METROLINX
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EGLINTON CROSSTOWN RAPID TRANSIT BENEFITS CASE
UPDATE

June 2012

Eglinton Crosstown Rapid Transit

Updated Benefits-Case Analysis

Multiple Account Evaluation Technical Note

June 2012

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1 Introduction

1.1 In June 2011 Metrolinx commissioned Steer Davies Gleave to undertake an evaluation of four options of the Eglinton Rapid Transit project and it provides an update to the 2009 Benefits Case Analysis (BCA) report regarding this project.

1.2 This technical note is not intended to be a free-standing BCA report, but rather a technical summary reporting the results of the four options evaluated. The findings of this note will feed into Metrolinx's internal project evaluation decision-making process.

1.3 A BCA typically uses a Multiple Account Evaluation (MAE) framework, which is a project assessment methodology that systematically identifies and analyses the broader impacts of each option being assessed. The framework appraises the relative costs and benefits of a number of different evaluation 'accounts' and hence the trade-offs between the different options. The accounts include:

- Transportation User Account
- Financial Account
- Environmental Account
- Economic Account
- Socio-Community Account

1.4 This technical note covers each of these accounts in turn, with an MAE summary table concluding the key evaluation results. Appendix Table A.1 documents the key project evaluation parameters.

2 Description of Options

Project Options

2.1 Four proposed options for the Eglinton Rapid Transit project have been developed. They have been defined in collaboration with Metrolinx together with a Base Case, against which all the options are assessed. The options are:

- **Base Case**: Committed transit network investment
- **Option 1:** Eglinton-Scarborough Crosstown LRT
- **Option 2:** Future Proofing Eglinton-Scarborough Crosstown LRT
- **Option 3:** Transit City Concept
- **Option 4:**Eglinton-Scarborough Subway

2.2 The following sections set out the descriptions of the Base Case and Options in more detail.

Base Case Definition

2.3 The Base Case definition should be broadly consistent with recent modelling undertaken by IBI on behalf of Metrolinx. This is over and above today's transit network and the following projects were assumed:

- Subway extension to Vaughan Corporate Centre;
- ATO implementation on the Yonge-University-Spadina line (providing 105sec headways to Finch Station);
- Electrification Study Reference Case;
- SRT State-of-good repair, operating at 2 minute headways;
- York Region Viva BRT (as per latest concept).

2.4 The assumed employment and population forecasts used for the assessment are identified in 'Places to Grow' the Growth Plan for the Greater Golden Horseshoe area and is consistent with those used in the Regional Transportation Plan, *The Big Move*.

Option 1: Eglinton-Scarborough Crosstown LRT

2.5 Option 1 is the recently approved proposal as part of the Toronto Transit Plan. It is a 24.4 km continuous LRT line between Weston Road and McCowan Road with a tunnelled section between Weston and Kennedy (and the removal of Ellesmere stop). The service headway is assumed to be 2min 15sec in both 2021 and 2031[1].

2.6 The route characteristics are shown in Table 2.1 and Figure 2.1 shows the proposed alignment and stops.

[1] The original assumption was that a 3 minute headway would operate in 2021. This was subsequently adjusted to 2min 15sec after the demand modelling suggested that a 3 minute headway would not support the forecast demand.

TABLE 2.1 OPTION 1 RUN TIME ASSUMPTIONS

Section	Stations (East to West)	Distance	Average Speed	Travel Time
SRT alignment (removal of Ellesmere stop)	▪ McCowan ▪ Scarborough Centre ▪ Midland ▪ Lawrence ▪ Kennedy	6.4 km	37kph	10 min
Tunnel	▪ Birchmount ▪ Warden ▪ Victoria Park ▪ Bermondsey ▪ Wynford ▪ Don Mills ▪ Laird ▪ Bayview ▪ Mount Pleasant ▪ Yonge - Eglinton ▪ Avenue ▪ Chaplin ▪ Bathurst ▪ Eglinton West ▪ Dufferin ▪ Caledonia ▪ Keele ▪ Weston	19.0 km	34kph	33.5 min
Total	**23 stations**	**25.4 km**	**35kph**	**43.5 min**
Headway	2min15sec			

2.7 Local bus service definition is outlined in the two modelling memos that were sent to IBI Group on April 18th 2011 and April 22nd 2011. The local bus network changes are as follows:

- Remove the trunk of the #34 / #32 route
- Make western terminus of #34 bus routes Kennedy Station
- Make eastern terminus of #32C route Keele-Eglinton Station
- Make eastern terminus of #32, #32A and #32D routes Weston station.
- #47 buses diverted along Eglinton to connect to Caledonia station at a new bus loop on the east side of the rail corridor

- Combine #51 and #56 buses into a single route with a short leg on Eglinton Ave between Laird and Leslie (instead of both connecting west to Yonge-Eglinton Station). Eliminate #56B if necessary. Headway of 10 minutes for combined route. Make western terminus of #54 and #54A buses at Don Mills-Eglinton instead of Yonge-Eglinton. Route via Don Mills instead of via Leslie.
- Make northern terminus of #100 branch at Don Mills-Eglinton – i.e. same as #100A branch
- #67 buses diverted along Eglinton to connect to Victoria Park station. #67A bus terminates there.
- #161 Rogers Rd would operate to terminus at Weston &Eglinton Station, both ways via Rogers, Weston. Service west of Weston Rd. replaced by revised 171 Mount Dennis.
- #168 Symington would be extended from Avon Loop to Weston &Eglinton Station, both ways via Weston. Remove modelled #168B line which is no longer in service. AM peak service every 4 minutes.
- #32D service renumbered as #170, name changed to EMMETT and headway changed to 15 min.
- #171 Mount Dennis is not in GGH model at present, but a community circulator is present today. Changes are: "171 Mount Dennis bus service would be changed to operate from Weston & Eglinton Station via east on Eglinton, south on Black Creek, west on Humber Boulevard, west on Alliance, north on Jane, east on Lambton, south on Rockcliffe, east on Alliance, east on Cliff, east on Cordella, east on Louvain, east on Humber Boulevard, north on Black Creek west on Eglinton. AM peak service every 20 minutes."
- #71 and #71B merged into a single route, number #71 but following route of today's #71B. AM peak service every 15 minutes.
- All #35 Jane buses connect to Eglinton-Weston station via Eglinton and Weston Rd.

Option 2: Future Proofing Eglinton-Scarborough Crosstown LRT

2.8 The purpose of this test is to review the costs and benefits of future-proofing Option 1 by constructing longer platforms and increasing the potential capacity of the line. It assumes the same alignment, journey times and station locations as Option 1 except headways were shortened to 3.5 minutes in 2021[2] and 3 minutes in 2031.

Option 3: Transit City Concept

2.9 This option represents the original Transit City concept. It is a 19 km LRT line between Weston and Kennedy with a tunnelled section between Keele and Laird. The SRT continues to run as a separate system (so transfer at Kennedy is required)and same headway and run time as in the BAU. The route characteristics are summarized in Table 2.2 and Figure 2.2 shows the proposed alignment and stops.

[2] The original assumption was that a 4 minute headway would operate in 2021. This was subsequently adjusted to 3.5 minutes after the demand modelling suggested that a 4 minute headway would not support the forecast demand.

TABLE 2.2 OPTION 3 RUN TIME ASSUMPTIONS

Section	Stations (East to West)	Distance	Average Speed	Travel Time
On street(Dedicated alignment)	Kennedy Ionview Birchmount Warden Lebovic Pharmacy Victoria Park Bermondsey Wynford Ferrand Don Mills Leslie	7.8 km	25 kph	19 min
Tunnel	Laird Bayview Mount Pleasant Yonge - Eglinton Avenue Chaplin Bathurst Eglinton West Oakwood Dufferin Caledonia Keele	10.5 km	34 kph	19 min
Surface	Blackcreek Weston	0.7km	25 kph	2 min
Total	**26 stations**	**19.0 km**	**29 kph**	**40 min**
Headway	4 min in 2021 3 min15sec in 2031			

Option 4: Eglinton-Scarborough Subway

2.10 This option assumes subway technology same alignment and stop locations as Option 1 to Kennedy, but with subway technology. The route then extends eastwards to Scarborough Centre with a stop near the intersection of Lawrence and McCowan (for access to Scarborough General Hospital). The route characteristics are summarised below and Figure 2.3 shows the proposed alignment and stops while Table 2.3 sets out the run times and distances.

TABLE 2.3 OPTION 4 RUN TIME ASSUMPTIONS

Section	Stations (East to West)	Distance	Average Speed	Travel Time
Tunnel	Scarborough Centre Lawrence East Kennedy Birchmount Warden Victoria Park Bermondsey Wynford Don Mills Laird Bayview Mount Pleasant Yonge - Eglinton Avenue Chaplin Bathurst Eglinton West Dufferin Caledonia Keele Weston	23.1 km	36 kph	39 min
Total	**20 stations**	**23.1 km**	**36kph**	**39 min**
Headway	5 min in 2021 4 min in 2031			

FIGURE 2.1 OPTIONS 1 AND 2: EGLINTON SCARBOROUGH CROSSTOWN

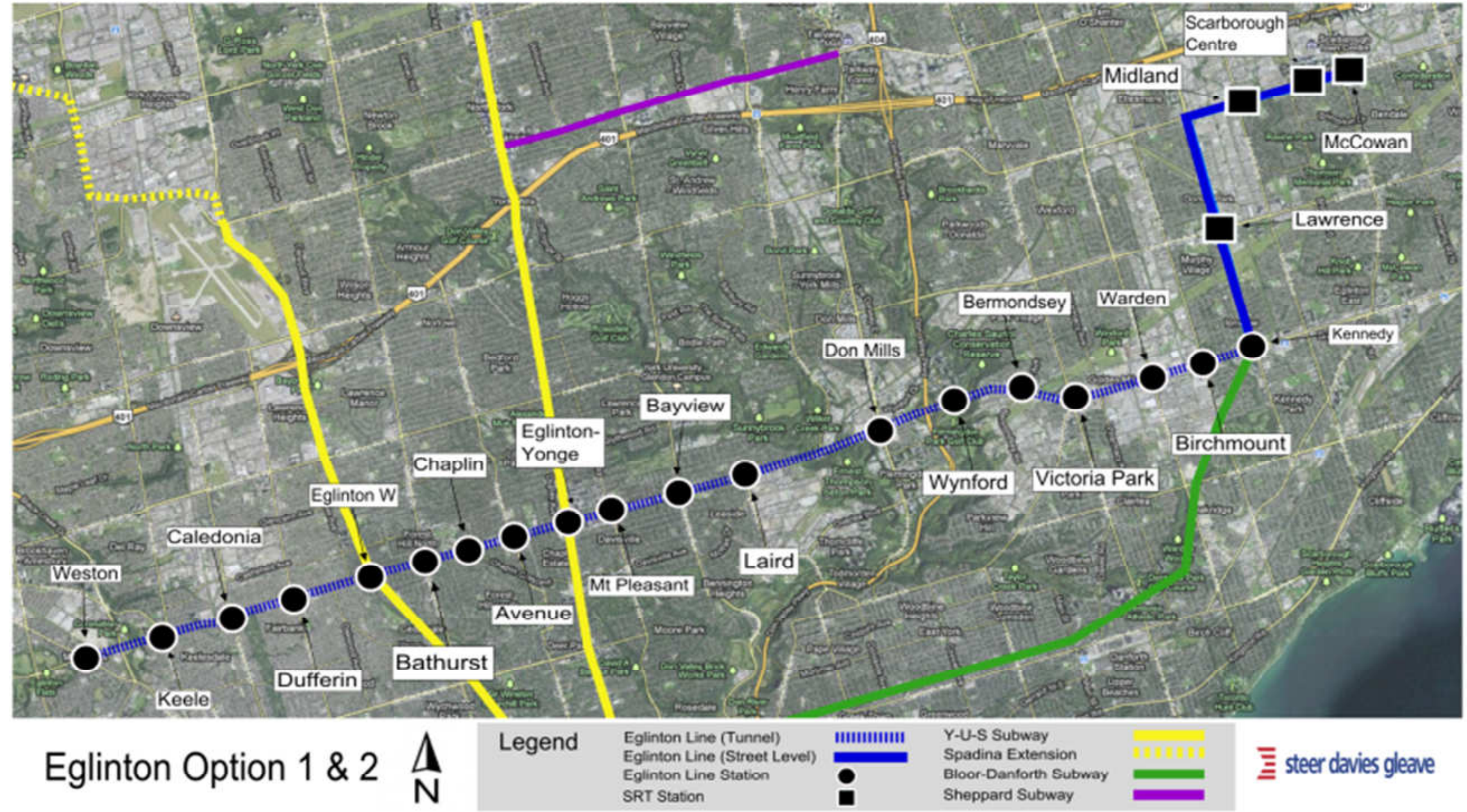


FIGURE 2.2 OPTION 3: FUTUREPROOFING EGLINTON SCARBOROUGH CROSSTOWN

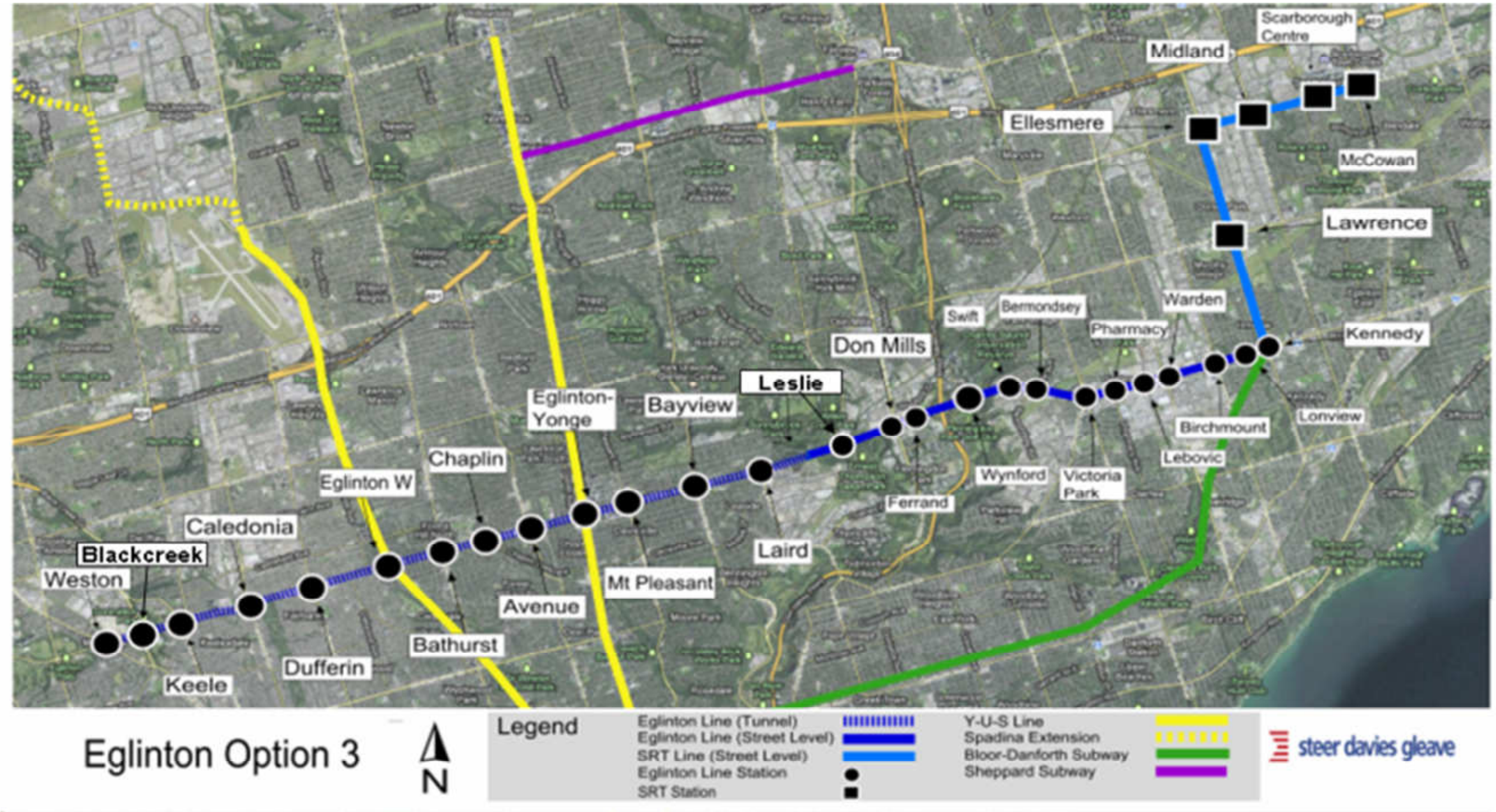
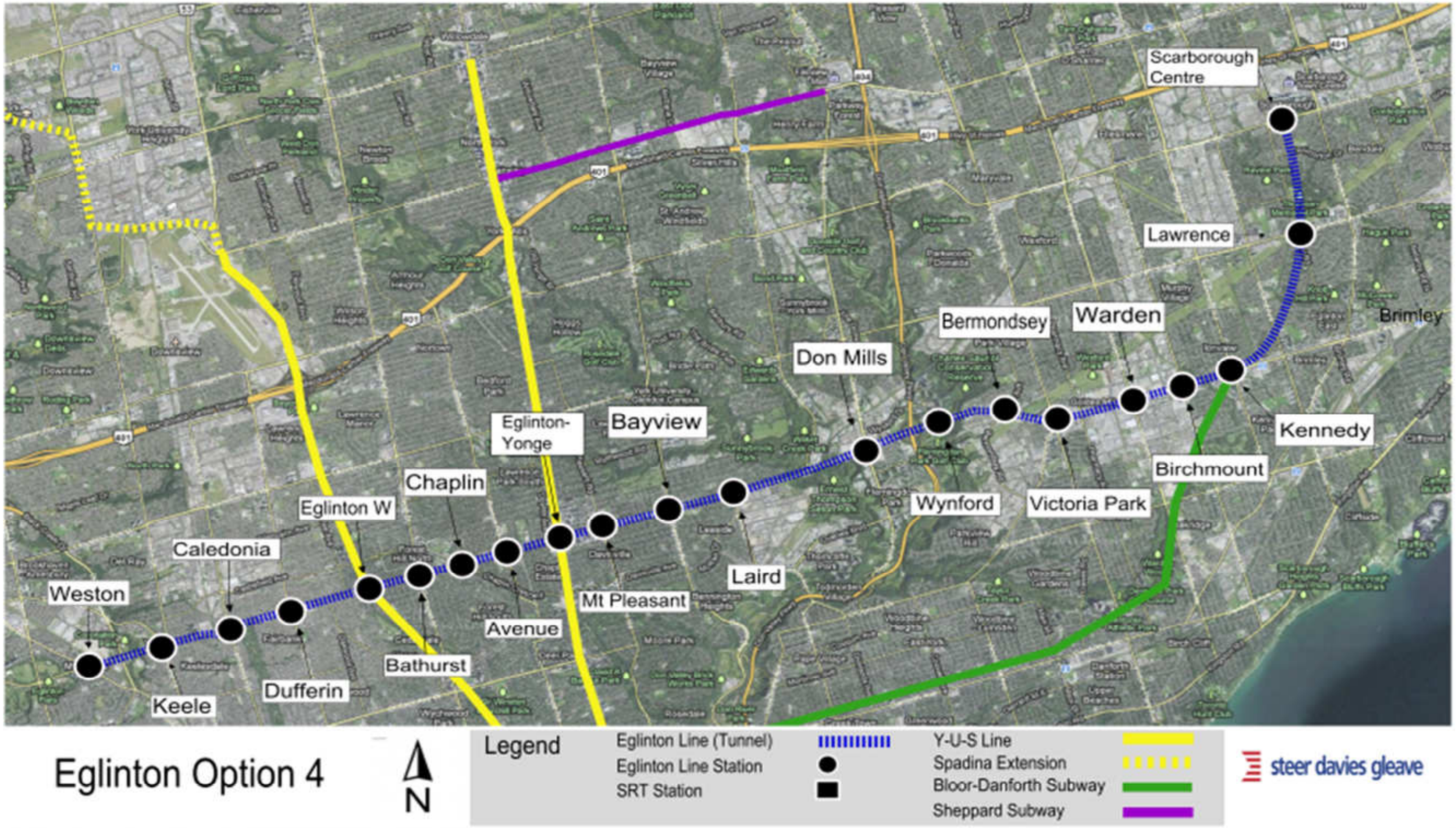


FIGURE 2.3 OPTION 4: TRANSIT CITY CONCEPT



Summary Statistics

2.11 The following table summarizes the key characteristics of each option. Option 1 and 2 offer the longest route and require the most vehicles, Option 3 has the highest number of stations and Option 4 has the greatest maximum carrying capacity.

TABLE 2.4 SUMMARY STATISTICS BY OPTION

Statistic	Option 1	Option 2	Option 3	Option 4
Distance (km)	25.4	25.4	19.0	23.1
Stations	23	23	26	20
Journey time (min each way)	43.5	43.5	40.0	39.0
Peak Headway (2021)	2.25	3.5	4.0	5.0
Peak Headway (2031)	2.25	3.0	3.25	4.0
Peak Frequency TPH (2021)	26.7	17.1	15	12
Peak Frequency TPH (2031)	26.7	20	18.5	15
Vehicles per train	3	4	3	5
Capacity per vehicle (planning)	163	163	163	200
Capacity (2021 paxpphpd)	13,040	11,177	7,335	12,000
Capacity (2031 paxpphpd)	13,040	13,040	9,028	15,000
Vehicles required (2021)	142	120	73	98
Vehicles required (2031)	142	143	90	121

3 Transportation Account

Introduction

3.1 The Transportation User Account assesses the additional benefits to existing and new transit users, as well as highway users, resulting from implementation of each project option. The analysis quantifies savings to journey times and automobile operating costs, as well as safety benefits. Other indicators, such as service quality and crowding, are addressed qualitatively.

3.2 All quantifications and monetised values are incremental to the Base Case and are in 2011 prices, unless otherwise stated.

Ridership

3.3 The Greater Golden Horseshoe Model (GGHM) produces ridership and revenue forecasts for the proposed Eglinton subway extension options. Table 3.1 and Figure 3.1 set out the forecast 3-hour AM peak period boardings for each option. Table 3.2 sets out the annual ridership forecasts in millions.

3.4 The results show that in terms of total boardings, Option 1 has the highest level of boardings, as it offers the most frequent service and offers a seamless through service to passengers who would otherwise use SRT and interchange at Kennedy. Option 3 has the lowest ridership as passengers travelling along the SRT portion still have to interchange at Kennedy and the on-street section slows the journey times. Option 2 attracts a marginally lower number of transit users compared to Option 1 as it operates at a slightly shorter headway. While Option 4 offers a faster journey time, the attractiveness is off-set by fewer access stations at the eastern end and therefore fewer rapid transit boardings as those passengers shift to local buses.

TABLE 3.1 RIDERSHIP FORECASTS (BOARDINGS IN 3-HOUR AM PEAK PERIOD)

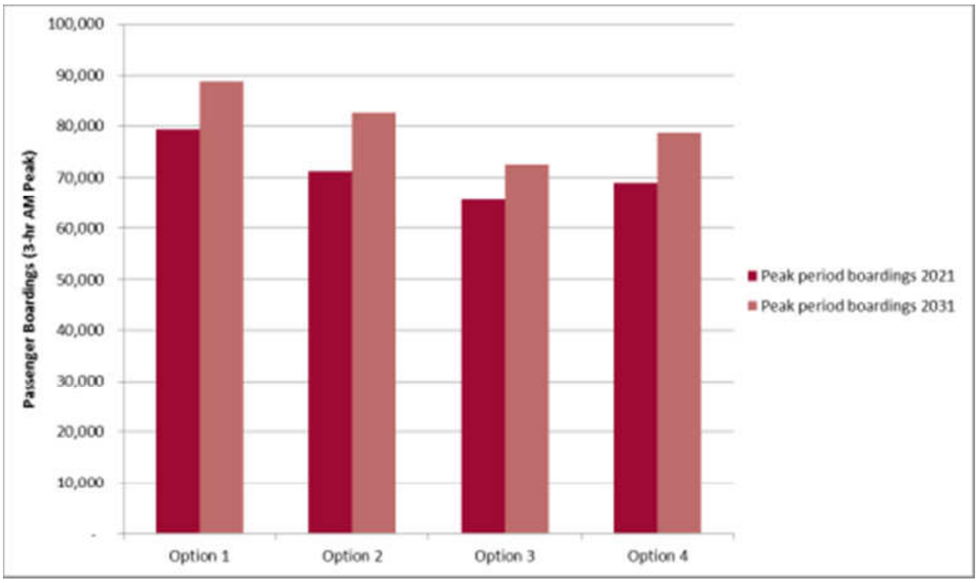
	Option 1	Option 2	Option 3	Option 4
Peak period boardings 2021[3]	79,300	71,200	65,600	68,900
Peak period boardings 2031	88,800	82,600	72,500	78,600

TABLE 3.2 RIDERSHIP FORECASTS (BOARDINGS IN MILLIONS PER ANNUM)

	Option 1	Option 2	Option 3	Option 4
Annual boardings 2021	127	114	105	111
Annual boardings 2031	143	133	117	126

[3] The boarding and load estimates for Option 1 and 2 do not reflect post model adjustments to reduce headways so that the forecast ridership cannot be fully accommodated

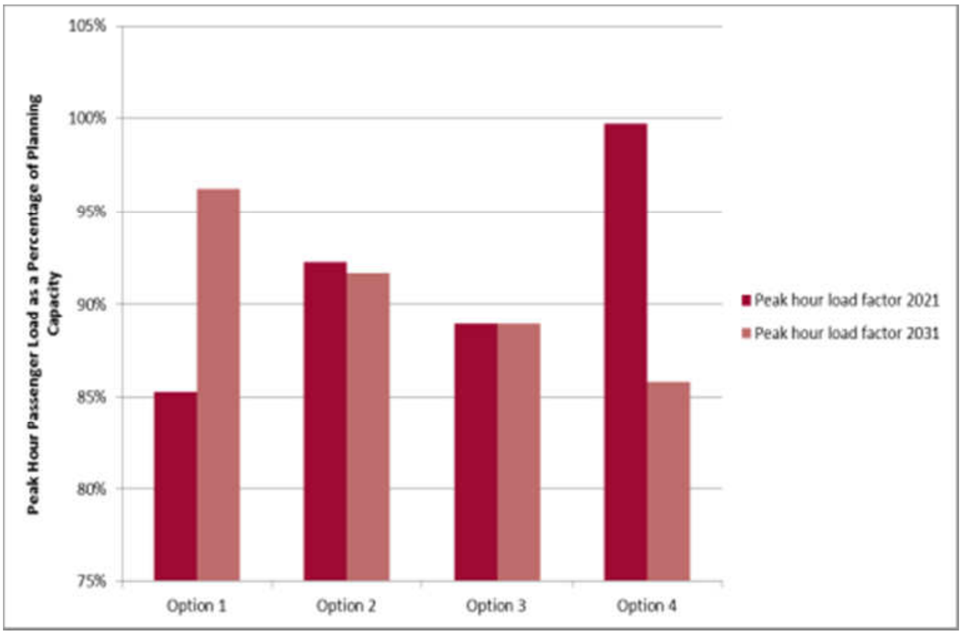
FIGURE 3.1 PEAK PERIOD RIDERSHIP



Capacity

3.5 Figure 3.2 shows the peak hour loading to capacity percentage (assuming that the peak hour load represents 55% of the total 3-hour period loading) with all options operating within the planned capacity in both forecast years. Should additional capacity be required beyond 2031, this can be achieved by operating at shorter headways, although Option 1 is already operating close to its maximum capacity.

FIGURE 3.2 LOAD FACTOR FORECASTS (AM PEAK HOUR)



Loading Profiles

3.6 The following figures show the loading profiles of each option for 2031. In all options the westbound direction is the busiest during the AM peak, with significant numbers of boarders at Scarborough Centre and Don Mills in particular.

3.7 The number of boardings and alightings is highest at Scarborough, Kennedy, Western, Don Mills and Eglinton-Yonge, effectively where the Eglinton Rapid Transit line intersects other TTC subway services and at the terminus where feeder bus services promote interchange.

3.8 Option 3 results suggest that the SRT does not provide sufficient capacity to accommodate the future demand from that section of the network (in both the BAU and with rapid transit scenario), meaning that some passengers will be crowded off the SRT or will travel in high levels of crowding. This means that the modelled benefits of Option 3 have been overstated, or conversely the other options should yield additional cost savings compared to a more appropriate BAU with enhanced transit services to meet future demand. It should also be noted that a larger proportion of SRT users interchange at Kennedy for the Bloor-Danforth TTC service compared to the other options.

FIGURE 3.3 LOADING PROFILES – OPTION 1 2031 AM PEAK WESTBOUND

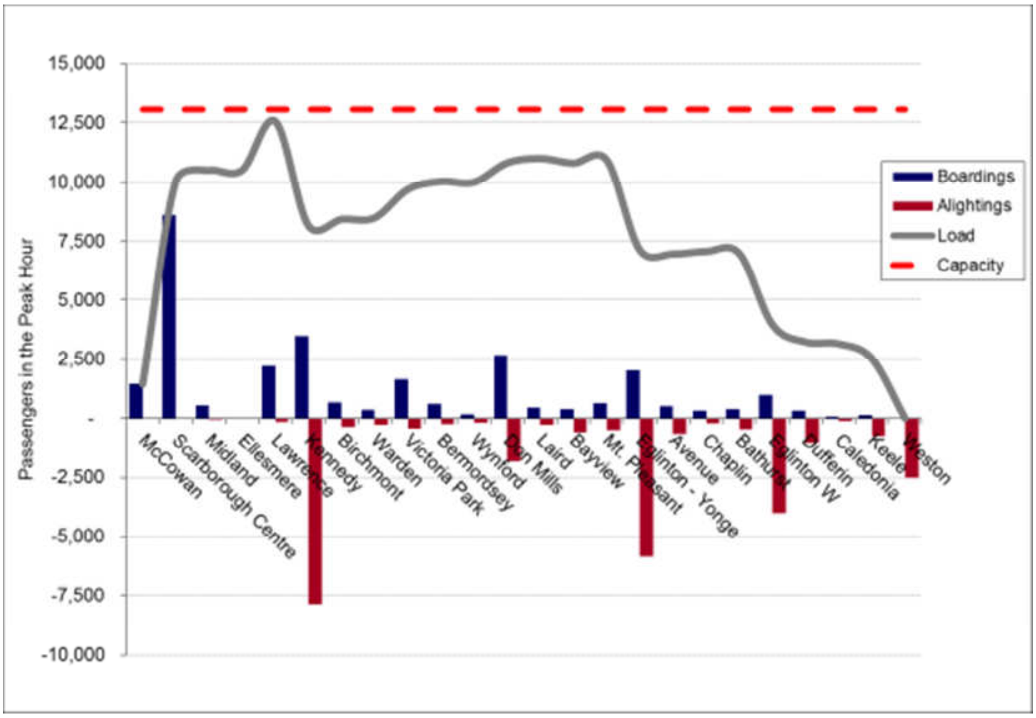


FIGURE 3.4 LOADING PROFILES – OPTION 1 2031 AM PEAK EASTBOUND

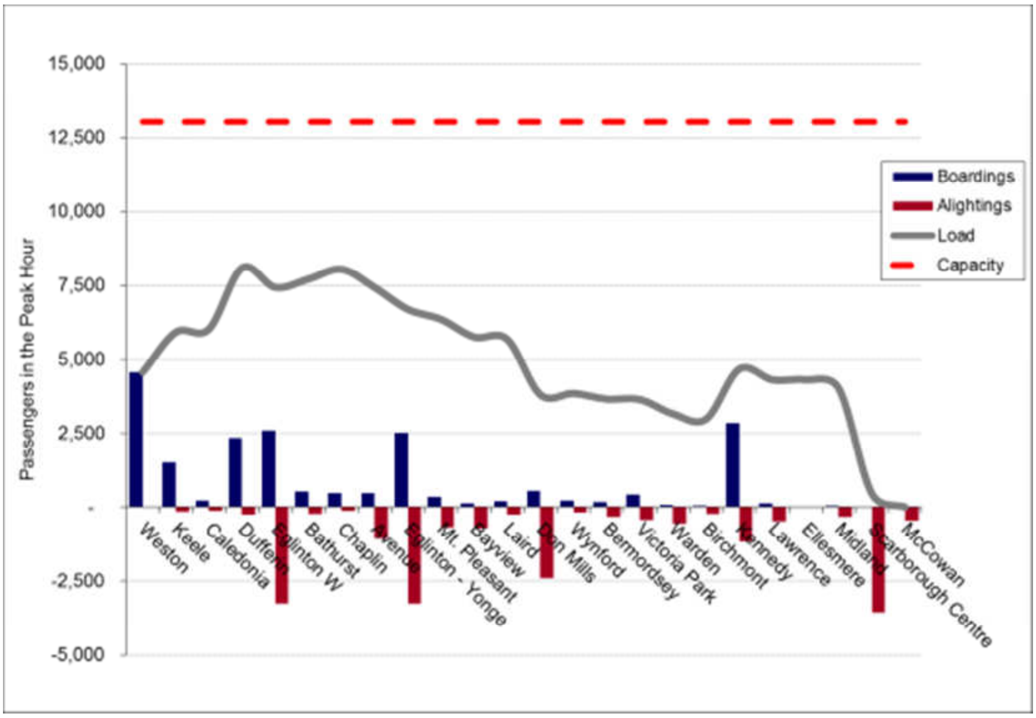


FIGURE 3.5 LOADING PROFILES – OPTION 2 2031 AM PEAK WESTBOUND

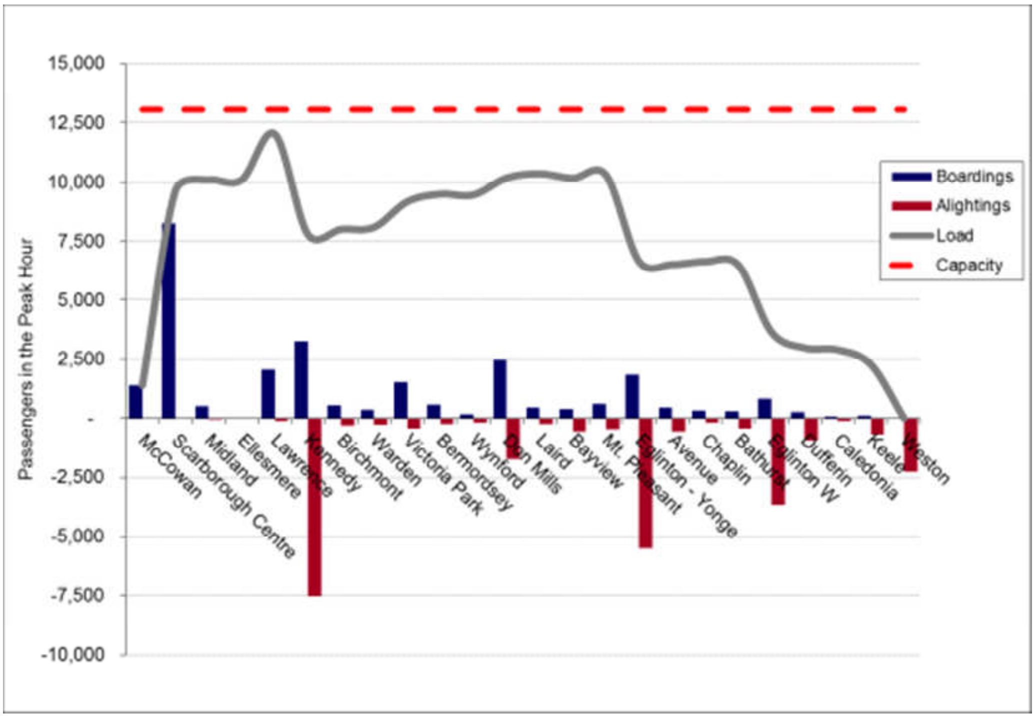


FIGURE 3.6 LOADING PROFILES – OPTION 2 2031 AM PEAK EASTBOUND

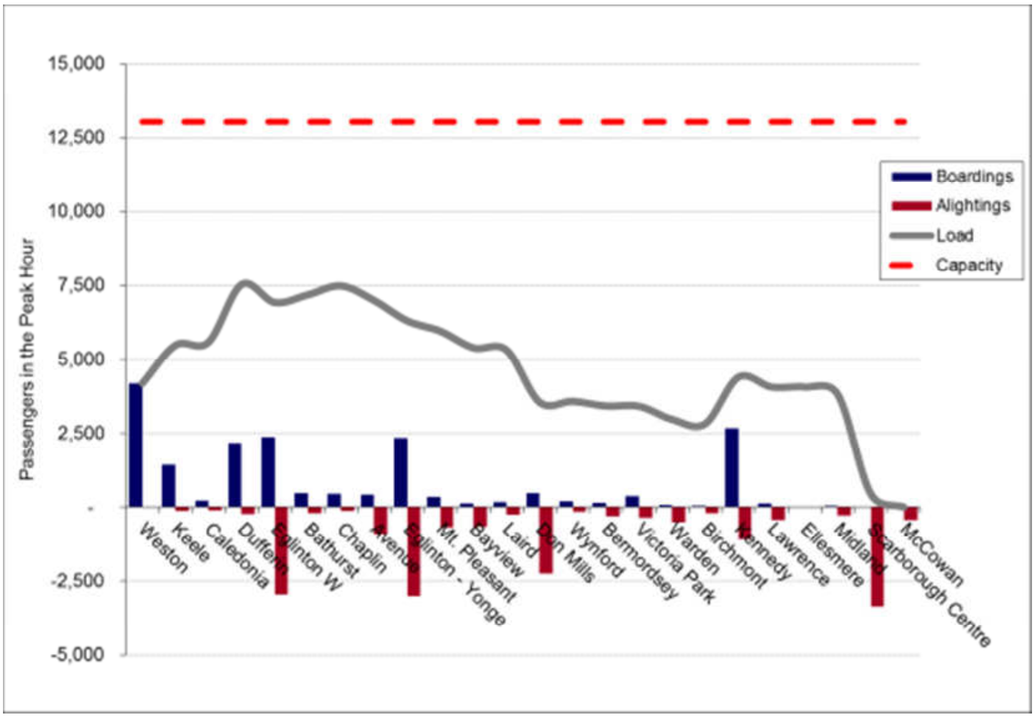


FIGURE 3.7 LOADING PROFILES – OPTION 3 2031 AM PEAK WESTBOUND

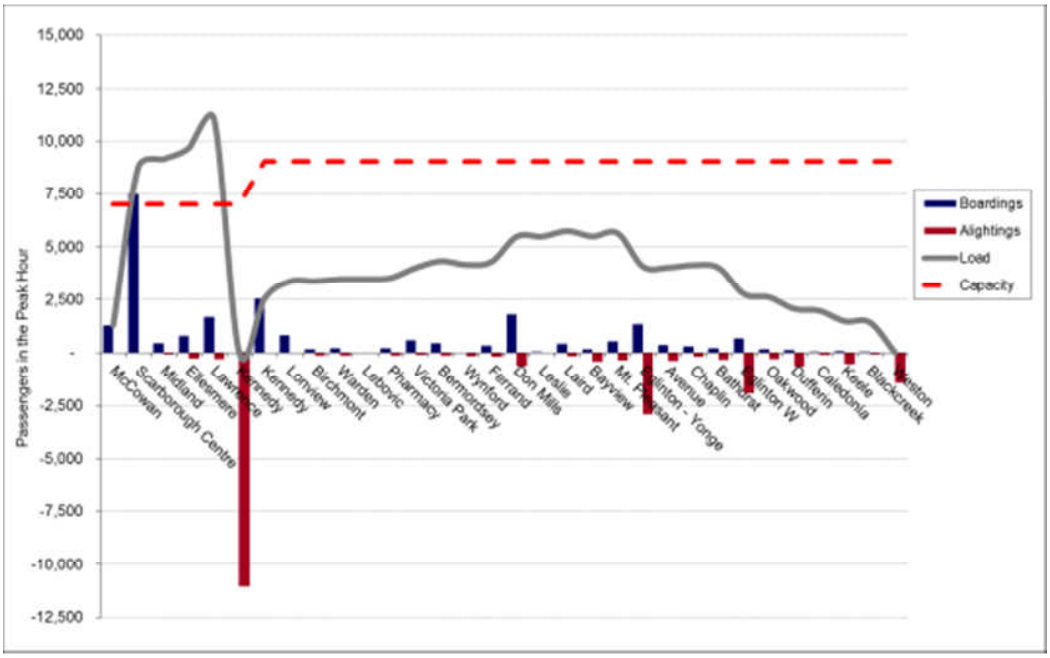


FIGURE 3.8 LOADING PROFILES – OPTION 3 2031 AM PEAK EASTBOUND

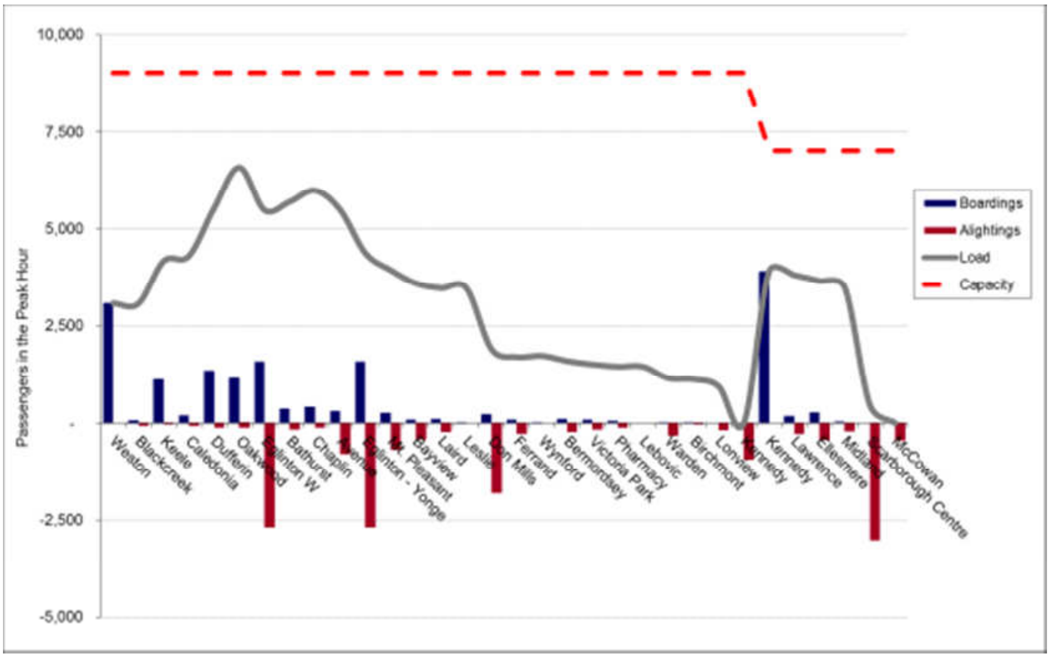


FIGURE 3.9 LOADING PROFILES – OPTION 4 2031 AM PEAK WESTBOUND

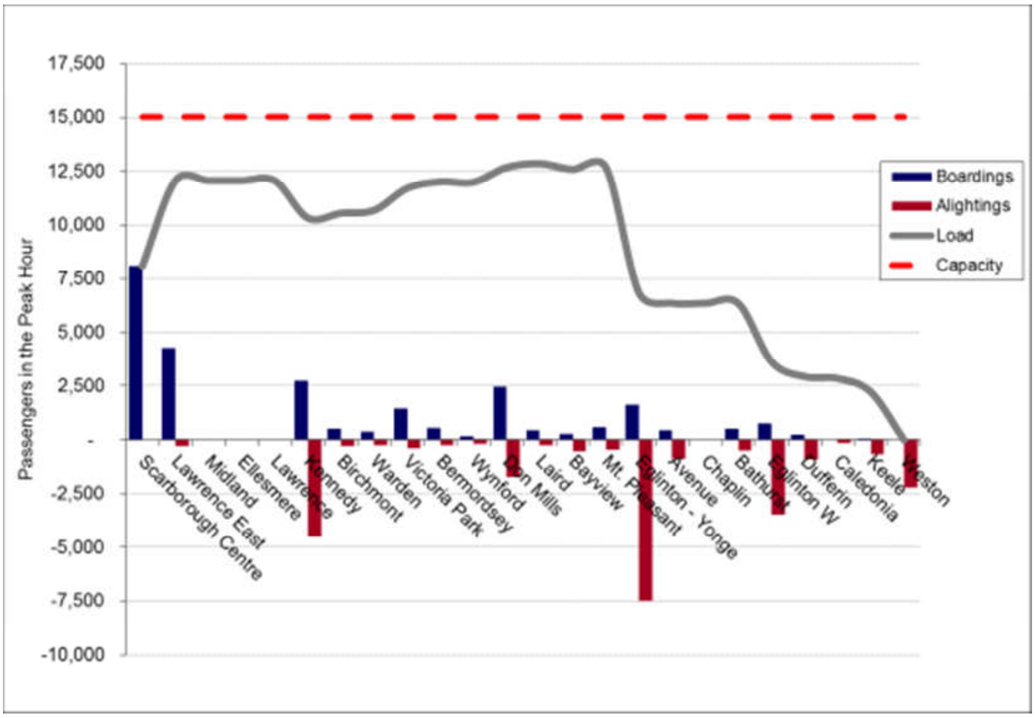
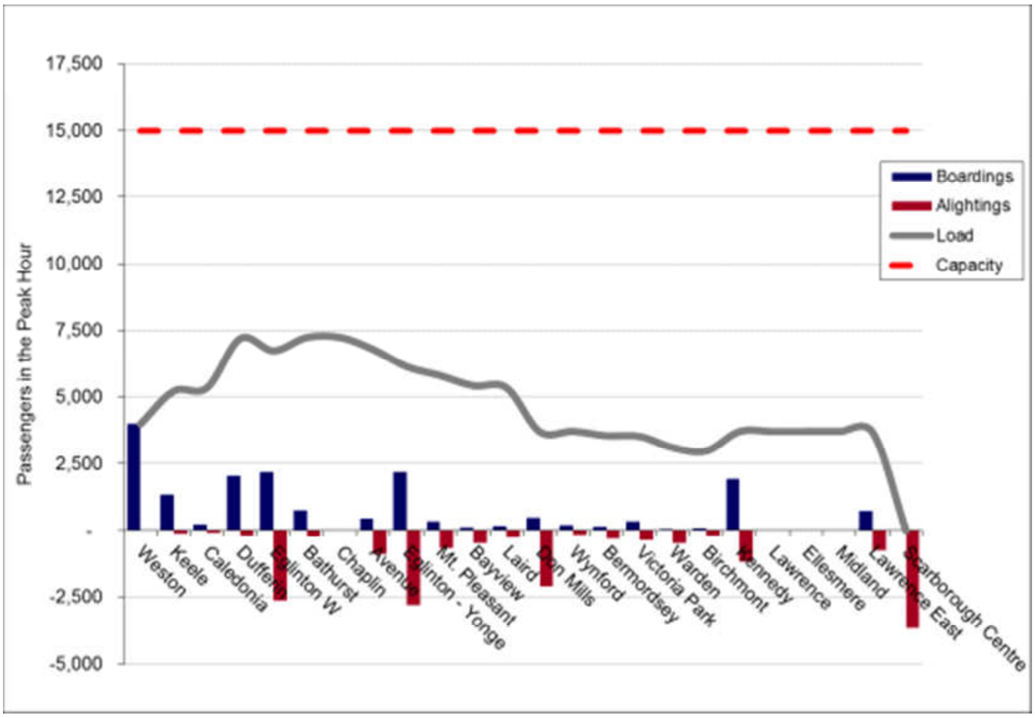


FIGURE 3.10 LOADING PROFILES – OPTION 4 2031 AM PEAK EASTBOUND



Transportation User Benefits

Travel Time Savings

3.9 Incremental travel time savings were calculated using the Greater Golden Horseshoe (GGH) Model, which is the forecasting tool Metrolinx uses to carry out a BCA on transit projects.

3.10 The travel time savings in minutes are monetised using a weighted average Value of Time of $13.6 per hour in 2011 prices (growing at 1.6% per annum in real terms), as assumed by the GGH Model.

Transit Users

3.11 Existing transit users are expected to experience a benefit to their generalized travel time due to a more enhanced service that a grade-separated rapid transit will create. In addition, users that transfer from auto to transit will do so to benefit from travel time savings as a result of their mode shift.

Auto Users

3.12 Mode shift of travellers from auto to transit as a result of the subway extension is expected to decrease congestion and thus improve travel times for the remaining highway users. The auto user benefits have been estimated by applying unit benefit rates per new transit user.

3.13 Table 3.3 shows the monetized benefits of transit and auto user travel time savings for each option in 2011 present values, discounted over the 30 year period from start of service. Option 1 generates the greatest travel time benefits, while Option 3 produces the least time saving benefits. This is because a significant proportion will be at-grade running and auto benefits from mode shift will be partially offset by the reduction in road capacity.

TABLE 3.3 TRANSIT USER TRAVEL TIME BENEFITS ($M 2011)

	Option 1	Option 2	Option 3	Option 4
Transit User Benefits	$1,604	$1,351	$810	$1,162
Auto User Benefits	$282	$244	$103	$235
Total User Benefits	**$1,886**	**$1,595**	**$913**	**$1,397**

Safety Benefits

3.14 As with a reduction in auto vehicle kilometres, a saving in costs associated with traffic collisions is assumed. These costs are largely related to human costs through fatality or injury, and infrastructure repairs incurred by the City and/or Region.

3.15 Based on the 2004 Canadian Motor Vehicle Traffic Collision Statistics the estimated collision cost is $0.073 per vehicle kilometre in 2011 prices, constant in real terms in the future. Applying this unit rate to the number of auto vehicle kilometres that are increased by the subway extension, the safety savings are estimated.

Auto Operating Cost Savings

3.16 In addition to travel time benefits, auto users are expected to benefit from a reduction in auto operating costs. This estimation is derived from the incremental reduction in auto vehicle kilometres over the GTA highway network.

3.17 The marginal vehicle operating cost, based on average 2011 Canadian Automobile Association (CAA) calculations, is $0.56/km in 2011 prices (increasing at 2% per annum in real terms). Applying this unit rate to the net number of auto vehicle kilometres. Some individuals may decide to reduce the number of vehicles owned because they feel that they could rely on the transit network. In those cases the individuals would also save on car ownership costs.

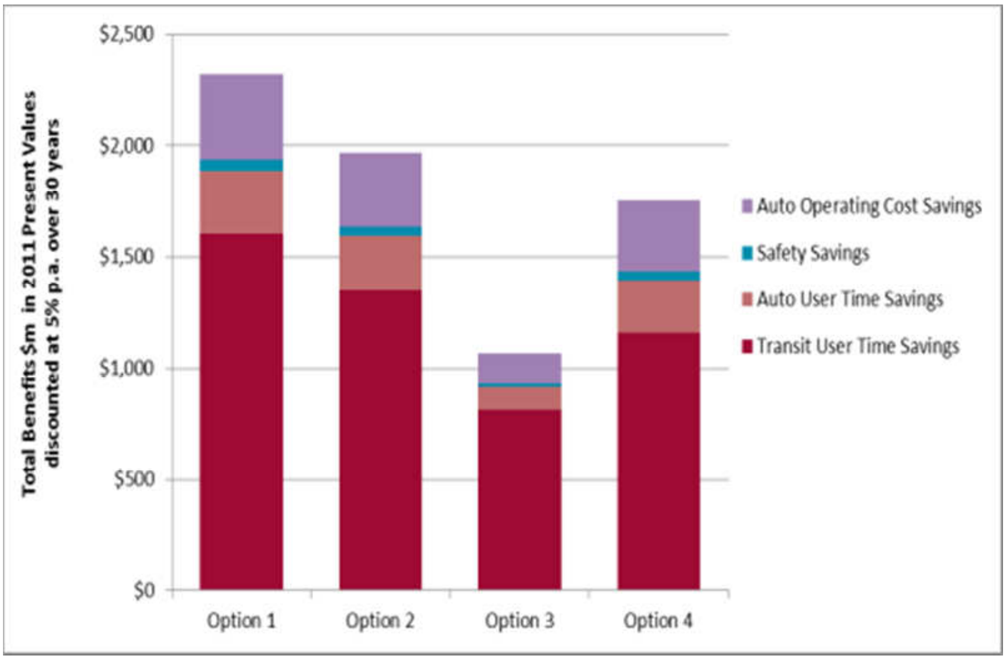
3.18 The annual vehicle kilometres removed from the road network in 2021, auto operating cost and safety savings over the 30 year appraisal period is set out in Table 3.4. Option 1 delivers significantly higher levels of mode shift compared to auto. Option 3 has the lowest levels of auto benefits because on-street running is expected to affect other road users.

TABLE 3.4 AUTO OPERATING COST AND SAFETY SAVINGS

	Option 1	Option 2	Option 3	Option 4
VKT removed (km per annum in millions 2021)	17.8	14.6	5.6	12.7
Safety Savings ($m PV)	$50	$43	$18	$41
Auto Operating Cost Savings ($m PV)	$385	$331	$97	$313

3.19 In summary, the monetized user benefits of each option is summarized in Figure 3.11. Option 1 provides the highest level of total user benefits with $2,321m in 2011 present values and prices, while Option 3 provides the lowest levels of total user benefits at $1,070m.

FIGURE 3.11 TOTAL USER BENEFITS ($M 2011 PRESENT VALUES AND PRICES)



Other Benefits

Journey Time Reliability

3.20 As well as travel time and other quantified savings, transit users will also benefit from other factors, such as a higher quality service, better reliability and greater convenience, as a result of implementing rapid transit.

3.21 In comparison to the transit service in the Base Case, underground options have particular benefits from being grade separated from the road network and so it is anticipated that the reliability and service benefits would be greater the further the underground section is extended. Buses in mixed-traffic are affected by general traffic conditions on a daily basis, particularly during congested periods, while underground systems can provide reliable journey times with the exception of occasional incidents on the line.

3.22 Reliability is an important attribute of a mode which transit passengers value. Travellers wish to arrive at their destination at their planned time and perceive early or late arrivals as a disbenefit. Those concerned about arriving late to their destination will begin their journey earlier if they believe that their journey time has a significant amount of travel time variability.

3.1 Variability of journey times is usually not captured in transportation models, including the GGH model. This is because simple average speeds/travel times are coded, and incorporating reliability would be technically challenging. Where rapid transit replaces a bus service without priority in place, reliability benefits would be significantly more than if the bus had priority. In the case of the Sheppard subway, reliability benefits have been estimated externally from the modelling framework.

3.2 To quantify the value of reliability, a for a typical journey time of 10 minutes per passenger the variability (standard deviation) of underground system is assumed to be between 1 and 1.5 minutes[4] shorter than conventional bus. However, this reliability is perceived as being greater – passengers who are waiting at a bus stop for a late bus will be disadvantaged, and in many cases irregular running of buses result in bunching, uneven headways and passengers being denied boarding due to crowding. As such this 1 to 1.5 minute is weighted by 3 to account for the "perceived" value. For longer journeys the variation of journey times is naturally greater and passengers would perceive greater reliability benefits for longer journeys.

3.3 In the context of the Eglinton rapid transit it is assumed that the average journey time is 15 minutes (roughly a third of the end-to-end journey time). Applying the reliability benefit of 4.5 generalized (1.5 weighted by 3) minutes per new subway user, the estimated journey time reliability savings is set out in Table 3.5.

3.4 Given that there is limited data around the current and future reliability of buses, a range of reliability estimates have been set out with a higher bound defined as 50% higher than the lower bound.

TABLE 3.5 RELIABILITY SAVINGS ($M IN 2011 PRESNET VALUES AND PRICES)

Journey Time Reliability	Option 1	Option 2	Option 3	Option 4
Lower Bound (4.5 gen.mins/pax)	$1,565	$1,395	$852	$1,192
Upper Bound (6.75 gen.mins.	$2,348	$2,092	$1,278	$1,788

3.5 It should be noted that for the purpose of consistency with previous BCA reports, the BCR with and without reliability benefits are shown separate from the Traditional User Benefits account.

[4] A standard deviation of 1 minute means that 68% of all journeys arrive within 1 minute of the scheduled time.

4 Financial Account

Introduction

4.1 The Financial Account assesses the direct incremental 'cash' items of the Eglinton rapid transit project. This includes an overview of costs and revenues compared to the Base Case. Any savings resulting from the implementation of the options are also included.

Revenues

4.2 Incremental revenue is calculated using the GGH model, assuming forecast demand at an average fare of $1.90 in 2001 prices per trip, inflated to 2011 prices. For evaluation purposes the fare levels are assumed to rise in line with inflation in the future. The annual incremental transit revenues from additional ridership in 2021 and 2031, as well as the present value totals over the 30 year evaluation period is set out in Table 4.1.

TABLE 4.1 INCREMENTAL TRANSIT REVENUES ($MILLIONS)

	Option 1	Option 2	Option 3	Option 4
Incremental Revenues 2021 ($m per annum)	$10.4	$8.2	$5.6	$7.0
Incremental Revenues 2031 ($m per annum)	$15.0	$12.4	$8.9	$11.9
Total Incremental Revenues ($m in 2011 PV and prices)	$160	$139	$101	$138

Capital Costs

4.3 The capital cost estimates prepared are conceptual and opinions of expected costs for the four options considered. Options 1, 2 and 3 are based upon LRT technology while Option 4 assumes existing TTC subway technology.

4.4 The estimate has been prepared without design or engineering input, but is based upon existing information and work carried out on other similar transit projects with costs calculated to reflect both the engineering requirements anticipated for this project and expected local levels of pricing. The cost estimates in this report are independent of the estimation work carried out by Metrolinx and the Toronto Transit Commission (TTC).

4.5 The costs are summarized in Table 4.2 and broken down by construction costs (including tunnelling, vehicles), other costs (such as property, design and management) and with contingencies separately identified. These costs are presented in 2011 prices and account for 3% inflation over the spending period. It does not include financing related interest costs for the construction period.

4.6 Some of the capital costs can be deferred to a later date, namely the cost of purchasing additional vehicles in order to operate an enhanced frequency in the future.

4.7 Table 4.3 sets the additional fleet costs, assumed to be incurred in 2025 for a 2026 in-service date.

TABLE 4.2 INITIAL CAPITAL COSTS ($M 2011 PRICES INCLUDING REAL INFLATION)

	Option 1	Option 2	Option 3	Option 4
Construction	4,313	4,508	2,817	5,114
Other costs	1,145	1,198	800	1,396
Contingencies	1,463	1,530	934	1,830
Total Initial Capital Costs	**6,921**	**7,237**	**4,551**	**8,340**

TABLE 4.3 FUTURE CAPITAL COSTS ($M 2011 PRICES)

	Option 1	Option 2	Option 3	Option 4
2031 Fleet enhancement	$0	$126	$93	$91

4.8 It should be noted that these estimates have been produced by the Steer Davies Gleave team and it is understood that, in parallel, Metrolinx have produced separate capital cost estimates. The Metrolinx estimate is not represented in this report, but is used in the addendum issued as part of 2009 Eglinton BCA report.

4.9 Overall the capital costs of Option 4 is the highest at $8.3 billion. Option 3 has the lowest cost estimate at $4.6 billion, primarily because a third of the route is constructed at street level rather than in tunnel. Option 2 costs are marginally higher than Option 1 because longer stations have been constructed so that the longer train lengths can be accommodated.

Capital Costs Avoided

4.10 Under the Base Case scenario, it is assumed that the SRT will be upgraded so that it would remain in a “state of good repair”. Based on previous work done estimates, the cost of upgrading the SRT is $470 million.

4.11 If options 1, 2 or 4 were taken forward, the SRT would no longer be upgraded, therefore a cost saving of $470 million would be achieved for those options.

Operating and Maintenance Costs

4.12 In terms of operating costs, annual subway operating costs were developed using operating costs unit rates provided by TTC per train hour, vehicle kilometre, operating vehicles, station and route length. Table 4.4 shows the change in vehicle hours operated of this annual cost by mode for 2031. Options 1, 2 and 4 also benefit from SRT operating cost savings where the SRT is essentially replaced by the implementation of rapid transit along the corridor.

4.13 The figures show that the number of bus hours are reduced significantly – primarily a result of reconfiguring the bus network to complement the subway services. The result is that there is a significant operating cost saving associated with implementing rapid transit (a saving of $40 million per annum upwards) compared to the Base Case.

TABLE 4.4 ANNUAL OPERATING STATISTICS BY MODE

	Option 1	Option 2	Option 3	Option 4
Change in annual train hours operated (2031 in train hours)	393,700	331,300	265,300	231,100
Change in annual bus hours operated (2031 in bus hours)	-793,920	-784,670	-811,579	-818,179
Change in annual SRT hours operated (2031 in bus hours)	-108,400	-108,400	0	-108,400
Incremental Train Operating Costs ($m Per Annum 2011 Prices)	$96.6	$88.1	$68.0	$69.7
Incremental Bus and SRT Operating Costs ($m Per Annum 2011 Prices)	-$137.9	-$140.8	-$109.7	-$141.8
Net Operating Costs 2031 ($m Per Annum 2011 Prices)	**-$41.2**	**-$52.6**	**-$41.7**	**-$72.1**
Net Operating Costs ($m 2011 Present Values and Prices)	**-$406**	**-$519**	**-$417**	**-$715**

Comparing Benefits and Costs

4.14 Having considered the user benefits and costs over the 30-year project evaluation period, the benefits and costs are compared to determine the net benefit (benefits minus costs) and Benefit Cost Ratio (BCR) for each option. The results are shown in Table 4.5 while Table 4.6 sets out the other impacts not included in the BCR calculations, namely incremental revenues, carbon savings and journey time reliability benefits.

TABLE 4.5 COMPARISON OF BENEFITS AND COSTS ($M IN 2011 PRESENT VALUE AND PRICES DISCOUNTED AT 5% PER ANNUM OVER 30 YEARS)

	Option 1	Option 2	Option 3	Option 4
COSTS				
Capital Costs	$5,305	$5,417	$3,345	$6,371
SRT Costs Avoided	-$417	-$417	$0	-$417
Incremental Operating Costs	-$406	-$519	-$417	-$715
Total Costs	**$4,482**	**$4,482**	**$2,928**	**$5,240**
BENEFITS				
Transit User Time Savings	$1,604	$1,351	$810	$1,162
Auto User Time Savings	$282	$244	$103	$235
Safety Savings	$50	$43	$18	$41
Auto Operating Cost Savings	$385	$331	$138	$313
Total Benefits	**$2,321**	**$1,969**	**$1,070**	**$1,752**
Net Benefit (NPV)	**-$2,161**	**-$2,512**	**-$1,858**	**-$3,488**
BCR	**0.52:1**	**0.44:1**	**0.37:1**	**0.33:1**

TABLE 4.6 OTHER BENEFITS ($M IN 2011 PRESENT VALUE AND PRICES DISCOUNTED AT 5% PER ANNUM OVER 30 YEARS)

	Option 1	Option 2	Option 3	Option 4
Incremental Revenue ($m PV)	$160	$139	$101	$138
GHG Emissions Savings ($m PV)	$7.1	$6.1	$4.3	$5.9
Quantified Reliability Benefits ($billions PV)	$1.5-$2.3	$1.4-$2.0	$0.9-1.3	$1.2-1.8

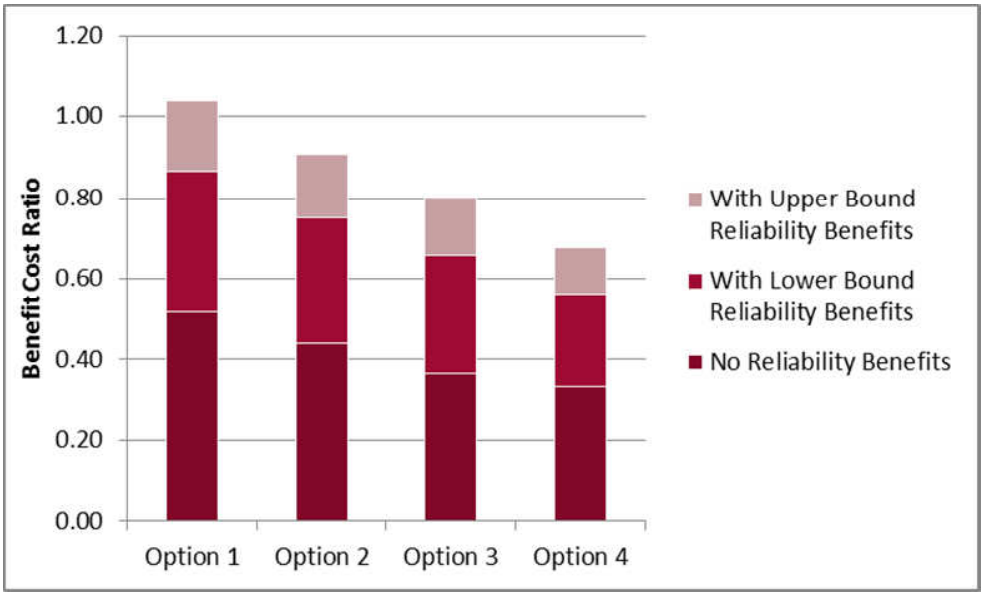
4.15 The results show that overall in BCR terms Option 1 performs the best with a BCR of 0.52:1. Option 4 performs the weakest at 0.33:1. Although not explicitly included in the 2009 BCA framework, if quantified reliability benefits were included, the BCRs would increase significantly. Given that a key benefit of constructing a grade-separated transit line is to deliver reliable journey times, excluding these benefits would significantly underestimate the case for rapid transit.

4.16 Table 4.7 (and Figure 4.1 graphically) illustrates the BCRs of each option if the lower and upper bound reliability benefits were included in the BCR calculation. It shows that the relative performances of the options against one another remain the same, but the BCRs are notably higher, with the BCR Option 1 in the 0.9-1.0:1 range, meaning that the transportation benefits alone would offset the project costs. The rank of the project options remain unchanged whether or not reliability benefits are included. Option 1 returns the highest amount of benefit per dollar invested.

TABLE 4.7 BENEFIT COST RATIOS WITH RELIABILITY BENEFITS INCLUDED

	Option 1	Option 2	Option 3	Option 4
BCR with Reliability Lower Bound Benefits	0.87:1	0.75:1	0.66:1	0.56:1
BCR with Reliability Upper Bound Benefits	1.04:1	0.91:1	0.80:1	0.68:1

FIGURE 4.1 BENEFIT COST RATIOS WITH RELIABILITY BENEFITS INCLUDED



Note that in 2020 Metrolinx detected an error in these GHG emission reduction calculations. The corrected estimate is that the project will reduce GHG emissions by 11,000 tonnes of CO_2e/year for Option 3. This estimate is in line with the estimates for other LRT projects, such as the Finch West LRT, as well as with the published 2009 BCA for Eglinton.

5 Environmental Account

Greenhouse Gas Emissions

5.1 Rapid transit encourages auto users to take transit and this mode shift results in a decrease in greenhouse gas (GHG) emissions. The reduction in GHGs is approximated by CO_2 emissions which is estimated through a unit rate per vehicle kilometre reduced.

5.2 As shown in Table 5.1, Option 1 produces the greatest CO2 reduction because of its ability to attract the most number of users from private auto.

TABLE 5.1 REDUCTION IN CO_2 EMISSIONS

	Option 1	Option 2	Option 3	Option 4
2021 Reduction in CO2 thousands of tonnes	500	410	260	360
2031 Reduction in CO2 thousands of tonnes	770	680	490	690
NPV Value ($m)	$7.1	$6.1	$4.3	$5.9

Other Environmental Issues

During Construction

5.3 It is assumed that the construction procedures would mitigate any significant environmental impact and would be incorporated into any future design of the project.

5.4 All options involve considerable tunnelling work and excavation for stations. There will be environmental risks associated with aspects such as groundwater contamination. The removal of excavated soil would also likely generate a large number of construction vehicle trips. Option 3 would generate fewer of such vehicle trips due to its shorter tunnel.

5.5 Construction work would also likely bring significant dust, noise and vibration impacts to the local community over the short term. This typically originates from construction vehicles, excavation works around station areas and in particular along the surface sections of Option 3 where the local residents and business would be affected to a greater extent.

During Operations

5.6 In addition to GHG emission reduction, reduced auto usage is likely to aid the reduction in Criteria Air Contaminates (CAC) emissions which lead to local air quality improvements. It will also reduce the level of traffic and transit related noise and vibration, improving the overall environment.

5.7 Table 5.2 summarizes the assessment of other environmental impacts during construction and operations.

TABLE 5.2 OTHER ENVIRONMENTAL IMPACTS

	Option 1	Option 2	Option 3	Option 4
During Construction	Moderate construction related impacts	Moderate construction related impacts	Moderate construction related impacts	Moderate construction related impacts
	××	××	××	××
During Operations	Moderate improvement to local environment	Moderate improvement to local environment	Slight improvement to local environment	Moderate improvement to local environment
	✓✓	✓✓	✓	✓✓

6 Economic Development Account

Temporary Impacts During Construction

6.1 The capital investment into transit is expect to create direct and indirect employment, leading to increased wages and GDP to the GTHA region. Table 6.1 sets out the employment and income impacts during the construction phase of the project and is closely linked to capital spend. All monetary values are in 2011 prices.

6.2 It should be noted that these results are high level estimates based on the 2009 BCA and adjusted on a pro-rata basis according to the capital costs.

TABLE 6.1 EMPLOYMENT AND INCOME IMPACTS DURING CONSTRUCTION

Option	Direct Annual Impacts During Construction			Total (Direct and Indirect) Impacts During Construction		
	Employment	Wages	GDP	Employment	Wages	GDP
	(Jobs)	($m)	($m)	(Jobs)	($m)	($m)
Option 1	35,000	$1,400	$3,700	54,400	$2,200	$5,700
Option 2	36,100	$1,500	$3,800	56,200	$2,300	$5,900
Option 3	22,400	$900	$2,400	34,800	$1,400	$3,700
Option 4	42,500	$1,800	$4,500	66,100	$2,700	$7,000

Long Term Impacts

6.3 Investment in transit leads to user benefits and this will have a secondary impact on the productivity of the GTHA. This is primarily due to businesses having access to a wider pool of labour and they can do more business because of improved accessibility and reduced congestion. Table 6.2 sets out the long term economic impacts as a result of the Eglinton rapid transit options. All monetary values are in 2011 prices.

6.4 The results contain three elements. Firstly the ‘direct’ economic impacts are the immediate increase in economic activity in the study area caused by the improvements. In addition to these direct impacts, further additional activity is generated through the supply chain – as the ‘direct activity’ increases the local demand for goods and services. Taking also the supply chain into account results in ‘direct and indirect’ impacts. It should be noted that these results are high level estimates based on the 2009 BCA and adjusted on a pro-rata basis according to the total user benefits.

6.5 Both the direct and indirect impacts are ‘gross’ in the sense that they estimate increase in economic activity within the study area, without accounting for the likelihood that much of this activity is relocated from elsewhere. However, we do have estimates of the net increase in employment – i.e. the total increase in employment at a national level – from the Wider Economic Benefits assessment. The net employment impact is therefore shown in the last column of Table 6.2. These are a subset of the Direct and Indirect impacts.

Land Value Uplift

6.6 As rapid transit improved accessibility of an area, it becomes more desirable and the land values increase as a result. Table 6.3 summarizes the estimated land value uplift for each option. These estimates are based on assessment assumptions consistent with the 2009 BCA but undertaken on the revised alignment and station locations..

Wider Economic Benefits

6.7 Wider Economic Benefits are a set of economic welfare benefits arising from market failures in the non-transportation economy. The Benefit Case Analysis implicitly assumes that there are no such market failures. Any benefits arising from market failures are therefore fully additional to those gains already included in the Benefit Case Analysis.

6.8 Three main WEBs have been quantified as part of this assessment:

- Agglomeration Benefits - Productivity gains arising from increasing the 'effective density' of economic activity in urban areas.
- Labour Supply Benefits - The tax take on additional economic activity arising from more workers joining the labour market.
- Imperfect Competition Benefits - Benefits from increased output where there are price cost margins.

6.9 A separate technical note on Wider Economic Benefits explains these impacts, the assessment undertaken and our results in detail[5]. Since Option 2 is a close variant of Option 1, and of inferior BCR, it was not included in the assessment.

6.10 Table 6.4 shows the results.

[5] Eglinton Crosstown Rapid Transit – Wider Economic Benefits, Technical note, June 2012

TABLE 6.2 LONG TERM EMPLOYMENT AND INCOME IMPACTS (ANNUAL IMPACTS IN 2031)

Option	Direct Annual Impacts in 2031 (Gross)[6]			Total (Direct and Indirect) Annual Impacts in 2031 (Gross)[5]			Net employment impacts[7]
	Employment	Wages	GDP	Employment	Wages	GDP	
	(Jobs)	($m)	($m)	(Jobs)	($m)	($m)	(Jobs)
Option 1	700	$28	$75	1,070	$43	$114	179
Option 2	600	$24	$64	910	$37	$96	N/A[8]
Option 3	320	$13	$35	490	$20	$52	105
Option 4	530	$21	$57	810	$33	$86	151

TABLE 6.3 LAND VALUE UPLIFT ESTIMATES

Option	Land Value Uplift ($m)	
	Low	High
Option 1	$780	$1,800
Option 2	$780	$1,800
Option 3	$8,30	$2,060
Option 4	$770	$1,720

[6] These numbers are 'Gross' impacts on the GTHA area, without correcting for jobs or activity displaced from outside the GTHA area.

[7] These figures are net additional jobs, correcting for jobs displaced from elsewhere. They are a subset of the Direct and Indirect Employment Impacts.

[8] The estimates of net additional jobs are outputs form the Wider Economic Benefits assessment, which did not include Option 2.

TABLE 6.4 WIDER ECONOMIC BENEFITS

Option	Wider Economic Benefits ($m PV)			
	Agglomeration Benefits	Labour Supply Benefits	Imperfect Competition Benefit	Total
Option 1	291	51	8	***350***
Option 2	N/A	N/A	N/A	N/A
Option 3	147	24	4	***175***
Option 4	194	38	6	***238***

Summary

6.11 Having estimated the economic impacts during construction, over the long term and the land value uplift, the economic development impacts can be summarized in Table 6.5 below.

TABLE 6.5 ECONOMIC DEVELOPMENT IMPACT SUMMARY

	Option 1	Option 2	Option 3	Option 4
Economic Impacts During Construction	✓✓✓	✓✓✓	✓✓	✓✓✓
Long Term Economic Impacts	✓✓✓	✓✓✓	✓✓	✓✓✓
Land Value Uplift ($bn)	$0.8-$1.8	$0.8-$1.8	$0.8-$2.1	$0.8-$1.7

7 Social Community Account

Land Use Changes

7.1 Constructing rapid transit, when combined with complementary local planning initiatives, is expected to promote a more compact and mixed used communities.

7.2 There is considerable potential for increased intensification along the corridor, particularly in the middle and eastern segments of the corridor. The intersection with Yonge is a Provincially-designated Urban Growth Centre, and can continue, with greater transit service, to expand its role as a high-density Mobility Hub.

7.3 As Option 3 does not offer a step–change in transit provision along the SRT section, this option is likely to perform weaker in terms of land use changes in the section. However, it has considerably more stops in the on-street section, so this area may achieve more densification along the length of the corridor. Option 4 has fewer stations, but subways are perceived as superior because of its high carrying capacity.

7.4 Overall, the differences in land use impacts between each option is relatively modest - all options are capable of promoting the considerable land use changes.

Health

7.5 All options promote additional transit use, and transit use is associated with improved physical fitness and health. Option 1 attracts the most number of passengers out of their private autos and therefore expected to provide the greatest health benefit.

Accessibility

7.6 Accessibility can refer to a number of aspects of transit. Proximity to transit is already reflected in the station/stop spacing and the modelled walking distances including interchange. These are all part of the transit time savings captured under the Transportation User Benefits account.

7.7 Accessibility can also refer to how the stations/stops connect with the urban fabric. For example, the access to subway requires accessing underground platforms and for those who are less mobile this can be particularly challenging. However, step-free access is provided to mitigate these issues.

7.8 Rapid transit is perceived as a higher order transit service and people are willing to walk further to access it compared to a conventional bus service in the Base Case. Therefore the perceived accessibility of a areas on the periphery of conventional the transit catchment is improved by rapid transit.

7.9 On-street transit services provide better accessibility than underground services. Option 3 therefore performs better under service access than the other options.

Summary

7.10 Table 7.1 summarizes the social community impacts.

TABLE 7.1 SOCIAL COMMUNITY IMPACTS

	Option 1	Option 2	Option 3	Option 4
Land Use Impacts	Promotes densification along corridor	Promotes densification along corridor	Promotes densification along corridor except SRT section	Promotes densification along corridor
	✓✓✓	✓✓✓	✓✓	✓✓✓
Health	Significant increase in transit use	Significant increase in transit use	Moderate increase in transit use	Significant increase in transit use
	✓✓	✓✓	✓	✓✓
Accessibility	Slight improvement in accessibility	Slight improvement in accessibility	Moderate improvement in accessibility	Slight improvement in accessibility
	✓	✓	✓✓	✓

8 MAE Summary

MAE Summary Table

8.1 Table 8.1 provides a summary table with the key MAE findings for each option.

TABLE 8.1 MAE SUMMARY TABLE

	Option 1	Option 2	Option 3	Option 4
Transportation Account				
Transportation Benefits (PV $m)	$2,321	$1,969	$1,070	$1,752
Reliability Benefits (PV $m)	$1,500 - $2,300	$1.400 - $2,000	$900 - $1,300	$1,200-$1,800
Wider Economic Benefits (PV $m)	$350	N/A	$175	$238
Financial Account				
Costs (PV $m)	$4,482	$4,482	$2,928	$5,240
Benefits Less Costs (PV $m) [1]	-$2,161	-$2,512	-$1,858	-$3,488
Benefit Cost Ratio (Excl. Reliability Benefits)	0.52:1	0.44:1	0.37:1	0.33:1
Illustrative Benefit Cost Ratio Including Reliability Benefits)	0.9:1-1.0:1	0.8:1-0.9:1	0.7:1-0.8:1	0.6:1-0.7:1
Illustrative Benefit Cost Ratio Including Wider Economic Benefits AND lower bound Reliability Benefits)	1.01:1	N/A	0.77:1	0.65:1
Environmental Account				
GHG Emissions (PV $m)	$7.1	$6.1	$4.3	$5.9
Impacts During Construction	××	××	××	××
Impacts During Operation	✓✓	✓✓	✓	✓✓
Economic Development Account				
Economic Impacts During Construction	✓✓✓	✓✓✓	✓✓	✓✓✓
Long Term Economic Impacts	✓✓✓	✓✓✓	✓✓	✓✓✓
Land Value Uplift ($m)	$800 - $1,800	$800 - $1,800	$800 - $2,100	$800 - $1,700
Social Community Account				
Land Use Shaping	✓✓✓	✓✓✓	✓✓	✓✓✓
Health	✓✓	✓✓	✓	✓✓
Accessibility	✓	✓	✓✓	✓

[1] Excludes reliability benefits

APPENDIX

A

PROJECT EVALUATION ASSUMPTIONS

A1 APPENDIX 1

Project Evaluation Parameters

A1.1 The key project evaluation parameters are set out in Appendix Table A.1.

APPENDIX TABLE A.1 EVALUATION PARAMETERS

Factor	Value	Source
Discount Rate	5% (real terms)	Province of Ontario
Discount Year/Price Base	2011	Project assumption
Construction Commencing	2012	Project assumption
Opening Year	2020	Project assumption
Evaluation Period	30 years from opening 2012-2049	Project assumption
Benefits Ramp-Up	Year 1 - 80% Year 2 - 90% Year 3 - 95% Year 4 - 100%	Project Assumption
Value of Time Business Other Weighted Average	 $35.16 (2008$) $10.82 $13.02	Transport Canada, Greater Golden Horseshoe Model
Value of Time Growth	1.64% per annum in real terms	Based on GDP per capita increases, GDP/ Population estimates from www.greatertoronto.org
Fare Growth	0% per annum in real terms	Project Assumption
Average Accident Cost	$0.07 per km	Collision Statistics: 2004 Canadian Motor Vehicle Traffic Collision Statistics, TP3322. Vehicle Kilometers: Statistics Canada, Catalogue No. 53-223-XIE, "Canadian Vehicle Survey"

Updated Multiple Account EvaluationUpdated Multiple Account Evaluation

Factor	Value	Source
Greenhouse Gas Emissions (Auto) 2006 2021 2031	 0.23 kg per km 0.21 kg per km 0.20 kg per km	Urban Transportation Emissions Calculator, Transport Canada, Greater Golden Horseshoe Model
Average Cost of CO_2	$0.01 per km $40/tonne (median cost)	Several literature sources, Transport and Environment Canada, Greater Golden Horseshoe Model and http://envirovaluation.org/index.php/2007/09/06/university_of_hamburg_forschungsstelle_n_1
Auto Operating Costs	In 2008$ + 2.0% p.a. increase in real terms 2007 - $0.50/km 2021 - $0.65/km 2031 - $0.79/km	Data in 2007 based on CAA calculation of average driving costs and includes operating and ownership costs (long-term costs). Increase based on Greater Golden Horseshoe Model
Auto User Benefits from Decongestion	2021 – 1.10 min/VKT 2031 – 1.26 min/VKT	Based on UK DfT externality cost calculator for Other A Roads/congestion level 4
Capital Cost Inflation	1.0% per annum increase in real terms	Project assumption based on CPI increases
Operating Cost Inflation	1.0% per annum increase in real terms	Project assumption
Annualization Factor	Peak Period -Annual 1,607	Based on TTC Improvements Report 2008