## HIGHWAY TWINNING FEASIBILITY STUDY

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

Project No. 151046.00

## Preliminary Screening/Assessment PROJECT SUMMARY (FINAL) July, 2016



## ISO 9001

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## Solving today's problems with tomorrow in mind

July 13, 2016

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Dear Mr. Ward:

## RE: Highway Twinning Feasibility Study - Preliminary Screening/Assessment Phase, Final Project Summary

Thank you for giving us the opportunity to undertake this important study on your behalf. As you know we have been undertaking a significant amount of work during the Preliminary Screening/Assessment phase.

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 during the Detailed Feasibility Study phase.

Yours truly,

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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 (94.9 km); and
- Corridor 8: Highway 107 - Porter's Lake to Duke Street, Bedford ( 33.3 km ).

In general, the study is looking at current economic conditions of communities throughout the proposed corridors and at the trends to determine if twinning, upgrading or new construction of the highways is 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 an intensive 60 calendar day period involving a concentrated review of available information, additional data collection in the time available, and a comparison of the eight highway corridors against specific criteria developed to identify the sections of highway that provide the best value overall for NSTIR and the road users.

Our approach during the Preliminary Screening/Assessment phase of the work has been to evaluate the costs associated with implementing the highway upgrades (Class D cost estimates) and the associated revenue generation potential from tolling, along with other economic benefits that could be realized. A matrix assessment has been carried out 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 60 day period, and have received valuable and timely input during the course of the assessment.

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


## CHAPTER 2 <br> Traffic Analysis And Forecasts

### 2.1 Data Review and Analysis

NSTIR provided the majority of the data that were used as key inputs in preparing traffic and revenue forecasts for each of the 8 corridors and to evaluate them during the PSA phase. This included auto and truck traffic data, collision data, previous studies and reports, population projections, and historic economic trends on tourism, motor vehicle registrations, and GDP outlook. The CBCL team reviewed the data and also carried out additional data collection from various sources to supplement the above. Since historic traffic data and socio-economic trends and projections are key drivers for traffic growth, we discuss these two main categories of data below.

### 2.1.1 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 highways sections as the basis of deriving our traffic volume forecasts, traffic data were processed for a total of 56 sections for the 8 corridors. The availability of AADT, 24hour volumes, and heavy vehicle counts or percentages 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. We have made adjustments 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.

### 2.1.2 Independent Economic Indicators

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

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

The sources for GDP forecasts included Conference Board of Canada (CBOC), TD Canada Trust, and Bank of Montreal (BMO). Population forecast data from Statistics Canada (Scenarios M1 and M4, 2015-2038, of which M4 resembles the official forecasts used by Nova Scotia Department of Finance and Treasury Board); however, 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 2.1 illustrates the projected trends assuming linear growth and the respective Compound Annual Growth Rates (CAGR) based on the forecasts and extrapolation of historic data. 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.

Generally, the provincial GDP is expected to have a long term positive growth trend around $1 \%$ to 2050 . However, there is a projected decline in total population immediately from 2016 onwards based on the M4 scenario. The M1 scenario has population decrease around 2025. While traffic growth is often linked with population and employment growth, the declining provincial population would suggest that traffic growth could also decline. During the PSA phase, the objective was to develop forecasts based on the available data, and additional refinements will occur during phase 2.
Based on the multiple independent GDP projections and the available time and data for the PSA phase, a simpler approach was adopted using GDP as the key input into supporting traffic growth across the corridors anchored in extrapolation of the historic traffic growth rates. 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 is $18 \%$ slower than the growth from 2016 to 2025 .


### 2.2 Traffic Forecasts

From the data review and analysis findings, the forecast approach in the PSA phase was 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. 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. As discussed above, post 2025 adjustments to the traffic growth were made to reflect the population decline and the $18 \%$ slower economic growth. For the Highway 107 corridor, an available computer transportation model (owned by 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 Chapter 2.6.

To assist in the development of the forecasts, the 8 highway corridors were divided into 56 sub-sections at locations where traffic volumes changed. For The results of the regression forecasts and modelling are expressed in Compound Annual Growth rates (CAGRs) for each of the 56 highway sections for AADT and truck volumes. The range of CAGR for each corridor is shown in Table 2.1. For comparison, the AADT growth rate for the existing Cobequid Pass toll highway is also included.

Table 2.1 - Traffic Volume Compound Annual Growth Rates (ranges defined by the individual sections)

| Input / Assumption | C1 <br> $\mathbf{1 0 1}$ <br> (A) | C2 <br> $\mathbf{1 0 1}$ (B) | C3 <br> $\mathbf{1 0 3}$ (C) | C4 <br> $\mathbf{1 0 4}$ (D) | C5 <br> $\mathbf{1 0 4}$ (E) | C6 <br> $\mathbf{1 0 4}$ (F) | C7 <br> $\mathbf{1 0 4}$ (G) | C8 <br> $\mathbf{1 0 7}$ (H) | Cobequid <br> Pass 104 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \# of Sections | 4 | 6 | 10 | 6 | 4 | 2 | 12 | 10 | 4 |
| Auto CAGR - Lowest <br> volume section | $0.35 \%$ | $0.65 \%$ | $0.76 \%$ | $0.47 \%$ | $-1.71 \%$ | $0.00 \%$ | $-1.45 \%$ | $0.30 \%$ | $0.11 \%$ |
| Auto CAGR - Highest <br> volume section | $0.91 \%$ | $1.85 \%$ | $2.37 \%$ | $2.02 \%$ | $1.45 \%$ | $1.61 \%$ | $2.44 \%$ | $1.30 \%$ | $1.47 \%$ |
| Corridor Growth <br> (Auto VKT) | $0.24 \%$ | $1.30 \%$ | $1.55 \%$ | $0.98 \%$ | $0.53 \%$ | $1.19 \%$ | $1.09 \%$ | $0.79 \%$ | $1.44 \%$ |


| Input / Assumption | C1 <br> $\mathbf{1 0 1}$ <br> (A)* | C2 <br> $\mathbf{1 0 1}$ (B) | C3 <br> $\mathbf{1 0 3}$ (C) | C4 <br> $\mathbf{1 0 4}$ (D) | C5 <br> $\mathbf{1 0 4}(\mathrm{E})$ | C6 <br> $\mathbf{1 0 4}$ (F) | C7 <br> $\mathbf{1 0 4}$ (G) | C8 <br> $\mathbf{1 0 7}$ (H) | Cobequid <br> Pass 104 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Truck CAGR** | $1.52 \%$ | $2.31 \%$ | $1.68 \%$ | $3.11 \%$ | $4.60 \%$ | $1.03 \%$ | $2.90 \%$ | $\mathrm{n} / \mathrm{a}$ |  |
| Corridor Growth <br> $($ Truck VKT)** | $1.23 \%$ | $1.88 \%$ | $1.36 \%$ | $2.53 \%$ | $3.74 \%$ | $0.93 \%$ | $2.36 \%$ | $\mathrm{n} / \mathrm{a}$ |  |

*Note: the letters in brackets in each column heading, e.g. (A) refer to the RFP map codes.
${ }^{* *}$ Note: there were a limited number of truck data points, values to be refined in Phase 2.

### 2.2.1 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 highway) and tolled and these are further described in the sections below. Two scenarios of starting toll rates in year 2020 were assessed in Phase 1 based on two sources:

- The 10 cents per km toll rate was 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 Chapter 2.5; and
- The 6 cents per km toll rate was based on preliminary willingness to pay surveys conducted in the province.

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

- Assumed opening year in 2020 for all 8 corridors;
- 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;
- Two scenarios of starting toll of $\$ 0.06 / \mathrm{km}$ and $\$ 0.10 / \mathrm{km}$ 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;
- $20 \%$ initial toll diversion for all corridors except Corridor 7 , and Corridor 8 ( $20 \%$ diversion means $20 \%$ of traffic diverted away from subject highway, while $80 \%$ of existing volume will remain on subject highway after tolling);
- Elasticity: for every $10 \%$ increase in toll, traffic will decrease by $2.1 \%$;
- 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 $15 \%$ 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
- \$20 / hour value of time in 2020 and remains constant over time - this is similar to the average wage rate in NS.

The corridor-specific assumptions are summarized in Table 2.2.
Table 2.2 - Summary of Toll Traffic and Revenue Forecast Assumptions

| Input / Assumption | $\begin{gathered} \hline \text { C1 } \\ 101(\mathrm{~A}) \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { C2 } \\ 101(B) \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { C3 } \\ 103 \text { (C) } \end{gathered}$ | $\begin{gathered} \hline \text { C4 } \\ 104 \text { (D) } \\ \hline \end{gathered}$ | $\begin{gathered} \hline C 5 \\ 104(E) \\ \hline \end{gathered}$ | $\begin{gathered} \hline \text { C6 } \\ 104 \text { (F) } \end{gathered}$ | $\begin{gathered} \hline \mathrm{C7} \\ 104 \text { (G) } \\ \hline \end{gathered}$ | $\begin{gathered} \hline \mathrm{C8} \\ 107(\mathrm{H}) \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Initial Toll Diversion (10c) | 20\% |  |  |  |  |  | 30\% | 5-20\% |
| Initial Toll Diversion (6c) | 16\% |  |  |  |  |  |  | 5-16\% |
| Toll Elasticity (10c) | $-2.10 \%$ decrease in traffic for every $+10 \%$ increase in toll |  |  |  |  |  |  | $\begin{gathered} \hline-2.10 \% \& \\ -0.5 \% \end{gathered}$ |
| Toll Elasticity (6c) | $-2.36 \%$ decrease in traffic for every $+10 \%$ increase in toll |  |  |  |  |  |  | $\begin{gathered} \hline-2.36 \% \& \\ -0.5 \% \end{gathered}$ |
| Toll Growth | 2\% | 2\% | 2\% | 1\% | 1\% | 2\% | 1\% | 2\% |
| Truck Split (2-8 Axles) | 17\% | 6\% | 7\% | 7\% | 3\% | 5\% | 5\% | 7\% |


| Input / Assumption | C1 <br> $\mathbf{1 0 1}(\mathrm{A})$ | C2 <br> $\mathbf{1 0 1}(\mathrm{B})$ | C3 <br> $\mathbf{1 0 3}(\mathrm{C})$ | C4 <br> $\mathbf{1 0 4}(\mathrm{D})$ | C5 <br> $\mathbf{1 0 4}(\mathrm{E})$ | C6 <br> $\mathbf{1 0 4}(\mathrm{F})$ | C7 <br> $\mathbf{1 0 4}(\mathrm{G})$ | C8 <br> $\mathbf{1 0 7}(\mathrm{H})$ |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Weighted Truck-to-Auto <br> 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

### 2.2.2 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 2.2 illustrates the forecast VKT trend of each highway corridor. The VKT from 2015 to 2019 are based on nontolled growth assumptions, and the VKT drop in 2020 is based on the initial diversion rates as shown in Table 2.2 (ranging from 5-30\%).

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 existing and 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 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.

### 2.3 Revenue Forecasts

To calculate toll revenue for each corridor, the VKT were multiplied by the associated toll rates for each horizon year. Figure 2.3 illustrates the annual toll revenue (in constant 2015\$) for key horizon years (in 5-

Figure 2.2-Annual Vehicle Kilometres Travelled Forecast (6 and 10 cents)

 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, are also included 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 to that of the Cobequid Pass, the modelled revenue growth would be similar to the revenue trend of Cobequid Pass.


For the lower starting toll of 6 cents per km in 2020, Figure 2.4 illustrates the annual revenue for each corridor (in constant 2015\$) for key horizon years (in 5-year increments).


Note the use of VKT for calculating toll revenues can over or under estimate revenues if a point tolling system is adopted. Initial analysis indicates relatively little variance between the two methods. Different toll collection methods and their implications on traffic and revenue forecasts will be assessed in greater detail in Phase 2. 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).

### 2.4 Analysis Tools

### 2.4.1 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 2.5, 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 2.5 - Proposed Highway 107 Corridor


## Toll Modelling

Tolls were implemented in the model as a link attribute and applied as a function of length. In all, 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 2.3 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 2.6. Considering that all corridors could start tolling in 2020, a starting toll rate of 10 cents per km was appropriate.

Table 2.3-Toll Scenarios

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

Figure 2.6 - 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 2.4, 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 $/ \mathrm{km}$, the starting toll at 10 cents $/ \mathrm{km}$ in 2020 does not reach 15 cents $/ \mathrm{km}$ by 2031 based on the $2 \%$ toll growth assumed - it would be closer to 13 cents $/ \mathrm{km}$. 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 2.4- Modelled Toll Elasticity for Highway 107 in 2031


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 2.5.

Table 2.5 - Traffic Forecast With and Without Tolls

| Alternative | Toll rates (\$/km) |  |  | VKT (Veh-km) |  |  |  |  | Diversion |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | East | Mid | West | Networkwide | 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.

An initial diversion of $20 \%$ was thus applied to other corridors 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.

### 2.5 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 numbers of collisions by severity for the 8 study corridors are illustrated in Figure 2.7. 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).

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 2.6.

Table 2.6 - Estimated Collision Reductions by Corridor

| Corridor ID | Existing Average Collisions per year <br> $(\mathbf{2 0 1 0 - 2 0 1 4 )}$ | Estimated Number of <br> Reduced Collisions per year <br> $(\mathbf{2 0 2 0}$ opening year) |
| :---: | :---: | :---: |
| $\mathbf{C 1 - 1 0 1}$ | 27.2 | 9.2 |
| $\mathbf{C 2 - 1 0 1}$ | 32.2 | 11.2 |
| $\mathbf{C 3 - 1 0 3}$ | 68.8 | 21.6 |
| $\mathbf{C 4 - 1 0 4}$ | 39.2 | 11.6 |
| $\mathbf{C 5 - 1 0 4}$ | 44.6 | 14.6 |
| $\mathbf{C 6 - 1 0 4}$ | 9.6 | 4.2 |
| $\mathbf{C 7 - 1 0 4}$ | 45.2 | 16.4 |
| $\mathbf{C 8 - 1 0 7}$ | 27.0 | 7.6 |

### 2.6 Travel Time, Travel Distance and Economic Benefits

In addition to collision cost 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 ( $\$ 0.51 / \mathrm{km}$ from CAA) and the average value of time used in this study (\$20/hour). Table $\mathbf{2 . 7}$ below summarizes the auto travel time / distance differences and the resulting annual cost savings.

Table 2.7-Travel Time, Distance and Cost Savings

|  |  |  |  | Existing Travel Times <br> (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 | $\begin{aligned} & \text { Distance } \\ & \text { (km) } \end{aligned}$ | Posted Speed | Travel Time 4pm Peak (mins) | Average Travel Speed (km/hr) | Assumed Operating Speed ( 10 km/h over posted) | Estima <br> ted <br> Travel <br> Time <br> (mins) | Travel Distanc e <br> 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 <br> 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.

## сhapter 3 Highway Corridors/Cost Estimates

### 3.1 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.

### 3.2 Review of NSTIR Cost History Data

For this part of the study, the objective was to identify subgrade construction contracts on 100 -series highways. Once the relevant projects were identified, their associated cost data were used to generate a cost per kilometre.

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 over the first few weeks of the PSA phase. 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 (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 this 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.

### 3.3 Class D Cost Estimating Methodology

### 3.3.1 Highway Construction

Cost estimating spreadsheets were created for each section of highway. Highway cross-section types were provided with an identity code for each condition such as twinning of existing highway at 35 metre offset, or twinning using narrow median, etc. Each corridor was divided into subsections depending on the type of highway cross-section that would be used. Unit rates (Cost/Km) for the type of cross-section were then used to develop costs for each subsection.

Grading unit costs were developed using historical data supplied by NSTIR as described in Chapter 3.2. The historical grading data were manipulated to remove items such as gravels in order to assure consistency, as the grading unit rate
includes clearing, grubbing, grading, and drainage infrastructure only. Items such as service roads have not been measured separately, and are deemed to be included in the historical data, or covered by the contingency item.

Spreadsheets were then developed to estimate quantities for the pavement structure from the subgrade up. A separate spreadsheet was created for the various cross-section types including Open Median, Narrow Median, Freeway Cable Barrier Median, and Major Arterial. Thicknesses for each type of gravel ( $1,1 \mathrm{~S}$, and 2 ) were assumed as follows:

- Type 1: 200 mm ;
- Type 2: 650mm on Highways 104 and 101; 550mm on Highways 103 and 107;
- Type 1S: 165 mm ; and
- Asphalt thicknesses for Type C-HF and B-HF: 50 mm and 100 mm respectively.

The paving unit cost spreadsheets were set up to allow the user to provide a percentage of the length to have guardrail, which in turn adjusts the width of the gravels and thus the estimated tonnages. Items included in the pavement structure spreadsheets include fine grading, geotextile, gravels, asphalt aggregates, asphalt binder, strong post guardrail and mobilization. Items such as pavement markings, rumble strips, and signage are deemed to be covered in the contingency item. The Class D estimates include a level of precision of $-20 \%$ to $+30 \%$ and are indicative at this stage.

### 3.3.2 Structures

Structures were not included in the per kilometre unit costs described above as the number of structures vary from section to section. Following determination of the preliminary alignments, identification of structure requirements was carried out. On alignments where the existing highway will comprise a portion of the new alignment, the existing structures were assessed for adequacy in the following areas:

- Age of structure;
- Bridge Inspection Report Rating; and
- Geometric adequacy.

Through this process three types of structures were identified: structures that would be replaced during the initial construction phase, structures that would be maintained for the life of the contract, and structures whose condition would warrant exhausting the remaining life before replacement prior to handover. Once the structures were identified, an area of deck was estimated for each structure using a combination of existing drawings, Google Earth's measurement tools and spans of structures (underpasses) crossing highway cross sections similar to those studied here.

A unit cost for structure construction was estimated based on the square metre area of deck. This unit cost was developed by analyzing historical construction costs (provided by NSTIR) as well as previous bridge projects designed and estimated by CBCL in Nova Scotia. This analysis was escalated to 2015 dollars and was estimated at $\$ 3500 / \mathrm{m}^{2}$. Cost data sample sets were not large enough to produce reliable unit costs by study section so overall provincial values have been used. Project specific allowances for each structure not included in the $\$ 3500 / \mathrm{m}^{2}$ include items such as demolition, water control, and construction requirements for long span water structures. The deck area for three and four side concrete box culverts was considered to be the width of the wearing surface multiplied by the length between each vertical leg. This allowed us to maintain the $\$ 3500 / \mathrm{m}^{2}$ unit cost to estimate these structures. Round corrugated steel and concrete culverts were considered to be included in the contingency item. The contingency also includes detours, changes in material costs, fluctuations in the labour market and changes required due to detailed design of road alignment.

In terms of detour routes, 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, following which 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 underpasses. At this stage we do not know the exact mode of construction for these structures, so these cost were also considered to be a part of the $30 \%$ contingency.

As for rehabilitation, our criteria for replacement was an NBI rating less than or equal to 5, and/or structures constructed before 1980. Structures that passed this criteria were kept and, for Class D purposes, rehabilitation costs were included with the per $\mathrm{km} O M \& R$ estimates. For the class C estimates we plan to develop these rehabilitation costs in greater detail, specifically for structures PIC 146, HFX 260, HFX 261, HFX 262, HFX 176, and HFX 177. Note that PIC 146, HFX 176 \& 177 were all constructed before 1980 but were decided to be kept either because of a very good inspection rating or because of unique construction location.

### 3.4 Cost Estimates by Corridor

Cost estimates were carried out for each section using the methodology described above. Two estimates were carried out for Sections 6 and 7 respectively. Each of these sections were specified by NSTIR to be initially constructed as undivided highways, allowing for full twinning in the future, as per the RFP. The cost estimates were developed with this in mind, however we also included an option to construct these sections as divided highways using the freeway cable barrier median. The costs of installing overhead gantry electronic toll collection equipment was also included in the cost estimates. The Class D cost estimates for each section are presented in Tables 3.1 and 3.2 below.

Table 3.1 - Class D Cost Estimates for Each Section (Sections 6 and 7 Undivided)

| Class D Construction Estimate - Section 6 \& 7 Major Arterial |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Corr | Highway | Description | Estimate | Land | Wetland | Total |
| 1 | 101 | Three Mile Plains to Falmouth | \$ 136,100,000 | \$3,402,500 | \$510,000 | \$140,000,000 |
| 2 | 101 | Hortonville to Coldbrook | \$ 158,200,000 | \$3,955,000 | \$2,448,000 | \$164,700,000 |
| 3 | 103 | Tantallon to Bridgewater | \$ 396,200,000 | \$9,905,000 | \$6,752,000 | \$412,900,000 |
| 4 | 104 | Sutherland's River to Antigonish | \$ 245,600,000 | \$6,140,000 | \$6,114,000 | \$257,900,000 |
| 5 | 104 | Taylor's Road to Auld's Cove | \$ 335,400,000 | \$8,385,000 | \$2,204,000 | \$346,000,000 |
| 6 | 104 | Port Hastings to Port Hawkesbury (Maj Art) | \$ 56,200,000 | \$1,405,000 | \$2,718,000 | \$60,400,000 |
| 7 | 104 | St. Peters to Sydney (Major Arterial) | \$ 392,900,000 | \$9,822,500 | \$39,594,000 | \$442,400,000 |
| 8 | 107 | Porters Lake to Duke Street, Bedford | \$ 328,200,000 | \$8,205,000 | \$6,310,000 | \$342,800,000 |
|  |  | Total | \$2,048,800,000 | \$51,220,000 | \$66,650,000 | \$2,167,100,000 |

Table 3.2 - Class D Cost Estimates for each Section (Sections 6 and 7 Divided)

| Class D Construction Estimate - Section 6 \& 7 Freeway Cable Barrier Median |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Corr | Highway | Description | Estimate | Land | Wetland | Total |
| 1 | 101 | Three Mile Plains to Falmouth | $\$ 136,100,000$ | $\$ 3,402,500$ | $\$ 510,000$ | $\$ 140,000,000$ |
| 2 | 101 | Hortonville to Coldbrook | $\$ 158,200,000$ | $\$ 3,955,000$ | $\$ 2,448,000$ | $\$ 164,700,000$ |
| 3 | 103 | Tantallon to Bridgewater | $\$ 296,200,000$ | $\$ 9,905,000$ | $\$ 6,752,000$ | $\$ 412,900,000$ |
| 4 | 104 | Sutherland's River to Antigonish | $\$ 245,600,000$ | $\$ 6,140,000$ | $\$ 6,114,000$ | $\$ 257,900,000$ |
| 5 | 104 | Taylor's Road to Auld's Cove | $\$ 335,400,000$ | $\$ 8,385,000$ | $\$ 2,204,000$ | $\$ 346,000,000$ |
| 6 | 104 | Port Hastings to Port Hawkesbury (Twin) | $\$ 880,300,000$ | $\$ 2,007,500$ | $\$ 2,718,000$ | $\$ 85,100,000$ |
| 7 | 104 | St. Peters to Sydney (Freeway Cable Barrier) | $\$ 643,700,000$ | $\$ 16,092,500$ | $\$ 39,594,000$ | $\$ 699,400,000$ |
| 8 | 107 | Porters Lake to Duke Street, Bedford | $\$ 328,200,000$ | $\$ 8,205,000$ | $\$ 6,310,000$ | $\$ 342,800,000$ |
|  |  | Total | $\$ 2,323,700,000$ | $\$ 58,092,500$ | $\$ 66,650,000$ | $\$ 2,448,400,000$ |

It should be noted that land costs were estimated using a percentage of construction cost (2.5\%), in consultation with NSTIR Real Estate staff. Wetland compensation is based on the estimated impacted wetland area within each corridor, assuming compensation will be based on twice the impacted area, and using $\$ 10$ per square meter as advised by NSTIR Environmental Services as being currently practiced.

### 3.5 Cost Estimates by Corridor - Comparison with NSTIR Estimates and Cobequid Pass

NSTIR provided some Class D estimates that they had carried out on each section. Table 3.3 below provides a comparison of these estimates to the CBCL Limited estimates. It should be noted that NSTIR did not provide an estimate for the entire length of Section 3 (Highway 103 Tantallon to Bridgewater), but did provide an estimate for the first portion (Tantallon to

Ingramport). The estimate shown in the table is simply an extrapolation of this estimate. It should also be noted that the cost of installing overhead gantry electronic toll collection equipment was not included in the comparison.

Table 3.3 - Comparison of CBCL Estimates to NSTIR Cost Estimates (Class D) using Sections 6 and 7 Undivided

| Corridor - Highway | Length (Km) | CBCL Class D Estimate | NSTIR Estimate | NSTIR Estimating Tool | $\begin{aligned} & \text { CBCL } \\ & \text { Cost/Km } \end{aligned}$ | NSTIR Cost/Km |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 - Highway 101 Three Mile Plains to Falmouth | 10.80 | \$118,500,000 | \$90,000,000 | \$108,696,612 | \$10,972,222 | \$8,333,333 |
| 2 - Highway 101 Hortonville to Coldbrook | 23.66 | \$140,600,000 | \$145,000,000 | \$172,419,873 | \$5,942,519 | \$6,128,487 |
| 3 - Highway 103 <br> Tantallon to Bridgewater | 68.05 | \$369,800,000 | \$452,550,000 | \$462,392,919 | \$5,434,240 | \$6,650,257 |
| 4 - Highway 104 Suth'ds River to Antigonish | 37.75 | \$232,400,000 | \$295,000,000 | N/A | \$6,156,291 | \$7,814,570 |
| 5 - Highway 104 Taylor's Road to Aulds Cove | 39.50 | \$313,400,000 | \$200,000,000 | \$328,192,334 | \$7,934,177 | \$5,063,291 |
| 6 - Highway 104 Port Hastings to Port Hawkesbury | 7.00 | \$51,800,000 | \$40,000,000 | N/A | \$7,400,000 | \$5,714,286 |
| 7 - Highway 104 <br> St. Peters to Sydney | 84.50 | \$379,700,000 | \$450,000,000 | N/A | \$4,493,491 | \$5,325,444 |
| 8 - Highway 107 Porters Lake to Duke Street, Bedford | 33.30 | \$293,000,000 | \$208,038,000 | N/A | \$8,798,799 | \$6,247,387 |
| Totals | 304.56 | \$1,899,200,000 | \$1,880,588,000 |  | \$6,235,721 | \$6,193,071 |
|  |  |  |  |  |  |  |
| Control: Cobequid Pass | 45.48 | \$356,180,000 | \$200,000,000 |  | \$7,831,574 | \$4,397,537 |
| Notes: 1. NSTIR Estimate for Section 3 is extrapolated from their estimate of $\$ 135 \mathrm{M}$ for Tantallon to Hubbards. <br> 2. NSTIR Estimate for the Cobequid Pass is reported cost of $\$ 113 \mathrm{M}$ factored to 2015 dollars at $3 \%$ compounded. <br> 3. CBCL Estimate for Cobequid Pass employs the same methodology as for the estimates for the 8 Sections. |  |  |  |  |  |  |

In order to assess how the Class D estimates may compare with an actual large scale highway twinning project, we carried out an estimate on the Cobequid Pass. We understand the Cobequid Pass project included the following:

- Beginning at Exit 7 and ending at the Masstown Road (Length 45.48 Km );
- New Open Median Expressway;
- 18 Bridge Structures; and
- 5 New Interchanges.

As indicated in Table 3.3, the cost estimate for the Cobequid Pass varies significantly from the adjusted actual construction cost. There are a number of reasons why this could be the case:

- The economy of scale inherent in large scale projects that results in significantly lower unit costs;
- The entire alignment was new construction except at each end, which meant that traffic control would not have been a major cost factor;
- The construction industry was in a slow period when the Cobequid Pass was built which would have increased competitive bidding; and
- Occupational Health and Safety and environmental protection requirements were different twenty years ago.

This comparison provides some insight that actual costs may be lower than the current Class D estimates.

### 3.6 Operations, Maintenance and Rehabilitation Costs

Operations , maintenance and rehabilitation (OMR) costs were reviewed for a number of highway sections including the Cobequid Pass in Nova Scotia, and the Fredericton-Moncton highway, the Trans-Canada (Brunway) and the Gateway highway projects in New Brunswick. Other national highway projects delivered via a PPP procurement were also reviewed and OMR costs derived.

Yearly summaries for the operations and maintenance for the Cobequid Pass (carried out by the Province under the Annual Maintenance Agreement) and the amounts for Major Maintenance are available in the annual reports of the Highway \#104 Western Alignment Corporation and were reviewed. In addition CBCL staff met with NBDOT representatives to review their OMR experience on the New Brunswick highway projects. A summary of the NS and NB projects is presented below in Table 3.4 along with annual OMR costs.

Table 3.4 - Summary of OMR Costs in NS and NB

| Project | Total $\mathbf{~ K m}$ | Total \# Structures | OMR Costs (avg) |
| :--- | :---: | :---: | :---: |
| Cobequid Pass | 45 | 16 | $\$ 2.5 \mathrm{M} / \mathrm{yr}$ |
| Fredericton Moncton Highway | 195 | 42 | $\$ 16.4 \mathrm{M} / \mathrm{yr}$ |
| Trans Canada (Brunway) | 275 | 72 | $\$ 22.0 \mathrm{M} / \mathrm{yr}$ |
| Gateway | 240 | - | $\$ 19.8 \mathrm{M} / \mathrm{yr}$ |

The average annual OMR costs per kilometre for the above projects ranged from $\$ 52,000$ to $\$ 84,000$. The projects range in age from 2 to 18 years and hence are not yet approaching the 30 year concession period under consideration for this project. Average annual per kilometre OMR cost of $\$ 100,000$ (for conservatism) was therefore used in the cost analysis.

For comparison, the estimated OMR costs per highway corridor are shown in Table 3.5.
Table 3.5 - Summary of OMR Costs per Highway Corridor

| Corridor | Highway | Description | OMR/Year |
| :---: | :---: | :--- | :---: |
| 1 | 101 | Three Mile Plains to Falmouth | $\$ 1,100,000$ |
| 2 | 101 | Hortonville to Coldbrook | $\$ 2,400,000$ |
| 3 | 103 | Exit 5 at Tantallon to Exit 12 at Bridgewater | $\$ 6,800,000$ |
| 4 | 104 | Sutherland's River to Antigonish | $\$ 3,800,000$ |
| 5 | 104 | Taylor's Road to Auld's Cove | $\$ 4,000,000$ |
| 6 | 104 | Port Hastings to Port Hawkesbury (Major Arterial) | $\$ 350,000$ |
| 7 | 104 | St. Peters to Sydney (Major Arterial) | $\$ 4,700,000$ |
| 8 | 107 | Porters Lake to Duke Street, Bedford | $\$ 3,300,000$ |

## chapter 4 Indicative Financial Viability

### 4.1 Approach to Indicative Financial Viability

High-level financial analysis was conducted during the PSA to determine indicative financial viability for each of the highway corridors. Because the revenue, construction cost and OMR cost data have been developed to only a Class ' $D$ ' Estimate level during the PSA, 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 ${ }^{1}$. 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 PSA 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 longterm 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. 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 (\$0.1/km) | 373,000,000 | 678,000,000 | 1,621,000,000 | 579,000,000 | 529,000,000 | 123,000,000 | 336,000,000 | 1,248,000,000 |
| Toll Revenues (\$0.06/km) | 232,000,000 | 422,000,000 | 1,008,000,000 | 361,000,000 | 330,000,000 | 76,000,000 | 242,000,000 | 765,000,000 |
| Construction Costs (real \$) | 140,000,000 | 164,700,000 | 412,900,000 | 257,900,000 | 350,600,000 | 60,400,000 | 442,400,000 | 342,800,000 |
| Annual OMR Costs (real \$) | 1,100,000 | 2,400,000 | 6,800,000 | 3,800,000 | 4,000,000 | 400,000 | 4,700,000 | 3,300,000 |
| 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 2015 real dollars, and were escalated at an assumed inflation rate. Key financial and timing assumptions are summarized in Table 4.2 below.

Table 4.2 - Financial Assumptions

| Assumption | Detail |
| :--- | :---: |
| Inflation Rate | $\mathbf{2 \%}$ |
| Federal Funding at SC (\%) | $\mathbf{2 5 \%}$ |
| Provincial Funding at SC (\%) | $\mathbf{2 5 \%}$ |
| Debt : Equity | $\mathbf{8 5 : 1 5}$ |
| Construction Debt Financing All-in Rate (\%) | $5 \mathbf{N O}^{\mathbf{2}}$ |
| Long-term Debt Financing All-in Rate (\%) | $\mathbf{8 \%}{ }^{\mathbf{3}}$ |
| Equity Return Rate (\%) | $\mathbf{1 5 \%}$ |

[^0]
### 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 $\$ 0.10 / \mathrm{km}$ or the flat $\$ 0.06 / \mathrm{km}$ (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 $\mathbf{\$ 0 . 1 0 / k m ~ N o m i n a l ~ ( E s c a l a t e d ) ~}$ Dollars \$ Rounded)

| Corridor | Corridor 1 | Corridor 2 | Corridor 3 | Corridor 4 | Corridor 5 | Corridor 6 | Corridor 7 | Corridor 8 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Sources of Funds |  |  |  |  |  |  |  |  |
| Forecasted Revenue | 373,000,000 | 678,000,000 | 1,621,000,000 | 579,000,000 | 529,000,000 | 123,000,000 | 336,000,000 | 1,248,000,000 |
| Federal Funding | 37,000,000 | 43,000,000 | 108,000,000 | 68,000,000 | 92,000,000 | 16,000,000 | 116,000,000 | 90,000,000 |
| Provincial Funding | 37,000,000 | 43,000,000 | 108,000,000 | 68,000,000 | 92,000,000 | 16,000,000 | 116,000,000 | 90,000,000 |
| Debt | 62,000,000 | 73,000,000 | 184,000,000 | 115,000,000 | 156,000,000 | 27,000,000 | 197,000,000 | 153,000,000 |
| Equity | 11,000,000 | 13,000,000 | 33,000,000 | 20,000,000 | 28,000,000 | 5,000,000 | 35,000,000 | 27,000,000 |
| Total Sources | 520,000,000 | 850,000,000 | 2,054,000,000 | 850,000,000 | 897,000,000 | 187,000,000 | 800,000,000 | 1,608,000,000 |
| Uses of Funds |  |  |  |  |  |  |  |  |
| Total Capital Costs | 147,000,000 | 173,000,000 | 434,000,000 | 271,000,000 | 368,000,000 | 63,000,000 | 465,000,000 | 360,000,000 |
| Total OMR Costs | 49,000,000 | 108,000,000 | 297,000,000 | 164,000,000 | 179,000,000 | 17,000,000 | 206,000,000 | 145,000,000 |
| Total Financing Payments | 224,000,000 | 263,000,000 | 619,000,000 | 400,000,000 | 543,000,000 | 94,000,000 | 685,000,000 | 531,000,000 |
| Total Uses | 420,000,000 | 544,000,000 | 1,350,000,000 | 835,000,000 | 1,090,000,000 | 174,000,000 | 1,356,000,000 | 1,036,000,000 |
| Excess (shortage) of funds based on the flat $\$ 0.1 / \mathrm{km}$ (real) toll rate used in modelling | 100,000,000 | 306,000,000 | 704,000,000 | 15,000,000 | -193,000,000 | 13,000,000 | -556,000,000 | 572,000,000 |
|  |  |  |  |  |  |  |  |  |

Based on the net overall funds at $\$ 0.10 / \mathrm{km}$, 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 2 Highway 101; (iv) Section 1 Highway 101; (v) Section 4 Highway 104; (vi) Section 6 Highway 104; (vii) Section 5 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 ( $\$ 0.06 / \mathrm{km}$ ) in the preliminary Willingness to Pay (WTP) survey results and the existing Cobequid Pass toll rates ( $\$ 0.10 / \mathrm{km}$ ). Those sections which fell at or below the WTP survey results of $\$ 0.06 / \mathrm{km}$ 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 ( $\$ 0.10 / \mathrm{km}$ ) 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. In some cases, consideration can also be given to adjacent sections (for example Corridor 1 is moderately viable while Corridor 2 is viable) but twinning Corridor 2 while leaving Corridor 1 as a two lane two way high volume section may not be ideal when considering other factors such as overall transportation system effectiveness.

Table 4.4 - Summary Financial Viability Results (Excess (Shortage) of Funds Based on Toll Rate of $\mathbf{\$ 0 . 0 6} \mathbf{~ k m}$ 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 | 232,000,000 | 422,000,000 | 1,008,000,000 | 361,000,000 | 330,000,000 | 76,000,000 | 242,000,000 | 765,000,000 |
| Federal Funding | 37,000,000 | 43,000,000 | 108,000,000 | 68,000,000 | 92,000,000 | 16,000,000 | 116,000,000 | 90,000,000 |
| Provincial Funding | 37,000,000 | 43,000,000 | 108,000,000 | 68,000,000 | 92,000,000 | 16,000,000 | 116,000,000 | 90,000,000 |
| Debt | 62,000,000 | 73,000,000 | 184,000,000 | 115,000,000 | 156,000,000 | 27,000,000 | 197,000,000 | 153,000,000 |
| Equity | 11,000,000 | 13,000,000 | 33,000,000 | 20,000,000 | 28,000,000 | 5,000,000 | 35,000,000 | 27,000,000 |
| Total Sources | 379,000,000 | 594,000,000 | 1,441,000,000 | 632,000,000 | 698,000,000 | 140,000,000 | 706,000,000 | 1,125,000,000 |
| Uses of Funds |  |  |  |  |  |  |  |  |
| Total Capital Costs | 147,000,000 | 173,000,000 | 434,000,000 | 271,000,000 | 368,000,000 | 63,000,000 | 465,000,000 | 360,000,000 |
| Total OMR Costs | 49,000,000 | 108,000,000 | 297,000,000 | 164,000,000 | 179,000,000 | 17,000,000 | 206,000,000 | 145,000,000 |
| Total Financing Payments | 224,000,000 | 263,000,000 | 619,000,000 | 400,000,000 | 543,000,000 | 94,000,000 | 685,000,000 | 531,000,000 |
| Total Uses | 420,000,000 | 544,000,000 | 1,350,000,000 | 835,000,000 | 1,090,000,000 | 174,000,000 | 1,356,000,000 | 1,036,000,000 |
| Excess (shortage) of funds based on the flat $\$ 0.06 / \mathrm{km}$ (real) toll rate used in modelling | -41,000,000 | 50,000,000 | 91,000,000 | -203,000,000 | -392,000,000 | -34,000,000 | -650,000,000 | 89,000,000 |

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 | 273,000,000 | 372,000,000 | 917,000,000 | 564,000,000 | 722,000,000 | 110,000,000 | 892,000,000 | 676,000,000 |
| Approximate toll rate to balance (cents/km) | 7 | 5 | 6 | 10 | 14 | 9 | 27 | 5 |
| Summary Rating | yellow | green | green | yellow | red | yellow | red | green |

Figure 4.1 - Estimated Toll Rate to Balance


### 4.3 Detailed Feasibility Study Phase

Additional financial analysis on the highway corridors will be conducted during the Detailed Feasibility Study phase of the assignment. During that phase, a value-for-money (VFM) analysis will be conducted using generally accepted best practices. This will involve establishing a period by period cash-flow profile under both traditional and PPP procurement delivery options on a "like for like" basis (i.e. assuming consistent timeline, specifications, performance standards, etc.). These cash-flow profiles will then be adjusted for the time value of money to provide a net present value (NPV) for each procurement delivery option and further adjusted for any other key differentials between the options (such as the different risk profiles).

## 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 Preliminary Screening/Assessment. The evaluation has been based on the preliminary interpretation of available secondary data sources. Additional evaluation of environmental constraints would be required in future phases to further characterize the environmental risk associated with the proposed corridors.

### 5.2 Previous Environmental Assessments and Studies

Previous 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 reviewed by CBCL.

Table 5.1 - Previous Environmental Assessments and Associated Studies

| Corridor | Document Title | Date Completed | Author | Comments |
| :---: | :---: | :---: | :---: | :---: |
| Corridor 1: <br> Highway 101 - <br> Three Mile <br> Plains to <br> Falmouth | CEAA Environmental Screening of the Highway 101 Twinning Project; St. Croix to Avonport | 2005 | Dillon Consulting Limited |  |
|  | MI'KMAW KNOWLEDGE STUDY, Highway 101 Twinning Project, St. Croix to Greenwood | 2004 | Mi'kmaq Environmental Services |  |
| Corridor 2: <br> Highway 101 - <br> Hortonville to Coldbrook | CEAA Environmental <br> Assessment Screening of Highway 101 Twinning: <br> Hortonville to Coldbrook, NS | 2012 | Dillon Consulting Limited | included MEKS and Archaeological Assessment |
| Corridor 3: <br> Highway 103 - <br> Exit 5 Tantallon <br> to Exit 12 <br> Bridgewater | CEAA Screening-Level Environmental Assessment Report for Highway 103 Twinning | 2012 | Stantec Consulting Limited | included MEKS |
| Corridor 4: <br> Highway 104 - <br> Sutherlands <br> River to <br> Antigonish | MI'KMAW KNOWLEDGE STUDY Highway 104 New Glasgow to Aulds Cove | 2004 | Mi'kmaq Environmental Services |  |
| Corridor 5: <br> Highway 104 - <br> Taylors Road to Aulds Cove | MI'KMAW KNOWLEDGE STUDY Highway 104 New Glasgow to Aulds Cove | 2004 | Mi'kmaq Environmental Services |  |
| Corridor 6: <br> Highway 104 - <br> Port Hastings to <br> Port <br> Hawkesbury | Class I Environmental Assessment Registration for Highway 104 Port Hastings to Port Hawkesbury | 2010 | Dillon Consulting Limited | Includes an Archaeological Assessment |
| Corridor 7: <br> Highway 104 - <br> St. Peter's to Sydney | NA | NA | NA | No environmental reports provided |
| Corridor 8: <br> Highway 107 - <br> Porter's Lake to <br> Duke Street, <br> Bedford | Highway 107 Extension to Highway 102 (Phases 1 and 2), Bedford NS - CEAA Screening Report | 2011 | Stantec Consulting Services |  |

Relevant information from previous environmental assessments and related studies provided to CBCL have been considered in the study and incorporated into the preliminary constraints mapping. The majority of the previous assessments and studies may need to be updated due to their age and increase in proposed highway twinning lengths.

### 5.3 Preliminary Assessment of Environmental Constraints

CBCL has completed a preliminary assessment of environmental constraints that could affect the feasibility of the proposed highway twinning corridors. The assessment includes 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 5.2 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 100 m of the Corridors (ACCDC and EA Data).

The evaluation of watercourse crossings and wetland interactions has been completed through 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 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.

All corridors have environmental data gaps and will require additional environmental studies to further evaluate the environmental risk and constraints. An assessment of environmental data gaps has been incorporated into the assessment and summarized in Table 5.2. 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.

The assessment results presented in Table 5.2 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.

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 Undertaken in the Environmental Assessment Regulations.

| 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: 126 | Area: 33.76 ha | Total: 61 | Area: 30.57 ha | Total: 48 | Area: 11.02 ha | Total: 15 | Area: 13.59 ha | Total: 158 | Area: 199.4 ha | Total: 80 | Area: 31.55 ha |
| Watercourse Crossings | Total: 28 |  | Total: 52 |  | Total: 94 |  | Total: 90 |  | Total: 39 |  | Total: 17 |  |  |  | Total: 40 |  |
| Environmentally Sensitive Feature | - Ramsar Wetland - Southern Bight, Minas Basin Bay of Fundy, NS <br> - Important Birds AreaSouthern Bight, Minas Basin Bay of Fundy, NS <br> - First Nations Significant Plant Area |  | - Important Birds AreaSouthern Bight, Minas Basin Bay of Fundy, NS |  | - Critical Habitat - Atlantic Salmon (5 Occurrences) <br> - First Nations Significant Plant Area |  | - Critical Habitat - Atlantic Salmon (1 Occurrence) |  | - Critical Habitat - Atlantic Salmon (1 Occurrence) <br> - Tracadie Harbour Marine Habitat |  | None identified |  | - Critical Habitat - Atlantic Salmon (2 Occurrences) <br> - First Nations Significant Plant Area |  | - Anderson Lake (Atlantic Whitefish) |  |
| Protected Areas | None identified |  | None identified |  | - Simms Settlement Provincial Park <br> - South Panuke Wilderness Area <br> - Gold River First Nations Reserve <br> - Mahone Bay Water Supply Area |  | None identified |  | - Pomquet/Afton First Nations Reserve <br> - Linwood Protected Beach |  | - Port Hawkesbury Water Supply Area |  | - Coxheath/ Westmount Municipal Water Supply Area |  | - Dartmouth Municipal Water Supply <br> - Halifax Lateral Corridor <br> - 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 | Moderate: Relevant project specific environmental studies have been completed but will require updates. |  | 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 <br> - 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 <br> - Federal EA - Trigger < 50 km of an all season highway in a new right-of-way <br> - CEAA 67 Requirements (Federal Lands) - PWGSC Parcel 15870579 (Ben Eoin) |  | - Provincial EA - Trigger > 2 km of 4 lane highway <br> - CEAA 67 Requirements (Federal Lands) |  |
| Provincial Permitting | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval <br> - Agricultural Marshland Conservation Act Considerations |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  | - Watercourse Alteration <br> - Wetland Alteration and Compensation <br> - Crown Land Act Approval |  |
| Federal Permitting | - Navigation Protection Act Approval <br> - Fisheries Act Authorization and Compensation |  | - Fisheries Act Authorization and Compensation |  | - Navigation Protection Act Approval <br> - Fisheries Act Authorization and Compensation <br> - First Nations Land Acquisition (Gold River First Nations) |  | - Fisheries Act Authorization and Compensation |  | - Navigation Protection Act Approval <br> - Fisheries Act Authorization and Compensation <br> - First Nations Land Acquisition (Pomquet/Afton) |  | None identified |  | - Navigation Protection Act Approval <br> - Fisheries Act Authorization and Compensation |  | - Navigation Protection Act Approval <br> - Fisheries Act Authorization and Compensation |  |

## 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 is considered to be a key output from the screening phase and assisted in undertaking a quantitative review of the significant analysis that has been carried out. The criteria developed were discussed in some detail with NSTIR prior to undertaking the screening/assessment.

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 D cost estimates, traffic and revenue forecasts, travel time and travel cost savings, collision reduction numbers, and an initial 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 and 8 score in the top 4 in the matrix analysis and are rated as Green in the Toll Rate Analysis. Corridors 5 and 7, both rated Red in the toll analysis, are ranked $6^{\text {th }}$ and $7^{\text {th }}$ respectively in the Assessment Matrix. Corridors 2 and 6 achieve different rankings in each analysis, with Corridor 6 being rated a Yellow in the Toll Rate analysis while raking $8^{\text {th }}$ in the Assessment Matrix. Corridor 4 is ranked Yellow in the Toll Rate Analysis while being ranked $3^{\text {rd }}$ in the matrix analysis. A review of the matrix scoring indicates that these differences were due in part to the considerably different scores achieved in Criteria 4 Collision Reduction, with Corridor 4 scoring considerably higher under this criteria. All analyses carried out indicate that Corridor 7 scored very low and consideration should be given to dropping this section from the detailed feasibility phase.

In summary the preliminary screening assessment 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,
- Corridor 1 is a credible candidate (moderate matrix ranking, moderate financial viability but a key component between Corridor 2 and the rest of the twinned portion of Highway 101),
- Corridors 6 (low matrix ranking and moderate financial viability) and 5 (mid-level matrix ranking but poor financial viability) are potential candidates,
- while Corridor 7 is an unlikely candidate (low matrix score and very poor financial viability).

Criteria for Screening/Assessment Matrix (FINAL)
Dated July 12,2016


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[^0]:    ${ }^{1}$ 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.
    ${ }^{2}$ For the purposes of this PSA, highly conservative all-in rates have been used for indicative purposes.
    ${ }^{3}$ For the purposes of this PSA, highly conservative all-in rates have been used for indicative purposes.

