional level. Based on Statistics Canada data, the province's 18 census divisions were aggregated into 5 economic regions for the population growth analysis. The geographic boundaries of these Regions and the respective location of the candidate sections are shown in **Figure 2.1**.

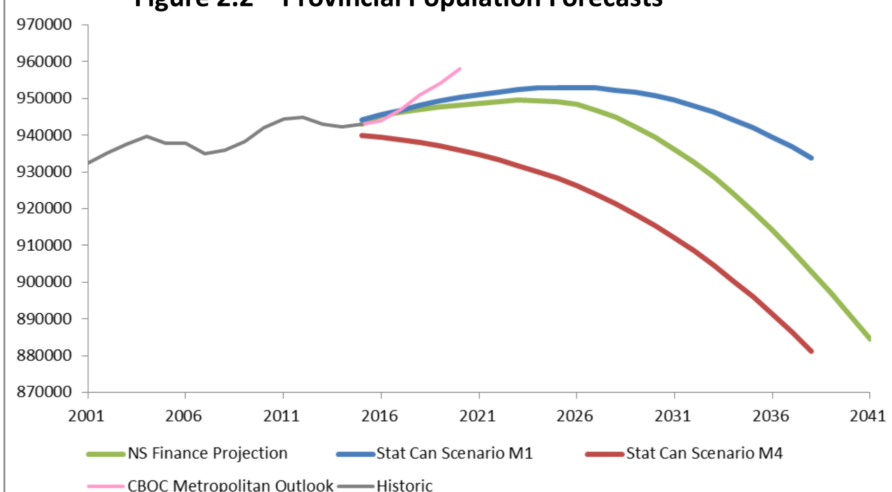
Figure 2.1 – Economic Regions in Nova Scotia



2.1.1 Population Forecast

Three sources of Provincial population projections were reviewed: Nova Scotia Finance and Treasury Board (NSFTB), Statistics Canada (SC), and Conference Board of Canada (CBOC). The comparison of the various population forecast sources are shown in **Figure 2.2**.

Figure 2.2 – Provincial Population Forecasts

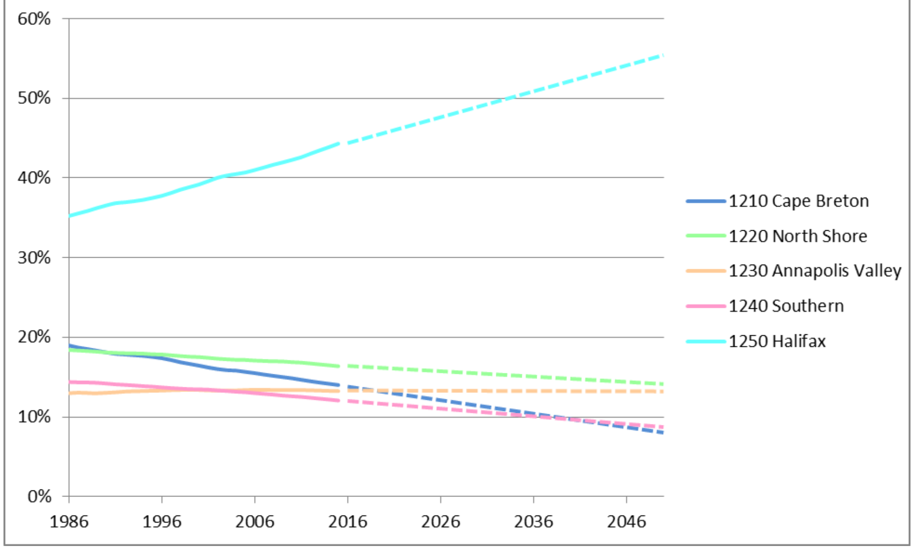


The NSFTB projection was available for 2016-2041, while two SC scenarios were available up to 2038. The CBOC outlook was only available for 5 years out and hence were only included for comparison of short term forecasts. The historic population data was obtained from Stats Canada: *Table 051-0001 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual (persons unless otherwise noted).*

Based on the above comparison, the NSFTB projection is more moderate than the SC Scenario M1, yet sustains some longer growth compared to Scenario M4. According to the NSFTB projections, population decline is expected beyond year 2023.

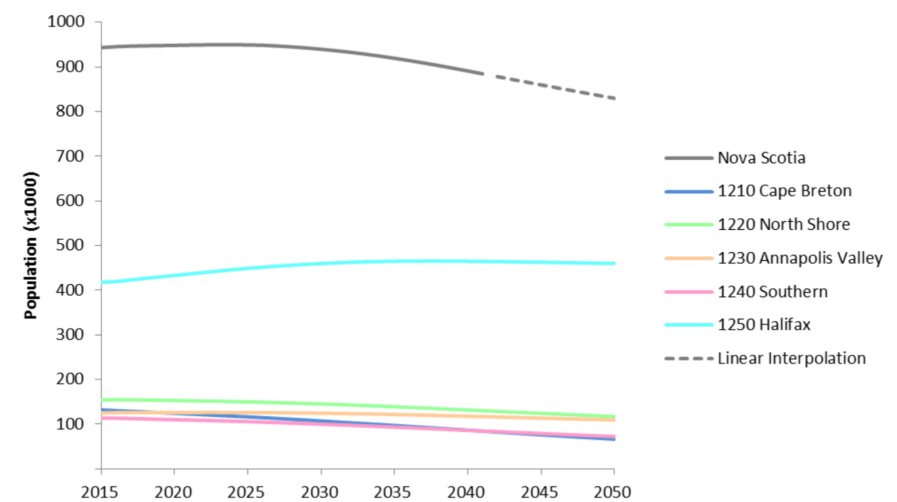
However, based on HRM forecasts and the CBOC metropolitan outlook, the Halifax region is expected to sustain population growth despite an overall provincial decline. Since there are no available population projections for the five economic regions in the long term, the project team estimated population forecasts for the 5 economic regions (so that traffic forecasts can be developed) based on a projected share of the population break down.

Figure 2.3 – Regional Population Breakdown



Using historic data from Statistics Canada, we identified that the Halifax and Annapolis Valley regions have been taking on an increasing share of the provincial population for the past 30 years. Based on linear regression, the population breakdown of the province was extrapolated for the next 34 years (from 2016 to 2050), as shown in **Figure 2.3**. The projected trend indicates that the Halifax economic region will contain more than half of the total Provincial population by 2050. The year 2050 was used in this study based on a 30-year assessment assuming twinning or new construction, if feasible, could start in year 2020. This is further discussed in sections **2.2** and **2.3.** When this trend was applied to the NSFTB provincial population projections for future horizon years, the resulting trend shows a population increase for the Halifax region up to 2038 and Annapolis region up to 2023, but the rest of the regions will have decreasing population. After these years, the regional population for Halifax and Annapolis will plateau and decline along with the other regions. The results of this forecast method are shown in **Figure 2.4**.

Figure 2.4 – Regional Population Projection



The increasing share of population in Halifax Region will sustain a positive growth of approximately 0.9% Compound Annual Growth Rate (CAGR) per year up to 2026, positive growth plateau up at 0.2% CAGR from 2026-2038, and will then decline at -0.1% CAGR per year from 2038-2050.

Between the year 2016 and 2050, the rest of the provincial population is predicted to decline at a CAGR of -0.1%, Cape Breton at -1.9%, North Shore at -0.8%, Annapolis at -0.4%, and Southern Region at -1.3%.

2.1.2 Economic Indicators

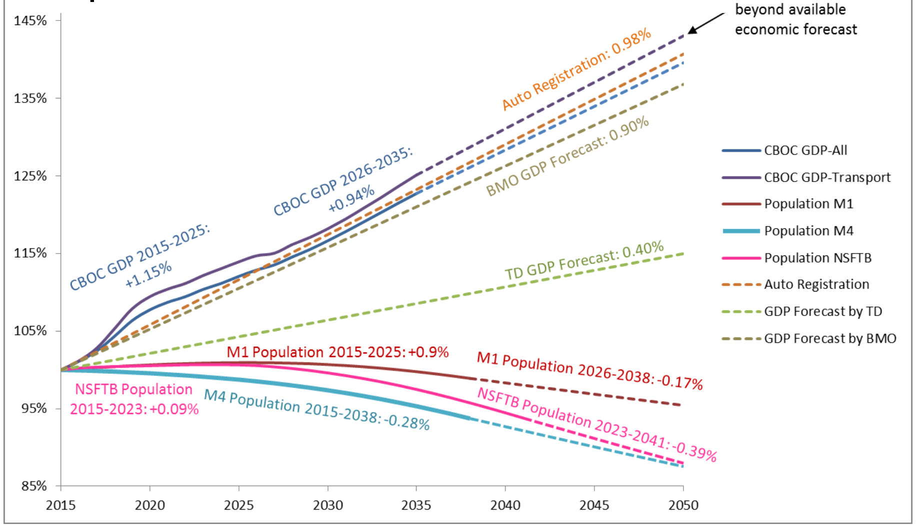
The following economic data were considered in our data analysis and traffic forecast approach:

- Gross Domestic Product (GDP);
- Employment;
- Household Income (Total and Disposable);
- Auto Registration; and
- Tourism.

The sources for GDP forecasts included Conference Board of Canada (CBOC), TD Canada Trust, and Bank of Montreal (BMO). There were no employment forecasts – only historic provincial employment data (Statistics Canada) between 1976 and 2014. Historic auto registration data from Statistics Canada (1999-2014) and tourism arrival data (2005-2014) were also reviewed for potential extrapolation analysis to project growth beyond 2015.

Figure 2.5 illustrates the projected trends assuming linear growth and the respective Compound Annual Growth Rates (CAGR) based on the forecasts and extrapolation of historic data. The provincial population forecast is also included for comparison. Historic tourist arrival trips in the Province have been generally flat or declining and were not used for any forecast projections and therefore, not included in the graph. Historic household total and disposable income data from Statistics Canada (1990-2013) were also reviewed and could grow at 1.7% per year if it were extrapolated to 2050. We have not included this in the graph since it has not been used to support traffic growth.

Figure 2.5 – Historic and Projected Growth of Independent Economic Variables



Generally, the provincial GDP is expected to have a long term positive growth trend around 1% to 2050. Meanwhile, both NSFTB and Statistics Canada population projections expect the provincial population to decline starting at various points in the future. The NSFTB projected population decline was estimated in 2023, while the SC Scenario M1 was in 2025, and SC Scenario M4 in 2016. As traffic growth is often linked with population and employment growth, the declining provincial population would suggest that traffic growth could also decline, despite the positive GDP growth trend.

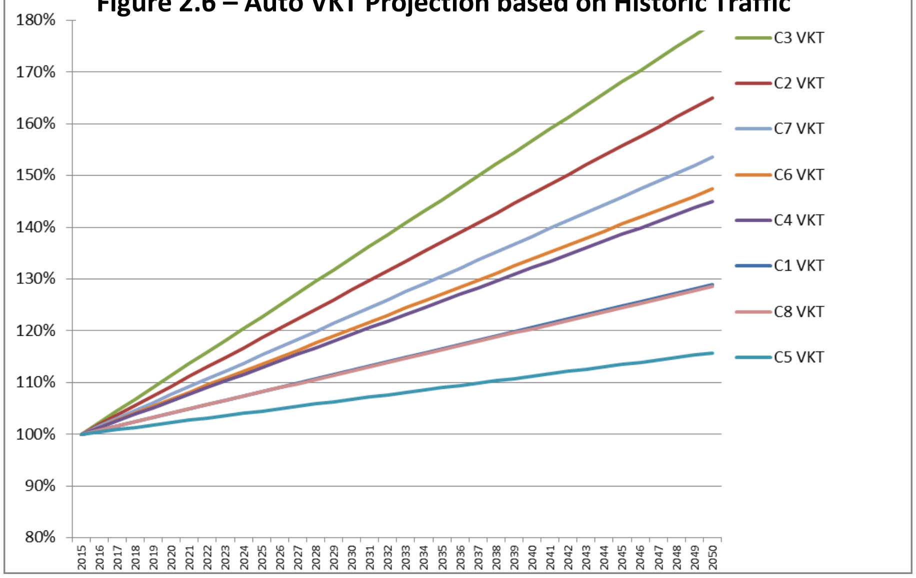
2.1.3 Historic Traffic Volume

The following sources of historic traffic volumes were available for review and analysis from NSTIR:

- Traffic Volumes of Primary Highway System, dated 2005 to 2014;
- Road Safety and Collision Rates Database, dated 2008 to 2012;
- NSTIR Volume Census as part of the GIS Database, dated 2009 to 2011;
- 24-Hour Traffic Volumes for various highway/arterial sections, dated 2009 to 2011; and
- Axle Counts for various highway/arterial sections.

Using existing 100 series highway sections and the adjacent trunk highway sections, traffic data were processed and analyzed for a total of 56 sections for the 8 corridors. The historic traffic volume data were then used to prepare Vehicle Kilometres Travelled (VKT) projections based on linear extrapolation, which are shown for autos in **Figure 2.6**.

Figure 2.6 – Auto VKT Projection based on Historic Traffic



The VKT projections were based on the availability of AADT, 24-hour volumes, and heavy vehicle counts or percentages, and these varied widely for each corridor and section. When all available sources were combined, the AADT count inventory was only partially complete, and a number of the sections had unique values that were not necessarily carried-over from previous years. The truck volume inventory was only complete for a limited number of sections. These data conditions have resulted in judgement being applied to our data analysis and forecast approach using the historic traffic data. Adjustments were made for outlier values which generated excessive rates of growth or decline in the AADT's, which could not be sustainable over the long term. We also note that the NSTIR traffic data represents potential single data collection points in time and traffic volumes fluctuate within each year, therefore, data processing refinements were required to account for these fluctuations.

2.1.4 Relationship between Vehicles-Kilometers Traveled (VKT) and Economic Indicators

Given the number of variables that could influence traffic growth, the project team undertook a correlation analysis to determine if a relationship existed between Population, GDP, and VKT that could be used for traffic forecasting based on changes to population or GDP or simply based on historic traffic growth. The analysis was performed using elasticity based on the following data:

- Statistics Canada National and Provincial Total Vehicle Kilometres Travelled (2000-2009)[1];
- Provincial Population Forecast by NSFTB (2016-2041);
- Nova Scotia Regional Populations Estimates (1986-2015);
- Truck Commodity Origin and Destination Surveys (2004-2014); and
- Long Term GDP Outlook by CBOC (2015-2035).

Based on the available VKT data, we calculated its elasticity with GDP and Population over the 2000 to 2009 period (shown in **Table 2.1**). The 10-year period between the three factors was used to avoid any volatility associated with economic downturns and cyclical effects.

Table 2.1 – VKT Elasticity with GDP and Population (2000-2009)

VKT	Canada	NF	PEI	NS	NB	QC	ON	MN	SK	AB	BC	YK	NW	NU
VKT Δ	7%	-7%	1%	9%	-6%	7%	7%	11%	7%	18%	2%	23%	5%	4%
Population Δ	10%	-2%	3%	0%	0%	7%	11%	5%	3%	22%	9%	11%	7%	19%
Elasticity	0.76	3.44	0.43	18.43	83.78	1.01	0.60	1.97	2.60	0.80	0.21	2.10	0.71	0.23
GDP Δ	16%	26%	19%	17%	17%	14%	12%	20%	12%	23%	22%	42%	42%	32%
Elasticity	0.46	-0.29	0.06	0.51	-0.36	0.48	0.58	0.53	0.60	0.78	0.09	0.55	0.11	0.13

There was no significant change in population (0%) during the 2000-2009 period for Nova Scotia as shown above, and therefore the elasticity between VKT and population in Nova Scotia is not very stable or valid for use in forecasting. This also applies to other Atlantic provinces. Based on a review of elasticity values for other provinces and for Canada as an average, we selected the nation-wide elasticity figures to move forward in this study.

Furthermore, we also calculated elasticity of Truck VKT growth from 2004-2014 against GDP for the transportation industry, as shown in **Table 2.2**. For consistency, the nation-wide elasticity will also be carried forward.

[1] Note: The Vehicle Survey by Statistics Canada was discontinued since 2009, data correlation could only be performed between the available periods.

Table 2.2 – Trucking VKT Elasticity with Transportation GDP (2004-2014)

VKT	Canada	NF	PEI	NS	NB	QC	ON	MN	SK	AB	BC	YK	NW	NU
Truck VKT Δ	19%	85%	90%	46%	40%	26%	5%	0%	39%	28%	-1%	-24%	-53%	78%
GDP Δ	21%	22%	22%	-4%	3%	13%	18%	25%	18%	41%	24%	32%	32%	0%
Elasticity	0.88	3.84	4.02	-10.99	12.44	1.98	0.27	-0.01	2.23	0.68	-0.05	-0.74	-1.67	168.72

2.2 Non-Toll Traffic Forecasts

From the available data at the outset of the PSA phase, the forecast approach was originally based on developing a linear regression trend of the historic AADT and truck data and extrapolating the trend to year 2050 for each section in each corridor, with influence of economic indicators applied to adjust traffic growth rates proportionately.

In the DFS phase, the forecast methodology was refined using a weighted approach, where population forecast, GDP outlook, and historic traffic projections were all considered with each contributing a specific weight to achieve a combined growth rate. The horizon year 2050 was selected based on a 30-year forecast and the assumption that any of the corridors could be constructed or twinned by 2020. For the Highway 107 corridor, an available computer transportation model (owned by Halifax Regional Municipality, or HRM) for the Halifax area and the corridor, was also used to develop forecasts specific to Highway 107. Documentation of the model and the specific work carried out using the model is further discussed in section **2.6**.

Based on the available time and data for the PSA phase, a simpler forecasting approach was adopted using GDP and historic traffic volumes as the key inputs into supporting traffic growth across the corridors. Although GDP growth is expected to continue increasing, we examined the growth rates before and after the year 2025 to identify the difference in GDP growth rates during the years where the population decrease was most significant (i.e. post 2025). We found that the projected GDP growth between 2025 and 2038 was forecast to be 18% slower than the growth from 2016 to 2025. The PSA phase traffic forecast incorporated this slowdown in the GDP forecast but did not result in any negative traffic growth when population was forecast to decline.

During the DFS phase, the traffic growth calculations for each corridor were refined using the weighted approach, where the Regional Population and GDP forecasts were translated into VKT forecasts using the elasticity relationship identified in **Section 2.1.4** and the following equation for the growth rate (*GR*):

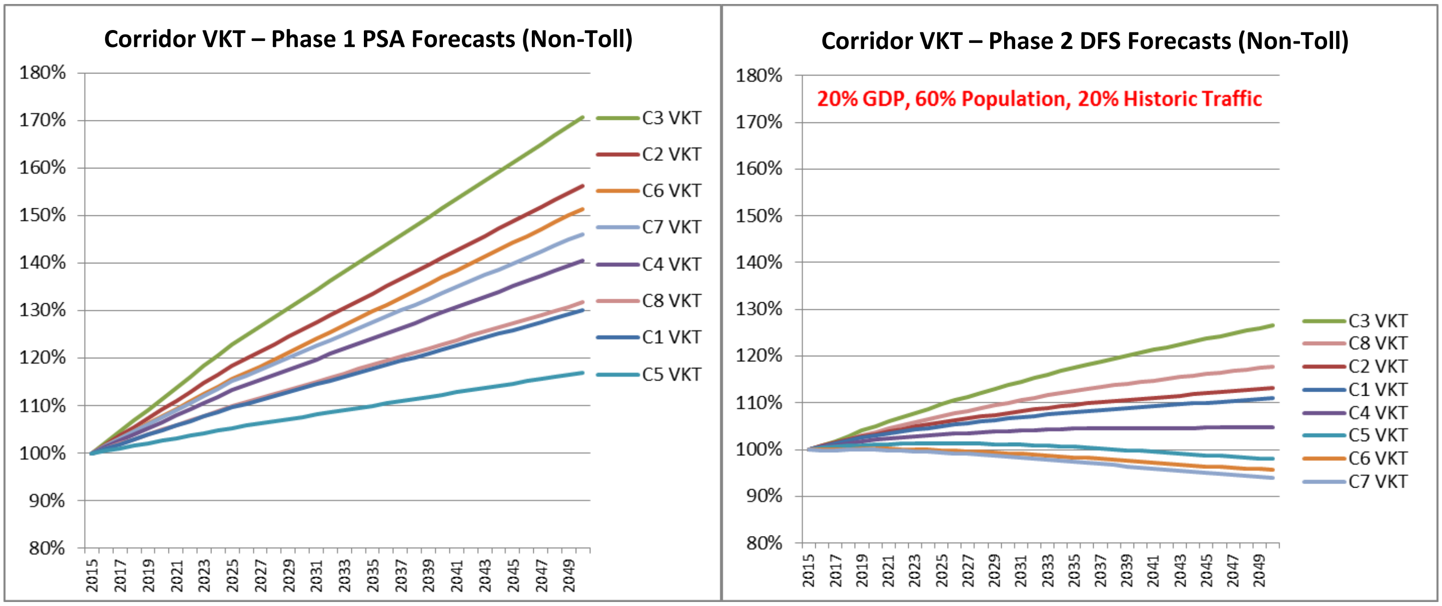
$$GR_{n,\ GDP\ or\ Population} = \left(\frac{GDP_n}{GDP_{2015}} - 1\right) * Elasticty_{GDP\ or\ Population} + 1 \rightarrow for\ n = 2016, 2017, \ldots 2050$$

The projected VKTs based on each of the three factors were then combined using weighted factors computed as follows:

$$GR_{Combined} = GR_{Pop} * Weight_{Pop} + GR_{GDP} * Weight_{GDP} + GR_{Traffic} * Weight_{Traffic}$$

Several weighting options were considered in the study and based on review and input from NSTIR, the overall growth rates for each corridor were 60% based on regional population, 20% based on provincial GDP, and 20% based on historic traffic trends in the corridor. **Figure 2.7** provides a comparison of VKT forecasts between the methods adapted in the two phases.

Figure 2.7 – Auto VKT Comparison between PSA and DFS Methods



There was a significant reduction in the projected VKT for all corridors due to the increased influence of population forecasts on the VKT based on NSTIR inputs. As identified in section **2.1.1**, the population for many parts of the province is expected to decline except the Halifax region. As a result, the VKT and revenue forecasts estimated in the DFS phase were significantly more conservative.

The 8 highway corridors were originally divided into 56 sections used by NSTIR. The results of the traffic forecasts and modelling are expressed in Compound Annual Growth rates (CAGRs) for each of the 56 highway sections for auto and truck AADT volumes and VKT. The range of CAGR for each corridor is shown in **Table 2.3**. For comparison, the AADT growth rate for the existing Cobequid Pass toll highway (which was calculated using historical traffic data) is also included.

Table 2.3 – Corridor Compound Annual Growth Rates (ranges defined by the individual sections)

Input / Assumption	C1 101	C2 101	C3 103	C4 104	C5 104	C6 104	C7 104	C8 107	Cobequid Pass 104
# of Sections	4	6	10	6	4	2	12	10	4
Auto CAGR – Lowest volume section	0.02%	0.09%	0.38%	-0.11%	-0.51%	-0.60%	-0.89%	0.29%	0.11%
Auto CAGR – Highest volume section	0.16%	0.43%	0.83%	0.35%	0.16%	-0.11%	0.21%	0.52%	1.47%
Corridor Growth (Auto VKT)	0.11%	0.30%	0.62%	0.05%	-0.12%	-0.28%	-0.24%	0.38%	1.44%
Corridor Growth (Truck VKT)**	1.08%		1.34%	1.13%	1.58%	1.99%	0.93%	1.52%	n/a

2.3 Toll Traffic Forecast

While the above section **2.2** identified the projected base traffic growth without tolling, this section documents the assumptions made regarding the key elements of toll traffic forecasts:

- **Initial Traffic Diversion**: *How much traffic will remain on the new highways when tolling begins?*
- **Alternative Routes**: *How do the new highways compare/compete with existing parallel trunk highways?*
- **Willingness to Pay**: *What is an acceptable amount of toll for the average highway user?*
- **Toll Elasticity**: *What happens to traffic volumes when the toll rate rises over time due to inflation?*

2.3.1 Origin-Destination Patterns

Information on origin-destination (OD) patterns for each corridor was obtained from Streetlight Data, a "Big Data" analytics provider that offers historic and current real-world travel data via GPS-integrated devices. Trip patterns were captured in both directions, for a full year of all-day and all-week (Sunday to Saturday) data segregated by personal and commercial vehicles. The Streetlight Data outputs are trip ratios between OD pairs (e.g. interchange to interchange), which were translated to trip OD matrices and link volumes using observed 2015 AADT. The OD matrices were then adjusted and validated against additional ramp counts that were conducted in April 2016. The validated OD matrices and link volumes were then used to develop traffic forecasts for each corridor.

The purpose of using origin-destination data was to refine the toll forecast methodology developed in the PSA phase, which was originally based on applying a corridor-wide toll diversion rate on the corridor link traffic volumes and VKT. The trip OD matrices allow unique diversion rates to be applied to each OD pair based on comparing the benefits (or disbenefits) of using a toll facility compared with the non-toll alternative.

2.3.2 Willingness to Pay Surveys

The CBCL team conducted two willingness to pay (WTP) studies of the general population of drivers in Nova Scotia (those with driver's licenses) and of the transportation firms who ship goods in Nova Scotia to estimate their WTP for toll and value of time (VOT), respectively. The WTP studies encompassed the eight corridors targeted in this project. The estimates for WTP for toll and VOT for the general population and transportation firms in Nova Scotia directly feed into the toll traffic forecasts.

The CBCL team designed, conducted, and obtained the WTP survey data from a telephone survey. The survey randomly contacted households in all census divisions in Nova Scotia with the goal of having 1,000 eligible adults complete the survey. The total surveys were distributed over the corridors such that approximately 100 survey completions were targeted for each of the corridors 1, 2, 4, 5, 6, 7 and 200 survey completions were targeted each for corridors 3 and 8. Provided the responding person had a driver's license, was over the age of 18 and had used at least one of the corridors of interest within his/her community, he or she was invited to complete the survey. Upon the close of the survey, 1,027 respondents who qualified to do the survey completed it. Details of the survey methodology for the general population can be found in Appendix A, section 2.

The project team similarly designed and implemented a telephone survey across Nova Scotia to measure the WTP for toll and the VOT for transportation firms. Details on the sample survey methodology for this survey can be found in Appendix A, section 3. Contact information on these businesses was obtained using InfoCanada's business database for companies which fall under the following categories of specialized freight trucking, general freight trucking, freight transportation arrangement and courier and express delivery. Companies which belong to the latter category were included in the study since timeliness of shipments is an important factor in the success of their business operations. Examples of companies which fall under freight transportation arrangement category are freight forwarders or customs brokers.

Initially, the project team contacted 341 companies which matched the selection criteria mentioned above and invited them to participate in the study. A person knowledgeable about typical shipments and who can make routing decisions based on transit times or shipment costs completed the survey. Of the 341 companies contacted, 66 eligible firms completed the survey.

The statistical analyses of the results from the survey for the general population showed that the median WTP for toll was 6 cents/km which translates to the VOT estimate of $12/hour. The project team conducted a literature review and found that the survey estimate of $12/hour is within range of what would be expected using the U.S. Department of Transportation's (USDOT) 2014 Guidance on Valuation of Travel Time in Economic Analysis[2]. The methodology and results from the WTP for toll study can found in Appendix B of this report.

[2] https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic, accessed May 1, 2016.

The statistical analysis of the survey results from transportation firms in Nova Scotia show that the median WTP for toll was 10 cents/km which translated to the VOT estimate of $17/hour. The USDOT's 2014 Guidance on Valuation of Travel Time in Economic Analysis does not provide guidance on estimating VOT for freight transportation as it is highly complex. Based on the VOT estimate of $17/hour, at the very least, this estimate captures the savings for drivers' costs since the average hourly wage for truck drivers in Canada is about $21/hour[3] . A review of the trucker salaries in Nova Scotia posted on the Government of Canada's Job Bank shows salaries in the range of $13 to $19 per hour[4]. The methodology and results from the WTP for toll study for transportation firms can found in Appendix C of this report.

The survey components for both WTP studies also included questions which probed the interest levels in different toll payment methods. Within the general population survey, about 49 percent of respondents prefer to open an electronic toll collection account with a transponder. The next most popular payment option is to stop and pay cash at the toll booth at 37 percent. About 5 percent of people claimed that they are against paying tolls. Transportation firms prefer to pay electronically at 71 percent. Currently, 74 percent of firms have an existing toll collection account that uses a transponder (likely for the Cobequid Pass or the bridge tolls). The full tabulation and analysis of the survey questions from both the general population and transportation firm questionnaires are in Appendices D and E, respectively.

2.3.3 Forecast Assumptions based on Twinning and Tolling

The following global forecast assumptions were made for all corridors assuming each were twinned (with the exception of Corridors 6 and 7 which were assumed to be new 2-lane controlled access highways) and tolled and these are further described in the sections below.

Two scenarios of starting toll rates in year 2020 were assessed based on two sources:

- A 10 cents per km toll rate was used based on toll optimization analyses using the HRM transportation model (it was also close to the existing 2015 toll rate for Cobequid Pass (which was approximately 9 cents per km) – please see section **2.4**; and
- A 6 cents per km toll rate was used based on willingness to pay survey results.

Key assumptions on toll diversion and elasticity were based on sensitivity modelling using the HRM transportation model:

- All corridors were twinned except C6 and C7 where forecasts were based on a 2-lane controlled access highway;
- Forecasts are based on stand-alone facilities in each corridor with no bundling of the corridors;
- Assumed opening year of tolling in 2020 for all 8 corridors;
- Two scenarios of starting toll of $0.06 / km and $0.10 / km in 2020, with 1-2% annual increase in tolls. Toll rates are same all day and every day, which is the same approach that Cobequid Pass operates today;
- Toll traffic diversion and toll elasticity for each corridor were based on sensitivity tests using HRM Model for Highway 107 and results were rationalized for application to other corridors;
  - 16% initial toll diversion for all corridors except Corridor 7, and Corridor 8 (16% diversion means 16% of traffic diverted away from subject highway, while 84% of existing volume will remain on subject highway after tolling);
  - Elasticity: for every 10% increase in toll, traffic will decrease by 2.7%;
- Diversion for Corridors 1-7 determined through cost functions which considers the availability of alternate routes, travel time ratios between alternate routes, and toll cost;
- Conservative 3-years of ramp-up period (85%, 90%, 95% for the first 3 years) to reflect early reluctance to tolls;
- 22% of autos and 85% of trucks in each corridor will pay using ETC (electronic toll collection such as MacPass), while the rest will pay cash tolls. Split based on existing Cobequid Pass payments;
- ETC discount provided for each corridor based on existing Cobequid Pass toll rate structure; and
- $12 / hour value of time in 2020 and remains constant over time – based on WTP Survey results.

[3] The average annual trucker salary in Canada in 2010 dollars is $40,700. Assuming a 40 hour work week or 2,080 hours per year, the average salary on an hourly basis is $19.57/hour. (In 2016 dollars, $21.33/hour). http://www.servicecanada.gc.ca/eng/qc/job_futures/statistics/7411.shtml, accessed on June 4, 2016.

[4] http://www.jobbank.gc.ca/job_search_results.do?page=1&d=50&fprov=12&sort=M&action=s0&lang=en&fn=7411&sid=20, accessed on June 6, 2016

The corridor-specific assumptions are summarized in **Table 2.4**.

Table 2.4 – Summary of Toll Traffic and Revenue Forecast Assumptions

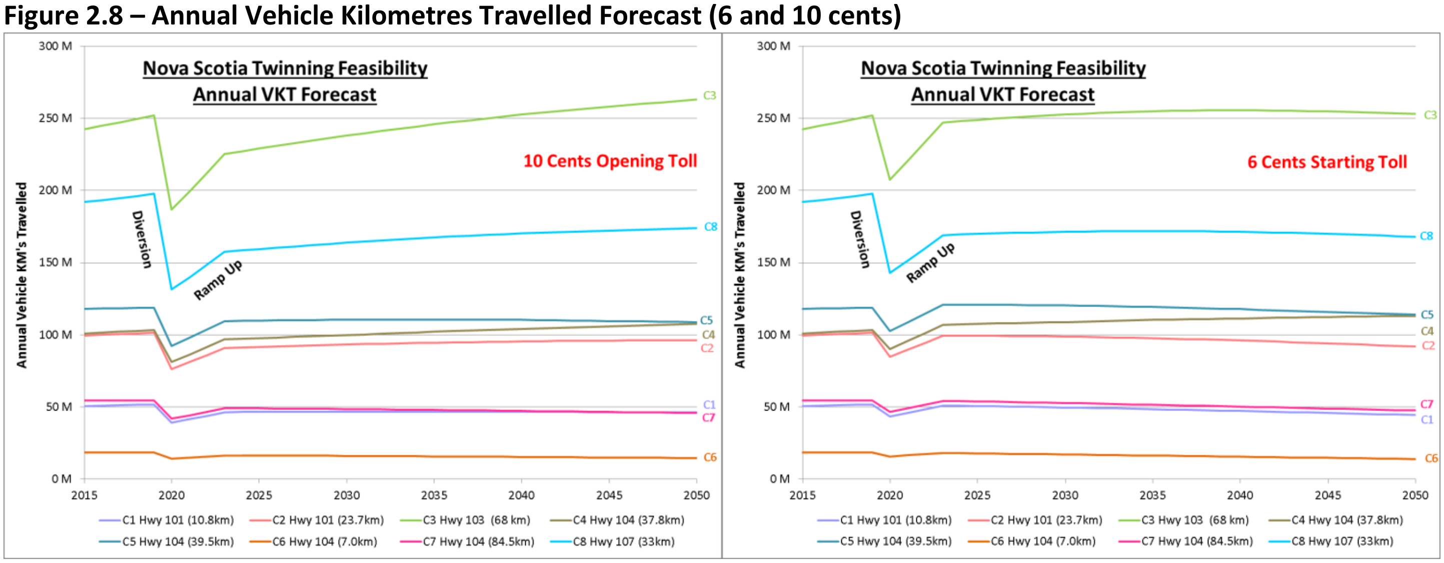
Input / Assumption	C1 101	C2 101	C3 103	C4 104	C5 104	C6 104	C7 104	C8 107
Initial Toll Diversion ($0.10)	20-24%	20-34%	26-42%	48-50%	62%	25%	82%[3]	5-20%
Initial Toll Diversion ($0.06)	10-14%	10-24%	16-32%	38-40%	52%	15%	72%	5-16%
Toll Elasticity (10c)	-2.10% decrease in traffic for every +10% increase in toll							-2.7% & -0.5%
Toll Elasticity (6c)	-2.36% decrease in traffic for every +10% increase in toll							-2.7% & -0.5%
Toll Growth	2%	2%	2%	1%	1%	2%	1%	2%
Truck Split (2-8 Axles)	17%	6%	7%	16%	16%	5%	5%	7%
Weighted Truck-to-Auto Toll Rates[2]	2.8	2.9	3.1	3.1	2.9	3.1	3.1	3.1

1. Based on Cobequid revenue reports 2000-2014, adjusted to 2015$,
2. Truck Class Rates based on Cobequid Pass Toll Rates for Vehicle Classes 6-12
3. Diversion means the amount of traffic diverted away from the improved highway. In the case of Corridor 7, the cost of using the improved highway (value of travel time plus toll) will be a higher cost than using the existing trunk road. Hence majority of highway traffic is not expected to use the improved corridor and will remain on existing Highway 4.

2.3.4 Vehicle Kilometres Travelled

For toll highway projects, traffic forecasts are often expressed as vehicle kilometres travelled (VKT) which is the product of traffic volumes and corridor length. **Figure 2.8** illustrates the forecast VKT for each highway corridor. The VKT from 2015 to 2019 are based on non-tolled growth assumptions, and the VKT drop in 2020 is based on the initial diversion rates as shown in **Table 2.4** (ranging from 5-62%). Corridor 3 has the highest existing and future VKT; while Corridor 6 will have the lowest, which is directly proportional to the length of the corridors. However, the longest Corridor 7 has moderately low VKT values because of the low future volume projections, the proposed two-lane facility (as opposed to a 4-lane highway), and that traffic diversion will only come from trunk Highway 4, with little to no diversion from Highway 105. For sections with lower traffic growth rates such as Corridor 4, 5 and 7, a lower toll rate growth was assumed so that traffic growth was not dampened due to the toll elasticity.

Figure 2.8 – Annual Vehicle Kilometres Travelled Forecast (6 and 10 cents)



2.4 Revenue Forecasts

To calculate toll revenue for each corridor, the VKT were multiplied by the associated toll rates for each horizon year. **Figure 2.9** illustrates the annual toll revenue (in constant 2015$) for key horizon years (in 5-year increments) for each corridor based on the 10 cent / km toll. The revenue forecasts for Cobequid Pass, based on a linear projection of historic data, were reviewed for comparison. Corridor 3 would see the highest revenue, while Corridor 6 would have the lowest overall. Toll revenue growth in Corridors 3 and 8 are more rapid than Cobequid Pass due to differences in length, toll growth, traffic growth rates, and base toll parameters. A sensitivity analysis shows that when these five parameters are modified to match the Cobequid Pass, the modelled revenue growth would be similar to the revenue trend of the Pass.

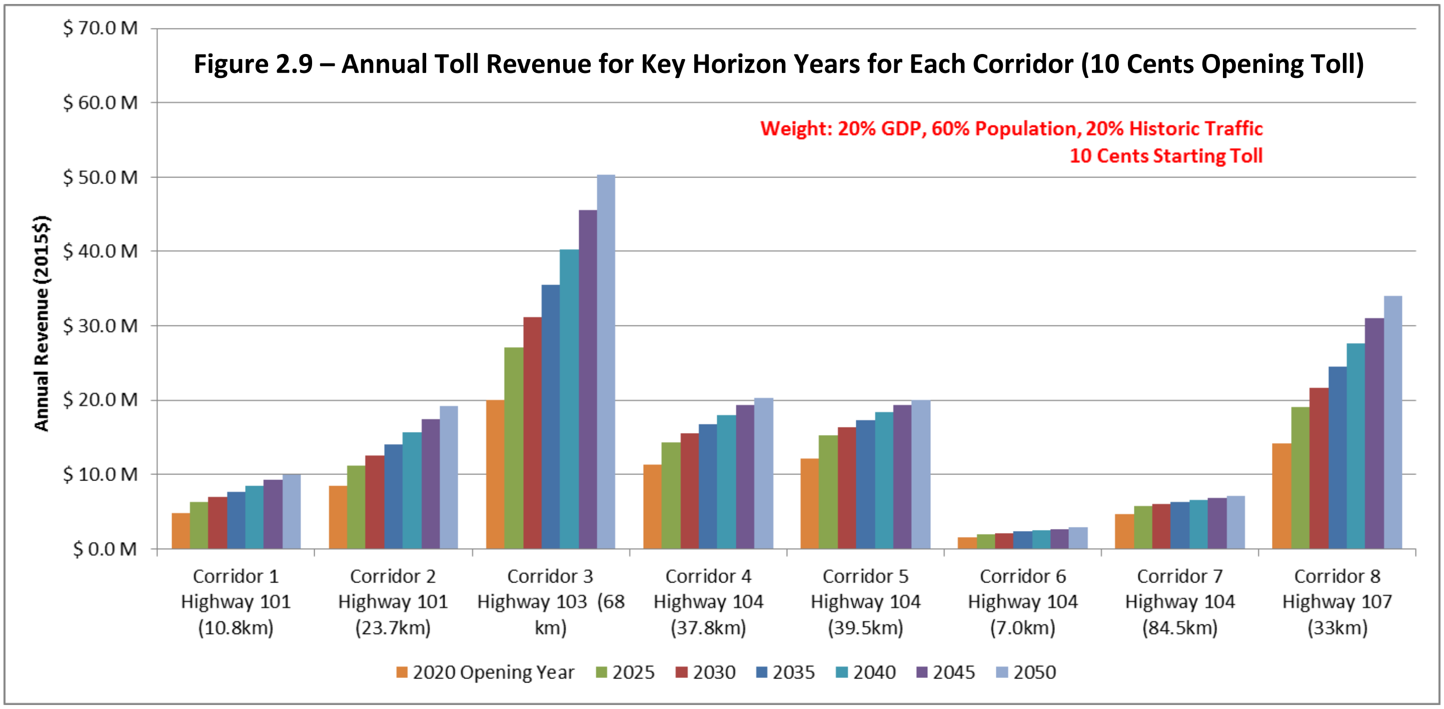


Figure 2.9 – Annual Toll Revenue for Key Horizon Years for Each Corridor (10 Cents Opening Toll)

For the lower starting toll of 6 cents per km in 2020, **Figure 2.10** illustrates the annual revenue for each corridor (in constant 2015$) for key horizon years (in 5-year increments).

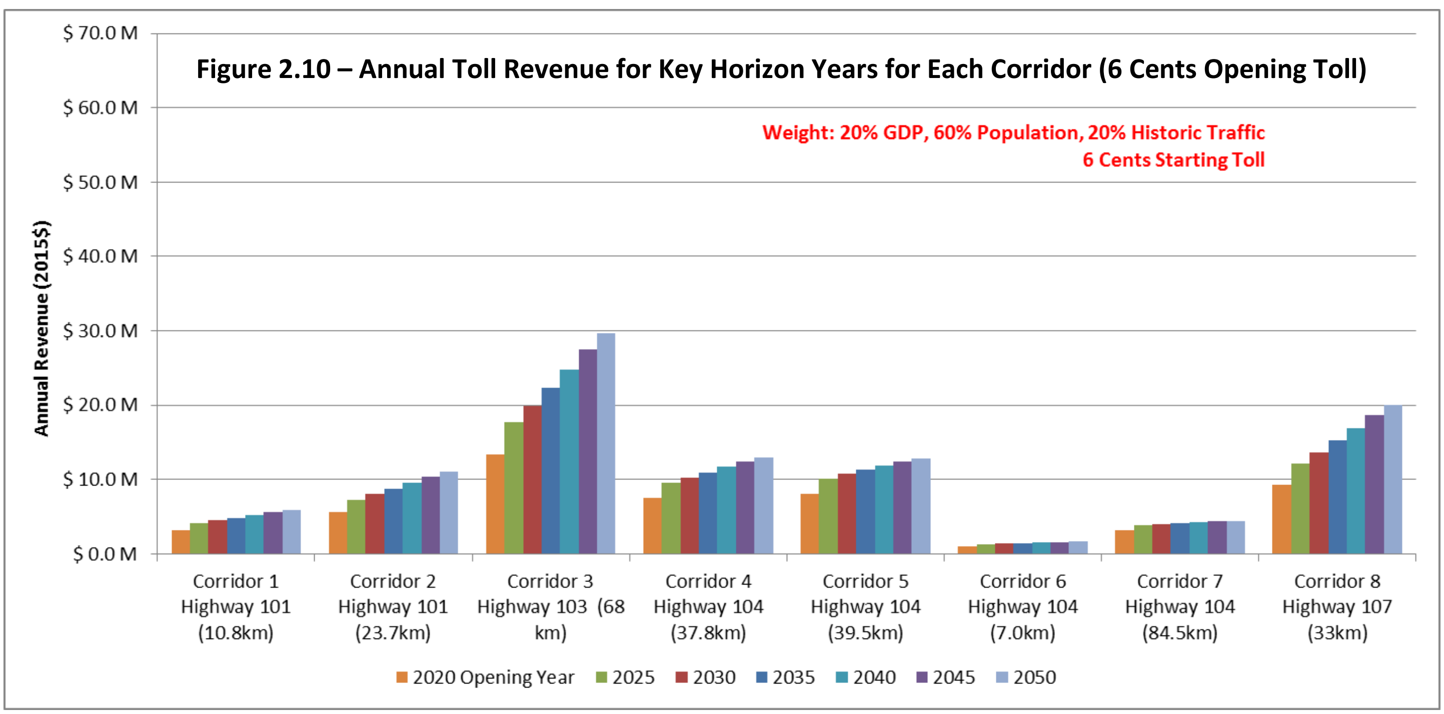


Figure 2.10 – Annual Toll Revenue for Key Horizon Years for Each Corridor (6 Cents Opening Toll)

Note the use of VKT for calculating toll revenues can over or under estimate revenues if a point tolling system is adopted instead of an all-electronic tolling system that relies on distance-based tolls. The annual toll revenue forecasts also assume no leakage, that is, all tolls are collected without any losses from toll evasion, toll system equipment and detection failures, out-of-country vehicles, and non-revenue vehicles (such as from emergency services).

2.5 Analysis Tools

2.5.1 Halifax Regional Municipality Model

As discussed previously, key assumptions on toll diversion, elasticity and optimization were based on the HRM Model. HDR received the latest PTV VISUM transportation model from HRM, and this model was used to test toll scenarios for the Highway 107 corridor, to provide an assessment of the impact of tolling the corridor, and to determine toll traffic diversion rates and toll elasticities for this corridor and potential application to other corridors. The model is a peak hour model that only forecasts passenger vehicle modes as trucks were not part of the HRM model. HDR reviewed the model travel demand and networks for 2031 as coded and, assisted by discussions with HRM staff, applied modifications so as to represent future conditions with the proposed 107 corridor in place. As shown in **Figure 2.11**, the facility (including the Lake Loon to Preston bypass and connection to Bedford), was coded as a 4 –lane highway with a capacity of 3,200 vehicles per hour. This was divided into three sections for analysis (west, mid and east corridor).

Figure 2.11 – Proposed Highway 107 Corridor

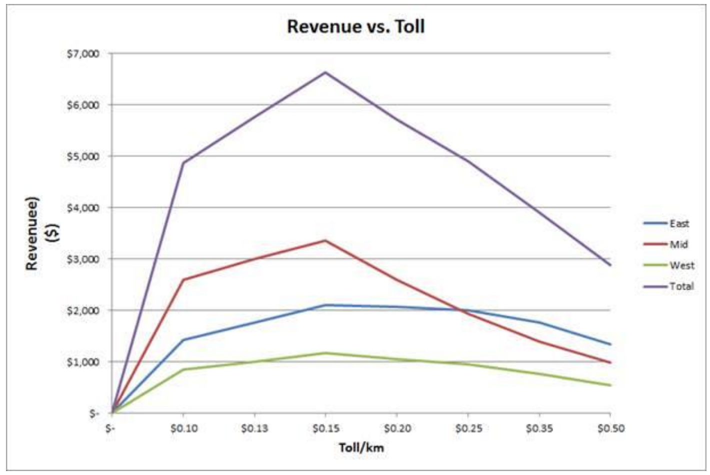
2.5.2 Toll Modelling – PSA Phase

Tolls were implemented in the model as a link attribute and applied as a function of length. During the PSA phase, seven 2031 PM peak hour toll scenarios were run, along with a no-toll scenario, using per-km toll rates varying from 10 cents to 50 cents. The same toll was applied on each component of the new corridor. A value of time of $20 per hour, the same as in the existing HRM model, was used. **Table 2.5** below summarizes the vehicle hours travelled (VHT), vehicle kilometres travelled (VKT) and the revenues. Based on a comparison of toll scenarios, an optimal toll of 15 cents per km was identified for 2031, as shown in **Figure 2.12**. Considering that all corridors could start tolling in 2020, a starting toll rate of 10 cents per km was appropriate.

Table 2.5 - Toll Scenarios

Alternative	Toll rates ($/km)	VHT (Veh-Hr)	VKT (Veh-km)	Revenue ($)
No tolling	0	**666**	**56,283**	**0**
1	0.1	**573**	**48,624**	**4,862**
2	0.125	**544**	**46,040**	**5,755**
3	0.15	**523**	**44,132**	**6,620**
4	0.2	**456**	**38,065**	**5,710**
5	0.25	**395**	**32,582**	**4,887**
6	0.35	**318**	**26,018**	**3,903**
7	0.5	**234**	**19,154**	**2,873**

Figure 2.12 - Toll Optimization for 2031



The elasticity of demand with regard to price was compared for each toll increment, noting that elasticities are highest on the west portion of the corridor towards Bedford, where there are several competing routes, and lowest on the east portion between Porters Lake and Dartmouth, where there are no alternative highways and only one parallel road. Based on the 2031 sensitivity results documented in **Table 2.6**, an average overall -0.21 elasticity value was adopted for all 8 highway corridors for the purposes of estimating traffic diversion based on incremental toll rate increases. At 2% toll growth per year, the traffic would decrease by 0.42% per year. Or at 1% toll growth per year, the traffic would increase by 0.21%. Although the sensitivity results show that the elasticity was higher at the optimal toll rate of 15 cents/km, the starting toll at 10 cents/km in 2020 does not reach 15 cents/km by 2031 based on the 2% toll growth assumed – it would be closer to 13 cents/km. Based on the fact that other corridors have less competing road alternatives compared to that of the 107 corridor, the average overall elasticity of -0.21 was appropriate for the PSA.

Table 2.6 – Modelled Toll Elasticity for Highway 107 in 2031

Alternative	Toll rates ($/km)		Elasticity (in terms of)							
			VHT (Vehicle Hours of Travel)				VKT (Vehicle Kilometres of Travel)			
	All corridors		East Corridor	Mid Corridor	West Corridor	Overall Corridor	East Corridor	Mid Corridor	West Corridor	Overall Corridor
1	0.10	Alt 1 vs 2	-0.048	-0.297	-0.200	**-0.202**	-0.048	-0.308	-0.199	**-0.213**
2	0.125	Alt 2 vs 3	-0.038	-0.312	-0.163	**-0.196**	-0.038	-0.322	-0.163	**-0.207**
3	0.15	Alt 3 vs 4	-0.048	-0.652	-0.282	**-0.381**	-0.048	-0.686	-0.281	**-0.412**
4	0.20	Alt 4 vs 5	-0.137	-0.950	-0.379	**-0.533**	-0.137	-1.007	-0.378	**-0.576**
5	0.25	Alt 5 vs 6	-0.303	-0.684	-0.524	**-0.492**	-0.303	-0.700	-0.524	**-0.504**
6	0.35	Alt 6 vs 7	-0.548	-0.695	-0.646	**-0.618**	-0.548	-0.684	-0.646	**-0.616**
7	0.50									

Based on Value of Time = $20/hour. Elasticity is the ratio of the change in VKT or VHT to the change in toll rates between alternatives

Demand and Diversion Estimation

The HRM model only had a 2031 forecast scenario but a 2020 scenario at the starting toll rate of 10 cents / km, as well as the no-toll option, were developed to forecast volumes for the opening day condition and to generate forecasts at 5 year increments to 2045 for each section of the corridor, as well as for the corridor as a whole. The results of this analysis are shown in **Table 2.7**.

Table 2.7 – Traffic Forecast With and Without Tolls

Alternative	Toll rates ($/km)			VKT (Veh-km)					Diversion		
	East	Mid	West	Network-wide	East	Mid	West	Corridor	East	Mid	West
					Corridor				Corridor		
2020 - No tolling	0	0	0	**809,877**	11,874	28,080	9,729	**49,683**			
2031 - No tolling	0	0	0	**866,310**	14,828	31,269	10,489	**56,586**			
2035 - No tolling	0	0	0	**872,222**	15,477	31,811	10,501	**57,789**			
2045 - No tolling	0	0	0	**886,627**	16,492	33,004	10,586	**60,082**			
2020 - Alt 1	0.10	0.10	0.10	**805,463**	11,302	22,811	7,618	**41,732**	5%	19%	22%
2031 - Alt 1	0.10	0.10	0.10	**861,498**	14,271	25,910	8,444	**48,624**	4%	17%	20%
2020 - Alt 3	0.15	0.15	0.15	**804,039**	11,041	19,786	6,759	**37,586**	7%	30%	31%
2031 - Alt 3	0.15	0.15	0.15	**859,715**	13,993	22,376	7,762	**44,132**	6%	28%	26%
2035- Alt 3	0.15	0.15	0.15	**865,703**	14,732	22,948	7,809	**45,488**	5%	28%	26%
2045 - Alt 3	0.15	0.15	0.15	**880,913**	16,066	24,239	7,941	**48,245**	3%	27%	25%

Based on the 10 cents / km assumption in 2020 and 2031 (Alt 1), it was estimated that the starting toll would cause approximately 20-22% of the corridor volume to divert away from Highway 107 and the remaining volume would continue to use Highway 107. For the east end of Highway 107 due to limited alternatives, only 5% would divert away from 107 at the same toll rates.

Based on the above result, an initial diversion of 20% was thus applied to other corridors during the PSA phase, except where it was deemed to be higher due to the competing trunk highway. For Corridor 7, since only a 2-lane facility was analyzed instead of a 4-lane facility a higher diversion of 30% away from the new facility was assumed as part of the PSA forecast.

2.5.3 Toll Modelling – DFS Phase

Based on the results from the WTP survey that was conducted during the DFS phase, the median Willingness-to-Pay was a lower toll rate of 6 cents/km and the Value of Time was $12-$17/hour. This required a revision to the HRM model in order to identify the highway traffic diversion ratio as well as the toll elasticity for corridor 8 / Highway 107, and in turn provide insights to other corridors. **Table 2.8** provides the results of this revision.

Table 2.8 – Traffic Forecast of No-Toll, 6 Cents, and 10 Cents Toll (2031)

Alternative	VKT (Veh-km)					Diversion			
	Network-wide	East Corridor	Mid Corridor	West Corridor	Corridor Overall	East Corridor	Mid Corridor	West Corridor	Corridor Overall
No tolling	**866,310**	14,828	31,269	10,489	**56,586**	-	-	-	**-**
6c/km	**862,423**	14,256	24,971	8,249	**47,476**	4%	20%	21%	**16%**
10c/km	**861,136**	14,021	20,123	7,244	**41,388**	5%	36%	31%	**27%**

The traffic forecast results under the $12/hour VOT assumption are comparable to those under the $20/hour VOT assumption, with some minor variations. Under a lower value of time, a higher degree of diversion is expected (since there is a lower willingness to pay for tolls), which is evident in these results. Comparing the $0.10/km results (i.e. Alternative 1), it can be seen that under the lower $12/hr VOT:

- Diversion increases slightly on the east portion of corridor (from 4% to 5%);
- Diversion increases significantly on the middle portion (from 17% to 36%); and
- Diversion increases moderately on the western portion (from 20% to 31%).

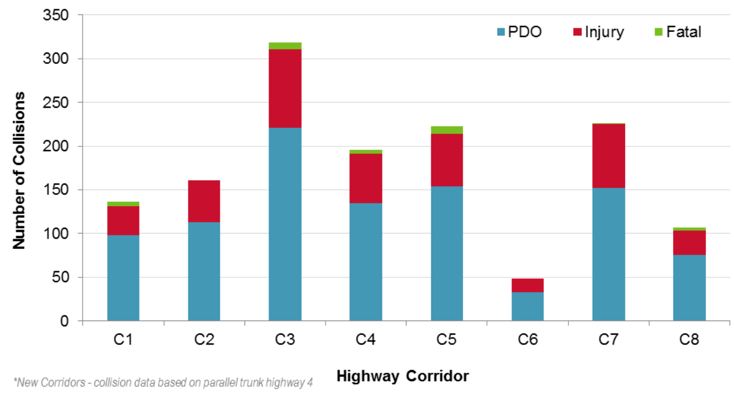
These patterns align with the calculated elasticities from the PSA phase (shown in Table 2.8) where the middle portion of the corridor has the highest elasticity (and thus is significantly impacted by tolling) and the east portion has the lowest elasticity (and thus experiences minimal impact from tolling), with the west portion falling in the middle of the elasticity range.

Under the 6 cents/km toll rate and $12/hour VOT assumption used in the DFS phase, the traffic forecast results are quite comparable to the 10 cents/km toll rate and $20/hour VOT assumption used in the PSA phase, since both these scenarios apply a similar generalized cost value on the corridor to simulate tolling.

2.6 Collision Analysis

Historical collision data for the existing 8 highway corridors and Trunk Highway 4 for new construction corridors (Corridor 6 and 7) was used to assess the relative safety performance of the 8 study corridors and the potential benefits of the proposed twinning and new construction on collision reductions. Collision data was provided by NSTIR for 5 years spanning from 2010 to 2014 for all existing highways and from 2009 to 2013 for Trunk Highway 4. There were two sections for Corridor 8 (Highway 107) that had no existing collision data. The total number of collisions by severity for the 8 study corridors are illustrated in **Figure 2.13.** Corridor 3 (Highway 103) had the highest number of collisions with 319 collisions over the 5 most recent years followed by two sections of Highway 104: Corridor 7 (226) and Corridor 5 (223).

Figure 2.13 – Total Number of Collisions for Study



Collision reductions and safety performance benefits for each study corridor from the increased capacity and twinning are expected. For each corridor, the collision types were reviewed to determine the percentage of collisions that could be reduced from twinning. On average, approximately 30-35% of collisions could be reduced within each corridor based on elimination of intersection-related, angle, and head-on collisions and some reduction in single vehicle, rear-end, and sideswipe collisions. The reduced collisions per year by impact type and the results are shown in **Table 2.9.**

Table 2.9 – Estimated Collision Reductions by Corridor

Corridor ID	Existing Average Collisions per year (2010-2014)	Estimated Number of Reduced Collisions per year (2020 opening year)
C1 – 101	27.2	9.2
C2 – 101	32.2	11.2
C3 – 103	68.8	21.6
C4 – 104	39.2	11.6
C5 – 104	44.6	14.6
C6 – 104	9.6	4.2
C7 – 104	45.2	16.4
C8 – 107	27.0	7.6

2.7 Travel Time, Travel Distance and Economic Benefits

In addition to collision reduction benefits, the proposed twinning will also offer travel distance and travel time cost savings resulting from higher posted and operating speeds (given no capacity constraints) and shorter lengths. To estimate the potential economic benefits due to travel cost savings, the length and travel times of the proposed twinned highway were compared to the existing subject corridors and to other competing roads. The differences were then converted into monetary terms using average vehicle operating costs ($0.51 / km from CAA) and the average value of time used in this study ($20/hour). **Table 2.10** below summarizes the auto travel time / distance differences and the resulting annual cost savings.

Table 2.10 – Travel Time, Distance and Cost Savings

				Existing Travel Times (Average Over a Year based on Google)		Esimated Travel Times for Proposed Facility (Free-flow)		Savings for Full Length Trip		Annual Cost Savings for an Auto Driver		
Corridor ID	Route	Distance (km)	Posted Speed	Travel Time 4pm Peak (mins)	Average Travel Speed (km/hr)	Assumed Operating Speed (10 km/h over posted)	Estimated Travel Time (mins)	Travel Distance Savings (km)	Travel Time Savings (mins)	Travel Distance Savings ($)	Travel Time Savings ($)	Total Savings ($)
										$0.51	$20.00	
C1	Proposed Twinned Highway 101 - Three Mile Plains to Falmouth	9.5	110			120	4					
	Existing Highway 101	9.5	100	6	95			0	2	$0	$270	$270
	Trunk Highway 1	10.0	50	14	50			1	8	$130	$1,270	$1,400
C2	Proposed Twinned Highway 101 - Hortonville to Coldbrook	24.8	110			120	11					
	Existing Highway 101	24.6	100	16	105			0	3	-$50	$430	$380
	Trunk Highway 1	24.6	50	40	46			0	21	-$50	$3,430	$3,380
C3	Proposed Twinned Highway 103 - Tantallon to Bridgewater	68.1	110			120	31					
	Existing Highway 103	68.4	100	42	103			0	9	$90	$1,430	$1,520
	Trunk Highway 3/325, Highway 213	84.6	70	90	65			17	47	$4,220	$7,770	$11,990
C4	Proposed Twinned Highway 104 - Sutherland's River to Antigonish	39.5	110			120	18					
	Existing Highway 104	37.8	100	22.0	108			-2	3	-$430	$480	$50
	Trunk Highway 4 + 4/104 Common Section	42	80-100	40	68			3	19	$690	$3,150	$3,840
C5	Highway 104 - Taylor's Road to Auld's Cove	40.0	110			120	18					
	Existing Highway 104	40.0	100	24	104			0	5	$0	$760	$760
	Trunk Highway 4/Sunrise Trail	35.2	80	35	73			-5	11	-$1,220	$1,760	$540
C6	Highway 104 - Port Hastings to Port Hawkesbury	7.0	100			110	4					
	Trunk Highway 4	7.7	80	9	66			1	4	$180	$580	$760
C7	Highway 104 - St. Peter's to Sydney	84.5	100			110	42					
	Trunk Highway 4	88.4	80	70	83			4	22	$990	$3,630	$4,620
C8	Highway 107 - Porter's Lake to Duke Street, Bedford	33.3	110			120	15					
	Trunk Highway 7 / 107 / 7 / 33	39.0	50-70	44	65			6	21	$1,460	$3,440	$4,900
	Trunk Highway 7 / 111 / 7 / 33	37.9	50-90	48	65			5	20	$1,180	$3,270	$4,450

Proposed twinning on Corridor 3 (Highway 103) produces the highest travel cost savings due to the limited alternatives available in this area of the province which comprise Highway 3 and 325. In some cases, the proposed twinned highway is not necessarily shorter in length compared to the existing facility or the alternative; however, in all cases, there should be travel time savings from the higher operating speeds as any delays due to congestion on a 2-lane have been eliminated. There will also be truck travel cost savings based on similar calculations. However, the relative comparison of the cost savings by corridor will remain the same as the autos.

2.8 Toll Collection Systems

All of the toll traffic forecasts presented thus far have been based on the assumption that NSTIR will operate a "closed" all-electronic tolling system with distance-based tolls for all corridors. This chapter provides a summary of the available tolling systems and toll design options, along with a recommendation for this study.

2.8.1 Overview

Toll collection system technology has changed dramatically over the past 15 years and is continuing to change. Simply erecting a toll booth, placing a toll collector in it and collecting cash has given way to Open Road Tolling (ORT) and All Electronic Tolling (AET). Decisions on which toll collection system to deploy are far more complicated. Factors such as regional economics, vehicle type usage, space availability, roadway configurations, capital construction costs, annual O&M expenses and interoperability all contribute to the decision process.

2.8.2 Toll System Technologies

There are three basic types of toll system technologies in use today: manual, electronic toll collection with cash paying option and all electronic tolling (AET). Each of these technologies are discussed below and are summarized in the below table. The two existing toll facilities in Nova Scotia (Cobequid Pass and the Halifax Harbour Bridge) both have a toll collection system (MacPass) that utilizes an electronic toll collection method via a transponder but also accepts cash.)

Table 2.11 – Comparison of Toll Systems

Toll Systems	Manual Toll Collection	Electronic Toll Collection (ETC) with a Cash Option	All Electronic Tolling (AET)
Examples		 	 
Revenue Collection (see Note 1 below)	No revenue loss – 100% of toll revenue is collected – customer is required to have cash on hand to pay the toll.	Minimal revenue loss – almost 100% of toll revenue is collected – cash customer is required to have cash on hand to pay the toll.	Potential revenue loss due to non-payment, non-identification and/or inadequate enforcement.
Collection Point of Tolls	Patron pays at tolling point – potential safety concerns from customers stopping or weaving to find the right lane – delays to customers due to backups at the tolling points.	ETC customers can pay the toll without stopping at the tolling point – cash customers may encounter safety concerns or delays.	Customers can pay the toll without stopping at the tolling point – increases safety and convenience.
Toll Rates and Adjustments	Rates need to accommodate ease of collection and extensive public notification is required for any rate adjustments.	As there are cash lanes included in this option rates need to accommodate ease of collection and extensive public notification is required for any rate adjustments.	Public notification of a rate adjustment would probably still be required but not as onerous - as cash is not a concern rates can be flexible and adjustments can be indexed to CPI – annual adjustments can be authorized several years in advance – rates can also be adjusted by time of day or by level of congestion.
Vehicle Throughput Per Lane	Vehicle throughput is limited to 400-600 vehicles per hour depending on toll rate, vehicle type and the toll collector or machine.	Higher vehicle throughout – up to 1,200 vehicles per hour if manual and ETC are in the same lane or 2,200 vehicles per hour in a bypass lane.	Vehicle throughput up to 2,200 vehicles per hour – increases traffic flow by customers not being required to stop and pay toll.
Environment	Negative environmental impacts due to increased noise levels and auto emissions.	Improved environmental impacts due to a reduction in noise levels and auto emissions in the ETC lanes.	Greater improvement in environmental impacts due to a reduction in noise levels and auto emissions in all lanes.
Fuel Savings	No fuel savings.	Fuel savings realized only in the ETC lanes from customers not stopping and starting or idling while waiting to pay the toll.	Maximum fuel savings as all lanes are ETC lanes and customers are not stopping and starting or idling while waiting to pay the toll.
Operating and Maintenance Expenses	Higher operating and maintenance expenses - payroll costs associated with the toll collector staff, heating and air conditioning, etc.	Slightly lower operating and maintenance expenses - there will still be some payroll costs associated with the toll collector staff in the cash lanes, heating and air conditioning, etc.	Lower operating and maintenance expenses – no payroll costs, no heating/air conditioning, etc.

Toll Systems	Manual Toll Collection	Electronic Toll Collection (ETC) with a Cash Option	All Electronic Tolling (AET)
Capital Construction Costs (see Note 2 below)	Capital construction costs are higher than an AET facility but less than an ETC with a Cash Option Facility.	Capital construction costs are the highest of the three modes of collection.	Capital construction costs are the lowest of the three modes of collection.
Land Concerns	More land is needed due to the inclusion of toll booths and a toll plaza amount of land would be determined by the traffic numbers and number of toll booths required – right of way may not exist for needed land.	Some land is needed to accommodate the cash paying option but is minimized by the inclusion of the ETC facility.	Depending on the location selected little or no additional land is required as no toll booths or toll plazas are required and the gantry can span the travel lanes.

Note 1: Collection of revenues can also be affected by the placement of the tolling points.
Note 2: The construction cost differential between a two lane AET structure on the mainline and a two lane AET structure on a ramp would be insignificant.

Manual Toll Collection: Once the primary toll technology in use, manual toll collection has significantly declined over the past 15 years. With a manual toll collection facility, a driver would stop at the tolling location and pay the toll. Payment is usually with cash although a few agencies do accept credit cards in the lanes. Manual toll collection could be either with a toll collector in the toll booth or an automatic coin machine. Typically this mode of toll collection can process between 400 and 600 vehicles per hour depending on the toll rate, type of vehicle and the collector or machine.

Major advantage of manual toll collection:

- There is no leakage and 100% of revenues are collected.

Major disadvantages of manual toll collection:

- Increased capital construction costs;
- Increased annual operating and maintenance expenses;
- Vehicles have to stop to pay the toll thereby impacting traffic flow and creating congestion;
- Delays to the patron in their travels;
- Additional fuel consumption; and
- Adverse effect on the environment due to vehicle emissions.

Electronic Toll Collection with Cash Paying Option: This method of toll collection combines the manual process described above with an electronic toll collection process. This can be accomplished by accepting both methods in the same lane or by constructing bypass lanes that would include a gantry to house the electronic toll collection equipment. For lanes that accept both cash and electronic toll collection up to 1,200 vehicles per hour can be processed. If the facility consists of a bypass for electronic toll collection then the cash lanes can process between 400 – 600 vehicles per hour as explained above while the bypass lanes can process up to 2,200 vehicles per hour at highway speeds. If a vehicle passes through the bypass lanes without an electronic transponder it will be treated as a violator and subject to the violation process of the toll agency.

Major advantages of this collection mode:

- Cash paying patrons can pay their toll at the tolling point while ETC customers can pay their toll without stopping, possibly at highway speed;
- Less leakage with almost 100% of revenues are collected;
- Higher vehicle throughput – up to 1,200 vehicles per hour if both collection modes are in the same lane, up to 2,200 vehicles per hour if electronic toll collection is in bypass lanes; and
- Environmental and fuel savings from the electronic collection mode.

Major disadvantages of this collection mode:

- Increased capital construction costs;
- Increased annual operating and maintenance expenses; and
- Cash customers would need to stop and pay toll thereby impeding traffic flow.

<u>All Electronic Tolling (AET)</u>: Simply, AET is the collection of all tolls without any cash toll booths. The goal of Electronic Toll Collection (ETC) is to eliminate delays caused by the manual collection of tolls while simultaneously benefitting the environment as vehicles are not stopping and idling at tolling plazas thereby resulting in the reduction of vehicle emissions. Despite the overwhelming success of ETC programs throughout North America, a certain percentage of patrons on toll roads still prefer to pay for their tolls with cash. Toll agencies, either to further reduce congestion at the toll plazas, to avoid capital construction costs, or to lower operating expenses, are selecting to implement All Electronic Tolling.

AET relies on transponders and the video recognition of a patron's license plate to identify the person responsible for the payment of the toll. This is accomplished through the use of high image quality cameras and Optical Character Recognition (OCR) software. Specifically, when a vehicle that is not equipped with a transponder passes through an AET tolling station, a video image of that vehicle's license plate is generated and then transmitted to the vehicle registration system to determine the registered owner of the vehicle. Once the vehicle's owner has been identified, an invoice for the toll is generated and mailed to the owner. The patron can then pay the invoice through one of the available payment options.

Technology is usually not the biggest hurdle when converting, or constructing, an AET facility. Most times the administrative and operational issues command the most time and attention. These would include interoperability, reciprocity, settlement, enforcement, business rules, back office processing, just to name a few. While these items are a concern they can be resolved with some detailed planning, research and meetings.

<u>Major advantages of this collection mode:</u>

- Safety and Convenience – there is no need to slow down or stop at the toll plaza to pay the toll, no weaving to find the right lane;
- Environmental – reduction in noise levels and auto emissions;
- Savings – fuel consumption;
- Efficiency – higher vehicle throughput and increased traffic flow – an AET lane can process up to 2,200 vehicles per hour; and
- Lower operating and capital costs.

<u>Major disadvantages of this collection mode:</u>

- Inability to collect tolls from all patrons whether through non-payment, non-identification or inadequate enforcement options;
- Confusion among patrons who are looking for a toll booth to pay the toll; and
- Political and public relation concerns as typically a video toll is higher than an ETC toll thereby drawing the inference of inequity.

A successful AET implementation is based on the system deployed and the public's acceptance. Conducting public and public official outreach before, during and after conversion is important and can eliminate a lot of apprehensions on the part of the consumer. Another key aspect for a successful implementation is to test the system at designated intervals prior to as well as during the installation of the system. Testing should also be conducted upon completion of the installation and prior to going live. This will ensure that the system is ready to handle live traffic.

2.8.3 Electronic Toll Collection System

An electronic toll collection system is comprised of four parts: Automated Vehicle Identification (AVI), Automated Vehicle Classification (AVC), Transaction Processing and Violation Enforcement.

An AVI would include the transponder (or electronic tag), an antenna, a reader and Automated License Plate Recognition (ALPR) cameras and software. An AVC would consist of in-ground loops, height sensors, treadles, light curtains and software. Transaction Processing is basically Customer Service Center services and would include account establishment and maintenance, toll posting, customer inquiries and replenishments. Violation enforcement would include cameras, ALPR software, in-lane police patrols, violation notices, suspensions and holds. Below is a description of how an ETC system would work.

An Electronic Toll Collection (ETC) system is utilized to collect electronic and cash toll payments as well as isolate and identify violating vehicles. An ETC System that has been properly designed and tested will perform at an accuracy rate of 99.5%. This accuracy is achieved with a variety of sensor systems that detect, track, classify, capture license plate images, and report this data to a lane computer as well as utilizing a proven monitoring and maintenance system. The Violation Enforcement System (VES) is employed as the primary means of detecting, recording and reporting data and images of violating vehicles to the Violation Processing Center (VPC). Digital images are taken of all vehicles (license plate) that are detected in the toll lane. Once a valid form of toll payment is associated with a specific vehicle, the images are deleted. The license plate image is presented for automated or manual image review to visually determine if the license plate image is acceptable based upon established criteria.

Now that an electronic version of the license plate is created, that plate can be checked against the database of account holder license plates to ensure that a violation notice, is not sent to a customer. After this check is complete, and assuming the license plate failed to match one of the customers, the license plate data is sent to the Province's vehicle registration office for a match against the registered owner of that license plate. A name and address is then returned which is once again matched against the customer database to ensure a violation notice is not sent to an account holder that is in good standing. Once determined that there is no match against the customer database, a violation notice is printed and mailed.

2.8.4 Interoperability

Interoperability is the ability of toll agencies to process and settle ETC transactions from customers of other toll agencies that possess a valid prepaid ETC account. In essence, it allows an ETC customer to pay for tolls from multiple toll agencies using one transponder and one account. An example of interoperability is the E-ZPass Group in the northeast United States. The E-ZPass Group is currently comprised of 37 toll agencies in 16 states. A customer with a prepaid ETC account and a transponder can travel on any facility of any of the 37 toll agencies and have the toll deducted from their prepaid account. In Nova Scotia, the Halifax Harbour Bridges, Cobequid Pass and Confederation Bridge all accept the same electronic transponder but a customer needs to open an ETC account with each agency. Discussions should take place with each of the tolling agencies in Nova Scotia as well as the E-ZPass Group to determine the best interoperability arrangement. In addition the decision process should include the make-up of the traveling community.

2.8.5 Toll System Design Options

There are different toll design options available to implement an all-electronic tolling system including the placement of tolling infrastructure such as gantries and tolling equipment for detecting, scanning or taking video images of license plates. The various toll design options are:

- **Closed system with distance-based tolls, mainline-only tolling points:** A closed system with distance-based tolls and having only mainline tolling points maintains toll barriers at strategic points along the mainline. Tolls are calculated on the basis of vehicle class and distance traveled. In a closed system, tolling points are situated such that no toll-free traffic movements are permitted. Typically, a motorist would have a transponder in his/her vehicle; however, a motorist traveling without a transponder will have his/her license plate photographed at each of the mainline tolling points and receive an invoice in the mail based upon distance travelled;
- **Closed system with distance based tolls, ramp only tolling points:** A closed system with distance-based tolls and ramp tolling points maintains toll barriers at all entrance and exit ramps as well as at the beginning and end of the system. Tolls are calculated on the basis of vehicle class and distance traveled. In a closed system, tolling points are situated such that no toll-free traffic movements are permitted. Typically, a motorist would have a transponder in his/her vehicle; however, a motorist traveling without a transponder will have his/her license plate photographed at each of the tolling points and receive an invoice in the mail based upon distance travelled;
- **Closed system with distance-based tolls, mainline and ramp tolling points:** A closed system with distance-based tolls and mainline and ramp tolling points maintains toll barriers at all entrance and exit ramps as well as at strategic points along the mainline. Tolls are calculated on the basis of vehicle class and distance traveled. In a closed system tolling points are situated such that no toll-free traffic movements are permitted. Typically, a motorist would have a transponder in his/her vehicle; however, a motorist traveling without a transponder will have his/her license plate photographed at each of the tolling points and receive an invoice in the mail based upon distance travelled; and
- **Closed system with flat rate tolls, on-ramp only tolling points:** A closed system with flat rate tolls and on-ramp tolling points maintains toll barriers at all entrance ramps as well as at the beginning and end of the system. The toll is based on a fixed rate associated with the vehicle class. Tolls are not based on distance and trip distances for motorists are not tracked. In a closed system, tolling points are situated such that no toll-free traffic movements are

permitted. Typically, a motorist would have a transponder in his/her vehicle; however, a motorist traveling without a transponder will have his/her license plate photographed at each of the tolling points and receive an invoice in the mail based upon distance travelled.

2.8.6 Capital Costs

Capital construction costs are a major component for the implementation of any toll system. Depending on the system being implemented these costs can vary considerably.

Based on our experience and industry standards we have prepared preliminary Capital Costs for sample corridors based on an AET facility and as an ETC with cash option. The average cost for an AET toll gantry is approximately $2.2 M CDN to span two travel lanes, and $4.4 M CDN to account for both directions.

2.8.7 Other Noteworthy Items

Once a decision is made to implement tolling several other key factors concerning tolling need resolution. Key among them is the decision on the tolling structure. Should tolls be assessed based on distance or should they be set at a flat rate? Should they be static or dynamic? Should they be fixed or variable? What discount programs should be offered, if any? What are the impacts of tolling to the residents and businesses?

Next is how the tolls are collected. Should a standalone back office be established or should discussions center on joining an existing back office?

Funds need to be provided for replacement of the tolling system. Typically the useful life of tolling equipment and components is 8 years.

2.8.8 Recommendation

Based on the movement in the tolling industry and our experience, it is our recommendation that should the Province of Nova Scotia make a decision to implement tolling that they do so in the form of an All Electronic Toll System. To minimize costs, a closed system with mainline gantries would also be recommended; however, further discussions and work would be needed before a recommendation can be made in regards to the specific toll system design, interoperability with other tolling agencies and the items mentioned in the preceding section.

CHAPTER 3 HIGHWAY CORRIDORS/COST ESTIMATES

3.1 Review of NSTIR Cost History Data

Highway cost data were received from NSTIR in a number of different ways. Several spreadsheets, digital copies of tender forms, and hard copies of tender documents were obtained at the start of the project. All of this information was compiled and was cross listed based on the contract number for each project. With a list of hundreds of projects, it was important to select which projects were relevant to the study and which ones were not. The following criteria were used to compile a list of relevant projects:

- Projects on 100-series highways;
- Projects involving twinning (2 lanes) or new construction (2 or 4 lanes) of highway;
- Projects involving subgrade work only;
- Projects with detailed cost data; and
- Projects where the section length and boundaries were identified.

Projects that did not meet these five conditions were removed from the list. It should be noted that some subgrade projects included costs for type 1 gravel, type 2 gravel, and design/build items. The associated costs for these items were removed from the total cost of the project as these costs were accounted for in the paving contract assessment as a separate part of the feasibility study.

Now with a list of relevant projects, a cost per unit length could be generated. Since the cost data encompassed construction over a number of years, the associated cost for each project was translated to 2015 dollars. A rate of 3%, compounded year over year, was used to achieve this. This rate was confirmed through the Engineering News Record (ENR) construction price index. Finally, the 2015 cost for each project was divided by the section length to generate a cost per kilometre.

3.2 Cost Estimates and Schematic Design – PSA and DFS Methodologies

3.2.1 Description of Alignments

Alignment information provided by NSTIR was imported to CBCL Limited's GIS software (ArcView), then converted to KMZ format for import to Google Earth Professional. In sections where alignments did not exist, they were created using the measurement tool within Google Earth Professional. The measurement tool was also used to trace over the alignments provided by NSTIR so that consistent information would be available for all eight corridors.

Google Earth Pro is a useful tool for determining preliminary alignments. It allows the user to see where potential conflicts lie such as homes and waterbodies, such that they can be avoided where possible. Locations of existing highway features including interchanges, bridges (grade separation and watercourse crossings) are all clearly visible and can be measured using the measurement tool. All alignments created were logged, and locations of grade separations, bridges, interchanges, and service road crossings were noted and recorded by station.

Class D cost estimates were carried out using information provided by NSTIR and from CBCL Limited databases to develop an approximate cost per lineal metre for new highway construction. Mapping along each corridor was compiled, watercourse locations determined, and the NSTIR bridge database was consulted. Bridges were assumed to be required over watercourses where bridges currently exist. Span information was used to estimate bridge costs on a square metre basis based on CBCL's extensive bridge cost database. New interchange structures were assumed for all overpasses, and extensions to existing structures were assumed for all underpasses. Where data were available, any underpass older than 50 years were assumed to be replaced.

For highway costs, NSTIR data were consulted where available to estimate the lineal metre cost. For example, the cost and amount of the recent twinning work on Highway 103 was reviewed and the unit cost updated to 2015 dollars. The number was then applied to extend the highway to Bridgewater, with adjustments made to account for number of bridges, underpasses, overpasses, and major culverts. Where NSTIR data were not available for a given section, an average depth of cut was assumed that lead to an average width between daylight lines, thus providing amounts of clearing, grubbing and mass excavation. An average width of subgrade, along with reasonable assumptions of gravel and asphalt thicknesses was used to determine quantities of materials from the subgrade to the finished surface for cost estimating purposes. The limited detailed information available means that significant contingency allowances are applied to Class D estimates to provide some comfort in the estimated cost. We also reviewed historical operations, maintenance and renewal/replacement costs that the Province has incurred for series 100 highways with the goal of establishing a Class D level estimate for the OMR costs of the assets.

Class C cost estimates were undertaken by refining the alignments based on new and available information collected or prepared during the Detailed Feasibility Study phase.

Class C cost estimates require a level of design of approximately 30%. In order to provide a reasonable estimate for grading, plan/profiles were produced. Light Imaging, Detection And Ranging (LIDAR) data were used to produce existing grade surfaces for each highway corridor that was to undergo a Class C estimate. Finished grade profiles were assumed based on the profiles of the existing highways that the new lanes will parallel. Standard NSTIR cross-section templates were then applied to the profiles to determine limits of cut and fill, lengths of culverts, and amounts of excavation and filling. The footprint of the grading was used to determine amounts of clearing, grubbing and land acquisition. Pavement structure was determined using reasonable assumptions of gravel and asphalt thicknesses with input from the geotechnical consultant on subgrade quality for a given construction location. The subgrade width is more refined than what would be used in a Class D estimate, and resulted in a more accurate estimate of material needs, and thus more accurate cost. Preparing the various classes of construction estimates at the various design milestones, giving indicative and substantive estimates of capital costs using unit rates was performed using methodology prescribed by the Canadian Institute of Quantity Surveyors (CIQS), Treasury Board of Canada, or the Association for Advancement of Cost Engineering (AACE).

3.3 Linear Highway Construction – DFS Design Approach and Cost Estimating Methodology

Schematic designs were performed for each section using Civil 3D. Lidar data were used to generate an existing grade surface for each section. The surfaces were then globally lowered by 300mm to account for grubbing. Horizontal and vertical alignments were then designed. Corridors were subsequently created using the appropriate cross-section assembly (NSTIR Standards) for each highway section under design.

Where twinning of existing highways is to be done, the designs presented a challenge. No survey information was available to provide the line work of most of the existing highways. Therefore, tangents and curves were drawn along existing highway centrelines within AutoCAD using Google Earth as a backdrop. Contours were then generated from the existing grade surfaces, and the centreline vectors were adjusted to match the crowns defined by the Lidar. The centrelines were then offset by 3.7 metres to provide the horizontal alignments of the edge of the future median lanes. Profiles of the existing highway were generated along these alignments, and finished grade tangents and vertical curves were then added on a best-fit basis. The existing lane alignments (future median lane alignments) were then offset the appropriate distance to create a centreline for the type of twinned cross-section under consideration (35m open, 30 metre open, 21.4 metre open, etc.) to form the edge of the median lane for the new twinned section. The corridors for the new lanes were built from the centreline of the median. The profiles for the new lanes thus follow the existing highway. Superelevation using the AASHTO method built into Civil 3D was applied to all corridors. Resulting daylight lines were generated to provide the footprint for the new construction. Corridors were then created at existing interchange ramps in the twinned sections to blend with the new lanes. NSTIR standards for acceleration and deceleration lanes and taper lengths were used on the new lanes.

Where twinning through undeveloped areas (Marshy Hope By-Pass on Section 4 Highway 104, Section 6 – Highway 104 Port Hastings to Port Hawkesbury, and portions of Section 8, Highway 107 Porter's lake to Duke Street, Bedford) horizontal and vertical alignments that were previously developed by NSTIR were used, and revised as necessary. Some adjustments were made to follow NSTIR standards through the design review process. Section 7 (Highway 104 St. Peter's to Sydney) was designed using NSTIR standards. All new highway sections had the grades adjusted to achieve a cut/fill balance. On sections 4 and 8, the balance was achieved for the overall section by making up imbalances on the twinned sections by making the necessary adjustments on the new sections. Balancing of twinned sections was not carried out, and surplus/borrow quantities were estimated as applicable.

Civil 3D/AutoCAD was used extensively to estimate quantities. The following are brief descriptions of how each major item was estimated:

- Clearing: An offset of 5 metres of the daylight lines was used to calculate the areas;
- Grubbing: Area within the daylight lines less areas where fill thickness exceeds 2 metres and area of wetlands;
- Swamp Excavation: Area of wetlands times an assumed average depth of 2.5 metres;
- Unclassified Excavation (where balanced and where borrow is required): Civil 3D output for cut plus the grubbing area times 0.3 metres;
- Unclassified Excavation (where there will be a surplus): Civil 3D output for fill plus the grubbing area times 0.3 metres;
- Excavation and Disposal of Surplus Material: Civil 3D output for Cut less estimated fill required;
- Common Borrow: Civil 3D output for fill less estimated cut;
- Compaction: Volume of material required to build the subgrade plus the volume of gravel Types 1 and 2;
- Fine Grading: Area of subgrade;
- Rock Fill: Wetland areas filled to a depth of 1 metre, and using 2.0 tonnes per cubic metre. Remainder of wetlands filled with common material;
- Gravel Types 1 and 2: Civil 3D output in cubic metres and using 2.4 tonnes per cubic metre. Type 1S quantities are included in Type 1. Thicknesses for each type of gravel (1,1S, and 2) were assumed as follows:
    - Type 1: 200mm;
    - Type 2: 650mm on Highways 104 and 101; 550mm on Highways 103 and 107;
    - Type 1S: 165mm;
- Emulsified Asphalt Tack: Area of asphalt in square metres times 0.15 Litres per square metre;
- Asphalt Binder: 6 percent of tonnage of B-HF and C-HF asphalt;
- Liquid Asphalt Primer: Area of asphalt in square metres times 1.0 Litres per square metre;
- Asphalt Concrete Removal: All asphalt on existing highways in excess of future 2-lane width, interchange ramp modifications and Jersey Barrier locations;
- Cold Planing: Area of tie-in to existing asphalt using NSTIR standard detail;
- Rumble Strips: Length of highway times 2, 3 or 4 where applicable;
- Asphalt Mix Type B-HF and C-HF: Civil 3D output in cubic metres and using 2.4 tonnes per cubic metre;
- Guardrails: Civil 3D output relative to slopes and half of ramp lengths for strong post, NSTIR standards for remaining;
- Pipe/Box Culverts: Culverts sized using hydrologic/hydraulic calculations: Lengths for each were estimated for each size by drawing a line along the watercourse between daylight lines. 450mm diameter pipes are catch basin leads with assumed length of 50 metres each;
- Catch Basins: In median at assumed spacing of 250 metres;
- Geotextiles: Area of subgrade. Heavy Geotextile in assumed Karst risk areas;
- Mobilization: Varying percentage of construction costs to an upset limit;
- Hydroseeding: Clearing area less fine grading area;
- Signs: Based on counts from our Highway 104 Twinning project on a per kilometre basis and at interchange zones;
- Access Roads: based on Civil 3D modelling on two separate sections, reduced to a per kilometre basis for remaining sections;
- Animal Control Fencing: Section by section basis – development levels, etc. Various percentages of section length.

Cost estimating spreadsheets were tabulated for each section. Unit rates were obtained from NSTIR's database and adjusted to 2015 dollars. For items where NSTIR data were not available, inquiries were made to suppliers and contractors without being project specific. Environmental protection was not designed, and therefore no quantities were developed. An allowance of 1.5% of construction cost was added to cover this item.

The cost estimate for Section 7 was derived using a slightly different process to the other sections. This is because this section was to be initially designed as a two-lane controlled access highway, however, NSTIR wished to leave the option open for full twinning in future upgrades.

Section 7 was originally modelled using an assembly for typical freeway cable median barrier cross section. Quantities were extracted for the four-lane, divided highway including interchanges and structures. The assembly was then changed to a typical major arterial cross section. Quantities were extracted for the two-lane, undivided highway. The quantities for the interchanges were not changed from the cable median barrier estimate. The cost of each structure was held constant, however in some instances the quantity of structures was changed from two to one.

In order to include climbing lanes in the Class C estimate, most quantities from the two-lane major arterial were increased by a factor of 1.125. The factor was calculated by the length of road-lane method. We assumed that 25% of the total length of the highway would have three lanes. The total length of road-lanes was calculated to be 188.8. The total length of road-lanes for the two-lane major arterial was calculated as 167.8. Using those lengths of road-lanes, a multiplication factor of 1.125 calculated and then applied to the civil quantities that were anticipated to increase from the two-lane major arterial estimate. Some quantities that would not change, such as guardrail, were held constant.

This method was checked by normalizing the total cost of affected line items from the four-lane cable median barrier estimate to the two-lane major arterial. The total cost of the affected line items was divided by the corresponding length of road-lanes for both estimates. The difference between the normalized costs was 2.0%.

3.4 Highway Structures – DFS Design Approach and Cost Estimating Methodology

Class C capital cost estimates were prepared separately from highway construction estimates for structures with spans greater than 3 metres.

3.4.1 Existing Structures

With the exception of a few sections, the proposed twinned highway will mirror an existing highway. These existing sections contain approximately 85 structures varying in both age and condition. As such, these structures were classified into three categories in order to prepare Class C cost estimates:

1. Replace.
2. Maintain.
3. Exhaust.

Criteria used to classify the structures included age (as determined from existing construction drawings) and condition rating (as determined from NSTIR inspection reports). NSTIR uses a NBIS (National Bridge Inspection Standards) rating system in their inspections. These inspections are intended to be performed every two years but often the frequency of these inspections are reduced. The rating system ranges from 0 to 9 with 0 representing failure and 9 representing excellent condition.

The classification system used for preparation of the Class C estimates and its' general criteria are summarized in **Table 3.1** below.

Table 3.1 – Classification System for Preparing Class C Cost Estimates

Classification	Description	Criteria	Capital Cost Implications
Replace	These structures are generally at an age and condition state where ongoing maintenance of the existing structure would result in a higher lifecycle cost when compared to constructing and maintaining a new structure.	Date Built: <1970 OR NBIS Rating: <=6	Capital Costs will include demolition and design and construction of a new structure.

Classification	Description	Criteria	Capital Cost Implications
Maintain	These structures are either relatively newly constructed or have been maintained and are in very good condition. These structures are typically constructed to modern standards and will likely be maintained for the life of the contract.	Date Built: >1990 AND NBIS rating: >=8	Upgrade costs (likely minor). Scheduled maintenance and rehabilitation were included in OM&R costs.
Exhaust	Life cycle costs for these structures are likely lowest by exhausting their useful life through ongoing maintenance and rehabilitation before eventually being replaced.	Remaining Structures	Upgrade costs based on most current inspection report. Scheduled maintenance and rehabilitation as well as replacement costs were included in OM&R at date of estimated replacement (~60 years old).

It should be noted that the criteria listed above were not rigid and judgement was sometimes used. For example, if a bridge was constructed in 1968 but had numerous in-water piers or long steel spans, it may have been more cost effective to exhaust the remaining life in the structure considering their higher than average replacement costs. These types of structures were handled on a case by case basis. Deeply buried concrete box culverts were also considered separately as ongoing inspection and maintenance was more likely the most cost effective option if the condition rating was greater than 5.

3.4.2 Conceptual Design

Conceptual designs were prepared based on requirements of Canadian Highway Bridge Design Code, CAN/CSA S6-14, and the current NSTIR Standard Specification. Bridges were laid out based on profiles determined from the conceptual alignments. During design, the following criteria were assumed:

- Precast concrete superstructures are preferred over steel superstructures;
- All abutments are to be integral (i.e. no joints or bearings) or semi-integral (i.e. no joints);
- 2:1 stable slopes are preferred over earth retaining structures;
- Superstructures are to be continuous over piers (i.e. no joints);
- Decks are to be 225mm thick for single span and 250mm for multiple spans;
- All reinforcement is galvanized; and
- All concrete is high performance concrete.

Geotechnical information used in design has been derived from several sources:

- Geotechnical reports and studies along the studied corridors provided by NSTIR;
- Borehole logs from existing drawings provided by NSTIR; and
- Geotechnical desktop study performed by Golder Associates as part of this study.

It should be noted for Section 7 that relevant geotechnical information was primarily limited to well logs identified in the study by Golder and Associates. The wells logs identified a depth of bedrock below the surface. For each structure the depth to bedrock was assumed to be similar to the nearest well, or an average of several well depths, if applicable. The well logs provided little information about the competency of the bedrock and, as such, a detailed investigation of this section may find that piles need to be driven to greater depths to achieve adequate bearing capacity.

3.4.3 Construction Detour Philosophy

The philosophy for the majority of the construction, specifically the twinned structures, would be that traffic would drive on the existing structure while the new structure was being constructed. After construction of the first structure traffic would be re-routed onto the new structure while the existing structure was being replaced or rehabilitated. This would minimize costs, requiring only a temporary detour and avoid the use of a temporary bridge. Temporary structures or detours would be required on most underpasses although in some instances the minor road over the underpass has been realigned allowing a construction methodology similar to that described for the twin structures.

3.4.4 Rehabilitation

Structures that were classified as “maintain” or “exhaust” were assumed to be rehabilitated to acceptable standards as part of the capital works. The latest structure inspection reports were consulted in determining the different components on the structure requiring attention. The rehabilitation philosophy assumes any deteriorated areas of concrete are repaired. However, in most cases the condition of the deck was not extensively documented. In these cases, an assumed concrete repair area of 15% has been utilized. Where the superstructure is constructed of steel, all steel has been recoated. Further standard modifications and repairs were applied to the majority of structures, and include:

- Bearing replacement;
- Semi-integral retrofit (i.e., remove joints at abutments, if possible);
- On continuous structures, removal of joints over pier via a link slab;
- Addition of approach slabs where none exist;
- Lifting and repaving asphalt;
- Installation of new bridge rail if existing is non code-compliant; and
- Installation of new slope drains.

Estimates for this rehabilitation work has been included in the Class C Capital cost estimates.

3.4.5 Class C Cost Estimates

Detailed cost estimates have been developed. In addition to material costs, if applicable, allowances have been made for:

- Mobilization;
- Detours and temporary structures;
- Demolition;
- Water Control;
- Traffic Control; and
- Environmental Controls.

Unit costs have been derived from NSTIR’s average unit prices from September 2014 to September 2015 and CBCL’s in-house cost database. Anomalies in the average unit prices (i.e. insufficient data) have not been used and prices have been determined from conversations with local contractors or previous tender data from similar structures.

A Class C contingency of 20% is intended to account for:

- Changes in material costs;
- Fluctuations in the labour market;
- Changes required due to detailed design of road alignment; and
- Changes due to more detailed geotechnical information.

3.5 Summary

A summary of the Class C cost estimates is shown in **Table 3.2** below. This table includes the construction cost estimates as well as estimates for land costs, wetland compensation and engineering. It should be noted that land costs were estimated using a percentage of construction cost (2.5%), in consultation with NSTIR Acquisitions and Disposal staff.

Environmental approvals and compensation is based on the estimated impacted wetland area within each corridor, assuming compensation will be based on twice the impacted area. Engineering costs include design and construction administration and observation.

The costs of installing overhead gantry electronic toll collection equipment was also included in the cost estimates.

Table 3.2 – Summary of Class C Cost Estimates

Class C Construction Estimate				Land Costs	Wetland Compensation	Engineering Costs (5% of Construction)	Total Capital Cost
Sect	H/way	Description	Construction Estimate				
1	101	Three Mile Plains to Falmouth	$121,400,000	$3,035,000	$1,084,128	$6,070,000	$131,589,128
2	101	Hortonville to Coldbrook	$155,560,000	$3,889,000	$1,275,296	$7,778,000	$168,502,296
3	103	Tantallon to Bridgewater	$409,440,000	$10,236,000	$7,867,248	$20,472,000	$448,015,248
4	104	Sutherland's River to Antigonish	$261,750,000	$6,543,750	$3,672,320	$13,087,500	$285,053,570
5	104	Taylor's Road to Auld's Cove	$256,880,000	$6,422,000	$3,078,352	$12,844,000	$279,224,352
6	104	Port Hastings to Port Hawkesbury	$79,490,000	$1,987,250	$1,610,368	$3,974,500	$87,062,118
7	104	St. Peter's to Sydney	$449,990,000	$11,249,750	$7,520,040	$22,499,500	$491,259,290
8	107	Porter's Lake to Duke Street	$303,090,000	$7,577,250	$5,757,984	$15,154,500	$331,579,734
		Total	**$2,037,600,000**	**$50,940,000**	**$31,865,736**	**$101,880,000**	**$2,222,285,736**

3.6 Methodology for Operations, Maintenance and Rehabilitation

3.6.1 Operations

Costs for Operations, Maintenance and Rehabilitation (OM&R) were estimated for each year of the proposed 30 year contract and were prepared in 2016 dollars.

Operations activities included items such as:

- Winter snow removal, salting and ice control and salt management
- Roadside vegetation control, garbage removal;
- Emergency Response;
- Highway and structure inspections;
- Structure cleaning; and
- Highway monitoring.

An operations budget of $30,000/year per kilometer of twinned section of highway was derived from historical costs associated with Nova Scotia's Cobequid Pass.

3.6.2 Maintenance and Rehabilitation

Highways

Costs of M&R for new sections of highways were determined by applying NSTIR's Idealized Maintenance Plans for Life Cycle Cost Analysis (LCCA) of new construction as shown in **Table 3.3**. Each treatment was estimated on a square meter basis utilizing NSTIR's average unit pricing for the previous three years.

For existing sections of roadway to be included as part of the twinned highway, NSTIR provided a summary of the sections as they existed in the province's pavement management application (HPMA). This summary included the next recommended year and treatment for each section. After application of these initial treatments, subsequent treatments were planned based on the aforementioned LCCA maintenance schedule.

Table 3.3 – NSTIR's Idealized Maintenance Plans for Life Cycle Cost Analysis of New Construction

Flexible Pavement	
Year	**Treatment**
3	Crack Filling and Crack Sealing
6	Microsurfacing/Thin Overlay
9	Selective Patching/Crack Filling and Crack Sealing
12	Tack/50mm C-HF Overlay/PGAB 58-28/Shoulder Gravel
15	Crack Filling and Crack Sealing
18	Microsurfacing/Thin Overlay
21	Selective Patching/Crack Filling and Crack Sealing
24	Mill 50mm/Tack/50mm C-HF Overlay/PGAB 58-28/Shoulder Gravel
27	Selective Patching/Crack Filling and Crack Sealing
30	Microsurfacing/Thin Overlay
33	Selective Patching/Crack Filling and Crack Sealing
36	Tack/50mm C-HF Overlay/PGAB 58-28/Shoulder Gravel
39	Selective Patching/Crack Filling and Crack Sealing

<u>**Structures**</u>

Unit prices for structure maintenance and rehabilitation (M&R) have been prepared based on NSTIR's one year average unit price table, conversations with contractors and an in-house cost database. A general schedule of maintenance and rehabilitation was prepared to estimate life cycle costs. The schedule is intended to cover most M&R items typically found on structures. For NSTIR, concrete repairs are typically reactionary as opposed to predictive so in order to relate the quantity of the concrete repairs to the size of the bridge, the quantity of scheduled concrete repair was taken as a percentage of the deck area. A higher percentage was applied to existing structures when compared with new structures to account for the likely higher deterioration rates in older structures.

While this quantity of concrete is certainly not exact, it provides a nominal allowance and the Class C contingency should provide for any deviance from the estimation. The schedule used in estimating M&R costs is outlined in **Table 3.4**. Year one costs do not apply as they were included with the capital costs but the item is included in the schedule for planning purposes.

Table 3.4 – Assumed Schedule of Structure Maintenance and Rehabilitation

Treatment	Sub Treatment	Year	Notes
Bearings	Replacement	1, 30	Costs account for jacking and traffic control.
Joints	Assembly Replacement	1, 30	
	Seal Replacement	5, 10, 15, 20, 25	
Wearing Surface	Mill, Waterproof and Repave	1, 30	
	Mill and Repave	15	
Coatings	Recoating	1, 30	
	Spot Repair	10, 18	
	Overcoating	24	
Concrete	Misc. Repair	1, 5, 10, 15, 20, 25, 30	Estimated at 5% of deck surface for existing structures and 2% of deck surface for new structures.
Replacement	Demolish and Rebuild	Structure replacement estimated at age of 60 years	As required for structures maintained to end of useful life.

It should be noted that the trend in bridge design over the past few decades has been to focus on life cycle costs by eliminating items such as joints, bearings and steel components that require coatings (if possible). As such, M&R estimates are significantly higher for older structures when compared with new.

CHAPTER 4 INDICATIVE FINANCIAL VIABILITY

4.1 Approach to Indicative Financial Viability

High-level financial analysis was conducted during the DFS to determine indicative financial viability for each of the highway corridors. For the purposes of this report, indicative financial analysis was conducted on a simplified annual cash flow basis – netting estimated toll revenues against estimated debt, equity, and OMR payments over the term of the assumed operating period[5]. Interest during construction was assumed to be capitalized during the construction period, with a percentage lump-sum payment at substantial completion by the federal and provincial governments.

The financial analysis conducted during the DFS is intended to be indicative in nature and does not represent a full analysis of all revenues and costs anticipated. For example, costs have not been risk-adjusted and procurement or other upfront/ongoing costs have not been included – these can have a material impact on results.

The sum of the netted cash flows for each section is intended to provide NSTIR with a generalized indication of long-term financial viability. The results also allow for the ranking of corridors by level of indicative financial viability.

4.1.1 Revenue, Cost and Timing Assumptions

Base revenue and costs for each corridor, including Toll Revenues, Construction Costs and OMR Costs have been estimated by HDR and CBCL, respectively, and rounded. Construction Periods for each corridor have been rounded upwards to the nearest full year. The results are shown in **Table 4.1**.

Table 4.1 – Revenue, Cost and Timing Assumptions

Assumption	Corridor 1	Corridor 2	Corridor 3	Corridor 4	Corridor 5	Corridor 6	Corridor 7	Corridor 8
Toll Revenues ($0.10/km)	339,000,000	624,000,000	1,680,000,000	728,000,000	781,000,000	98,000,000	278,000,000	1,110,000,000
Toll Revenues ($0.06/km)	212,000,000	383,000,000	1,042,000,000	475,000,000	507,000,000	60,000,000	179,000,000	683,000,000
Construction Costs (real $)	121,400,000	155,560,000	409,440,000	261,750,000	256,880,000	79,490,000	449,990,000	303,090,000
Annual OMR Costs (real $)	1,500,000	3,000,000	8,200,000	4,300,000	4,500,000	700,000	6,900,000	5,200,000
Construction Period (years)	3	3	6	3	5	1	4	4
Operating Period (years)	30							

4.1.2 Financial Assumptions

The financial analysis has been prepared as an annual cash flow during both the construction and operating phases. Revenue and cost figures prepared by HDR and CBCL were in 2016 real dollars, and were escalated at an assumed inflation rate. Key financial and timing assumptions are summarized in **Table 4.2** below (it should be noted that while the financing rates were current when the analysis was done, future economic changes may put some upward pressure on interest rates, which, if it occurs, will increase project financing costs and may impact on the relative viability of some sections).

Table 4.2 - Financial Assumptions

Assumption	Detail
Inflation Rate	**2%**
Federal Funding at SC (%)	**25%**
Provincial Funding at SC (%)	**25%**
Debt : Equity	**87 : 13**
Construction Debt Financing All-in Rate (%)	**3.25%**
Long-term Debt Financing All-in Rate (%)	**5.25%**
Equity Return Rate (%)	**13%**

[5] Debt and equity payments have been approximated as a proxy based on a straight-line amortization of debt and equity at assumed all-in rates.

4.2 Summary of Results

A summary of the financial analysis is provided in **Tables 4.3, 4.4 and 4.5** below, showing sources and uses of funds through the construction and operating periods in nominal dollars by highway corridor. The 'Excess (shortage) of funds based on the flat $0.10/km or the flat $0.06/km (real) toll rate used in modelling represents the difference between total sources and uses of funds, providing a generalized indication of each corridor's long-term financial viability.

Table 4.3 – Summary Financial Viability Results (Excess (Shortage) of funds based on $0.10/km Nominal (Escalated) Dollars $ Rounded)

Corridor	Corridor 1	Corridor 2	Corridor 3	Corridor 4	Corridor 5	Corridor 6	Corridor 7	Corridor 8
Sources of Funds								
Forecasted Revenue	339,000,000	624,000,000	1,680,000,000	728,000,000	781,000,000	98,000,000	278,000,000	1,110,000,000
Federal Funding	31,000,000	40,000,000	106,000,000	68,000,000	66,000,000	21,000,000	110,000,000	78,000,000
Provincial Funding	31,000,000	40,000,000	106,000,000	68,000,000	66,000,000	21,000,000	110,000,000	78,000,000
Debt	55,000,000	70,000,000	184,000,000	118,000,000	115,000,000	36,000,000	192,000,000	136,000,000
Equity	8,000,000	10,000,000	27,000,000	18,000,000	17,000,000	5,000,000	29,000,000	20,000,000
Total Sources	464,000,000	784,000,000	2,103,000,000	1,000,000,000	1,045,000,000	181,000,000	719,000,000	1,422,000,000
Uses of Funds								
Total Capital Costs	125,000,000	161,000,000	423,000,000	270,000,000	265,000,000	82,000,000	442,000,000	313,000,000
Total OMR Costs	46,000,000	89,000,000	247,000,000	129,000,000	134,000,000	21,000,000	208,000,000	155,000,000
Total Financing Payments	142,000,000	182,000,000	479,000,000	306,000,000	301,000,000	93,000,000	501,000,000	354,000,000
Total Uses	313,000,000	432,000,000	1,149,000,000	705,000,000	700,000,000	196,000,000	1,151,000,000	822,000,000
Excess (shortage) of funds based on the flat $0.1/km (real) toll rate used in modelling	**151,000,000**	**352,000,000**	**954,000,000**	**295,000,000**	**345,000,000**	**-15,000,000**	**-432,000,000**	**600,000,000**

Based on the net overall funds at $0.10/km, the corridors can be ranked as follows from most to least financially viable: (i) Section 3 Highway 103; (ii) Section 8 Highway 107; (iii) Section 5 Highway 104; (iv) Section 2 Highway 101; (v) Section 4 Highway 104; (vi) Section 1 Highway 101; (vii) Section 6 Highway 104 and (viii) Section 7 Highway 104**.**

Analysis was conducted to determine the relative financial viability of the individual sections based on the preliminary cost estimates, the traffic revenue forecasts and the level of toll required (assuming federal and provincial funding of 25% respectively) for the section to break even financially. The financial viability range was bracketed by what survey respondents said they were willing to pay ($0.06/km) in the Willingness to Pay (WTP) survey results and the existing Cobequid Pass toll rates ($0.10/km). Those sections which fell at or below the WTP survey results of $0.06/km were deemed to be very viable and are noted in green. Those sections which required a toll rate in excess of the existing Cobequid Pass rate ($0.10/km) were deemed to be not good candidates from a financial viability perspective and are coded in red. Those sections which fell between the two thresholds were determined to be moderately viable, from a financial perspective.

Values developed for this analysis are shown in **Tables 4.4 and 4.5** and the chart in **Figure 4.1**.

Financial viability is only one measure and Chapter 6 of this document outlines a series of qualitative factors which will have a bearing on the overall suitability of sections, particularly for those sections which may be considered to be moderately viable from a financial perspective.

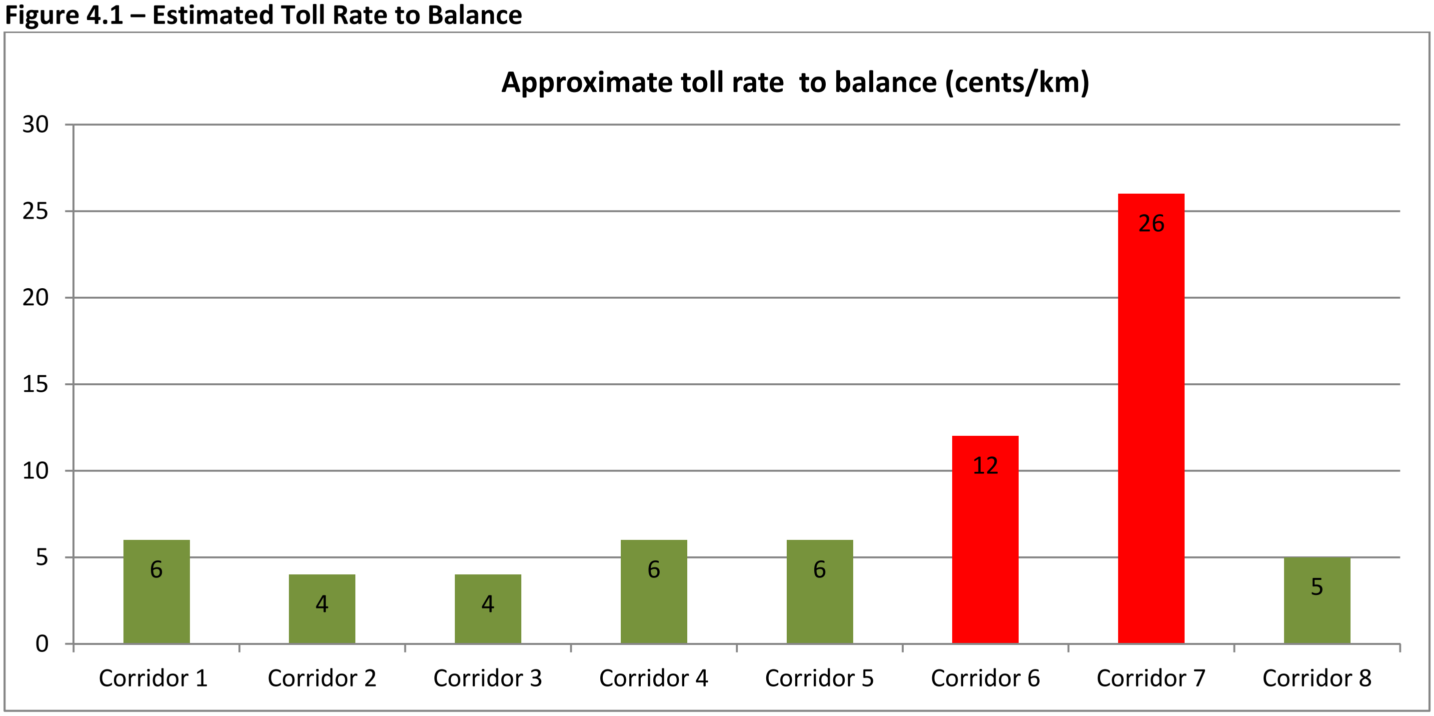
Table 4.4 – Summary Financial Viability Results (Excess (Shortage) of Funds Based on Toll Rate of $0.06 km Nominal (Escalated) Dollars $ Rounded)

Corridor	Corridor 1	Corridor 2	Corridor 3	Corridor 4	Corridor 5	Corridor 6	Corridor 7	Corridor 8
Sources of Funds								
Forecasted Revenue	212,000,000	383,000,000	1,042,000,000	475,000,000	507,000,000	60,000,000	179,000,000	683,000,000
Federal Funding	31,000,000	40,000,000	106,000,000	68,000,000	66,000,000	21,000,000	110,000,000	78,000,000
Provincial Funding	31,000,000	40,000,000	106,000,000	68,000,000	66,000,000	21,000,000	110,000,000	78,000,000
Debt	55,000,000	70,000,000	184,000,000	118,000,000	115,000,000	36,000,000	192,000,000	136,000,000
Equity	8,000,000	10,000,000	27,000,000	18,000,000	17,000,000	5,000,000	29,000,000	20,000,000
Total Sources	337,000,000	543,000,000	1,465,000,000	747,000,000	771,000,000	143,000,000	620,000,000	995,000,000
Uses of Funds								
Total Capital Costs	125,000,000	161,000,000	423,000,000	270,000,000	265,000,000	82,000,000	442,000,000	313,000,000
Total OMR Costs	46,000,000	89,000,000	247,000,000	129,000,000	134,000,000	21,000,000	208,000,000	155,000,000
Total Financing Payments	142,000,000	182,000,000	479,000,000	306,000,000	301,000,000	93,000,000	501,000,000	354,000,000
Total Uses	313,000,000	432,000,000	1,149,000,000	705,000,000	700,000,000	196,000,000	1,151,000,000	822,000,000
Excess (shortage) of funds based on the flat $0.06/km (real) toll rate used in modelling	**24,000,000**	**111,000,000**	**316,000,000**	**42,000,000**	**71,000,000**	**-53,000,000**	**-531,000,000**	**173,000,000**

Table 4.5 – Estimated Toll Rate to Balance

Corridor	Corridor 1	Corridor 2	Corridor 3	Corridor 4	Corridor 5	Corridor 6	Corridor 7	Corridor 8
Required revenue to net zero	188,000,000	272,000,000	726,000,000	433,000,000	436,000,000	113,000,000	710,000,000	510,000,000
Approximate toll rate to balance (cents/km)	6	4	4	6	6	12	26	5
Summary Rating	**green**	**green**	**green**	**green**	**green**	**red**	**red**	**Green**

Figure 4.1 – Estimated Toll Rate to Balance



CHAPTER 5 ENVIRONMENTAL EFFECTS AND CONSTRAINTS

5.1 Background

CBCL has completed a preliminary evaluation of potential environmental constraints associated with each of the proposed highway corridors as part of the Detailed Feasibility Study. The evaluation has been based on the preliminary interpretation of available secondary data sources and a field reconnaissance of the Corridors. Additional evaluation of environmental constraints are being completed to further characterize the environmental risk associated with the proposed corridors, these studies were completed during the 2016 calendar year.

5.2 Environmental Assessments and Studies

Previous and current environmental assessments and associated studies have been completed for some sections of the proposed highway twinning corridors. NSTIR and NS Department of Internal Services provided CBCL with environmental assessment documentation and data that they deemed relevant to the proposed twinning corridors for consideration in the assessment. See **Table 5.1** below detailing the documents received from NSTIR, and those being reviewed and also being completed by CBCL.

Table 5.1 – Previous Environmental Assessments and Associated Studies

Corridor	Document Title	Date Completed	Author	Comments
Corridor 1: Highway 101 - Three Mile Plains to Falmouth	Highway 101 Phase 4 Twinning Three Mile Plains to Falmouth Environmental Assessment Report	2009	Stantec Consulting Limited	
	MI'KMAW KNOWLEDGE STUDY, Highway 101 Twinning Project, St. Croix to Greenwood	2004	Mi'kmaq Environmental Services	
Corridor 2: Highway 101 - Hortonville to Coldbrook	CEAA Environmental Assessment Screening of Highway 101 Twinning: Hortonville to Coldbrook, NS	2012	Dillon Consulting Limited	included MEKS and Archaeological Assessment
Corridor 3: Highway 103 - Exit 5 Tantallon to Exit 12 Bridgewater	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report
	CEAA Screening-Level Environmental Assessment Report for Highway 103 Twinning	2012	Stantec Consulting Limited	included MEKS
Corridor 4: Highway 104 - Sutherlands River to Antigonish	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report
	Highway Twinning Feasibility Studies Corridor 4 – Ungulate Pellet Group Inventory (PGI)	2016	CBCL Limited	Draft Report
	MI'KMAW KNOWLEDGE STUDY Highway 104 New Glasgow to Aulds Cove	2004	Mi'kmaq Environmental Services	
Corridor 5: Highway 104 - Taylors Road to Aulds Cove	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report

Corridor	Document Title	Date Completed	Author	Comments
Corridor 5: Highway 104 - Taylors Road to Aulds Cove	MI'KMAW KNOWLEDGE STUDY Highway 104 New Glasgow to Aulds Cove	2004	Mi'kmaq Environmental Services	
Corridor 6: Highway 104 - Port Hastings to Port Hawkesbury	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report
	Class I Environmental Assessment Registration for Highway 104 - Port Hastings to Port Hawkesbury	2010	Dillon Consulting Limited	Includes an Archaeological Assessment
Corridor 7: Highway 104 - St. Peter's to Sydney	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report
Corridor 8: Highway 107 - Porter's Lake to Duke Street, Bedford	Highway Twinning Feasibility Study Corridors 3, 4, 5, 6, 7 and 8 Environmental Site Reconnaissance Survey	2016	CBCL Limited	Draft Report
	Highway 107 Extension to Highway 102 (Phases 1 and 2), Bedford NS - CEAA Screening Report	2011	Stantec Consulting Services	

As a result of preliminary assessment and review, additional discipline specific studies were completed in 2016. See **Table 5.2** below detailing the additional studies completed on behalf of NSTIR.

Table 5.2 – On-going Environmental Assessments and Associated Studies

Corridor	Environmental Discipline	Comments
Corridor 3: Highway 103 - Exit 5 Tantallon to Exit 12 Bridgewater	Avifauna Breeding Birds Aquatics Watercourse Assessment Wood Turtle Vegetation Species Diversity Forest Ecosystem Classification Wetlands Wetland Determination and Delineation Wetland Depth Probing Wetland Functional Assessment	Survey completed during 2016 field seasons. Reports currently being prepared.
Corridor 4: Highway 104 - Sutherlands River to Antigonish	Avifauna Breeding Birds Breeding Owls Aquatics Watercourse Assessment Wood Turtle Vegetation Species Diversity Forest Ecosystem Classification Wetlands Wetland Determination and Delineation Wetland Depth Probing Wetland Functional Assessment	Survey completed during 2016 field seasons. Reports currently being prepared.

Corridor	Environmental Discipline	Comments
Corridor 5: Highway 104 - Taylors Road to Aulds Cove	Avifauna Breeding Birds Aquatics Watercourse Assessment Wood Turtle Vegetation Species Diversity Forest Ecosystem Classification Wetlands Wetland Determination and Delineation Wetland Depth Probing Wetland Functional Assessment	Survey completed during 2016 field seasons. Reports currently being prepared.
Corridor 6: Highway 104 - Port Hastings to Port Hawkesbury	Avifauna Breeding Owls Aquatics Watercourse Assessment Wetlands Wetland Determination and Delineation Wetland Depth Probing Wetland Functional Assessment	Survey completed during 2016 field seasons. Reports currently being prepared.
Corridor 7: Highway 104 - St. Peter's to Sydney	Avifauna Breeding Birds Breeding Owls	Survey completed during 2016 field seasons. Reports currently being prepared.
Corridor 8: Highway 107 - Porter's Lake to Duke Street, Bedford	Avifauna Breeding Birds Aquatics Watercourse Assessment Wood Turtle Vegetation Species Diversity Forest Ecosystem Classification Wetlands Wetland Determination and Delineation Wetland Depth Probing Wetland Functional Assessment	Survey completed during 2016 field seasons. Reports currently being prepared.

Relevant information from previous environmental assessments and related studies provided to CBCL have been considered in the study and incorporated into the preliminary constraints identification. Identified constraints should be reviewed and updated upon completion of studies conducted during the 2016 calendar year. Previous assessments and studies may need to be updated to better reflect the proposed highway twinning alignments and lengths.

5.3 Assessment of Environmental Constraints

CBCL has completed an assessment of environmental constraints that could affect the feasibility of the proposed highway twinning corridors. The assessment includes the results of a site reconnaissance, and the interpretation of available secondary data sources including previous environmental assessments and associated studies. Relevant data have been incorporated into the preliminary alignment and environmental constraints mapping. The results of the assessment are summarized in **Table 5.3** overleaf. The constraints assessment included identifying potential interactions with the following environmental features:

- Wetlands;
- Watercourse Crossings;
- Environmentally Sensitive Features (other than watercourses and wetlands);
- Protected Areas and Other Designated Areas; and
- Species of Conservation Concern within 100m of the Corridors (ACCDC and EA Data).

The evaluation of watercourse crossings and wetland interactions has been completed through a site reconnaissance; and the interpretation of multiple aerial imagery sources, LiDAR, and provincial databases (i.e. watercourses, wetlands, wet areas mapping). The preliminary footprint boundaries of the proposed highway were generated using digitized

Table 5.3 : Environmental Constraints Evaluation Summary Table

Environmental Constraints	*Corridor 1*	*Corridor 2*	*Corridor 3*	*Corridor 4*	*Corridor 5*	*Corridor 6*	*Corridor 7*	*Corridor 8*
Environmental Constraints Summary								
Wetlands Interactions	Total: 15* Area: 2.55 ha*	Total: 29* Area: 12.24 ha*	Total: 106 Area: 23.5 ha	Total: 81 Area: 12.4 ha	Total: 89 Area: 13.9 ha	Total: 16 Area: 4.8	Total: 181 Area: 199.4 ha	Total: 56 Area: 38.7 ha
Watercourse Crossings	Total: 28*	Total: 52*	Total: 70	Total: 77	Total: 75	Total: 9	Total: 125	Total: 42
Environmentally Sensitive Feature	• Ramsar Wetland - Southern Bight, Minas Basin Bay of Fundy, NS • Important Birds Area-Southern Bight, Minas Basin Bay of Fundy, NS • First Nations Significant Plant Area	• Important Birds Area-Southern Bight, Minas Basin Bay of Fundy, NS	• Critical Habitat – Atlantic Salmon (5 Occurrences) • First Nations Significant Plant Area	• Critical Habitat – Atlantic Salmon (1 Occurrence)	• Critical Habitat – Atlantic Salmon (1 Occurrence) • Tracadie Harbour – Marine Habitat	None identified	• Critical Habitat – Atlantic Salmon (2 Occurrences) • First Nations Significant Plant Area	• Anderson Lake (Atlantic Whitefish)
Protected Areas	None identified	None identified	• Simms Settlement Provincial Park • South Panuke Wilderness Area • Gold River First Nations Reserve • Mahone Bay Water Supply Area	None identified	• Pomquet/Afton First Nations Reserve • Linwood Protected Beach	• Port Hawkesbury Water Supply Area	• Coxheath/ Westmount Municipal Water Supply Area	• Dartmouth Municipal Water Supply • Halifax Lateral Corridor • East Hants Regional Municipal Water Supply
Species of Conservation Concern within 100 m of Corridor	Total: 25 Protected: 1	Total: 3 Protected: 0	Total: 353 Protected: 10	N/A N/A	Total: 2 Protected: 1	Total: 18 Protected: 0	Total: 41 Protected: 9	Total: 50 Protected: 0
Data Gaps	No gaps: Updated EA Report to be submitted to NSE in early 2017	Partial: Current relevant project specific environmental studies have been completed for the corridor.	Partial: Current relevant project specific environmental studies have been completed for a portion of the corridor.	Substantive: No current or relevant project specific environmental studies have been completed.	Partial: Current relevant project specific environmental studies have been completed for a portion of the corridor.	Partial: Relevant project specific environmental studies have been completed for a portion of the corridor, but may require updates.	Substantive: No current or relevant project specific environmental studies have been completed.	Substantive: No current or relevant project specific environmental studies have been completed. Draft EA is in progress for Duke Street to Akerley Blvd. portion of alignment.
Environmental Regulatory Approval Summary								
Environmental Assessment Requirements	• Provincial EA - Trigger > 2 Hectare of Wetland Disturbance (Avon River Estuary)	No Federal or Provincial EA – NSTIR EED likely Required	• CEAA 67 Requirements (Federal Lands)	• Provincial EA - Trigger > 2 km of 4 lane highway	• Provincial EA - Trigger > 2 km of 4 lane highway • CEAA 67 Requirements (Federal Lands) – Likely to be resolved	• Provincial EA - Trigger > 2 km of 4 lane highway	• Provincial EA - Trigger > 10 km of 2 or more lanes of highway • Federal EA – Trigger < 50 km of an all season highway in a new right-of-way • CEAA 67 Requirements (Federal Lands) – PWGSC Parcel 15870579 (Ben Eoin)	• Provincial EA - Trigger > 2 km of 4 lane highway • CEAA 67 Requirements (Federal Lands)
Provincial Permitting	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval	• Watercourse Alteration • Wetland Alteration and Compensation • *Crown Land Act* Approval
Federal Permitting	• *Navigation Protection Act* Approval • *Fisheries Act* Authorization and Compensation	• *Fisheries Act* Authorization and Compensation	• *Navigation Protection Act* Approval • *Fisheries Act* Authorization and Compensation • First Nations Land Acquisition (Gold River First Nations)	• *Fisheries Act* Authorization and Compensation	• *Navigation Protection Act* Approval • *Fisheries Act* Authorization and Compensation • First Nations Land Acquisition (Pomquet/Afton)	None identified	• *Navigation Protection Act* Approval • *Fisheries Act* Authorization and Compensation	• *Navigation Protection Act* Approval • *Fisheries Act* Authorization and Compensation

* - Estimated during desktop review

centerlines of existing roadways and applying a proposed offset depending on median type (i.e. narrow/freeway cable barrier median); in so doing, the footprints of the proposed new highways were determined. These boundaries and centerlines are approximate as there could be inconsistencies between data sources (i.e. different aerial imagery, CAD drawings). Watercourses intersecting the offset boundary and wetland areas within the boundary were enumerated and included in this assessment.

The assessment results presented in Table 5.3 should be reviewed with consideration of the resolution of data evaluated and the data gaps associated with each corridor. The quality and quantity of data used in the environmental constraints assessment varied between corridors and corridor sections. Data obtained from previous environmental assessments and studies have limitations based on the information source and completion dates. Assessment standards for ecological field programs, environmental assessments, archaeological assessments and Mi'kmaq Ecological Knowledge Studies (MEKS) have changed over time and much of the data utilized in this assessment would require additional study to validate or update the previous results. Additional consideration should be given to archaeological resources and First Nations land usage, rights and title in the next phase of the assessment to further evaluate the environmental constraints and risks associated with the proposed corridors.

Based on currently available reports, all but two of the corridors have environmental data gaps and will require additional environmental studies to further evaluate the environmental risk and constraints. Exceptions are, Corridor 1 – Stantec Consulting has updated their 2009 draft EA for submission to NSE in early 2017, Corridor 2 – Dillon Consulting completed the CEAA Environmental Assessment Screening of Highway 101 Twinning Hortonville to Coldbrook, NS, and no further EA is required for twinning. MEKS reports have been updated as of the end of December 2016 for both Corridor 1 and 2. An assessment of environmental data gaps has been incorporated into the assessment and summarized in Table 5.3. The results of the environmental data gap analysis have been divided into the following categories:

- Substantive Gaps - No current or relevant project specific environmental studies have been completed;
- Moderate Gaps - Relevant project specific environmental studies have been completed but will require updates; and
- Partial Gaps - Current relevant project specific environmental studies have been completed for a portion of the corridor.

These gaps should be updated upon completion of the 2016 survey reports. We expect this information to be available in the first quarter of 2017.

The assessment of potential environmental regulatory considerations and requirements was completed based on interpretation of the preliminary constraints mapping. The results of the assessment present current legislative requirements, which may be affected by changes to existing acts and regulations. The current Federal government has stated an intention to review and enhance environmental legislation which may affect the results of this assessment. It should also be noted that the Provincial Minister of Environment can require a project to undergo a Provincial Environmental Assessment even if it is not listed as an Undertaking in the Environmental Assessment Regulations.

CHAPTER 6 ASSESSMENT MATRIX AND RANKING

6.1 Overview

During the Preliminary Screening/Assessment phase, specific screening criteria were developed to identify the objectives/priorities associated with providing highway twinning and infrastructure improvements throughout the Province. The screening/assessment matrix was a key output from the screening phase and assisted in undertaking a quantitative review of the significant analysis that had been carried out. The criteria developed were discussed in some detail with NSTIR prior to undertaking the screening/assessment. Now that we have undertaken more detailed study and analysis for the Detailed Feasibility Study, we have updated the matrix to provide a consistent basis for comparison of the eight highway sections.

In terms of assumptions made, we have adopted twinning for all sections with the exception of Corridors 6 and 7 (Highway 104 Port Hastings to Port Hawkesbury, and St. Peter's to Sydney respectively). This is due to NSTIR's guidance in the RFP indicating that these sections would be constructed as new two-lane sections allowing for twinning in the future. The inputs to the matrix assessment have come primarily from the Class C cost estimates, updated traffic and revenue forecasts, travel time and travel cost savings, collision reduction numbers, and further review of environmental constraints. A toll rate of $0.10 per kilometre was used for the Cost vs Revenue (Criteria 2) analysis (which is roughly equivalent to the current Cobequid Pass rate).

A comparison of each highway section against all competing sections has been undertaken with sections being ranked in order of how well they achieve the objectives/priorities in the screening/assessment matrix. The results of the analysis are shown in the Assessment Matrix overleaf including the overall ranking of the highway sections.

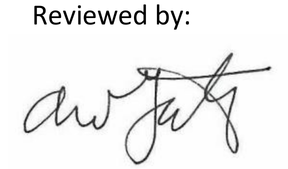
The Assessment Matrix analysis shows considerable commonality when compared with the Estimated Toll Rate analysis (Table 4.5). Corridors 2, 3, 4 and 8 score in the top 4 in the matrix analysis and are rated as Green in the Toll Rate Analysis. In addition, Corridors 1 and 5 are now rated as Green in the Toll rate Analysis. Corridors 6 and 7, both rated Red in the toll analysis, are ranked 7th and 8th respectively in the Assessment Matrix. None of the corridors are rated Yellow in the Toll Rate analysis compared to the results of the Preliminary Screening/Assessment report.

6.2 Conclusions

In summary the detailed feasibility study indicates that:

- Corridors 2 (high matrix ranking and good financial viability), 3 (high matrix ranking and good financial viability), 4 (high matrix ranking and reasonable financial viability) and 8 (high matrix ranking and good financial viability) are good candidates;
- Corridors 1 and 5 are credible candidates (moderate matrix ranking, good financial viability); and
- Corridors 6 (low matrix ranking and poor financial viability) and 7 (low matrix score and very poor financial viability) are unlikely candidates.

Prepared by: Reviewed by:



Audrey Muir, MITE, AFMCSCE
Senior Transportation Engineer
CBCL Limited

Andrew Gates, P.Eng.
VP Infrastructure Services
CBCL Limited

Highway Twinning Feasibility Study - Detailed Feasibility Study
Project Number: 151046.01

Criteria for Screening/Assessment Matrix (FINAL)
Dated January 19, 2017

				Best				Worst								
No.	**Criteria**	**Explanation**	**Score**	**Response Indicators**					**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
				5	**4**	**3**	**2**	**1**	**Highway 101** Three Mile Plains to Falmouth	**Highway 101** Hortonville to Coldbrook	**Highway 103** Exit 5 Tantallon to Exit 12 Bridgewater	**Highway 104** Sutherlands River to Antigonish	**Highway 104** Taylors Road to Aulds Cove	**Highway 104** Port Hastings to Port Hawkesbury	**Highway 104** St. Peter's to Sydney	**Highway 107** Porter's Lake to Duke Street, Bedford
1	Threshold for Twinning a Section of Highway	Based on 10,000 vpd from NSTIR's guidelines.		Traffic volume 12,000 to 15,000 (or more) vpd	Traffic volume 10,000 to 12,000 vpd	Traffic volume 8,000 to 10,000 vpd	Traffic volume 5,000 to 8,000 vpd	Traffic volume is less than 5,000 vpd	5	4	3	3	2	2	1	5
	Weighting								5%	5%	5%	5%	5%	5%	5%	5%
	Final Score								0.25	0.2	0.15	0.15	0.1	0.1	0.05	0.25
2	Cost vs Revenue Delta	The difference between the cost of the project and the amount of revenue that can be generated indicates the projects financial viability. Costs would include capital and OMR.		Revenue exceeds costs by > 50%	Revenue exceeds costs by up to 50%	Revenue = costs	Revenue is up to 15% below costs	Revenue is >25% below costs	5	5	5	5	5	4	1	5
	Weighting								30%	30%	30%	30%	30%	30%	30%	30%
	Final Score								1.5	1.5	1.5	1.5	1.5	1.2	0.3	1.5
3	Maximum Travel Time and Travel Cost Savings	Relates to the population and services being impacted by the construction of a twinned highway on this section (community access, better truck routes). **Based on Opening Year results.**		Cost Savings $60 million plus	Cost Savings $40 million to $60 million	Cost Savings $20 million to $40 million	Cost Savings $5 million to $20 million	Cost Savings $0 million to $5 million	2	4	5	3	2	2	4	4
	Weighting								20%	20%	20%	20%	20%	20%	20%	20%
	Final Score								0.4	0.8	1	0.6	0.4	0.4	0.8	0.8
4	Collision Reduction	This is an estimate of the annual reduction in the number of collisions. This is based on the number of collisions avoided as a result of the twinning. **Based on Opening Year results**.		Collisions reduced by greater than 20	Collisions reduced by between 15 and 20	Collisions reduced by between 10 and 15	Collisions reduced by between 5 and 10	Collisions reduced by less than 5	2	3	5	3	3	1	4	2
	Weighting								30%	30%	30%	30%	30%	30%	30%	30%
	Final Score								0.6	0.9	1.5	0.9	0.9	0.3	1.2	0.6
5	Environmental Issues	Environmental constraints and approval requirements that could delay or significantly limit the project would cause a lower score.		No identified significant environmental constraints	Environmental constraints can be mitigated through application of BMPs.	Provincial environmental assessment and ministerial approval required.	Multi-jurisdictional environmental assessment and approvals required.	Multi-jurisdictional environmental assessment with significant residual environmental constraints.	2	4	2	3	3	3	2	3
	Weighting								10%	10%	10%	10%	10%	10%	10%	10%
	Final Score								0.2	0.4	0.2	0.3	0.3	0.3	0.2	0.3
6	Land Acquisition	Square metres (m2) of land required by NSTIR for a particular highway seciton/corridor.		Less than 500,000 m2	Less than 1,000,000 m2	Less than 5,000,000 m2	More than 5,000,000 m2	More than 10,000,000 m2	5	4	3	4	1	3	3	3
	Weighting								5%	5%	5%	5%	5%	5%	5%	5%
	Final Score								0.25	0.2	0.15	0.2	0.05	0.15	0.15	0.15
	TOTAL OVERALL SCORE								**3.20**	**4.00**	**4.50**	**3.65**	**3.25**	**2.45**	**2.70**	**3.60**
								Check	100%	100%	100%	100%	100%	100%	100%	100%
								% Out of 5	64%	80%	90%	73%	65%	49%	54%	72%
								Ranking out of 8	6	2	1	3	5	8	7	4

APPENDIX A

Willingness to Pay – Survey Methodology

Highway Twinning Feasibility Study
Methodology Report

Prepared by R.A. Malatest & Associates Ltd.

for CBCL Limited and the Nova Scotia Department of Transpiration and Infrastructure Renewal

June 14, 2016

Contents

SECTION 1: Overview

The Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) has commissioned a study to explore the feasibility of twinning, upgrading or constructing eight sections of the 100-series highways. The study is being led by CBCL Limited Consulting Engineers in partnership with specialist consulting firms.

One aspect of the feasibility studies in a toll sensitivity analysis. As a sub-contractor to CBCL, R.A. Malatest & Associates Ltd. (Malatest) conducted a survey of residents of Nova Scotia with respect to their use of the eight corridors and their willingness to pay tolls on these sections if twinning was undertaken. Malatest conducted a total of 1,027 telephone surveys and weighted the data to better represent the distribution of drivers by geography, age group, and gender. The data were provided to HDR Inc. for further analysis.

Malatest also conducted a survey of freight carriers and related businesses regarding their use of the eight corridors and their willingness to pay tolls. A total of 70 telephone and online surveys were conducted and the unweighted data were provided to HDR Inc. for further analysis.

Both surveys also asked respondents their opinions (or their firm's opinions, in the case of the freight carrier survey) on the importance of faster travel times, predictable travel times, and improving safety on Nova Scotia's highways. In addition, the surveys gathered information on residents' and freight carriers' current use of transponders for tolls and their preferences for toll payment methods.

The eight highway corridors of interest to this study are as follows:

Corridor	Highways	Sections
1	101, 1	Three Mile Plains to Falmouth
2	101, 1	Hortonville to Coldbrook
3	103, 3/325/213	Tantallon to Bridgewater
4	104, 4	Sutherland's River to Antigonish
5	104, 4	Taylors Road East of Antigonish to Auld's Cove / Cape Breton Causeway
6	104/4	Port Hastings to Port Hawksebury
7	4, 105	Hwy 4: St. Peter's to Sydney / Hwy 105: Port Hasting to Sydney
8	107, 7/33/111	Porter's Lake to Duke Street in Bedford

This report outlines the survey methodology and the results of survey administration for both the general population survey and the freight carrier survey. The general population survey is addressed first, followed by the freight carrier survey. The survey results, including analysis of respondents' willingness to pay tolls, will be reported separately by HDR Inc.

SECTION 2: Survey of Residents

2.1 Survey Methodology (Residents)

The objective of the survey of residents was to complete at least 1,000 telephone surveys with residents from across Nova Scotia, with some over-sampling of certain areas in order to target sufficient response for each of the eight highway corridors of interest.

2.1.1 Survey Design

The survey was designed in collaboration with HDR Inc, and approved by NSTIR. The survey questionnaire has the following elements:

- Screening questions to screen out respondents who:
  - Do not drive/own a vehicle
  - Have not used the infrastructure in question within the past year
  - Are over the age of 80
  - Are under the age of 18
- Demographics
  - Location (what community do you reside in)
  - Age
  - Gender
  - Occupational status
- Highway usage
  - Use of target highway sections in the past 12 months (with respondents being presented with up to eight sections associated with up to four corridors in or near the respondent's Census Division, drawn from a total of 15 sections associated with the eight corridors)
  - Highway section used most frequently
  - Frequency and purpose of trips on weekdays
- Willingness to pay
  - Random scenario of a shorter trip for the corridor most often used by respondent (alternatively, if one of corridors 5, 6 or 8 was used, even if it was not the most frequently used corridors, these questions may have been asked about this corridor to bolster the number of surveys completed with respect to these corridors), chosen from up to two possible time/distance savings scenarios for each corridor
  - Willingness to pay a high, medium and low value toll for that shorter trip, with sets of high/medium/low values randomly selected from three possible sets for each corridor
- Importance of various aspects of highway improvement
  - Importance of *faster travel times* on a 10 point scale

    - Importance of *predictable travel times* on a 10 point scale
    - Importance of *improving road safety on Nova Scotia's highways* on a 10 point scale
- Toll payment options
    - Current use of a transponder toll collection account
    - Preferred method of paying tolls if implemented
- Comments (if any comments or opinions were volunteered by respondents)

2.1.2 Sampling Plan

Initial survey targets by Census Division and highway corridor were developed based on rankings of the likelihood of usage of corridors presented for each Census Division, and extrapolation of the number of survey completions that might be expected with respect to each corridor across all Census Divisions. After consideration of at theoretical scenario of a survey sample that would be proportionately representative by Census Division, individual Census Division targets were increased or decreased to try boost the number of anticipated survey completions for certain corridors of interest. The optimal target was to obtain at least 200 survey completions for corridors 3 and 8 and at least 100 survey completions for corridors 1, 2, 4, 5, 6, and 7.

While this method initially provided some direction with respect to representation of corridors within a Census Division, adjustments to the targets by Census Division were made periodically throughout survey administration based on the actual incidence within each Census Division of each corridor being chosen for the willingness-to-pay questions.

The sample of telephone numbers included:

- randomly selected listed telephone numbers stratified by Census Division (77% of sample),
- Random Digit Dialling (RDD) telephone numbers stratified by Census Division (13%of sample), and
- randomly selected verified cell phone numbers with telephone exchanges (first three digits after the area code) associated with cell phone rate centres in each Census Division (10% of sample).

2.2 Survey Administration (Residents)

2.2.1 Survey Method

This telephone survey was conducted from March 21 through April 4, 2016. Telephone calls were undertaken primarily between the hours of 17:00 to 21:00 on weekday evenings, 10:00 to 18:00 on Saturdays, and 12:00 to 20:00 on Sundays. Interviewers also were able to set and complete daytime appointments for weekdays Monday through Friday to accommodate respondent preferences, and a toll-free line was made available for respondents to call in should they wish to choose a different time to complete the survey. Surveying was conducted out of Malatest's call centre facility in Ottawa, Ontario.

Throughout survey administration, the CATI (Computer Assisted Telephone Interview) system was used to monitor survey progress by Census Division and corridor. Adjustments were made to survey targets based on the actual percentage a corridor was chosen within a Census Division in order to be representative of actual use. Once reliable proportions of actual corridor use were established during the first few days of surveying, it was possible to undertake more aggressive targeting by Census Division in order to meet survey targets. In order to help meet targets for underrepresented corridors, corridor override programming was enabled in the CATI system. The corridor override was used to boost the of the number of surveys with willingness-to-pay questions asked with respect to corridors that were less commonly selected as the most frequently used (corridors 5, 6, and 8) by overriding the participant's most-frequent corridor scenario with a scenario for one of these lesser used corridors..

2.2.2 Survey Outcome

The following table details the outcome of survey administration. Overall, 1,601 households (including non-qualifiers) completed screening questions, resulting in a valid survey response rate of 22.1%. This yielded 1,027 full surveys with qualified respondents who had travelled on at least one of the corridors of interest in the previous 12 months.

Table 2-1 Survey Call Dispositions

Call Disposition		#	Gross %	Valid %
TOTAL SAMPLE DRAWN		9,516	**100.0%**	
Not in Service	I	2,062	21.7%	-
Fax/Modem Line	I	123	1.3%	-
Non-Residential	I	87	0.9%	-
VALID SAMPLE		7,244	**76.1%**	100%
Busy signal	U	86	0.9%	1.2%
No Answer	U	971	10.2%	13.4%
Answering Machine	U	2,712	28.5%	37.4%
Appointment	U	115	1.2%	1.6%
Call Answered, Call Again	U	659	6.9%	9.1%
Language Barrier	U	14	0.1%	0.2%
Refusal	U	1,050	11.0%	14.5%
Incomplete Survey	U	36	0.4%	0.5%
Non-Qualifier: Non-driver/no vehicle	R	373	3.9%	5.2%
Non-Qualifier: Infrastructure not used	R	139	1.5%	1.9%
Non-Qualifier: age < 18	R	5	0.1%	0.1%
Non-Qualifier: age 80+	R	57	0.6%	0.8%
Completed Surveys	**R**	**1,027**	**10.8%**	**14.2%**

MRIA Response Rate (surveys and nonqualifiers out of valid sample)	***22.1%***

I = Invalid Sample, U = Unresolved, R = Responding Units;
MRIA (Market Research and Intelligence Association) standardized method of calculating Response Rate = R / (R + U)

Table 2-2 shows the distribution of full survey completions with qualified drivers by Census Division and the gross response rate for each.

Table 2-2 Gross Response Rates by Census Division

		Population (2011 Census)		Sampled (Phone Numbers Drawn)		Completed		
Census Division		Count	% of total	Count	% of total	Count	% of total	Gross Response Rate
1	Shelburne	14,496	1.6%	343	3.6%	30	2.9%	**8.7%**
2	Yarmouth	25,275	2.7%	312	3.3%	37	3.6%	**11.9%**
3	Digby	18,036	2.0%	223	2.3%	26	2.5%	**11.7%**
4	Queens	10,960	1.2%	341	3.6%	31	3.0%	**9.1%**
5	Annapolis	20,756	2.3%	284	3.0%	37	3.6%	**13.0%**
6	Lunenberg	47,313	5.1%	457	4.8%	64	6.2%	**14.0%**
7	Kings	60,589	6.6%	230	2.4%	30	2.9%	**13.0%**
8	Hants	42,304	4.6%	723	7.6%	80	7.8%	**11.1%**
9	Halifax	390,328	42.3%	2,562	26.9%	269	26.2%	**10.5%**
10	Colchester	50,968	5.5%	488	5.1%	54	5.3%	**11.1%**
11	Cumberland	31,353	3.4%	708	7.4%	41	4.0%	**5.8%**
12	Pictou	45,643	5.0%	354	3.7%	40	3.9%	**11.3%**
13	Guysborough	8,143	0.9%	202	2.1%	27	2.6%	**13.4%**
14	Antigonish	19,589	2.1%	275	2.9%	41	4.0%	**14.9%**
15	Inverness	17,947	1.9%	155	1.6%	27	2.6%	**17.4%**
16	Richmond	9,293	1.0%	488	5.1%	65	6.3%	**13.3%**
17	Cape Breton	101,619	11.0%	817	8.6%	75	7.3%	**9.2%**
18	Victoria	7,115	0.8%	554	5.8%	53	5.2%	**9.6%**
Total		**921,727**	**100.0%**	**9,516**	**100.0%**	**1,027**	**100.0%**	**10.8%**

The survey target was to obtain approximately 200 survey completions with willingness-to-pay questions asked with respect to corridors 3 and 8 and at approximately 100 survey completions with respect to corridors 1, 2, 4, 5, 6, and 7. Table 2-3 outlines the number of survey completions obtained with respect to each corridor. As illustrated, the survey results were very close to these targets.

Table 2-3 Corridor for which Willingness-to-Pay Questions Asked

Corridor	Surveys
C1: between Three Miles Plain and Falmouth	89
C2: between Hortonville and Coldbrook	107
C3: between Tantallon and Bridgewater	210
C4: between Sutherlands River and Antigonish	78
C5: between Talyor's Road and Aulds Cover	126
C6: between Port Hastings and Hawkesbury	92
C7: between St. Peters and Sydney	90
C8: between Porters' Lake and Bedford	235
Total	**1,027**

2.3 Data Processing (Residents)

2.3.1 Data Cleaning and Coding

Data was extracted from the CATI/CAWI system in SPSS format. The extraction included all completed survey cases, as well as cases for those who did not qualify for the survey for either not driving/owning a vehicle, being over 80 or under 18, or not utilizing the infrastructure.

The following actions was taken with the data post extraction:

- Application of appropriate value and variable labels;
- Updating of Census Division based on city/town responses if different from the Census Division initially assigned;
- Review and correction of outliers in answers regarding the frequency of trips by listening to interview recordings;
- Calculation of weekly equivalency if the number of trips provided was either by month or year; and
- Population of time, distance, and toll value variables presented in the randomly chosen scenarios and randomly chosen sets of toll costs.

2.3.2 Data Weighting

As the survey data were not necessarily representative of the driver population, the data were weighted to better represent the driver population by age, gender, and geography.

The data for completed survey cases (for drivers who reported using at least one of the highway sections of interest) and non-qualified drivers (drivers between 18 and 80 who reported not using at least one of the highway sections of interest) were combined and weighted via the following steps:

- Prepare estimates of the driver population in Nova Scotia, using statistics on the proportions of drivers in 2013 by age and gender applied to Nova Scotia population estimates. [1]
- **Wgt1:** Calculate initial age/gender weight: Apply basic weighting by age/gender (stratified by five age and two gender categories) for the entire sample across Nova Scotia. This is to address sampling-bias and non-response bias that led to under-representation of younger people, over-representation of older people.
- **Wgt2:** Adjust for geography: After applying Wgt1, make an adjustment for geography to control for the over/undersampling by Census Division (18 Census Divisions).
- **Wgt3:** Recalibrate age/gender: After applying Wgt2, rebalance the age/gender weights, which had been thrown off by the geographic weight. This only slightly unbalances distributions by Census Division.

After application of the weighting, analysis of the survey results can be undertaken with the survey completions with qualified drivers who use the highway infrastructure of interest.

It may be noted that the data weights do not necessarily take into account deviations from the provincial average in terms of in age/gender distributions within the different Census Divisions. However, overall, the weighted survey results can be said to be generally representative of the ages, genders, and geographic distributions of all drivers in Nova Scotia.

Taking into account sampling design effects associated with over-/under-sampling and the application of the final data weights, the overall survey results can be estimated to have a maximum margin of sampling error of ±4.4% at a 95% confidence level (19 times out of 20).

The final dataset was provided to HDR Inc. for analysis of the willingness-to-pay responses and other survey questions.

[1] Using data from Transport Canada's *Canadian Motor Vehicle Traffic Collision Statistics 2013* and Statistics Canada *Table 051-0001 - Estimates of population, by age group and sex for July 1, Canada, provinces and territories, annual*.

SECTION 3: Survey of Freight Carriers

3.1 Survey Methodology (Freight Carriers)

The objective of this survey was to complete between 50 and 100 surveys with companies from across Nova Scotia whose primary function is transporting freight or who make logistical decisions on forwarding freight.

3.1.1 Survey Design

The survey was designed with the following elements:

- Firmographics
  - Name of firm
  - Location (in what city or town is your firm located)
  - Local or headquarters location
  - Type of trucking firm
    - For hire carrier
    - For hire operator
    - Private carrier
    - Freight forwarder/freight broker
  - Local or long haul firm
  - Number of employees (those involved in freight transport and all others)
  - Number of power units
  - Type of freight transported
- Highway usage
  - Use of the 15 targetted highway sections associated with the eight corridors of interest in the past 12 months
  - Highway section used most frequently
- Value of road improvements
  - Random scenario of a shorter shipment for the corridor most often used by company (with up to two possible scenarios of distance/time savings for each corridor)
  - Willingness to pay a high, medium and low value toll for that shorter trip (with sets of high/medium/low values randomly selected from three possible sets for each corridor)
- Importance of various aspects of highway improvement
  - Importance of *faster travel times* on a 10 point scale
  - Importance of *predictable travel times* on a 10 point scale

    - Importance of *improving road safety on Nova Scotia's highways* on a 10 point scale
- Toll Payment Options
    - Current use of a transponder toll collection account
    - Preferred method of paying tolls if implemented
- Comments (if any comments or opinions were volunteered by respondents)

The design of the freight carrier survey was more appropriate for completion via an online survey, since the survey asked respondents to identify up to 16 highway sections used and to provide the percentage of all shipments that used each corridor. However, the survey was designed with interview scripts so that it could also be completed over the phone if necessary.

3.1.2 Sampling Plan

A census approach to sampling was taken, with survey invitations extended to all firms in the industries groups categorized by North American Industry Classification System (NAICS) code in table 7-1. In total 341 companies were invited to complete the survey. It may be noted that InfoCanada's NAICS coding may be imprecise at the level of five-digit NAICS, which may explain the apparent disproportion between local and long-distance specialized freight listings.

Table 3-1 Industry Groups included in Survey

NAICS	Description	Info Canada Listings Nova Scotia
48411	General Freight Trucking – Local	59
48422	Other Specialized Freight (Except Used Goods) Trucking, Local	2
48423	Other Specialized Freight (Except Used Goods) Trucking, Long Distance	210
48851	Freight Transportation Arrangement	34
49211	Couriers and Express Delivery Services	36
Total Unique Leads Trucking		**341**

3.2 Survey Administration (Freight Carriers)

3.2.1 Survey Method

A personalized invitation letter was sent to each company in the sample on April 21, 2016. The letter outlined the details of the study and provided an access code and link to the survey. The link to the survey (http://NStrucking.malatest.net) directed respondents to a landing page where they were able to enter their access code and begin the online survey. In an effort to maximize responses, given the limited sample of freight carrier companies in Nova Scotia, firms who were not part of the original

InfoCanada sample were also given provisions to complete the survey without an access code. Those who were sent the invitation could have referred the survey to other contacts within the industry, although such uptake proved to be minimal.

Telephone follow-up was conducted from May 11 through May 22, 2016, with the objective of reaching the appropriately qualified contact at firms that had not yet responded, encouraging them to participate, and ensuring that they had the correct logon information to do so. Telephone interviewers may also have completed the survey interview with respondents over the phone, and were trained on strategies for completing the more complicated questions (e.g., percentage of all shipments on each of 15 highway sections) over the phone. Telephone calls were undertaken primarily between the hours of 9:00 to 17:00 on weekdays. A toll-free line was made available for companies to call in should they wish to choose a different time to complete the survey or if they had any questions about the study. Surveying was conducted out of Malatest's call centre facility in Ottawa, Ontario.

3.2.2 Survey Outcome

The following table details the outcome of survey administration. 82 firms (including non-qualifiers) completed screening questions, resulting in a valid survey response rate of 26.4%. This yielded 70 full surveys (69 with respondents who were in the original InfoCanada sample and one with a respondent who self-recruited).

Table 3-2 Survey Call Dispositions

Call Disposition		#	Gross %	Valid %
TOTAL SAMPLE*		342	100.0%	
Not in Service	I	11	3.2%	-
Fax/Modem Line	I	1	0.3%	-
Residential/Wrong Wrong Number	I	19	5.6%	-
VALID SAMPLE		311	90.9%	100%
Busy signal	U	1	0.3%	0.3%
No Answer	U	32	9.4%	10.3%
Answering Machine	U	79	23.1%	25.4%
Appointment	U	6	1.8%	1.9%
Call Answered, Call Again	U	75	21.9%	24.1%
Refusal	U	34	9.9%	10.9%
Incomplete Survey	U	2	0.6%	0.6%
Non-Qualifier (not involved in trucking, freight subcontracted out, etc.)	**R**	**12**	**3.5%**	**3.9%**
Completed Surveys	**R**	**70**	**20.5%**	**22.5%**
MRIA Response Rate				***26.4%***

*Includes 341 listings from InfoCanada and one self-recruit referred by another respondent.
I = Invalid Sample, U = Unresolved, R = Responding Units;
MRIA (Market Research and Intelligence Association) standardized method of calculating Response Rate = R / (R + U)

3.3 Data Processing (Freight Carriers)

Data were extracted from the CATI/CAWI system in SPSS format. The extraction included all 70 completed survey cases.

The following action was taken with the data post extraction:

- Application of appropriate value and variable labels;
- Review of response data to verify completion of relevant questions and that responses were in range; and
- Population of time, distance and toll value variables presented in the randomly chosen scenarios and sets of toll values.

The data for the freight carrier survey were not weighted prior to provision to HDR Inc. for analysis.

APPENDIX B

Willingness to Pay – Toll Methodology

Memo

Date:	Sunday, May 01, 2016
Project:	NSTIR Highway Twinning Feasibility Study
To:	Carl Wong
From:	May Raad
Subject:	Drivers' Willingness to Pay Study Results

I. Introduction

HDR conducted a willingness to pay (WTP) study of the general population of drivers in Nova Scotia (those with driver's licenses) to estimate their willingness to pay for toll and value of time (VOT). The WTP study encompassed eight corridors of interest across Nova Scotia. The Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) is researching the potential for building toll roads in the following corridors:

1. Highway 101 – Three Mile Plains to Falmouth, 9.5 km;
2. Highway 101 – Hortonville to Coldbrook, 24.7 km;
3. Highway 103 – Exit 5 at Tantallon to Exit 12 Bridgewater, 71 km;
4. Highway 104 – Sutherlands River to Antigonish, 37.8 km;
5. Highway 104 – Taylors Road to Aulds Cove, 38.4 km;
6. Highway 104 – Port Hastings to Port Hawkesbury, 6.75 km;
7. Highway 104 – St. Peters to Sydney, 80 km; and,
8. Highway 107 – Porter's Lake to Duke Street, Bedford, 33 km.

The data required to estimate WTP came from a telephone survey designed and conducted by the research team. The survey randomly contacted households in all census divisions in Nova Scotia with the goal of having 1,000 eligible adults complete the survey. The total surveys were distributed over the corridors such that *approximately* 100 survey completions were targeted for each of the corridors 1, 2, 4, 5, 6, 7 and 200 survey completions were targeted each for corridors 3 and 8. Provided the responding person had a driver's license, was over the age of 18 and had used at least one of the corridors of interest within his/her community, he or she was invited to complete the survey. Upon the close of the survey, 1,027 respondents who qualified to do the survey completed it.

HDR is interested to measure automobile WTP in cents per km from the interviewed respondents to improve travel times across any of the above corridors. An important derivative of the WTP estimate is the value of time (VOT) drivers place on travel time savings.

II. Willingness to Pay Studies

Traditionally, stated preference (SP) studies are used to produce models which forecast demand for toll as a function of toll cost and trip times and traveller details such as income and household size. However, the stated preference modelling approach is out of scope for this study. HDR drew from the modelling techniques used in WTP studies as budget and project time lines were limited.

WTP studies, as with stated preference studies, are based on the principles of contingent valuation, i.e. a method of estimating the value that a person places on a good or service. WTP studies test a person's sensitivities to various price points by first offering a price suggestion of 'medium' value and then depending on whether the respondent says yes or no to that medium price, is then offered a different price. If the respondent said yes to the medium price suggestion, the study then asks if they would pay a suggested higher price. If the respondent said no to the medium suggested price, then the study would offer a suggested lower price.

Contingent valuation studies such as WTP or SP studies go beyond the abilities of simple opinion surveys which ask how much would one pay for a toll road and leaves it to the respondent to enter a price. Studies which ask outright how much a person would pay for toll road are unreliable as answers tend to be skewed against paying any toll even though there are obvious economic benefits to users.

III. Willingness to Pay Design

In the introduction of the survey, the respondents were told that the purpose of the survey is to explore interest in improving travel times and safety on major highways in Nova Scotia. The concept of paying toll was not introduced until the end of survey and after the WTP experiments so as not to bias the experiments as people generally have negative attitudes towards toll.

Before being presented with the WTP experiments, the respondents were reminded again that improving existing roads, twinning roads, and building new roads can help improve travel times. A definition of 'twinning road sections' was provided once more which included the benefits of improved safety for all road users.

Respondents were provided with a plausible trip scenario which traversed the span of their reference corridor. They were provided with its trip length in kilometers and its trip travel time in minutes. Then they were presented with another plausible trip scenario for the same corridor but the length of the trip was shorter and travel time was shorter by a certain number of minutes. The amount of travel time savings was provided to them. Finally, they were then presented with plausible monetary amounts and asked if those time savings on the new route would be worth that amount.

The monetary amounts were based on fixed toll costs per km travelled in the new route. Three different amounts were pre-calculated in the survey tool for each of the eight corridors and their scenarios. The amounts reflected a range of costs which reflected plausible low to high payments. The respondent was always provided first with the medium cost and then depending on whether the respondent said no/yes to the medium cost, the respondent would then be asked if he/she would pay the lower/higher value.

A respondent has four possible outcomes in the WTP study. He/she either says 1. No to the medium price and no the lower price, 2. No to the medium price and yes to the lower price, 3. Yes to the medium price and no to the higher price and 4. Yes to the medium price and yes to the higher price.

HDR produced three different WTP experiments to add variability in the responses across the respondents. Respondents were matched to a particular version in a random fashion. The price points for each value level and each version are in Table 1.

Table 1: Toll Price WTP Values (cents/km)

Survey Version	Median	High	Low
Version 1	10	14, 16, 17	5
Version 2	5	6, 7	3
Version 3	5	10	3

Depending on the corridor each respondent was asked to consider in the WTP experiment, the price suggestions in cents/km in Table 1 were converted to trip toll prices based on the distance travelled in the corridor. This was done to demonstrate the total cost a respondent would have to value if they were to take the route suggested in the survey as opposed to the reference route. For example, if the respondent was asked to consider the valuation to take a new route in corridor 1 which was 9.5 km for a time savings of 9 minutes and was presented with version 1 of the WTP experiments, then the medium, high, low toll trip values would be 95 cents, $1.50, 50 cents, respectively. (The values are not always exactly the product of the suggested cost per km toll times the distance due to rounding). The full set of possible toll trip prices per corridor and WTP version is in Table 2 below.

Table 2: Toll Trip Price Values (cents/km)

Corridor	Random Version	Medium Value	High Value	Low Value
1	1	95 cents	$1.50	50 cents
1	2	50 cents	60 cents	30 cents
1	3	50 cents	95 cents	30 cents
2	1	$2.50	$4.00	$1.25
2	2	$1.25	$1.50	75 cents
2	3	$1.25	$2.50	75 cents
3	1	$6.75	$11.00	$3.50
3	2	$3.50	$4.50	$2.25
3	3	$3.50	$6.75	$2.25

Corridor	Random Version	Medium Value	High Value	Low Value
4	1	$4.00	$6.50	$2.00
4	2	$2.00	$2.50	$1.25
4	3	$2.00	$4.00	$1.25
5	1	$4.00	$6.50	$2.00
5	2	$2.00	$2.50	$1.25
5	3	$2.00	$4.00	$1.25
6	1	70 cents	$1.00	35 cents
6	2	35 cents	50 cents	20 cents
6	3	35 cents	70 cents	20 cents
7	1	$8.50	$14.00	$4.00
7	2	$4.00	$5.50	$2.75
7	3	$4.00	$8.50	$2.75
8	1	$3.25	$5.50	$1.50
8	2	$1.50	$2.25	$1.00
8	3	$1.50	$3.25	$1.00

Corridors 1, 2, 3, 4, 5, and 8 have two competing routes or 'scenarios' to a proposed toll route. Respondents questioned about those corridors were randomly presented with either scenario 1 or scenario 2 as the reference route when considering the value of the proposed 'new' route with faster travel times. The presentation of either scenario 1 or scenario 2 was done in a random fashion. Table 3 below provides a description and road length of each corridor's reference scenario. Because of differing expected travel speeds on these reference routes, time savings from traveling on the new proposed route vary and are provided in the same table.

Table 3: Description of Road Scenarios

Corridor	Scenario	Description	Presented Distance of Reference Route	Time Savings of New Route
1	1	The section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	9.5	1
1	2	The section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or The Evangeline Trail	10	9
2	1	The section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	24.5	4

Corridor	Scenario	Description	Presented Distance of Reference Route	Time Savings of New Route
2	2	The section of Highway 1 from Hortonville to Coldbrook, known as The 'Old Highway 1' or the Evangeline Trail	24.5	28
3	1	The section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	68	8
3	2	The sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or The Lighthouse Route	85	56
4	1	The section of Highway 104 (The TransCanada) from Sutherlands River (Exit 27) to Antigonish	38	2
4	2	The sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	42	20
5	1	The section of Highway 104 (The TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	40	4
5	2	The section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as The 'Old Highway 4' or the Sunrise Trail	35	15
6	1	The sections of either Highways 104 or 4, known as The 'Old Highway', which stretch from Port Hastings (at The roundabout near the Cape Breton Causeway) to Port Hawkesbury	8	5
7	1	The sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	88	25
8	1	The section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	39	27
8	2	The sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia, known as the 'Old Highway 7'	38	31

IV. Study Results

Upon completion of the study, the outcomes from the WTP experiments per version over all qualified respondents are summarized in Table 4.

Table 4: Count of Survey Respondents by WTP Outcome

Survey Version	(1) Not WTP low	(2) WTP at least low but less than medium	(3) WTP at least medium but less than high	(4) WTP high	Total
Version 1	136	46	97	72	351
Version 2	153	22	60	116	351
Version 3	120	26	92	87	325
Total	409	94	249	275	1027

HDR used regression algorithms for censored data[1] to find a mathematical function which would best explain the patterns in the data responses as a function of toll price per km. Since the experiments have one lower and one upper price suggestion, it is not known how much higher or how much lower the price would have to be before it was accepted. In other words, the experiments are censored since we know only either a range or upper or lower limits for WTP. The true values are 'censored' since they were not presented.

For example, for those respondents who said it would be worth the high value of $1.50 to travel 9.5 km in corridor 1, there is very much the possibility they could value it at a higher cost. Hence the need for regression models which accommodate censorship. The advantage of such models is that probabilities of valuing at least a certain price can be modelled without the need to continually experiment with differing higher or lower prices.

The algorithms output the median WTP for a given corridor and scenario. The median WTP estimate is that value such that 50 percent or more of the referenced population will pay at least that value and 50 percent are WTP less than that amount given the presented gains in time savings. HDR weighted the scenario responses to produce aggregated estimates at the corridor level. Table 5 presents the median WTP aggregated at the corridor level with the corridor level VOT estimate.

[1] Hintze, J. (2013). NCSS 9. NCSS, LLC. Kaysville, Utah, USA. www.ncss.com. See Chapter 550 Distribution (Weibull) Fitting.

Table 5: Median WTP and VOT Estimates per Corridor and for Nova Scotia.

Corridor	Median WTP Estimated (cents/km)	VOT Estimate ($/hour)
1	3.76	$14.43
2	6.70	$13.32
3	5.33	$11.75
4	8.38	$34.21
5	4.40	$13.63
6	6.41	$7.37
7	10.03	$13.78
8	5.82	$4.05
Nova Scotia	5.90	$11.76

In general, drivers in Nova Scotia are willing to pay 6 cents/km and their estimated VOT is $12/hour. This is an estimate of the individual VOT extrapolated to the adult population in Nova Scotia with driver's licenses. This value is within range of what would be expected using the U.S. Department of Transportation's (USDOT) 2014 *Guidance on Valuation of Travel Time in Economic Analysis*[2].

The USDOT recommends estimating general value of travel time savings by taking 50 percent of a jurisdiction's median household income and dividing by the total number of annual work hours. The median household income for Nova Scotia as of 2013 from Statistics Canada is $70,020[3]. In 2016 dollars, that amounts to $72,869.

Using the guidance's approach, the VOT estimate at the household level for Nova Scotia is $17.50. This study's estimate of $12/hour is reasonable given that it is at the individual level and on average there is more than one earner per household. The USDOT Guidance mentions that if there is more than one traveller in a vehicle, then their value of travel time savings are independent and additive and not necessarily identical to that of the driver (see page 5 of guidance).

HDR also obtained an estimate of the individual median income in Nova Scotia as of 2013[4] and extrapolated to 2016 yielding a value of $30,503. Since the median income includes both full time and part time workers, to obtain an average hourly annual rate, one needs to divide by an estimate of average annual hours actually worked. For Canada this is 1,704 hours[5]. If we assume that average annual hours worked in Nova Scotia are close to the national average, then the individual's VOT in Nova Scotia using the USDOT approach yields an estimate of

[2] https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic, accessed May 1, 2016.
[3] http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/famil108a-eng.htm, accessed May 1, 2016

[4] http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/index.cfm?Lang=E
[5] https://stats.oecd.org/Index.aspx?DataSetCode=ANHRS

$9/hr. This value is comparable to the study's estimate of $12/hr for individual VOT at the provincial level.

Comments

At the corridor level, corridor 8's VOT is lower than expected given the observed levels of congestion during weekday peak travel times. The time savings which the new proposed route has over the two reference trips is approximately 30 minutes each (see Table 3); however, the valuation of these time savings is low, averaging $4/hour for the entire corridor. This lower value of time is possibly due to the type of respondents who agreed to participate in the study. While the method to contact households by telephone was random, those who actually had wanted to participate may not be representative of all those who use corridor 8 for commuting. Employed persons due to busy schedules may not have the motivation to answer a telephone or may have unlisted phone numbers. Future studies targeting corridor 8 commuters should consider and budget for either a large mail-out survey or work with existing survey panel lists with known commuter members.

Corridor 4's higher than expected VOT stems from the median WTP of 6 cents/km to save only 2 minutes on a 40 km distance trip for those who had to consider the scenario 1 route versus the new proposed route. The toll of just over $2 for the trip appeared to provide good value for any type of time savings. Generally, within those corridors with two scenarios, HDR observed that the scenarios with the modest time savings (less then 9 minutes) had significantly higher VOT estimates than the estimates derived for those scenarios with greater time savings (9 minutes or more).

A possible reason for the higher estimated VOT for those presented with the modest time savings is that even though the time savings were generally low (ranging from 1 to 8 minutes) the respondents may have factored in the safety aspect implied with the new route. For an average trip cost of less than two dollars ($1.75) which is essentially pocket change these days, the cost provided good value for the combined benefits of reduced travel times (even though small) and implied improved road safety. This safety benefit would also have factored into the valuation in the scenarios with the greater travel time savings; however, while the median WTP per km is higher for these groups, the rate of increase in the WTP per km with increasing travel time savings drops. The weighted average of $12/hour of the VOT estimates over all the scenarios provides an estimate which represents the valuation of travel time savings of the respondents and as well, falls within the expected VOT for this population based on the guidelines from the USDOT.

APPENDIX C

Willingness to Pay – Freight Survey

Memo

Date:	Friday, June 10, 2016
Project:	NSTIR Highway Twinning Feasibility Study
To:	Carl Wong
From:	May Raad
Subject:	Freight Willingness to Pay and Value of Time Study Results

I. Introduction

HDR conducted a willingness to pay (WTP) study of transportation firms who ship goods in Nova Scotia to estimate their willingness to pay for toll and value of time (VOT). Contact information on these businesses was obtained using InfoCanada's business database for companies which fall under the following North American Industrial Classification System (NAICS) categories of specialized freight trucking or NAICS code 4842, general freight trucking or NAICS code 4841, freight transportation arrangement or NAICS code 48851 and courier and express delivery or NAICS code 49211. Companies which belong to the latter category were included in the study since timeliness of shipments is an important factor in the success of their business operations. Examples of companies which fall under freight transportation arrangement category are freight forwarders or customs brokers.

Initially, the research team contacted 341 companies which matched the selection criteria mentioned above and invited them to participate in the study. We asked that a person knowledgeable about typical shipments and who can make routing decisions based on transit times or shipment costs complete the survey. Of the 341 companies contacted, 70 completed the survey; however, four were dropped from further analysis. Three of the four were dropped since their main line of business was not as a freight carrier, freight forwarder or courier. The remaining respondent was dropped as another respondent from the same firm had completed the study and both had provided very similar responses. The numbers of respondents by NAICS category are in Table 1.

Table 1: Breakdown of Respondents by NAICS Category

NAICS Category	Number of Respondents
Specialized Freight (4842)	43
General Freight (4841)	9
Freight Transportation Arrangement (48851)	7
Couriers and Express Delivery Services (49211)	7
Total	**66**

The WTP study encompassed eight corridors of interest across Nova Scotia. The Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) is researching the potential for building toll roads in the following corridors:

1. Highway 101 – Three Mile Plains to Falmouth, 9.5 km;
2. Highway 101 – Hortonville to Coldbrook, 24.7 km;
3. Highway 103 – Exit 5 at Tantallon to Exit 12 Bridgewater, 71 km;
4. Highway 104 – Sutherlands River to Antigonish, 37.8 km;
5. Highway 104 – Taylors Road to Aulds Cove, 38.4 km;
6. Highway 104 – Port Hastings to Port Hawkesbury, 6.75 km;
7. Highway 104 – St. Peters to Sydney, 80 km; and,
8. Highway 107 – Porter's Lake to Duke Street, Bedford, 33 km.

HDR is interested to measure freight WTP in cents per km from the interviewed respondents to improve travel times across any of the above corridors. An important derivative of the WTP estimate is the value of time (VOT) these firms place on travel time savings.

II. Willingness to Pay Studies

Traditionally, stated preference (SP) studies are used to produce models which forecast demand for toll as a function of toll cost and trip times and traveller details such as income and household size. However, the stated preference modelling approach is out of scope for this study. HDR drew from the modelling techniques used in WTP studies as budget and project time lines were limited.

WTP studies, as with stated preference studies, are based on the principles of contingent valuation, i.e. a method of estimating the value that a person places on a good or service. WTP studies test a person's sensitivities to various price points by first offering a price suggestion of 'medium' value and then depending on whether the respondent says yes or no to that medium price, is then offered a different price. If the respondent said yes to the medium price suggestion, the study then asks if they would pay a suggested higher price. If the respondent said no to the medium suggested price, then the study would offer a suggested lower price.

Contingent valuation studies such as WTP or SP studies go beyond the abilities of simple opinion surveys which ask how much would one pay for a toll road and leaves it to the respondent to enter a price. Studies which ask outright how much a person would pay for toll road are unreliable as answers tend to be skewed against paying any toll even though there are obvious economic benefits to users.

While numerous research studies exist which use contingent valuation methods to measure demand for toll from the general population, those which focus on freight carrier demand for toll are less frequent. This is because of the highly complex nature related to the decision making of one or more stakeholders in the planning of travel routes for shipments.

Given the smaller scope of this freight WTP study, the expectation is that the estimates will be indicative of the interviewed firms' WTP to pay for toll and their value of time.

III. Willingness to Pay Design

In the introduction of the survey, the respondents were told that the purpose of the survey is to explore interest in improving travel times and safety on major highways in Nova Scotia. The concept of paying toll was not introduced until the end of survey and after the WTP experiments so as not to bias the experiments as people generally have negative attitudes towards toll.

Before being presented with the WTP experiments, the respondents were reminded again that improving existing roads, twinning roads, and building new roads can help improve travel times. A definition of ‘twinning road sections’ was provided once more which included the benefits of improved safety for all road users.

Respondents were provided with a plausible trip scenario which traversed the span of their reference corridor. They were provided with its trip length in kilometers and its trip travel time in minutes. Then they were presented with another plausible trip scenario for the same corridor but the length of the trip was shorter and travel time was shorter by a certain number of minutes. The amount of travel time savings was provided to them. Finally, they were then presented with plausible monetary amounts and asked if those time savings on the new route would be worth that amount.

The monetary amounts were based on fixed toll costs per km travelled in the new route. Three different amounts were pre-calculated in the survey tool for each of the eight corridors and their scenarios. The amounts reflected a range of costs which reflected plausible low to high payments. The respondent was always provided first with the medium cost and then depending on whether the respondent said no/yes to the medium cost, the respondent would then be asked if he/she would pay the lower/higher value.

A respondent has four possible outcomes in the WTP study. He/she either says 1. No to the medium price and no the lower price, 2. No to the medium price and yes to the lower price, 3. Yes to the medium price and no to the higher price and 4. Yes to the medium price and yes to the higher price.

HDR produced three different WTP experiments to add variability in the responses across the respondents. Respondents were matched to a particular version in a random fashion. The price points for each value level and each version are in Table 2.

Table 2: Toll Price WTP Values (cents/km)

Survey Version	Median	High	Low
Version 1	10	16, 17	5
Version 2	5	6, 7	3
Version 3	5	10	3

Depending on the corridor each respondent was asked to consider in the WTP experiment, the price suggestions in cents/km in Table 2 were converted to trip toll prices based on the distance travelled in the corridor. This was done to demonstrate the total cost a respondent would have to value if they were to take the route suggested in the survey as opposed to the reference route. For example, if the respondent was asked to consider the valuation to take a new route in corridor 1 which was 9.5 km for a time savings of 9 minutes and was presented with version 1 of the WTP experiments, then the medium, high, low toll trip values would be 95 cents, $1.50, 50 cents, respectively. (The values are not always exactly the product of the suggested cost per km toll times the distance due to rounding). The full set of possible toll trip prices per corridor and WTP version is in Table 3 below.

Table 3: Toll Trip Price Values (cents/km)

Corridor	Random Version	Medium Value	High Value	Low Value
1	1	95 cents	$1.50	50 cents
1	2	50 cents	60 cents	30 cents
1	3	50 cents	95 cents	30 cents
2	1	$2.50	$4.00	$1.25
2	2	$1.25	$1.50	75 cents
2	3	$1.25	$2.50	75 cents
3	1	$6.75	$11.00	$3.50
3	2	$3.50	$4.50	$2.25
3	3	$3.50	$6.75	$2.25
4	1	$4.00	$6.50	$2.00
4	2	$2.00	$2.50	$1.25
4	3	$2.00	$4.00	$1.25
5	1	$4.00	$6.50	$2.00
5	2	$2.00	$2.50	$1.25
5	3	$2.00	$4.00	$1.25
6	1	70 cents	$1.00	35 cents
6	2	35 cents	50 cents	20 cents
6	3	35 cents	70 cents	20 cents
7	1	$8.50	$14.00	$4.00
7	2	$4.00	$5.50	$2.75
7	3	$4.00	$8.50	$2.75
8	1	$3.25	$5.50	$1.50
8	2	$1.50	$2.25	$1.00
8	3	$1.50	$3.25	$1.00

Corridors 1, 2, 3, 4, 5, and 8 have two competing routes or ‘scenarios’ to a proposed toll route. Respondents questioned about those corridors were randomly presented with either scenario 1 or scenario 2 as the reference route when considering the value of the proposed ‘new’ route with faster travel times. The presentation of either scenario 1 or scenario 2 was done in a random fashion. Table 4 below provides a description and road length of each corridor’s reference scenario. Because of differing expected travel speeds on these reference routes, time savings from travelling on the new proposed route vary and are provided in the same table.

Table 4: Description of Road Scenarios

Corridor	Scenario	Description	Presented Distance of Reference Route	Time Savings of New Route
1	1	The section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	9.5	1
1	2	The section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or The Evangeline Trail	10	9
2	1	The section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	24.5	2
2	2	The section of Highway 1 from Hortonville to Coldbrook, known as The 'Old Highway 1' or the Evangeline Trail	24.5	26
3	1	The section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	68	5
3	2	The sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or The Lighthouse Route	85	53
4	1	The section of Highway 104 (The TransCanada) from Sutherlands River (Exit 27) to Antigonish	38	3
4	2	The sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	42	18
5	1	The section of Highway 104 (The TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	40	2
5	2	The section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as The 'Old Highway 4' or the Sunrise Trail	35	13
6	1	The sections of either Highways 104 or 4, known as The 'Old Highway', which stretch from Port Hastings (at The roundabout near the Cape Breton Causeway) to Port Hawkesbury	8	5

Corridor	Scenario	Description	Presented Distance of Reference Route	Time Savings of New Route
7	1	The sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	88	19
8	1	The section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	39	26
8	2	The sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia, known as the 'Old Highway 7'	38	30

IV. Study Results

Upon completion of the study, the outcomes from the WTP experiments per version over all qualified respondents are summarized in Table 5.

Table 5: Count of Survey Respondents by WTP Outcome

Survey Version	(1) Not WTP low	(2) WTP at least low but less than medium	(3) WTP at least medium but less than high	(4) WTP high	Total
Version 1	4	2	7	5	18
Version 2	4	2	4	13	23
Version 3	8	2	8	7	25
Total	16	6	19	25	66

HDR used regression algorithms for censored data[1] to find a mathematical function which would best explain the patterns in the data responses as a function of toll price per km. Since the experiments have one lower and one upper price suggestion, it is not known how much higher or how much lower the price would have to be before it was accepted. In other words, the experiments are censored since we know only either a range or upper or lower limits for the WTP. The true values are 'censored' since they were not presented.

For example, for those respondents who said it would be worth the high value of $1.50 to travel 9.5 km in corridor 1, there is very much the possibility they could value it at a higher cost. Hence

[1] Hintze, J. (2013). NCSS 9. NCSS, LLC. Kaysville, Utah, USA. www.ncss.com. See Chapter 550 Distribution (Weibull) Fitting.

the need for regression models which accommodate censorship. The advantage of such models is that probabilities of valuing at least a certain price can be modelled without the need to continually experiment with differing higher or lower prices.

HDR presented each respondent with a corridor they said they frequently used as part of the WTP experiments. The final samples sizes on a per corridor basis as shown in Table 6 are low given an overall final sample size of 66 respondents. The WTP estimates at the corridor level are not possible due to the small samples. HDR observed a pattern however of significantly different WTP estimates between travel time savings that were less than 10 minutes and those that were 10 minutes or larger. HDR aggregated the respondents by level of time savings in Table 7.

Table 6: Count of Survey Respondents by WTP Outcome

Corridor	Scenario	Presented Time Savings	Number of Respondents
1	1	1	2
1	2	9	4
2	1	2	5
2	2	26	3
3	1	5	6
3	2	53	12
4	1	3	6
4	2	18	3
5	1	2	0
5	2	13	1
6	1	5	1
7	1	19	16
8	1	26	7
8	2	30	0
Total			**66**

Table 7: Count of Survey Respondents by Time Savings Category

Time Savings Category	Number of Respondents
Modest Time Savings (<10 minutes)*	20
Greater Time Savings (>= 10 minutes)**	46
Total	**66**

*Corridor scenarios 11, 12, 21, 31, 41, 61, **Corridor scenarios 22, 32, 42, 52, 71, 81

The algorithms output the median WTP for a given time savings category. The median WTP estimate is that value such that 50 percent or more of the referenced population will pay at least that value and 50 percent are WTP less than that amount given the presented gains in time savings. Table 8 presents the estimated median WTP and VOT for each time savings category.

Table 8: Median WTP and VOT Estimates per Time Savings Category and for Nova Scotia.

Time Savings Category	Median WTP Estimate (cents/km)	VOT Estimate ($/hour)
Modest Time Savings (<10 minutes)	5.0	$24.68
Greater Time Savings (>= 10 minutes)	10.4	$12.61
Nova Scotia	8.7	$17.00

In general, 50 percent of the surveyed freight carriers based in Nova Scotia are willing to pay **9 cents/km or more** (50 percent are WTP less than 9 cents) and their estimated VOT is $17/hour.

The U.S. Department of Transportation's (USDOT) 2014 *Guidance on Valuation of Travel Time in Economic Analysis*[2] does not provide guidance on estimating VOT for freight transportation as it is highly complex. The freight VOT consists of three main components: the VOT savings for the operator/driver, the savings of vehicle operating costs and the value of time savings to the freight carried. With respect to the latter component, examples of factors to consider are interest cost due to unproductive capital while freight is in transit, value and composition of freight, rate of obsolescence, rate of spoilage, amount of inventory and likelihood of running out of inventory because of delays, among other factors.

Nonetheless, researchers have attempted to study freight value of time using stated preference techniques. The amount of literature related to estimating the VOT in freight transportation is minimal comparted to that of the general population of travellers mainly due to the complexity of setting up the experimental design for this group and accessing the targeted decision makers in the freight transportation industry. In many of the larger transportation firms, multiple persons can be involved in route planning for a particular shipment(s).

HDR reviewed available literature in freight value of time savings and found that the VOT estimates greatly vary. For example a 2011 SP study (Komoanduri, A., et al, 2011[3]) presents freight value of time estimates for shipments across the Hudson moving into the greater New York Metropolitan area. The authors estimated truck VOT savings from $2.40 to $106.20 ($US) per hour depending on the type of commodity transported, the value of shipment and expected trip length.

Since this study's WTP questions only focused on valuing simple time savings for relatively short trip distances (9.5 km to 85 km), the resulting estimate of $17/hour, while lower than expected, is reasonable. HDR believes if additional factors such as level of reliability, the total distance the shipment travels, and the composition of the shipment were included into the design and importantly, a larger sample size of respondents was surveyed; the estimate for the

[2] https://www.transportation.gov/office-policy/transportation-policy/revised-departmental-guidance-valuation-travel-time-economic, accessed May 1, 2016.
[3] Komanduri, Anurag, Sashank Musti and Kimon Proussaloglou (2011) "Modeling Values of Time to Support Freight Decision-Making: Results from a Stated Preference Survey in New York", extracted on June 6, 2016 from http://onlinepubs.trb.org/onlinepubs/conferences/2012/4thITM/Papers-A/0117-000088.pdf.

Nova Scotia freight VOT could be higher. Based on the VOT estimate of $17/hour, at the very least, this estimate captures the savings for drivers' costs since the average hourly wage for truck drivers in Canada is about $21/hour[4]. A review of the trucker salaries in Nova Scotia posted on the Government of Canada's Job Bank shows salaries in the range of $13 to $19 per hour[5].

Comment

HDR observed that the estimated median WTP of 5 cents/km for modest time savings (savings of less than 10 minutes for the same trip) is lower than the estimated median WTP of 10 cents/km for the greater time savings (savings of 10 minutes for more for the same trip). This is a logical outcome as travellers would value greater time savings at a higher rate than modest time savings for the same trip.

Interestingly, when the estimated median WTP in cents/km is converted back to the estimated toll that respondents would pay for the average of the distances presented over the different corridor scenario distances and compared to the averaged travel time savings, the estimated VOT of $25/hour for the modest time savings category is significantly higher than the estimated VOT of $13/hour for trips taken in corridor scenarios with the greater time savings category[6].

A possible reason for the higher estimated VOT for those presented with the modest time savings is that even though the time savings were generally low (average of time savings of 4 minutes) the respondents may have factored in the safety aspect implied with the new route. For an average trip cost of less than two dollars ($1.73) which is essentially pocket change these days, the cost provided good value for the combined benefits of reduced travel times and implied improved road safety. This safety benefit would also have factored into the valuation in the scenarios with the greater travel time savings; however, while the median WTP per km is higher for this group, the rate of increase in the WTP per km with increasing travel time savings drops. The weighted average of $17.00/hour of the two types of VOT estimates provides an estimate which represents the valuation over all the presented time savings scenarios.

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[4] The average annual trucker salary in Canada in 2010 dollars is $40,700. Assuming a 40 hour work week or 2,080 hours per year, the average salary on an hourly basis is $19.57/hour. (In 2016 dollars, $21.33/hour). http://www.servicecanada.gc.ca/eng/qc/job_futures/statistics/7411.shtml, accessed on June 4, 2016.

[5] http://www.jobbank.gc.ca/job_search_results.do?page=1&d=50&fprov=12&sort=M&action=s0&lang=en&fn=7411&sid=20, accessed on June 6, 2016

[6] For example, the average (weighted by respondents) of the distances presented in the scenarios with the modest time savings is 34.6 km and the average for the greater time savings is 62.7 km. The average of the time savings for the modest time savings scenarios is 4.2 minutes while the average for the greater time savings scenarios is 31 minutes. Given that the estimated median VOT for the modest time savings scenarios is 5 cents/km, the average toll amounts to $1.73 = 5 cents * 34.6 km. If people are WTP $1.73 to save 4.2 minutes, their VOT on an hourly or 60 minute basis is $1.73 * 60 minutes/4.2 minutes or $24.68/hour. With respect for the greater time savings scenarios, the median toll is 10.40 cents * 62.7 km = $6.52. The estimated VOT is $6.52 * 60 minutes/31 minutes = $12.61.

APPENDIX D

Willingness to Pay – Survey Analysis (General Population)

Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR)

–General Population Willingness to Pay Survey Analysis - Draft

Introduction

This draft report presents a summary of HDR's findings from the Willingness to Pay Survey.

To that end, it is comprised of two sections:

- Survey summary, identifying the number of valid and useful responses received for each question; and
- Survey results, providing cross-tabulations summarizing the observed relationships between key surveyed variables, including census division, corridor use, occupation, age gender, travel purpose, travel time importance, willingness to pay, toll payment preferences, and having a transponder for a toll collection account.

Full tabulations of the breakdown or responses to each question, and a description of the survey process, are provided separately.

Survey Summary

The following tables indicate the number of valid survey responses (not including “no response“, “prefer not to say” or “don’t know”) received for each question and the frequency of each type of response. The responses in Table 1-1 display the raw counts while the responses in Tables 1-2 to 1-5 display the weighted counts by age, gender, and county. The 18-29 age group was pooled with the 30-44 group as the sample size was very small (put in the number those responding in this age category). Extrapolating results to represent all 18-29 year olds from those few respondents would introduce bias into the survey’s estimates. The respondents were presented with a subset of corridors based on the census division they were in.

Table 1-3 displays the frequency of trips on the highway section respondents used the most frequently. The first part of the table displays the number of times respondents use the highway section in question. The average amount of times the highway section is used weekly is 14. This is a reasonable number for those commuting to and from work on a daily basis. Most of the respondents (39 percent) frequent the highway section of interest annually an average of 41 times. The second part of the table summarizes the travel purpose for the frequently used highway. Personal trips appear to be the main reason for using the frequently used highway section. The majority of the respondents (72 percent) said that they use the highway section in question for personal business. Only 12 percent said they used it for commuting. On average, respondents use the primary highway section for personal business 89 percent of the time.**Table 1-1: Part A Responses**

Screening/Personal Details	Valid Responses	Response	Frequency
QA1 We would like to speak to licensed drivers who drive a vehicle (car, van, truck). Does this apply to you?	1601	Yes	76.6%
		No	23.4%
QA2 What community do you reside in?	1175	Shelburne	2.8%
		Yarmouth	3.5%
		Digby	2.4%
		Queens	2.8%
		Annapolis	3.2%
		Lunenberg	5.5%
		Kings	2.6%
		Hants	7.6%
		Halifax	25.6%
		Colchester	6.7%
		Cumberland	6.9%
		Pictou	4.1%
		Guysborough	2.3%
		Antigonish	3.7%
		Inverness	2.3%
		Richmond	6.1%
		Cape Breton	6.7%
		Victoria	5.1%
QA3 In which of the following ranges is your age?	1196	Under 18	0.4%
		30-44	18.1%
		45-64	45.7%

		65-79	30.9%
		80+	4.8%
QA4 Gender	1134	Male	49.9%
		Female	50.1%
QA5 What is your current employment or occupational status?	1130	Self-employed	8.8%
		Employed full-time	35.9%
		Employed part-time	8.3%
		Home-maker	2.5%
		Unemployed	4.0%
		Retired	38.5%
		Other occupational status	2.0%

Table 1-2: Part B1 Responses – Use of Targeted Highway Sections

Use of Targeted Highway Sections	Valid Responses	Specific Highway Section	Frequency		
			Yes	No	Unsure
QB1A I am going to read out a list of different streched of highway in Nova Scotia. For each one, please tell me if you have driven on the highway section any time in the past 12 months?	654	HS_11 (B1) the section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	64.7%	33.8%	1.5%
		HS_12 (B2) the section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or the Evangeline Trail	37.9%	60.6%	1.5%
	654	HS_21 (C1) the section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	61.4%	36.1%	2.5%
		HS_22 (C2) the section of Highway 1 from Hortonville to Coldbrook, known as the 'Old Highway 1' or the Evangeline Trail	41.7%	56.3%	2.0%
	521	HS_31 (A1) the section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	80.2%	19.8%	
		HS_32 (A2) the sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or the Lighthouse Route	55.0%	44.3%	0.7%
	340	HS_41 (E1) the section of Highway 104 (the TransCanada) from Sutherlands River (Exit 27) to Antigonish	84.9%	14.2%	0.9%
		HS_42 (E2) the sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	41.2%	56.1%	2.7%
	340	HS_51 (F1) the section of Highway 104 (the TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	76.3%	23.2%	0.5%
		HS_52 (F2) the section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as the 'Old Highway 4' or the Sunrise Trail	39.0%	59.1%	1.9%
	282	HS_61 (G) the sections of either Highways 104 or 4, known as the 'Old Highway', which stretch from Port Hastings (at the roundabout near the Cape Breton Causeway) to Port Hawkesbury	74.3%	24.5%	1.2%
		HS_71 (H1) the sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	64.7%	34.6%	0.7%
	255	HS_72 (H2) the section of Highway 105 on Cape Breton Island (the TransCanada Highway) stretching from Port Hastings (at the roundabout near the Cape Breton Causeway) to Sydney	71.1%	28.9%	
	541	HS_81 (D1) the section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	66.2%	32.0%	1.8%
		HS_82 (D2) the sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia,	52.1%	44.3%	3.7%

		known as the 'Old Highway 7'	
QB1B Of the highway sections you've used in the past 12 months, which one of the following have you used most often?	1027	HS_11 (B1) the section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	10.9%
		HS_12 (B2) the section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or the Evangeline Trail	0.8%
		HS_21 (C1) the section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	12.4%
		HS_22 (C2) the section of Highway 1 from Hortonville to Coldbrook, known as the 'Old Highway 1' or the Evangeline Trail	2.5%
		HS_31 (A1) the section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	24.8%
		HS_32 (A2) the sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or the Lighthouse Route	1.7%
		HS_41 (E1) the section of Highway 104 (the TransCanada) from Sutherlands River (Exit 27) to Antigonish	11.3%
		HS_42 (E2) the sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	1.3%
		HS_51 (F1) the section of Highway 104 (the TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	3.2%
		HS_52 (F2) the section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as the 'Old Highway 4' or the Sunrise Trail	2.0%
		HS_61 (G) the sections of either Highways 104 or 4, known as the 'Old Highway', which stretch from Port Hastings (at the roundabout near the Cape Breton Causeway) to Port Hawkesbury	2.2%
		HS_71 (H1) the sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	5.8%
		HS_72 (H2) the section of Highway 105 on Cape Breton Island (the TransCanada Highway) stretching from Port Hastings (at the roundabout near the Cape Breton Causeway) to Sydney	5.9%
		HS_81 (D1) the section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	10.3%
		HS_82 (D2) the sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia, known as the 'Old Highway 7'	4.9%

Table 1-3: Part B Responses – Frequency of Trips

Frequency of Trips	Valid Responses	Response	Min	Median	Max	Mean	sd	Freq.
QB5 Thinking about the highway section you use the most, [B1B most frequent section name], on average, how often would you say that you usually travel on weekdays, Monday through Friday on that highway section?	1027	trips per week	1	11	40	14	11	**30.1%**
		trips per month	1	9	25	10	8	**22.9%**
		trips per year	1	20	208	41	53	**39.4%**
		Never on weekdays						**7.2%**
		Don't know						**0.5%**
QB5A of those	948	Commuting to/from	0.0%	80.0%	100.0%	74.0%	29.2%	**11.9%**

weekday trips per [period] on [B1B most frequent section name], about how many of them are for each of the following purposes?		work or school						
		Personal business, shopping, recreation, other	0.1%	100.0%	100.0%	88.5%	25.7%	**71.7%**
		Work-related travel/employer's business	0.0%	51.0%	100.0%	62.3%	33.3%	**16.3%**

Table 1-4: Part C Responses

Willingness to Pay	Valid Responses	Response	Frequency
QC1 Would the travel improvements for that shorter trip be worth $[medium value] to you?	1027	Yes	51.6%
		No	48.4%
QC2 Would the travel improvements for that shorter trip be worth $[high value] to you?	530	Yes	52.7%
		No	47.3%
QC3 Would the travel improvements for that shorter trip be worth $[low value] to you?	497	Yes	19.6%
		No	80.4%
QC4 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important are faster travel times to you?	1027	1-Not at all important	13.3%
		2	4.2%
		3	6.3%
		4	4.5%
		5	17.2%
		6	10.4%
		7	14.1%
		8	14.1%
		9	4.4%
		10-Very Important	11.2%
		Unsure	0.2%
QC5 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important are predictable travel times to you?	1027	1-Not at all important	7.1%
		2	2.9%
		3	3.0%
		4	2.9%
		5	16.6%
		6	5.7%
		7	12.4%
		8	23.4%
		9	10.2%
		10-Very Important	15.2%
		Unsure	0.5%
QC6 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important to you is improving road safety on Nova Scotia's highways?	1027	1-Not at all important	0.9%
		2	0.6%
		3	0.1%
		4	0.4%
		5	3.0%
		6	1.6%
		7	2.1%
		8	7.4%
		9	9.4%
		10-Very Important	74.3%

		Unsure	0.2%
QC7 Do you currently have a transponder for a toll collection account, such as MACPASS, E-PASS, Straight Pass, or St. John Harbour Pass?	1027	Yes	38.2%
		No	61.8%
QC8 If tolls are implemented on the section of the highway that you use, how would you like to pay for them?	1027	Open an electronic toll collection account with a transponder	48.6%
		Stop and pay cash at the toll booth	37.1%
		Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration license plate recorded, and receive the invoice by mail at the address of your vehicle registration	8.2%
		I am against paying tolls of any amount	4.6%
		Don't know	1.1%
		Decline to answer	0.4%

Table 1-5: Part D Responses

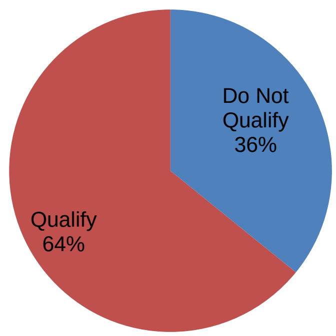
Survey Conclusion	Valid Responses	Response	Frequency
QD1 Any additional comments?	1027	Comment provided	14.7%
		No comment	85.3%

The following charts summarize the survey responses and show the frequency of the raw and weighted responses. Out of the 1,601 people that were surveyed, 64 percent completed the survey. The main reason that people did not complete the survey was that they did not drive or use the infrastructure in question.

The following can be observed. The older and retired population is over represented in the sample as can be seen in the non-weighted pie and bar charts in Figure 1-2 and Figure 1-4. The sample also under represents the number of people in Halifax as seen in Figure 1-5. To properly reflect the population of Nova Scotia, the sample is weighted by age, gender, and county.

Figure 1-6 shows that corridors 8 and 3 are the most frequently used at 30 and 20 percent while corridors 4 and 6 are the least frequently used at 6 percent. Figure 1-7 displays the average score that respondents of the survey value faster, more predictable, and safer travel times. It is clear that safer travel times are highly valued while faster travel times are not considered as important. Predictable travel time is slightly more preferred than faster travel time.

Figure 1-1: Response rate of respondents and reasons for not completing the survey.


Do Not Qualify 36%
Qualify 64%

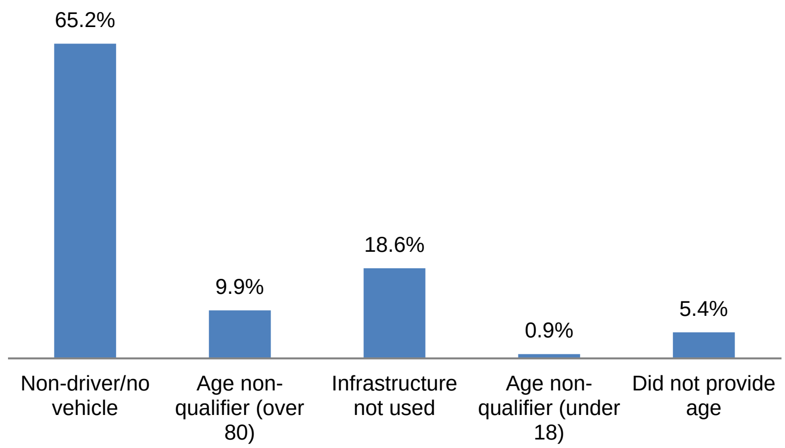

65.2%
9.9%
18.6%
0.9%
5.4%
Non-driver/no vehicle
Age non-qualifier (over 80)
Infrastructure not used
Age non-qualifier (under 18)
Did not provide age

Figure 1-2: Age range of respondents

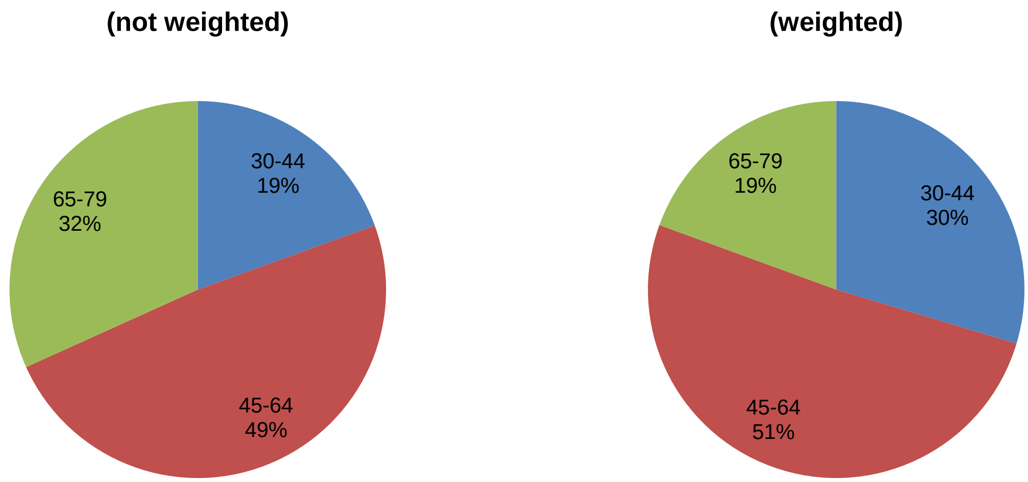


Figure 1-3: Gender of respondents

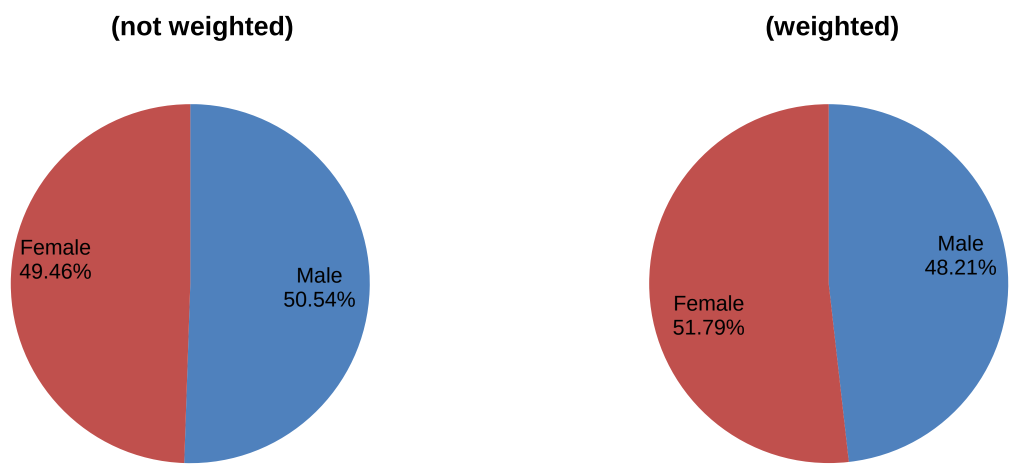


Figure 1-4: Occupation of respondents

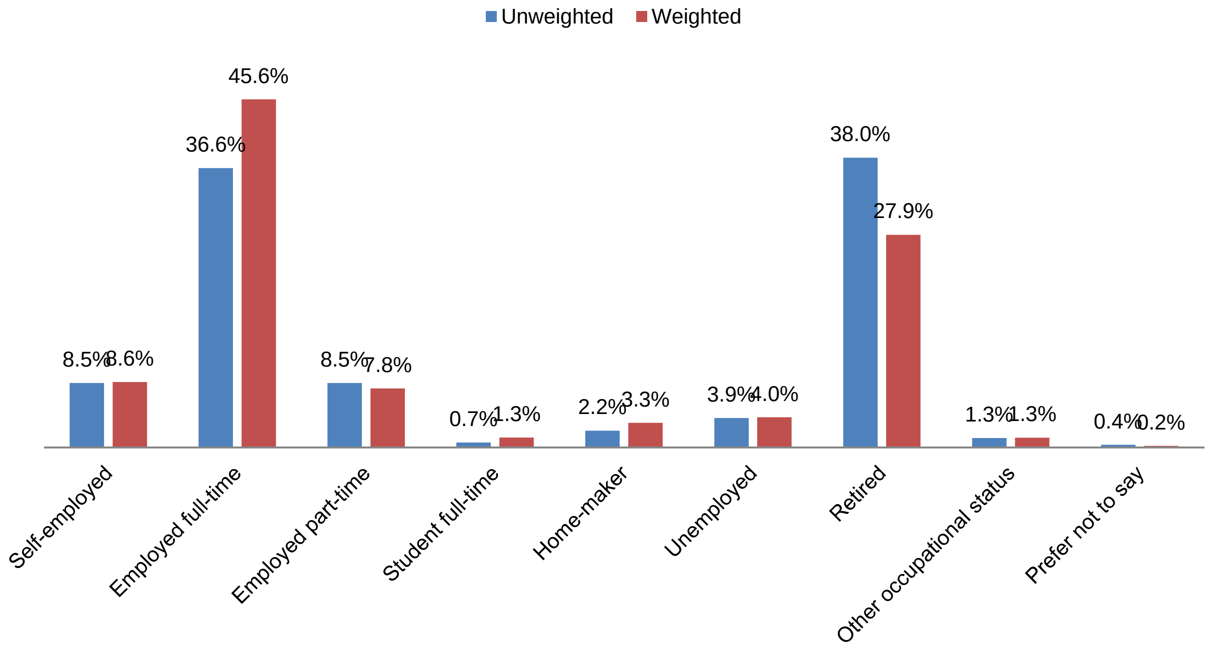


Figure 1-5: Census Division distribution of respondents

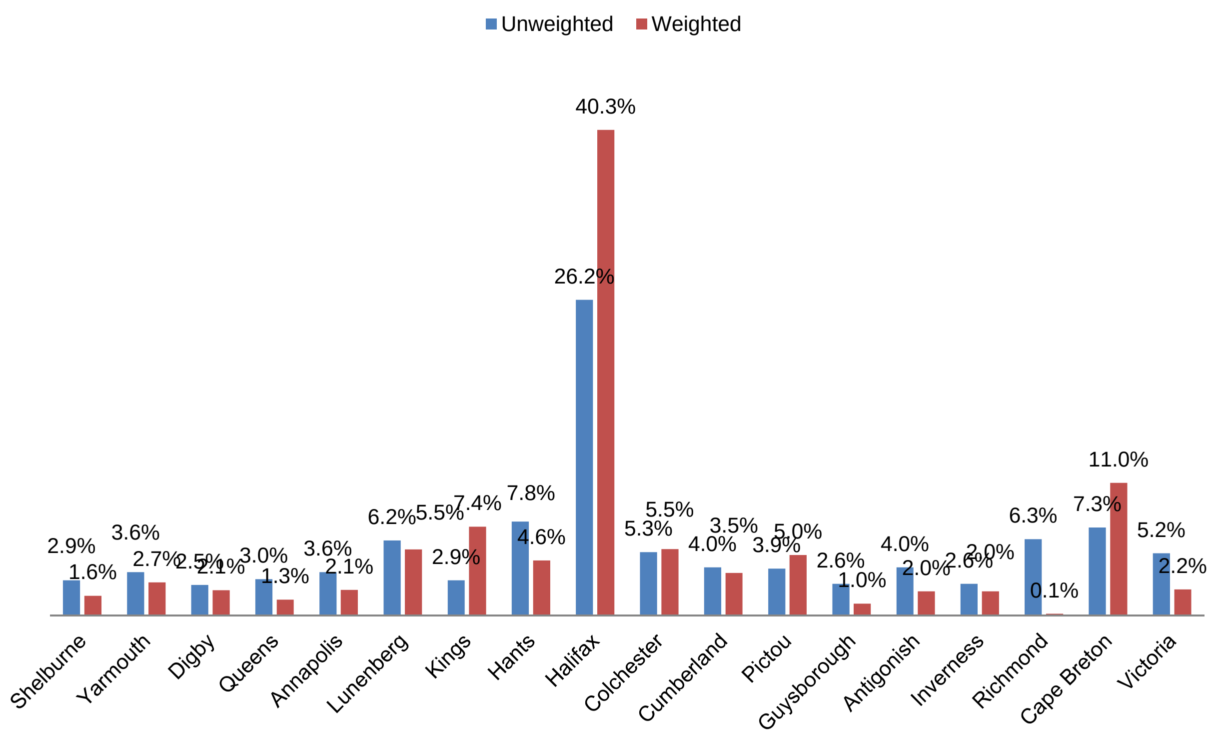


Figure 1-6: Corridor distribution of respondents (Weighted)

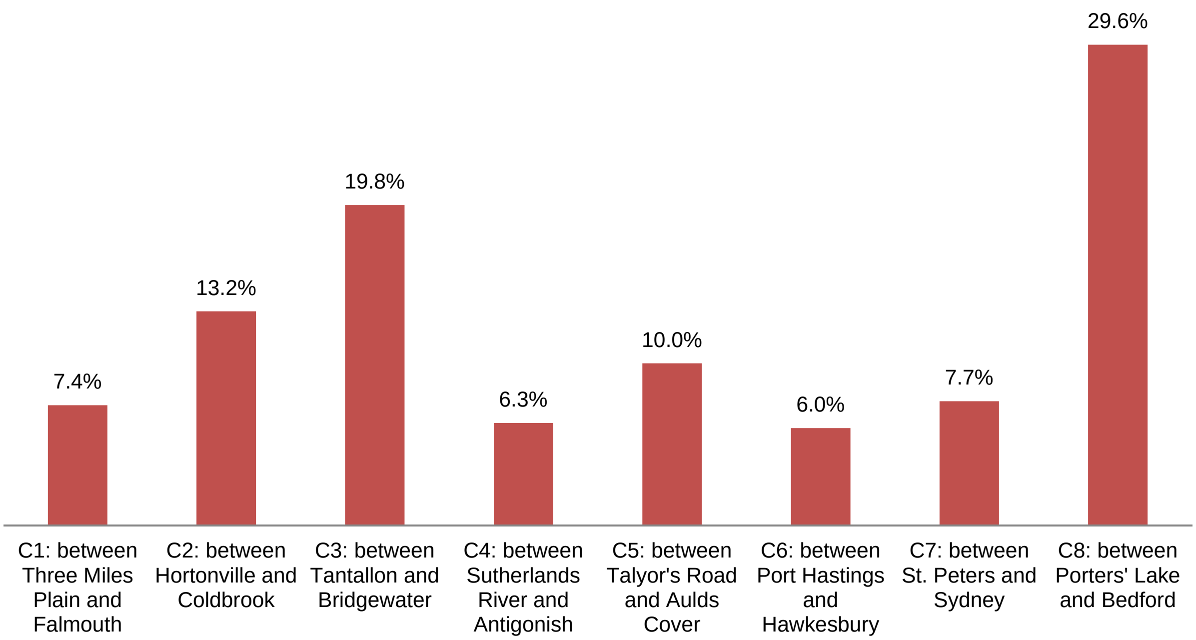
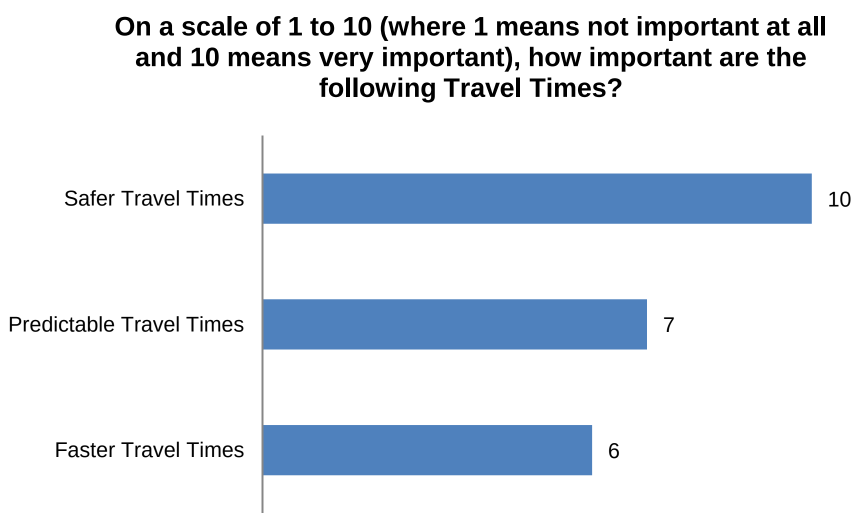


Figure 1-7: Mean travel time importance of respondents



Survey Results

In this section, a series of cross-tabulations are presented to document the survey findings and the possible influences of demographic and personal attributes on willingness to pay, toll payment preferences, and having a toll account..

Willingness to Pay

The following tables display the respondents' willingness to pay by census division, corridor, occupation, age gender, travel time priorities and purpose. The willingness to pay is categorized as 'Low', 'Medium', 'High', and 'Said 'No' to low prices'. People with 'Low' willingness to pay declined the medium price option but said yes to the low price. People with 'Medium' willingness to pay said yes to the specified medium price, but disagreed with the high price. People in the 'high' willingness to pay category said yes to the medium and high prices. The people who declined the low prices are placed in the remaining category, 'Said 'No' to low prices'.

Overall, about 61 percent of the population stated that they are willing to pay the specified low, medium, or high prices while the rest declined. From those who are willing to pay, 27 percent agreed to the high prices followed closely by the medium prices at 24 percent. Only about 9 percent of the respondents agreed to pay the low prices.

The county where people are least willing to pay the toll prices is Annapolis. Only 9 percent are willing to pay the specified high prices and 67 percent did not agree to any of the stated prices. Medium prices are most popular in Lunenburg at about 33 percent while high prices are most popular in Kings, Pictou, and Cape Breton at 45, 33, and 39 percent, respectively. People using corridors 4 and 7 are most willing to pay as less than 30 percent said no to the low prices. Approximately 38 and 45 percent of the people in corridors 4 and 7 are willing to pay the high prices. People using corridor 1 are the least willing to pay tolls as 66 percent said no to the low prices.

The older and retired population is less willing to pay as about half of them declined the lowest prices. In general, there does not seem to be a big difference in willingness to pay between males and females. Although, younger females are less willing to pay higher prices while older females seem more willing to pay higher prices compared to their male counterparts.

Those who are commuting are more willing to pay than those travelling for other purposes with 30 percent willing to pay high prices and only 32 percent declining the low prices. Finally, those who value faster, predictable and safer travel times are more willing to pay than those who do not.

Table 2-1: Willingness to pay by census division

	Census Division/County (%)														
	Yarmouth	Digby	Annapolis	Lunenberg	Kings	Hants	Halifax	Colchester	Cumberland	Pictou	Antigonish	Inverness	Cape Breton	Victoria	Total
Low	23.9	10.0	4.5	12.9	1.7	4.3	9.1	7.5	8.2	24.5	9.2	3.2	12.0	4.0	**9.5**
Med	19.3	21.6	18.8	32.6	18.7	20.1	29.3	25.0	27.0	12.6	18.8	24.7	15.2	20.7	**24.4**
High	22.1	27.1	9.3	19.1	44.8	24.3	21.7	29.3	29.2	32.8	25.4	24.1	39.3	30.9	**27.2**
Said 'No' to low	34.8	41.3	67.4	35.3	34.8	51.2	39.9	38.2	35.6	30.0	46.6	48.0	33.6	44.4	**39.0**
Row Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-2: Willingness to pay by corridor

	Corridor (%)								
	C1: between Three Miles Plain and Fal-mouth	C2: between Horton-ville and Cold-brook	C3: between Tant-allon and Bridge-water	C4: between Suther-lands River and Antigon-ish	C5: between Taylor's Road and Aulds Cover	C6: between Port Hast-ings and Hawkes bury	C7: between St. Peters and Sydney	C8: between Porters' Lake and Bedford	Total
Low	.6	3.9	10.1	17.0	10.6	17.9	8.5	10.3	**9.5**
Medium	12.7	19.6	30.7	18.6	16.5	14.0	17.1	33.1	**24.4**
High	20.5	35.3	21.7	38.3	19.8	32.2	44.9	23.3	**27.2**
Said 'No' to low price	66.2	41.2	37.5	26.1	53.1	35.9	29.5	33.2	**39.0**
Row Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Table 2-3: Willingness to pay for toll account by occupation

	Occupation							
	Self-employed	Employed full-time	Employed part-time	Home-maker	Unemployed	Retired	Other occupational status	Total
Low	7.9%	10.0%	8.0%	16.4%	5.8%	9.5%	7.5%	**9.5%**
Medium	17.9%	25.2%	26.6%	30.9%	30.0%	21.8%	33.8%	**24.4%**
High	32.1%	27.4%	31.3%	31.8%	44.1%	22.2%	16.7%	**27.2%**
Said 'No' to low price	42.1%	37.4%	34.1%	20.9%	20.1%	46.5%	41.9%	**39.0%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-4: Willingness to pay by age gender

	Age Gender							
	30-44		45-64		65-79		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Low	13.2%	9.7%	10.0%	8.1%	8.1%	7.6%	**10.6%**	**8.5%**
Medium	27.4%	26.0%	21.6%	27.2%	21.3%	20.3%	**23.2%**	**25.5%**
High	27.8%	28.0%	31.8%	26.5%	18.4%	23.5%	**28.1%**	**26.3%**
Said 'No' to low price	31.5%	36.4%	36.7%	38.2%	52.2%	48.7%	**38.1%**	**39.7%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-5: Willingness to pay by travel purpose

	Travel Purpose		
	Commuting	Work Related	Personal
Low	11.1%	4.0%	9.4%
Medium	26.9%	23.1%	24.3%
High	30.4%	28.9%	27.4%
Said 'No' to low price	31.6%	44.0%	38.8%
Row Total	**100.0%**	**100.0%**	**100.0%**

Table 2-6: Willingness to pay by importance of faster travel times

	Importance of Faster Travel Time		
	Low	Medium	High
Low	7.0%	9.4%	11.9%
Medium	14.5%	28.6%	28.1%
High	8.6%	26.7%	45.8%
Said 'No' to low price	69.9%	35.3%	14.3%
Row Total	**100.0%**	**100.0%**	**100.0%**

Table 2-7: Willingness to pay by importance of predictable travel times

	Importance of Predictable Travel Time		
	Low	Medium	High
Low	6.0%	9.3%	10.8%

Medium	14.5%	23.8%	28.2%
High	9.5%	25.2%	34.3%
Said 'No' to low price	70.0%	41.7%	26.7%
Row Total	**100.0%**	**100.0%**	**100.0%**

Table 2-8: Willingness to pay by importance of safer travel times

	Importance of Safer Travel Time		
	Low	**Medium**	**High**
Low	4.1%	8.1%	9.7%
Medium	19.1%	17.5%	25.0%
High	9.9%	14.0%	28.6%
Said 'No' to low price	66.8%	60.4%	36.6%
Row Total	**100.0%**	**100.0%**	**100.0%**

Toll Payment Preferences

The following tables display toll payment preferences of the respondents by census division, corridor, occupation, age gender, travel time priorities and purpose. The payment categories include opening an electronic toll collection account with a transponder, stopping and paying cash at the toll booth, continuing through the toll booth without stopping and receiving an invoice by mail, not paying any toll, not sure, and refusing to answer.

Overall, 49 percent of respondents prefer to open an electronic toll collection account with a transponder. This result is mainly driven by the people in Halifax as 69 percent of them selected this payment method. The next most popular payment option is to stop and pay cash at the toll booth. This is particularly preferred in the more rural counties. About 5 percent of people claimed that they are against paying tolls.

More than 50 percent of people using corridors 3 and 8 prefer to open an electronic toll collection account with a transponder. Stopping and paying cash at the toll booth is generally preferred by users of the other corridors.

Those who prefer paying tolls by opening an electronic toll collection account with a transponder are full-time employees, are commuting to school or work, are younger in age, and value faster and more predictable travel times. On the other hand, those who prefer stopping and paying cash at the toll booth are retired or home-makers. The small group that is not willing to pay any tolls consists mainly of males and users of corridors 1 and 2.

Table 2-9: Toll payment preferences by census division

	Census Division/County (%)														
	Yarmouth	Digby	Annapolis	Lunenberg	Kings	Hants	Halifax	Colchester	Cumberland	Pictou	Antigonish	Inverness	Cape Breton	Victoria	Total
Open an electronic toll collection account with a transponder	20.5	14.0	32.2	44.4	39.2	45.4	68.7	40.5	42.0	37.2	39.9	34.7	27.8	29.4	**48.6**
Stop and pay cash at the toll booth	65.5	65.9	55.3	33.7	42.9	31.1	18.9	50.7	41.5	57.5	40.6	58.2	57.0	55.4	**37.1**
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	12.3	10.1	4.5	13.4	9.0	12.0	5.1	2.5	13.2	5.2	15.9	3.9	14.5	8.2	**8.2**
I am against paying tolls of any amount	1.7	10.0	8.0	4.4	3.6	9.0	6.3	2.5	1.3	.0	2.4	3.2	.7	7.1	**4.6**
Don't know	.0	.0	.0	.9	5.3	1.9	.6	3.8	1.9	.0	1.2	.0	.0	.0	**1.1**
Decline to answer	.0	.0	.0	3.2	.0	.5	.5	.0	.0	.0	.0	.0	.0	.0	**.4**
Row Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-10: Toll payment preferences by corridor

	Corridor								
	C1: between Three Miles Plain and Fal-mouth	C2: between Horton-ville and Cold-brook	C3: between Tant-allon and Bridge-water	C4: between Suther-lands River and Antigon -ish	C5: between Taylor's Road and Aulds Cover	C6: between Port Hast-ings and Hawkes bury	C7: between St. Peters and Sydney	C8: between Porters' Lake and Bedford	Total
Open an electronic toll collection account with a transponder	36.7%	41.8%	50.5%	35.6%	40.5%	34.8%	28.8%	66.8%	**48.6%**
Stop and pay cash at the toll booth	41.8%	39.2%	33.7%	51.2%	49.1%	49.7%	58.1%	22.1%	**37.1%**

Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	10.1%	6.0%	8.2%	8.9%	9.0%	12.6%	11.7%	6.4%	**8.2%**
I am against paying tolls of any amount	9.8%	10.0%	5.9%	2.6%	1.4%	1.7%	1.1%	3.2%	**4.6%**
Don't know	1.2%	3.0%	.9%	1.7%	.0%	1.1%	.3%	.9%	**1.1%**
Decline to answer	.3%	.0%	.9%	.0%	.0%	.0%	.0%	.7%	**.4%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-11: Toll payment preferences by occupation

	Occupation							
	Self-employed	**Employed full-time**	**Employed part-time**	**Home-maker**	**Unemployed**	**Retired**	**Other occupational status**	**Total**
Open an electronic toll collection account with a transponder	58.7%	61.2%	33.8%	13.2%	39.2%	35.1%	43.6%	**48.6%**
Stop and pay cash at the toll booth	29.3%	25.9%	50.9%	63.9%	42.5%	49.6%	38.9%	**37.1%**
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	6.1%	7.2%	10.6%	16.3%	6.2%	8.2%	17.5%	**8.2%**
I am against paying tolls of any amount	4.5%	3.8%	4.8%	6.5%	9.4%	5.5%	.0%	**4.6%**
Don't know	1.5%	1.3%	.0%	.0%	2.6%	.9%	.0%	**1.1%**
Decline to answer	.0%	.5%	.0%	.0%	.0%	.6%	.0%	**.4%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-12: Toll payment preferences by age gender

	Age Gender							
	30-44		**45-64**		**65-79**		**Total**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Open an electronic toll collection account with a transponder	55.0%	63.7%	50.5%	44.0%	33.4%	38.1%	48.6%	48.7%

Stop and pay cash at the toll booth	30.3%	24.4%	30.1%	46.4%	42.5%	53.4%	32.5%	41.3%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	9.4%	9.0%	9.0%	5.4%	13.1%	5.8%	9.9%	6.5%
I am against paying tolls of any amount	3.8%	1.9%	7.5%	3.6%	8.2%	2.3%	6.6%	2.9%
Don't know	.0%	1.0%	2.1%	.6%	2.5%	.5%	1.6%	.7%
Decline to answer	1.4%	.0%	.7%	.0%	.3%	.0%	.8%	.0%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-13: Toll payment preferences by travel purpose

	Travel Purpose		
	Commuting	**Work Related**	**Personal**
Open an electronic toll collection account with a transponder	69.1%	60.5%	44.7%
Stop and pay cash at the toll booth	18.4%	21.5%	41.7%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	10.1%	10.5%	7.8%
I am against paying tolls of any amount	2.4%	6.7%	4.3%
Don't know	.0%	.6%	1.3%
Decline to answer	.0%	.2%	.2%
Row Total	100.0%	100.0%	100.0%

Table 2-14: Toll payment preferences by importance of faster travel times

	Importance of Faster Travel Time		
	Low	**Medium**	**High**
Open an electronic toll collection account with a transponder	38.5%	51.7%	53.9%
Stop and pay cash at the toll booth	42.7%	35.8%	33.5%

Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	6.2%	7.9%	10.5%
I am against paying tolls of any amount	11.3%	2.6%	1.2%
Don't know	1.3%	1.6%	.2%
Decline to answer	.0%	.4%	.7%
Row Total	100.0%	100.0%	100.0%

Table 2-15: Toll payment preferences by importance of predictable travel times

	Importance of Predictable Travel Time		
	Low	Medium	High
Open an electronic toll collection account with a transponder	37.9%	45.7%	54.2%
Stop and pay cash at the toll booth	44.6%	39.3%	32.9%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	6.8%	7.9%	8.9%
I am against paying tolls of any amount	9.8%	5.3%	2.5%
Don't know	.8%	1.2%	1.1%
Decline to answer	.0%	.6%	.4%
Row Total	100.0%	100.0%	100.0%

Table 2-16: Toll payment preferences by importance of safer travel times

	Importance of Safer Travel Time		
	Low	Medium	High
Open an electronic toll collection account with a transponder	64.9%	51.1%	48.0%
Stop and pay cash at the toll booth	26.0%	28.0%	38.1%

Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice by mail at the address of your vehicle registration	5.3%	3.0%	8.6%
I am against paying tolls of any amount	3.8%	17.8%	3.7%
Don't know	.0%	.0%	1.2%
Decline to answer	.0%	.0%	.4%
Row Total	100.0%	100.0%	100.0%

Have Toll Account

The following tables display whether or not the respondents currently have a transponder for a toll account by census division, corridor, occupation, age gender, and travel purpose. Overall, about a third of those who completed the survey currently have a transponder to a toll account. This is mainly driven by 73 percent of the people living in Halifax. This can also be seen by users of corridor 8, where 67 percent already have transponders. It does not seem as common however for people to have transponders for toll accounts living in or using other counties and corridors. Based on the frequency of responses, those who are more inclined to have transponders for a toll collection account are employed full-time, commute to work, travel for work related purposes, are younger, and are male.

Table 2-17: Currently have transponder for toll account by census division

	Census Division/County (%)														
	Yarmouth	Digby	Annapolis	Lunenberg	Kings	Hants	Halifax	Colchester	Cumberland	Pictou	Antigonish	Inverness	Cape Breton	Victoria	Total
Yes	7.2	7.3	8.7	17.7	7.4	27.6	73.1	24.7	23.9	24.3	12.9	8.4	8.9	6.8	**38.2**
No	92.8	92.7	91.3	82.3	92.6	72.4	26.9	75.3	76.1	75.7	87.1	91.6	91.1	93.2	**61.8**
Row Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 2-18: Currently have transponder for toll account by corridor

	Corridor								
	C1: between Three Miles Plain and Falmouth	C2: between Hortonville and Coldbrook	C3: between Tantallon and Bridgewater	C4: between Sutherlands River and Antigonish	C5: between Talyor's Road and Aulds Cover	C6: between Port Hastings and Hawkesbury	C7: between St. Peters and Sydney	C8: between Porters' Lake and Bedford	Total

Yes	29.8%	25.3%	39.3%	21.4%	21.9%	13.0%	10.2%	66.9%	**38.2%**
No	70.2%	74.7%	60.7%	78.6%	78.1%	87.0%	89.8%	33.1%	**61.8%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-19: Currently have transponder for toll account by occupation

	Occupation							
	Self-employed	Employed full-time	Employed part-time	Home-maker	Unemployed	Retired	Other occupational status	Total
Yes	49.1%	48.1%	30.7%	16.1%	26.5%	26.6%	24.3%	**38.2%**
No	50.9%	51.9%	69.3%	83.9%	73.5%	73.4%	75.7%	**61.8%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-20: Currently have transponder for toll account by age gender

	Age Gender							
	30-44		45-64		65-79		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Yes	45.3%	44.5%	43.5%	34.7%	25.4%	26.9%	**40.6%**	**36.1%**
No	54.7%	55.5%	56.5%	65.3%	74.6%	73.1%	**59.4%**	**63.9%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-21: Currently have transponder for toll account by travel purpose

	Travel Purpose		
	Commuting	Work Related	Personal
Yes	44.5%	43.4%	36.6%
No	55.5%	56.6%	63.4%
Row Total	**100.0%**	**100.0%**	**100.0%**

APPENDIX E

Willingness to Pay – Survey Analysis (Freight)

Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR)

Freight Willingness to Pay Survey Analysis - Draft

HDR Corporation

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Introduction

This draft report presents a summary of HDR's findings from the Freight Willingness to Pay Survey. The sampling frame for the freight study was for-hire local or long distance carrier firms within office locations in the province of Nova Scotia under North American Industry Classification System (NAICS) code 4841, General Freight Trucking, NAICS 4842, Specialized Freight Trucking, NAICS 48851, Freight transportation arrangement, and NAICS 49211, Couriers and Express Delivery Services. Firms such as freight forwarders and third-party logistics firms within these NAICS classifications could also participate if they made routing decisions for the shipments they arranged. Private carriers, that is, firms whose main business is not trucking but who have units that truck their own freight, were also included in the survey. Only firms from Nova Scotia were targeted as they were more likely to use the highway segments under study.

The sample was drawn from InfoCanada's business listings for firms located within Nova Scotia classified with the above-mentioned industry codes. InfoCanada listed 341 firms that met the above criteria. All 341 firms were contacted. The goal was to obtain a sample size of 50 to 100 respondents for the freight willingness to pay study. In total, 70 surveys were completed, however 4 entries needed to be removed after data was validated, bringing the total useable completes down to 66. The research team ensured that the survey was completed by one person in the firm who is knowledgeable about typical shipments and who can make routing decisions based on transit times or shipment costs per kilometre travelled.

The survey was conducted by telephone or online so that respondents could properly evaluate the choices presented to them. The survey questionnaire was structured to capture information about the firm and the firm's corridor usage, willingness to pay for shorter travel times, travel priorities, toll payment preferences, and toll account status. Respondents were presented with all of the corridors under study, regardless of the respondent's business office location. The reason for this was that it was assumed that many freight companies may traverse the entire province on a regular basis. Indeed, about 10 percent of firms indicated yes to all the highway sections presented to them.

The report is comprised of two sections:

- Survey summary, identifying the number of valid and useful responses received for each question; and
- Survey results, providing cross-tabulations summarizing the observed relationships between key surveyed variables, including census division, corridor use, commodity type, firm characteristics, travel priorities, willingness to pay, toll payment preferences, and toll collection account status.

Full tabulations of the breakdown of responses to each question, and a description of the survey process, are provided separately. It is important to note that the results in this analysis pertain only to the firms in this survey and are not necessarily indicative of all the freight related firms in Nova Scotia. The sample size of 66 is not large enough to extrapolate information of the population of freight businesses in Nova Scotia. The results, however, do provide insight useful for planning and for anticipation of toll demand.

Survey Summary

The following tables indicate the number of valid survey responses for each question in Parts A to D of the questionnaire and the frequency of each type of response.

The firmographic responses in Part A are displayed in Table 1-1. Some of the categories in these questions were changed given the survey responses and sample sizes. The categories that were altered are those in question 6, the firm type, and question 11, the primary commodity shipped. Under the firm type category, 3 respondents selected 'Other' because they were both a for-hire and private freight firm. A separate category was created for these respondents. The remaining 2 respondents in the 'Other' category were Towing firms. Under the primary commodity category, about 40 percent of firms selected the 'Mixed' category. After investigating the responses in this category, HDR was able to map the responses to the existing commodity types. For instance, some respondents entered 'Automotive and Machinery' in the mixed category, so the 'Automotive' category was pooled with the 'Machinery and Electrical' category. The following can be observed from the responses in Part A: most of the firms in the sample are local For-Hire Carriers with less than 20 employees and less than 10 power units[1]. The primary commodity among firms varied with manufactured products, automotive and machinery, food, and less than truckload[2] being the most common.

The highway section usage for each firm can be observed in Table 1-2 and

[1] Power units refer to tractors plus straight trucks. A tractor unit is a heavy-duty towing engine that provides motive power by hauling a towed or trailered load.
[2] Less than a truckload is the transportation of relatively small freight.

Table 1-3. The responses provided in Table 1-2 indicate that the majority of the freight companies have freight that traverse the entire province on a regular basis regardless of the firm's location.

Table 1-3 displays the percent of shipments that travel on each highway section. The manner in which the firms responded for the frequency of shipments travelled across the highway sections was inconsistent. Some firms provided the percent of all freight on all routes including those not covered by this survey resulting in a sum of less than 100 percent across the sections. Also, some shipments pass over more than one highway, leading to the sum of greater than 100 percent. Other firms provided responses to each individual highway section that add to 100 percent. There were 4 firms that did not provide any response. It can be observed from the results in both tables that highway section 103 (corridor 3) appears to be the most frequently used.

The responses related to willingness to pay are provided in

Table 1-4. Firms were first asked if they were willing to pay the medium price to shorten their travel times, of which 67 percent agreed. The firms that said yes to the medium prices were then offered to evaluate the high prices; otherwise they were asked to evaluate a low price. Of those firms offered the high price, about 57 percent of them accepted to pay it. Of the 22 firms that were offered to pay the low price, 73 percent said no. Other willingness to pay related questions included travel time priorities and preferred method of payment for tolls. It is clear that the firms value safer travel times compared to faster and more predictable travel times with 73 percent of firms rating road safety a 10 from a scale of 1 to 10 (where 10 means very important). In addition, most firms prefer to pay electronically at 71 percent. Currently, 74 percent of firms have a toll collection account that uses a transponder.

Table 1-5 shows that 27 percent of firms provided additional comments. Most of the firms that provided comments agreed that improving the safety of the roads is the main reason they would like to see twinning. They agreed that roads need to be improved for larger vehicles; however they were not keen on paying tolls. They strongly felt that they are already paying a lot in fuel taxes and other industry related costs.

Table 1-1: Part A Responses

Screening/Personal Details	Valid Responses	Response	Frequency
QA4_A In what city or town is your firm located? - City.	66	Dartmouth	19.7%
		Halifax	18.2%
		Rest of NS	57.6%
		Prefer not to say	4.5%
QA4_B In what city or town is your firm located? - Province.	66	Nova Scotia	100.0%
QA5 Is this a local location or the headquarters location?	66	Local	28.8%
		Headquarters	71.2%
QA6 What type of trucking firm are you?	66	For-hire carrier	60.6%
		For-hire owner-operator	9.1%
		Private carrier	9.1%
		Freight forwarder or Load/Freight broker	13.6%
		For-hire and Private	4.5%
		Other	3.0%
QA7 Do you consider your firm to be a local or long haul firm?	66	Local	45.5%
		Long haul	13.6%
		Both	40.9%
QA8 How many people in your firm (including yourself and employee drivers, mechanics, support staff, supervisors and managers) are involved in the business of transporting freight?	66	1-4	27.3%
		5-9	7.6%
		10-19	24.2%
		20-49	13.6%
		50-99	10.6%
		100-499	9.1%
		500	6.1%
		Don't know	1.5%
QA10_Indicator How many power units (tractors plus straight trucks) are used in the business of transporting freight in your firm?	66	Response:	83.3%
		Not applicable	13.6%
		Prefer not to say	3.0%
QA10 How many power units (tractors plus straight trucks) are used in the business of transporting freight in your firm?	55	<10	37.9%
		10-50	30.3%
		>50	15.2%
		Not applicable	13.6%
		Prefer not to say	3.0%
QA11 Of the types of freight you transport, what would be your primary commodity? Please select one.	66	Food	12.1%
		Manufactured products	18.2%
		Automotive, Machinery and electrical	18.2%
		Less than Truckload	19.7%
		Other*	18.0%
		Mixed	10.6%
		Prefer not to say	3.0%

*Commodities include agricultural products, minerals, wood and products, waste and scrap and empty shipping containers

Table 1-2: Part B1A Responses – Use of Targeted Highway Sections

Use of Targeted Highway Sections	Valid Responses	Specific Highway Section	Frequency		
			Yes	No	Unsure
QB1A I am going to read out a list of different stretches of highway in Nova Scotia. For each one, please tell me if your shipments travelled on the highway section any time in the past 12 months?	66	HS_CODE_11 (B1) the section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	77.3%	21.2%	1.5%
		HS_CODE_12 (B2) the section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or the Evangeline Trail	37.9%	57.6%	4.5%
	66	HS_CODE_21 (C1) the section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	72.7%	27.3%	0.0%
		HS_CODE_22 (C2) the section of Highway 1 from Hortonville to Coldbrook, known as the 'Old Highway 1' or the Evangeline Trail	42.4%	53.0%	4.5%
	66	HS_CODE_31 (A1) the section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	84.8%	12.1%	3.0%
		HS_CODE_32 (A2) the sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or the Lighthouse Route	48.5%	45.5%	6.1%
	66	HS_CODE_41 (E1) the section of Highway 104 (the TransCanada) from Sutherlands River (Exit 27) to Antigonish	80.3%	18.2%	1.5%
		HS_CODE_42 (E2) the sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	39.4%	50.0%	10.6%
	66	HS_CODE_51 (F1) the section of Highway 104 (the TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	80.3%	19.7%	0.0%
		HS_CODE_52 (F2) the section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as the 'Old Highway 4' or the Sunrise Trail	39.4%	48.5%	12.1%
	66	HS_CODE_61 (G) the sections of either Highways 104 or 4, known as the 'Old Highway', which stretch from Port Hastings (at the roundabout near the Cape Breton Causeway) to Port Hawkesbury	63.6%	30.3%	6.1%
		HS_CODE_71 (H1) the sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	54.5%	40.9%	4.5%
	66	HS_CODE_72 (H2) the section of Highway 105 on Cape Breton Island (the TransCanada Highway) stretching from Port Hastings (at the roundabout near the Cape Breton Causeway) to Sydney	74.2%	21.2%	4.5%
	66	HS_CODE_81 (D1) the section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	65.2%	33.3%	1.5%
		HS_CODE_82 (D2) the sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia, known as the 'Old Highway 7'	53.0%	42.4%	4.5%

Table 1-3: Part B1B Responses – Percent of Shipments that Travel on each Highway Section

Frequency of Trips	Valid Responses	Response	Min	Median	Max	Mean	SD
QB1B Of the highway sections you've used in the past 12 months, on average, what is the percentage of your total shipments that travel on each of these sections?	49	HS_CODE_11 (B1) the section of Highway 101 from Three Mile Plains (Exit 5) to Falmouth	1.0%	10.0%	100.0%	15.4%	20.8%
	23	HS_CODE_12 (B2) the section of Highway 1 from Three Mile Plains to Falmouth, known as the 'Old Highway 1' or the Evangeline Trail	1.0%	5.0%	20.0%	4.4%	4.1%
	46	HS_CODE_21 (C1) the section of Highway 101 from Hortonville (Exit 10) to Coldbrook (Exit 14)	1.0%	10.0%	95.0%	15.5%	20.5%
	26	HS_CODE_22 (C2) the section of Highway 1 from Hortonville to Coldbrook, known as the 'Old Highway 1' or the Evangeline Trail	1.0%	5.0%	25.0%	6.8%	6.3%
	54	HS_CODE_31 (A1) the section of Highway 103 (South Shore) from Tantallon (Exit 5) to Bridgewater (Exit 12)	1.0%	9.5%	96.0%	17.1%	22.9%
	29	HS_CODE_32 (A2) the sections of Highways 3, 325, and 213 from Tantallon to Bridgewater known as the 'Old Highway 3' or the Lighthouse Route	1.0%	5.0%	70.0%	9.1%	15.5%
	51	HS_CODE_41 (E1) the section of Highway 104 (the TransCanada) from Sutherlands River (Exit 27) to Antigonish	1.0%	10.0%	100.0%	14.1%	19.1%
	22	HS_CODE_42 (E2) the sections of Highway 4 from Sutherlands River to Antigonish known as the 'Old Highway 4'	1.0%	5.0%	13.0%	6.0%	3.8%
	50	HS_CODE_51 (F1) the section of Highway 104 (the TransCanada) from Taylors Road East of Antigonish to Aulds Cove and the Cape Breton Causeway	1.0%	10.0%	100.0%	12.5%	18.2%
	23	HS_CODE_52 (F2) the section of Highway 4 from Taylors Road East of Antigonish to Aulds Cove, known as the 'Old Highway 4' or the Sunrise Trail	1.0%	5.0%	30.0%	6.3%	6.3%
	38	HS_CODE_61 (G) the sections of either Highways 104 or 4, known as the 'Old Highway', which stretch from Port Hastings (at the roundabout near the Cape Breton Causeway) to Port Hawkesbury	1.0%	5.0%	30.0%	7.2%	6.2%
	35	HS_CODE_71 (H1) the sections of either Highways 104 or 4, known as the 'Old Highway' on Cape Breton Island from St. Peters to Sydney	1.0%	5.0%	75.0%	10.3%	14.3%
	47	HS_CODE_72 (H2) the section of Highway 105 on Cape Breton Island (the TransCanada Highway) stretching from Port Hastings (at the roundabout near the Cape Breton Causeway) to Sydney	1.0%	10.0%	90.0%	14.5%	16.1%
	39	HS_CODE_81 (D1) the section of Highway 107 from Porter's Lake through Main Street to Duke Street in Bedford, Nova Scotia	1.0%	5.0%	50.0%	8.0%	10.7%
	32	HS_CODE_82 (D2) the sections of Highways 7, 33 and 111 from Porter's Lake to Duke Street in Bedford, Nova Scotia, known as the 'Old Highway 7'	1.0%	5.0%	50.0%	8.2%	11.5%

Table 1-4: Part C Responses

Willingness to Pay	Valid Responses	Response	Frequency
QC1 Would the travel improvements for that shorter trip be worth $[medium value] to you?	66	Yes	66.7%
		No	33.3%
QC2 Would the travel improvements for that shorter trip be worth $[high value] to you?	44	Yes	56.8%
		No	43.2%
QC3 Would the travel improvements for that shorter trip be worth $[low value] to you?	22	Yes	27.3%
		No	72.7%
QC4 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important are faster travel times to your firm?	66	1-Not at all important	3.0%
		3	4.5%
		4	1.5%
		5	9.1%
		6	6.1%
		7	15.2%
		8	13.6%
		9	7.6%
		10-Very Important	34.8%
		Unsure	4.5%
QC5 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important are predictable travel times to your firm?	66	1-Not at all important	1.5%
		2	4.5%
		4	3.0%
		5	9.1%
		6	4.5%
		7	12.1%
		8	10.6%
		9	15.2%
		10-Very Important	34.8%
		Unsure	4.5%
QC6 On a scale of 1 to 10 (where 1 means not important at all and 10 means very important), how important to you is improving road safety on Nova Scotia's highways?	66	2	3.0%
		4	1.5%
		5	1.5%
		7	3.0%
		8	9.1%
		9	9.1%
		10-Very Important	72.7%
QC7 Does your firm currently have any toll collection accounts that use a transponder, such as MACPASS, E-PASS, Straight Pass, or St. John Harbour Pass?	66	Yes	74.2%
		No	25.8%
QC8 If tolls are implemented on the section of the highway that you use, how would your firm like to pay for them?	66	Open an electronic toll collection account with a transponder	71.2%
		Stop and pay cash at the toll booth	9.1%
		Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	15.2%
		Don't know	4.5%

Table 1-5: Part D Responses

Survey Conclusion	Valid Responses	Response	Frequency
QD1 Any additional comments?	66	Provided comment	27.3%
		No comment	72.7%

The following tables and charts summarize some variables of interest for the surveyed firms. This includes the corridor and county distribution, the NAICS industry descriptions, travel time priorities, and willingness to pay of the firms.

The freight firms were assigned a corridor based on the maximum percent of all freight shipments on the identified highway sections. The corridor pertaining to the highway section with the largest percent of shipments was assigned as frequently used for that firm. The corridor distribution of the firms is provided in

Table 1-6. Corridors 3 and 7 are the most frequently used at 27 and 24 percent, respectively, while corridors 5 and 6 are the least frequently used at 1.5 percent. Although corridors 5 and 6 only have one respondent, it does not mean that they are not used by other firms. It can be seen in Table 1-2 that over 60 percent of the firms responded yes to using corridors 5 (HS_CODE_51 and HS_CODE_52) and 6 (HS_CODE_61). The reason for their small sample size is that the highways sections of the other corridors happen to be more frequently used for shipments than those in corridors 5 and 6.

The census division assigned to the firms comes from the InfoCanada listing based on the address of the firm provided in the InfoCanada listing. Figure 1-1 shows that almost half of the firms are located in Halifax and about 11 percent are located in the county of Cape Breton. The remaining firms are spread out among the other counties of Nova Scotia.

In part C of the questionnaire, respondents were asked to rank the importance of faster, more predictable, and safer travel time on a scale of 1 to 10, where 1 means not important at all and 10 means very important. The scale can be divided into low, medium, and high importance to better capture the travel time priorities of the respondents. The low, medium, and high importance categories correspond to values 1 to 4, 5 to 7, and 8 to 10, respectively, in the scale. As shown in Figure 1-3 the respondents value safer travel times above all other travel priorities.

Figure 1-4 displays the firms' willingness to pay based on the prices that were offered to them. Observe that 38 percent of firms accepted the high price (7 to 17 cents/km[3]) presented to them, 29 percent accepted the medium price (5 to 10 cents/km), 9 percent accepted the low price (3 to 5 cents/km), and 24 percent rejected the low price.

[3] As an example, if a respondent's reference trip was in corridor 1, scenario 1, and the high value of 17 cents/km was assigned as the toll to produce the 'high' value, the respondent would see a price of 17 cents/km * 9.5 km = $1.61 and rounded down to $1.50 for simplicity.

Table 1-6: Corridor distribution of firms and maximum percent of shipments

Corridor		Sample Size			Max % of shipments on corridor				
No.	Description	n	Total	Freq.	Min	Median	Max	Mean	SD
1	(between Three Miles Plain and Falmouth)	6	66	9.1%	10	37.5	100	45.00	31.62
2	(between Hortonville and Coldbrook)	8	66	12.1%	10	39.0	90	38.63	26.40
3	(between Tantallon and Bridgewater)	18	66	27.3%	1	25.0	96	36.88	30.30
4	(between Sutherlands River and Antigonish)	9	66	13.6%	1	25.0	100	30.11	30.37
5	(between Taylor's Road and Aulds Cover)	1	66	1.5%					
6	(between Port Hastings and Hawkesbury)	1	66	1.5%					
7	(between St. Peters and Sydney)	16	66	24.2%	8	30.0	90	33.40	23.86
8	(between Porters' Lake and Bedford)	7	66	10.6%	10	30.0	50	30.00	17.03

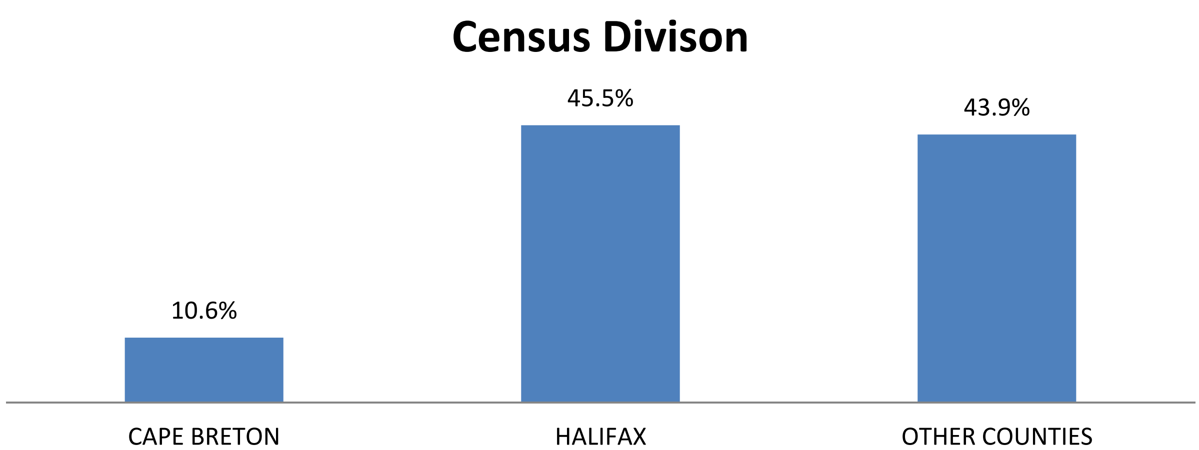

Figure 1-1: County distribution of firms

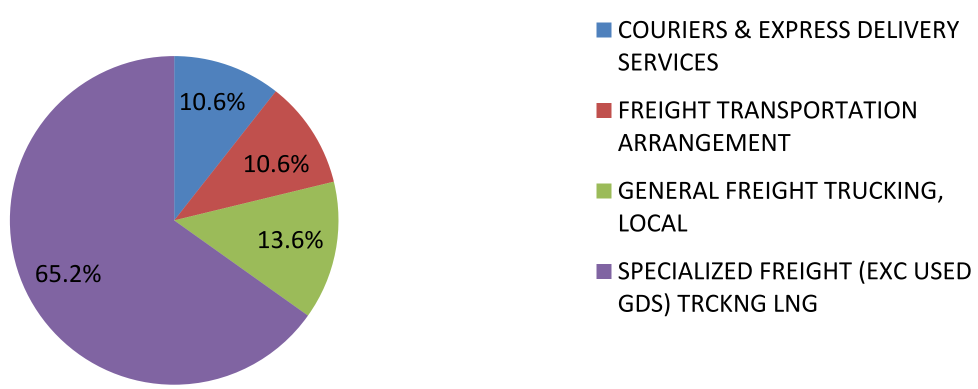

Figure 1-2: NAICS description from InfoCanada of firms

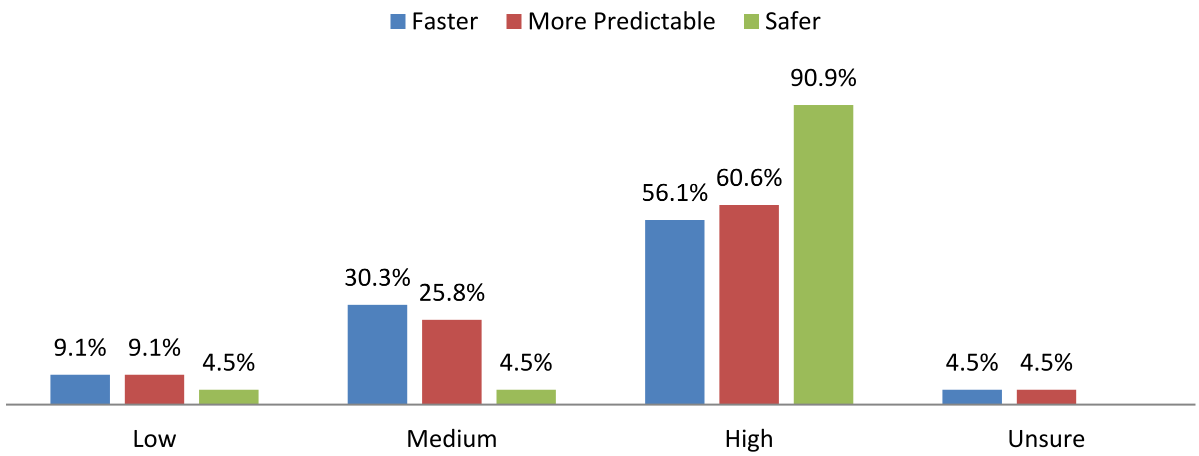

Figure 1-3: Level of travel priorities of firms

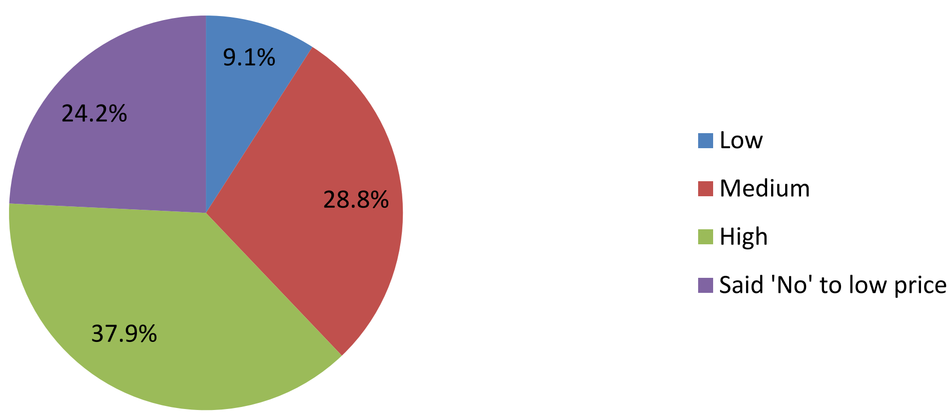

Figure 1-4: Firm's willingness to pay of prices provided

Survey Results

In this section, a series of cross-tabulations are presented to document the survey findings and the possible influences of firmographic attributes on willingness to pay, toll payment preferences, and toll account status.

Willingness to Pay

The following tables display the firms' willingness to pay by county, corridor, corridor frequency, commodity, firm size and type, driving radius of firm, location of headquarters (local or headquarters), and number of power units owned by firm. The willingness to pay is categorized as 'Low', 'Medium', 'High', and 'Said 'No' to low prices'. Firms with 'Low' willingness to pay declined the medium price option but said yes to the low price. Firms with 'Medium' willingness to pay said yes to the specified medium price, but disagreed with the high price. Firms in the ‘high’ willingness to pay category said yes to the medium and high prices. The firms who declined the low prices are placed in the remaining category, ‘Said ‘No’ to low prices’.

Overall, about 76 percent of the firms stated that they are willing to pay the specified low, medium, or high prices while the rest declined. From those who are willing to pay, 38 percent agreed to the high prices followed by the medium prices at 29 percent. Only about 9 percent of the firms agreed to pay the low prices but not the high or median prices.

The following can be observed in the tables below:

- Firms in Cape Breton, which represent 11 percent of the sample, are willing to pay high prices at 71 percent.
- Firms in Halifax are slightly less willing to pay the specified low, medium, and high prices than those outside of Halifax.
- Firms using Corridor 8 are willing to pay medium prices at 71 percent and did not reject any of the prices presented to them.
- Corridors that are used less than 50 percent of the time for shipments have higher willingness to pay at 44 percent. Meanwhile, the level of willingness to pay for corridors that are used more frequently appears to be evenly distributed.
- Firms shipping food, manufactured products, and automotive and machinery are more willing to pay than those shipping other commodities.
- Larger firms (100+ employees) agreed to pay high prices at 50 percent or reject all prices offered at 30 percent.
- Local firms seem a bit more willing to pay than headquarters.
- Freight forwarding companies are willing to pay high prices at 56 percent.
- Long haul firms did not appear as willing to pay. They either selected the medium prices that were presented to them or rejected all prices.
- The number of power units in a firm did not appear to affect the willingness to pay.

Table 2-1-1: Willingness to pay by county

	Census Division			
	HALIFAX	CAPE BRETON	OTHER[4]*	Column Total
Low	10.0%	0.0%	10.3%	9.1%
Medium	26.7%	14.3%	34.5%	28.8%
High	36.7%	71.4%	31.0%	37.9%
Said 'No' to low price	26.7%	14.3%	24.1%	24.2%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

*Other category includes firms under the remaining counties of Nova Scotia

Table 2-1-2: Willingness to pay by corridor

	Primary Corridor						
	2: (between Hortonville and Coldbrook)	3: (between Tantallon and Bridgewater)	4: (between Sutherlands River and Antigonish)	7:(between St. Peters and Sydney)	8:(between Porters' Lake and Bedford)	(Corridors 1,5,6)	Column Total
Low	12.5%	11.1%	0.0%	6.3%	14.3%	12.5%	9.1%
Medium	0.0%	22.2%	22.2%	31.3%	71.4%	37.5%	28.8%
High	50.0%	38.9%	44.4%	37.5%	14.3%	37.5%	37.9%
Said 'No' to low price	37.5%	27.8%	33.3%	25.0%	0.0%	12.5%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 2-1-3: Willingness to pay by percentage of shipments on primary corridor

	Frequency of firms by Percentage of Shipments on the Primary Corridor				
	1-24%	25-49%	50-100%	Prefer not to Say	Column Total
Low	13.0%	0.0%	21.4%	0.0%	9.1%
Medium	21.7%	28.0%	28.6%	75.0%	28.8%
High	43.5%	44.0%	28.6%	0.0%	37.9%
Said 'No' to low price	21.7%	28.0%	21.4%	25.0%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 2-1-4: Willingness to pay by commodity type

	Primary Commodity						
	Food	Manufactured products	Automotive, Machinery and electrical	Less than Truckload	Mixed	Other[5]	Column Total
Low	12.5%	0.0%	0.0%	23.1%	28.6%	0.0%	9.1%
Medium	50.0%	16.7%	33.3%	23.1%	14.3%	35.7%	28.8%
High	37.5%	58.3%	41.7%	30.8%	28.6%	28.6%	37.9%
Said 'No' to low price	0.0%	25.0%	25.0%	23.1%	28.6%	35.7%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

[5] Includes agricultural products, minerals, wood and products, waste and scrap, empty shipping containers, and ‘prefer not to say’

Table 2-1-5: Willingness to pay by employee size

	Number of Employees				
	1-9	10-19	20-99	100+	Column Total
Low	4.3%	18.8%	6.3%	10.0%	9.1%
Medium	34.8%	25.0%	31.3%	10.0%	28.8%
High	34.8%	43.8%	31.3%	50.0%	37.9%
Said 'No' to low price	26.1%	12.5%	31.3%	30.0%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 2-1-6: Willingness to pay by firm type

	Type of Trucking Firm				
	For-hire carrier	For-hire owner-operator or Towing	Private Carrier or For Hire and Private	Freight forwarder or Load/Freight broker	Column Total
Low	7.5%	25.0%	0.0%	11.1%	9.1%
Medium	30.0%	37.5%	25.0%	22.2%	28.8%
High	35.0%	37.5%	37.5%	55.6%	37.9%
Said 'No' to low price	27.5%	0.0%	50.0%	11.1%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%	100.0%

Table 2-1-7: Willingness to pay by driving radius of firm

	Driving Radius			
	Local	Long haul	Both	Column Total
Low	10.0%	11.1%	7.4%	9.1%
Medium	30.0%	44.4%	22.2%	28.8%
High	43.3%	11.1%	40.7%	37.9%
Said 'No' to low price	16.7%	33.3%	29.6%	24.2%
Row Total	100.0%	100.0%	100.0%	100.0%

Table 2-1-8: Willingness to pay by location of firm

	Type of Location		
	Local	Headquarters	Column Total
Low	15.8%	6.4%	9.1%
Medium	26.3%	29.8%	28.8%
High	42.1%	36.2%	37.9%
Said 'No' to low price	15.8%	27.7%	24.2%
Row Total	100.0%	100.0%	100.0%

Table 2-1-9: Willingness to pay by number of power units in firm

	Number of Power Units[6]				
	<10	10-50	>50	Not Applicable	Column Total
Low	12.0%	10.0%	10.0%	0.0%	9.1%
Medium	24.0%	25.0%	30.0%	44.4%	28.8%
High	44.0%	30.0%	40.0%	33.3%	37.9%
Said 'No' to low price	20.0%	35.0%	20.0%	22.2%	24.2%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Toll Payment Preferences

The following tables display toll payment preferences of the respondents by county, corridor, corridor frequency, commodity, firm size and type, driving radius of firm, location of headquarters, and number of power units owned by firm. The payment categories include opening an electronic toll collection account with a transponder, stopping and paying cash at the toll booth, continuing through the toll booth without stopping and receiving an invoice by mail, not paying any toll, not sure, and refusing to answer.

Overall, 71 percent of firms prefer to open an electronic toll collection account with a transponder. The next payment option, at 15 percent, is to have the license plate recorded. All of the categories have paying electronically as the most preferred option. Firms that had a moderate preference for paying cash at a toll booth use corridor 2, ship food as their primary commodity, are a moderate size of 10 to 19 employees, are for-hire carriers or owner-operators, local instead of long haul, and have less than 10 power units.

Table 2-2-10: Toll Payment Preferences by county

	Census Division			
	HALIFAX	CAPE BRETON	OTHER*	Column Total
Open an electronic toll collection account with a transponder	73.3%	85.7%	65.5%	71.2%
Stop and pay cash at the toll booth	6.7%	14.3%	10.3%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	16.7%	0.0%	17.2%	15.2%
Don't know	3.3%	0.0%	6.9%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

*Other category includes firms under the remaining counties of Nova Scotia

[6] Removed the 'Prefer not to say' category, which consisted of 2 respondents

Table 2-2-11: Toll Payment Preferences by corridor

	Primary Corridor						
	2: (between Hortonville and Coldbrook)	3: (between Tantallon and Bridgewater)	4: (between Sutherlands River and Antigonish)	7:(between St. Peters and Sydney)	8:(between Porters' Lake and Bedford)	(Corridors 1,5,6)	Column Total
Open an electronic toll collection account with a transponder	37.5%	83.3%	66.7%	81.3%	85.7%	50.0%	71.2%
Stop and pay cash at the toll booth	25.0%	5.6%	11.1%	6.3%	14.3%	0.0%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	37.5%	11.1%	22.2%	6.3%	0.0%	25.0%	15.2%
Don't know	0.0%	0.0%	0.0%	6.3%	0.0%	25.0%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-2-12: Toll Payment Preferences by percentage of shipments on primary corridor

	Frequency of firms by Percentage of Shipments on the Primary Corridor				
	1-24%	25-49%	50-100%	Prefer not to Say	Column Total
Open an electronic toll collection account with a transponder	69.6%	64.0%	85.7%	75.0%	71.2%
Stop and pay cash at the toll booth	13.0%	12.0%	0.0%	0.0%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	13.0%	24.0%	7.1%	0.0%	15.2%
Don't know	4.3%	0.0%	7.1%	25.0%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-2-13: Toll Payment Preferences by commodity type

	Primary Commodity						
	Food	Manufactured products	Automotive, Machinery and electrical	Less than Truckload	Mixed	Other[7]	Column Total
Open an electronic toll collection account with a transponder	62.5%	58.3%	75.0%	76.9%	85.7%	71.4%	71.2%
Stop and pay cash at the toll booth	37.5%	8.3%	0.0%	7.7%	0.0%	7.1%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	0.0%	33.3%	25.0%	15.4%	0.0%	7.1%	15.2%
Don't know	0.0%	0.0%	0.0%	0.0%	14.3%	14.3%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-2-14: Toll Payment Preferences by employee size

	Number of Employees				
	1-9	10-19	20-99	100+	Column Total
Open an electronic toll collection account with a transponder	65.2%	62.5%	93.8%	70.0%	71.2%
Stop and pay cash at the toll booth	8.7%	25.0%	0.0%	0.0%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	17.4%	12.5%	6.3%	30.0%	15.2%
Don't know	8.7%	0.0%	0.0%	0.0%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[7] Includes agricultural products, minerals, wood and products, waste and scrap, empty shipping containers, and 'prefer not to say'

Table 2-2-15: Toll Payment Preferences by firm type

	Type of Trucking Firm				
	For-hire carrier	For-hire owner-operator or Towing	Private Carrier or For Hire and Private	Freight forwarder or Load/Freight broker	Column Total
Open an electronic toll collection account with a transponder	67.5%	75.0%	87.5%	77.8%	71.2%
Stop and pay cash at the toll booth	12.5%	12.5%	0.0%	0.0%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	17.5%	12.5%	12.5%	11.1%	15.2%
Don't know	2.5%	0.0%	12.5%	11.1%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-2-16: Toll Payment Preferences by driving radius of firm

	Driving Radius			
	Local	Long haul	Both	Column Total
Open an electronic toll collection account with a transponder	66.7%	77.8%	74.1%	71.2%
Stop and pay cash at the toll booth	10.0%	0.0%	11.1%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	20.0%	11.1%	11.1%	15.2%
Don't know	3.3%	11.1%	3.7%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-2-17: Toll Payment Preferences by location of firm

	Type of Location		
	Local	Headquarters	Column Total
Open an electronic toll collection account with a transponder	78.9%	68.1%	71.2%
Stop and pay cash at the toll booth	0.0%	12.8%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	15.8%	14.9%	15.2%
Don't know	5.3%	4.3%	4.5%
Row Total	**100.0%**	**100.0%**	**100.0%**

Table 2-2-18: Toll Payment Preferences by number of power units in firm

	Number of Power Units				
	<10	10-50	>50	Not Applicable	Column Total
Open an electronic toll collection account with a transponder	56.0%	95.0%	80.0%	44.4%	71.2%
Stop and pay cash at the toll booth	16.0%	0.0%	0.0%	22.2%	9.1%
Continue through the toll booth without stopping, have your license plate recorded, and receive the invoice in the mail	24.0%	5.0%	20.0%	11.1%	15.2%
Don't know	4.0%	0.0%	0.0%	22.2%	4.5%
Row Total	**100%**	**100%**	**100%**	**100%**	**100%**

Have Toll Account

The following tables display whether or not the firms currently have a transponder for a toll account by county, corridor, corridor frequency, commodity, firm size and type, driving radius of firm, location of headquarters, and number of power units owned by firm. Overall, three quarters of the firms who completed the survey currently have a transponder to a toll account. This is mainly driven by 90 percent of the firms located in Halifax. In the county of Cape Breton, only 29 percent have a transponder

Having a transponder is common in almost all categories. Firms that are less likely to have a transponder are not located in Halifax, ship food as their primary commodity, and are freight forwarders.

Table 2-3-19: Currently have transponder for toll account by county

	Census Division			
	HALIFAX	CAPE BRETON	OTHER COUNTIES	Column Total
Yes	90.0%	28.6%	69.0%	**74.2%**
No	10.0%	71.4%	31.0%	**25.8%**
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-20: Currently have transponder for toll account by corridor

	Primary Corridor						
	2: (between Hortonville and Coldbrook)	3: (between Tantallon and Bridgewater)	4: (between Sutherlands River and Antigonish)	7:(between St. Peters and Sydney)	8:(between Porters' Lake and Bedford)	(Corridors 1,5,6)	Column Total
Yes	75.0%	72.2%	77.8%	62.5%	85.7%	87.5%	74.2%
No	25.0%	27.8%	22.2%	37.5%	14.3%	12.5%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-21: Currently have transponder for toll account by percentage of shipments on primary corridor

	Frequency of firms by Percentage of Shipments on the Primary Corridor				
	1-24%	25-49%	50-100%	Prefer not to Say	Column Total
Yes	95.7%	56.0%	64.3%	100.0%	74.2%
No	4.3%	44.0%	35.7%	0.0%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-22: Currently have transponder for toll account by commodity type

	Primary Commodity						
	Food	Manufactured products	Automotive, Machinery and electrical	Less than Truckload	Mixed	Other[8]	Column Total
Yes	37.5%	75.0%	66.7%	100.0%	85.7%	71.4%	74.2%
No	62.5%	25.0%	33.3%	0.0%	14.3%	28.6%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[8] Includes agricultural products, minerals, wood and products, waste and scrap, empty shipping containers, and 'prefer not to say'

Table 2-3-23: Currently have transponder for toll account by employee size

	Number of Employees				
	1-9	10-19	20-99	100+	Column Total
Yes	52.2%	81.3%	87.5%	90.0%	74.2%
No	47.8%	18.8%	12.5%	10.0%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-24: Currently have transponder for toll account by firm type

	Type of Trucking Firm				
	For-hire carrier	For-hire owner-operator or Towing	Private Carrier or For Hire and Private	Freight forwarder or Load/Freight broker	Column Total
Yes	87.5%	50.0%	75.0%	44.4%	74.2%
No	12.5%	50.0%	37.5%	55.6%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-25: Currently have transponder for toll account by driving radius of firm

	Driving Radius			
	Local	Long haul	Both	Column Total
Yes	60.0%	66.7%	92.6%	74.2%
No	40.0%	33.3%	7.4%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 2-3-26: Currently have transponder for toll account by location of firm

	Type of Location		
	Local	Headquarters	Column Total
Yes	94.7%	66.0%	74.2%
No	5.3%	34.0%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**

Table 2-3-27: Currently have transponder for toll account by number of power units in firm

	Number of Power Units				
	<10	10-50	>50	Not Applicable	Column Total
Yes	60.0%	90.0%	100.0%	55.6%	74.2%
No	40.0%	10.0%	0.0%	44.4%	25.8%
Row Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Summary of Findings

The results of the freight willingness to pay survey provided good insight on the types of firms in the sample and how they feel about paying tolls. Even though the sample size is small and may not properly reflect the entire freight firm population in Nova Scotia, the results provide a good starting point for future analyses. The majority of the sample consisted of small to moderate local for-hire carrier firms based in Halifax that frequently used corridors 3 and 7 for their shipments. The majority of the respondents made it clear that they valued safety above faster and more predictable travel times in their responses and additional comments. Overall, about three quarters of the firms have a toll collection account that uses a transponder, prefer to pay tolls electronically, and are willing to pay the low, medium, or high toll prices presented to them. From those who are willing to pay, 38 percent agreed to the high prices followed by the medium prices at 29 percent. Interestingly, about three quarters of the firms in Cape Breton, are willing to pay high prices. Firms that are more willing to pay the toll prices that were presented to them are freight forwarders, local instead of headquarters, and ship food, manufactured products, and automotive and machinery as their primary commodity. Firms less willing to pay are larger and long haul. Based on some of the additional comments provided, freight firms are not keen on paying tolls because they feel that they are already paying a lot in fuel taxes and other industry related costs such as registrations and permits. Also, the toll would be an additional cost to the consumer.