Appendix 3

SmartTrack Western Corridor Feasibility Review

TORONTO

Memorandum

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January 18, 2016

To: John Livey, Deputy City Manager

From: Jennifer Keesmaat, Chief Planner and Executive Director

Re: **SmartTrack Western Corridor Feasibility Review**

I am pleased to send you the final report of the feasibility review of the SmartTrack Western Corridor. The consultant, HDR, was asked to undertake an independent, high level assessment of options for extending a heavy rail corridor between Mount Dennis and the Mississauga Airport Corporate Centre (MACC), as part of the City's work on SmartTrack. Council directed staff to assess two heavy rail corridors: the Eglinton corridor, and a second corridor that extends further north on the Kitchener GO Corridor and turns south past Pearson Airport to the MACC. The approved western extension of the Eglinton Crosstown LRT (which hereafter will be referred to as Crosstown West) forms the base reference case for the review.

HDR was originally asked to complete this report by October for presentation to Executive Committee, and much of the technical analysis was undertaken by early September. However, the report could not be completed without the results of the SmartTrack ridership modeling. With ridership forecasts now available, HDR has been able to finalize the report. There are some aspects of the report that do not reflect the evolution of our discussions with Metrolinx over the ways in which SmartTrack and GO Regional Express Rail (RER) might be integrated more broadly. However, this does not have an impact on the findings of the assessment of new heavy rail corridor options.

The feasibility review examined heavy rail corridor options from several perspectives: technical requirements for heavy rail, service concept and integration with RER, regulatory requirements for heavy rail, land use compatibility and impacts, and cost. HDR was asked to determine whether feasible heavy rail corridor options might exist, recognizing that further detailed analysis would be required to confirm this.

Any feasible option would need to go through necessary environmental assessment approvals.

Appendix 3: SmartTrack Western Corridor Feasibility Review

This feasibility review was framed as a first stage analysis to support Council in its decision about whether and how to proceed with this aspect of SmartTrack.

The consultant's work was undertaken in stages. In the initial stage, HDR identified a number of corridor options; some of these were eliminated due to fatal flaws related to constructability and operability.

The corridor options that remained were further assessed to better understand their feasibility.

Key findings of HDR's analysis include:

- For technical reasons and for regulatory compliance, a new heavy rail corridor would need to be grade separated from other traffic and pedestrians. Based on an analysis of the study area terrain and features, HDR concluded that the corridor would need to be tunneled for significant stretches once it leaves the existing GO corridor. This would significantly raise construction costs.

- The remaining feasible options vary in their potential benefits, constraints and impacts. Concerning community impacts were identified for the Eglinton corridor options, including disruptions to Eglinton Flats and Black Creek, extensive property takings in several areas, and impacts to municipal roads and bridge structures.

- New infrastructure – such as additional tracks - would be required beyond the immediate corridor, including expansions to the Kitchener GO corridor. This additional infrastructure would be necessary to meet SmartTrack service commitments while also meeting RER and other rail service commitments in the Kitchener GO corridor.

- The consultant did not have sufficient information to fully assess the extent of new infrastructure that would be required on the Kitchener GO corridor, but two new tracks could be required as far as Union Station for the heavy rail options to be viable. This introduces untenable costs, and concerning community impacts.

- Costs are significant for the heavy rail options, ranging from $3.6 billion to $4.8 billion for the northern corridor options, and from $3.7 billion to $7.7 billion for the Eglinton corridor options. These costs do not reflect the additional costs of expanding the Kitchener GO corridor to accommodate additional tracks.

- Extending the Eglinton LRT as approved would cost approximately $1.3 billion. Optimization of the LRT extension would impact this cost. This is subject to further analysis.

- Projected ridership on the SmartTrack heavy rail corridor options is low compared to the LRT option.
    - Projected boardings on the LRT in 2031 are estimated to be 39,500 during the AM Peak Period (total sum, both directions).
    - The projected boardings on the LRT are almost twice that of the northern corridor alignments (19,500 AM Peak Period).

    - Boardings on the LRT are more than three times higher than the Eglinton Corridor heavy rail alignments (9,500 AM Peak Period).
- Of the continuous heavy rail options, the northern corridor performs better than the Eglinton corridor, carrying 86,886 daily riders compared to 76,617 daily boardings for the Eglinton Corridor. However, Crosstown West attracts 105,331 daily boardings.

As part of the analysis, HDR was asked to use the City's "Feeling Congested" framework as a basis for the comparison of the corridor options. HDR found the LRT option performed better overall on the eight measures used in our Feeling Congested framework. This framework contextualizes transit planning network decision-making in light of a broad and quantifiable range of city building objectives, as previously approved by City Council.

HDR notes areas in which the planned LRT extension could be optimized to improve travel times and address some traffic impacts. As reported to Executive Committee in October, City staff have begun working with Metrolinx to examine options for optimizing the western extension of the Eglinton Crosstown LRT.

Based on the negative community impacts a new heavy rail corridor would present; the significant, higher costs; and, the lower projected ridership associated with the heavy rail options, further due diligence pertaining to a heavy rail option for the western Corridor is not advised. Our analysis demonstrates that extending the Eglinton Crosstown LRT to the MACC would provide excellent rapid transit for this part of the City.

I will recommend to City Council an LRT option for the Western Corridor, requesting further direction to collaborate with Metrolinx towards an optimized LRT extension (which we will now refer to as Crosstown West), as part of the optimization of the Smart Track service concept.

Jennifer Keesmaat, MES, MCIP, RPP
Chief Planner & Executive Director
City Planning Division

SmartTrack Western Corridor Feasibility Review

City of Toronto

Final Report
Executive Summary

January 2016

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Executive Summary

Introduction

The SmartTrack Western Corridor Feasibility Review is a component of the overall SmartTrack work being undertaken by the City of Toronto, Metrolinx and the Toronto Transit Commission (TTC). The proposed SmartTrack service will include high frequency, bi-directional rapid transit service, stretching between the far west and northeast corners of the city and beyond. The proposed route occupies existing GO Transit heavy rail corridors for much of the distance; however, the 9 km section along Eglinton Avenue between Mount Dennis station on the GO Kitchener Corridor and the Mississauga Airport Corporate Centre (MACC) will require a new heavy rail corridor to be built where none exists today. Additionally, City Council requested that this study assess another option which would continue SmartTrack service north along the GO Kitchener Corridor to the Woodbine Racetrack area and then connect to the MACC with a new heavy rail link. The purpose of this study is to assess the feasibility of connecting heavy rail track alignments to the GO Kitchener Corridor for SmartTrack service along both of these corridors.

Feasibility Study Area & Objectives

The project area for this feasibility study is shown in Figure i below.

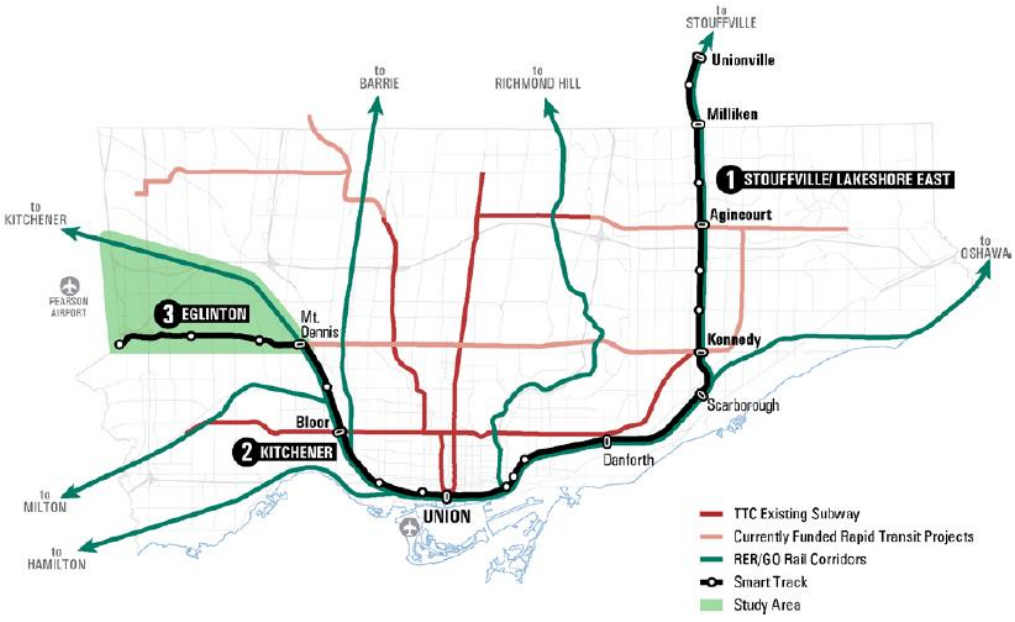

Figure i: Project Study Area

The primary objectives of this study can be summarized as follows:

- Develop heavy-rail corridor alignments connecting the GO Kitchener Corridor and the Mississauga Airport Corporate Centre and examine their technical feasibility, regulatory constraints/impacts, level of service constraints and impacts, land use impacts and order of magnitude costs.

- Compare the alignments against the previously approved Eglinton Crosstown LRT (ECLRT) Phase 2 Transit Project Assessment Process (TPAP) or Environmental Project Report (EPR) using the planning framework established in the City's "Feeling Congested?" initiative. The ECLRT service between Mount Dennis and the MACC (Commerce Boulevard) will be used as the base reference case.

- Provide input to the Regional Express Rail (RER) and SmartTrack planning process being jointly undertaken by Metrolinx and the City of Toronto, in the form of potential infrastructure requirements and their associated costs, impacts on surrounding public and private properties and the environment and potential mitigation measures, and any constraints or limitations to the level of train service that can be offered.

Heavy Rail Corridor Alternatives

There are three corridor alternatives being considered – two on Eglinton Avenue one via Woodbine and the Airport, as described below.

Eglinton Continuous Connection (Corridor 1)
SmartTrack service heading northwest from Union Station diverges from the GO Kitchener Corridor onto the Eglinton Corridor without interruption (i.e. single seat service - no transfer). SmartTrack follows Eglinton Avenue West between the Mount Dennis area and the Mississauga Airport Corporate Centre (MACC).

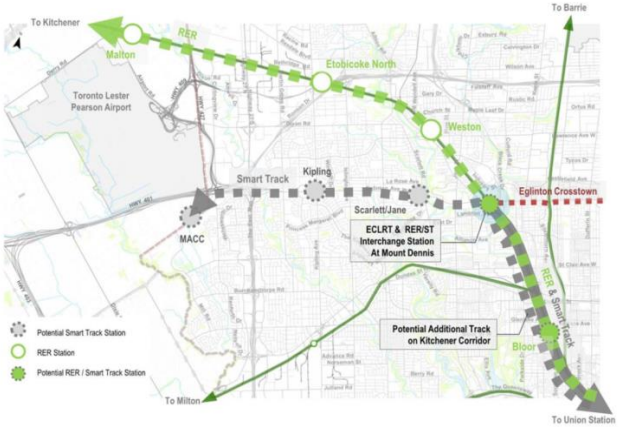

Figure ii: Eglinton Continuous Connection

Woodbine Continuous Connection (Corridor 2)

SmartTrack service heading north along the GO Kitchener Corridor from Union station continues along the GO Kitchener Corridor beyond Mount Dennis to the Woodbine area and then turns south (various alignments are considered) passing through the Pearson International Airport area and continuing to the MACC.

Figure iii: Woodbine Continuous Connection

Eglinton Standalone with Transfer (Corridor 3)

SmartTrack service heads north from Union Station along the GO Kitchener Corridor to Mount Dennis Station. Passengers continuing to the west on the SmartTrack service must transfer here onto a stand-alone SmartTrack rapid transit service that runs along Eglinton Avenue West between Mount Dennis Station and the MACC.

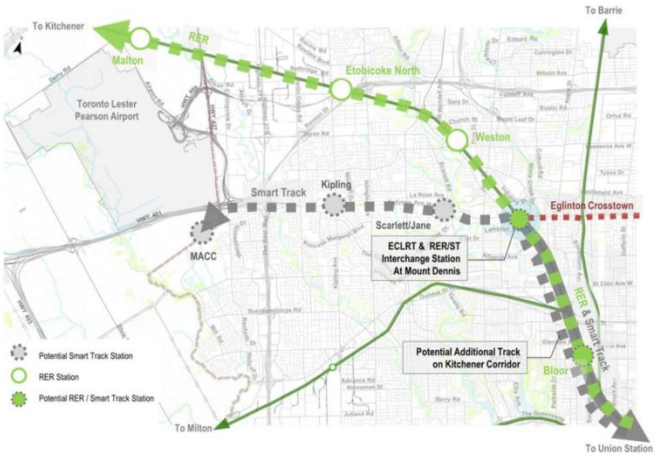

Figure iv: Eglinton Standalone with Transfer

Base Reference Case

The original EA for the Eglinton Crosstown LRT (ECLRT) covered the entire 33 km between Pearson International Airport (PIA)'s property limits and TTC's Kennedy Station. The western portion of the ECLRT alignment between Mount Dennis and the MACC (Commerce Boulevard) that was previously assessed in the approved EA is used as the base reference case for this study (See Figure v below). All SmartTrack corridors will be assessed against this base reference case for each aspect of the study.

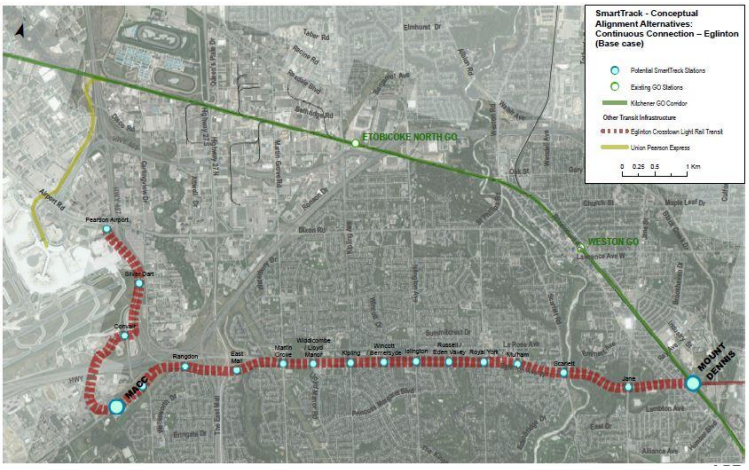

Figure v: SmartTrack Base Reference Case - ECLRT Western Extension

Technical Feasibility of Potential Track Alignments

SmartTrack is envisioned as an electrified heavy rail service; therefore, the alignments considered within this report are required to adhere to the engineering standards and related equipment requirements and regulatory environment that dictate heavy rail design and operation. A number of conceptual alignments were developed for each corridor following design criteria established in coordination with key stakeholders. All the conceptual alignments that are considered employ a combination of profile options (e.g. at grade, below grade/tunnelled, and above grade/elevated). These track alignments and variants are summarized in the table below:

Alignment Variants	New Corridor	Union Station to MACC (Orbitor)	Location of Drawing in Report
1Ae Elevated from Rogers Road to Scarlett Road; Tunnelled Scarlett Road to MACC	13.2 km 64% in tunnel 27% elevated	21.7 km	*Refer to Appendix 5, Drawings SK0001, 21*
1Aa Tunneled from west side of Black Creek Drive to Eglinton Flats; Elevated across Eglinton Flats; Tunnelled Scarlett Road to MACC	13.1 km 73% in tunnel 14% elevated	21.6 km	*Refer to Appendix 5, Drawings SK0004, 21*
1Ab Tunnelled from east side of Black Creek Drive to Eglinton Flats; Elevated across Eglinton Flats; Tunnelled Scarlett Road to MACC	13.1 km 74% in tunnel 14% elevated	21.6 km	*Refer to Appendix 5, Drawings SK0003, 21*
1Ba Tunnelled between GO and CP Tracks to Eglinton Flats; Elevated across Eglinton Flats; Tunnelled Scarlett Road to MACC	13.0 km 72% in tunnel 14% elevated	21.5 km	*Refer to Appendix 5, Drawings SK0002, 21*
1Bb Tunnelled between GO and Residential Properties to Eglinton Flats; Elevated across Eglinton Flats; Tunnelled Scarlett Road to MACC	13.0 km 72% in tunnel 14% elevated	21.5 km	*Refer to Appendix 5, Drawings SK0013, 21*
1C Tunnelled between Jane Street and Emmett Avenue (Eglinton Flats); Elevated across west end of Eglinton Flats; Tunnelled Scarlett – MACC	11.3 km 84% in tunnel 10% elevated	22.8 km	*Refer to Appendix 5, Drawings SK0005, 21*
1D Tunnelled between Ray Avenue and Jane Street; Elevated across Eglinton Flats; Tunnelled Scarlett – MACC	13.5 km 69% in tunnel 10% elevated	21.9 km	*Refer to Appendix 5, Drawings SK0042, 21*
2A Elevated over GO and west side of Highway 409; Tunnelled below Airport to MACC	9.4 km 69% in tunnel 19% elevated	30.4 km	*Refer to Section 5.1.2, Figure 10*
2B Elevated over GO and west side of Highway 409; Tunnelled below Airport Rd and Carlingview Dr.	9.9 km 70% in tunnel 18% elevated	30.9 km	*Refer to Appendix 5, Drawing SK0006*
2Ca Elevated on east side of Highway 427 to Fasken Drive; Tunnelled beyond to MACC	7.8 km 69% in tunnel 31% elevated	28.4 km	*Refer to Appendix 5, Drawing SK0008*
2Cb Tunnelled on east side of Highway 427 from GO Corridor connection to MACC	7.8 km 93% in tunnel 0% elevated	28.4 km	*Refer to Appendix 5, Drawing SK0009*

A technical evaluation of each of the corridor alignments was conducted. The results of which are summarized in the following tables. Key constraints and negative impacts are identified in red. Benefits of alignments are indicated in green.

Alignment Variant	Differentiating Characteristics (Key Issues, Risks & Concerns)
1Ae *Refer to Appendix 5,SK0001,21*	-Poor passenger transfer at Mount Dennis due to significant vertical distances -Visual Intrusion: 19m above Black Creek Drive and Jane Street -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade -Piers on Widened Road or in Eglinton Flats
1Aa *Refer to Appendix 5,SK0004,21*	-10 degree reverse curve on 3.74% grade and bridge -Difficult construction below ECLRT station & guideway -Tunnel Boring Machine (TBM) extraction conflicts with ECLRT MSF access -Long, steep grades on both sides of Mount Dennis station limit train performance (speed) -Photography Drive is closed; TTC buses must use No Frills driveway -Severe disruption to No Frills during/after construction -"Roller Coaster" track profile affects train performance -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade -Access road to Eglinton Flats east of Jane Street must be relocated -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd
1Ab *Refer to Appendix 5,SK0003,21*	-Long open trench on 2.5% grade extending from south of Rogers Rd to portal under CP bridge -Bridge over Black Creek and portal are below TRCA Regulation limit ***** FATAL FLAW ***** -Floodwaters would fill entire Mount Dennis Station and spill out tunnel portal onto Eglinton Flats -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade
1Ba *Refer to Appendix 5,SK0002,21*	-No station at Mount Dennis, but station at Jane Street creates future connection to Jane LRT -Significant +/- 1 km horizontal passenger transfer distance between Jane and Mount Dennis fare zones. **Potential fatal flaw.** -Portal is a tight fit between Black Creek Drive and proposed GO Mount Dennis platforms -Requires sequential shutdown and excavation across GO tracks *and* Eglinton Avenue for open cut construction OR *additional* CP track shift and sequential shutdown of Eglinton Avenue for TBM -"Roller Coaster" track profile affects train performance -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade
1Bb *Refer to Appendix 5,SK0013,21*	-No station at Mount Dennis, but station at Jane Street creates future connection to Jane LRT -Significant +/- 1 km horizontal passenger transfer distance between Jane and Mount Dennis fare zones. **Potential fatal flaw.** -No relocation of CP tracks; St. Clair bridge unaffected -Requires re-profiling Rogers Road overpass; raised intersection profile may not fit -Requires realignment of Weston Road between Rogers Road and Black Creek Drive onto front of properties located along Weston Road -Portal requires significant residential property taking -Requires open cut of Eglinton Avenue for TBM extraction -"Roller Coaster" track profile affects train performance -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd
1C *Refer to Appendix 5,SK0005,21*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -Uses planned GO Mount Dennis Station resulting in best ECLRT passenger transfer -Impact on the west end of Eglinton Flats -Portal along GO Corridor and TBM extraction shafts may conflict with active industrial buildings -Potential rebuilding of Jane Street Bridge -Significant tunnelling beneath residential properties, school and medical facilities in West Park -Deep tunnel (up to 22m) could present a challenge to locating emergency exits and vent shafts -Requires access to Eglinton Avenue via Emmett Avenue to be severed
1D *Refer to Appendix 5,SK0042,21*	-No relocation of CP tracks; St. Clair bridge unaffected -Uses expanded GO Mount Dennis Station resulting in best ECLRT passenger transfer -Requires re-profiling Rogers Road overpass; raised intersection profile may not fit -Requires realignment of Weston Road between Rogers Road and Black Creek Drive onto front of properties located along Weston Road -Portal requires significant residential property taking and tunnelling under school -Impact on the west end of Eglinton Flats -"Roller Coaster" track profile affects train performance -Elevated guideway impacts forested edge of Eglinton Flats between Jane Street and Scarlett Rd

Alignment Variant	Differentiating Characteristics (Key Issues, Risks & Concerns)
2A *Refer to Section 5.1.2*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Open air below grade station platform serving airport parking lots with access to People Mover -Potential impact to commercial properties at intersection of American Drive and Northwest Drive -Steep grades (+/-3.4%) on either side of Airport station -Reverse curve on a grade >2% -Multiple Emergency Exit Buildings (EEB) and ventilation shafts for long tunnel under PIA would conflict with GTAA groundside operations ***** FATAL FLAW *****
2B *Refer to Appendix 5, SK0006*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Open air below grade station platform serving airport parking lots with access to People Mover -Potential impact to commercial properties at intersection of American Drive and Northwest Drive -Steep grades (+/-3.4%) on either side of Airport station -Long, circuitous route to get to the MACC
2Ca *Refer to Appendix 5, SK0008*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Below grade station platform serving airport hotels -"Roller Coaster" track profile affects train performance -Impact to commercial properties at intersection of GO Corridor and Highway 427 -Long, steep grade (>1km; 3%) required to pass over Hwy 409/427 ramps and under Fasken Dr. -Long, circuitous route to get to the MACC
2Cb *Refer to Appendix 5, SK0009*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Below grade station platform serving airport hotels -Impact to commercial properties at intersection of GO Corridor and Highway 427 -Long, steep grade (>700m; 2.9%) required to pass under Hwy 409/427 stormwater ponds. -Premium cost for fully below grade alignment -Long, circuitous route to get to the MACC

As noted above, alignments 1Ab and 2A were considered fatally flawed and were not taken forward for further evaluation. Each of the remaining alignments, while not technically fatally flawed, would result in significant community impacts and/or operational penalties in one way or another.

Eglinton Standalone Alignment

The key distinguishing feature of this alignment, apart from its lack of a direct connection to the GO Kitchener Corridor, is that it would require a dedicated maintenance and storage facility (MSF). A brief review of available properties for an MSF along the Eglinton corridor resulted in the determination that property was not available for a new MSF. As a result, this corridor was deemed to be fatally flawed and the alignment was not considered any further.

Service Concept Feasibility Analysis

The purpose of this analysis was to identify the potential impact to existing or planned GO Kitchener Corridor track infrastructure that could result from the addition of SmartTrack service on the corridor, connecting seamlessly onto either the Eglinton or Woodbine SmartTrack Corridors. Of chief concern is the assumption that SmartTrack service is being layered on top of existing and planned services operated by GO and the Union Pearson Express. Although a variety of SmartTrack headways have been modelled (by others) to determine potential future ridership, for the purpose of this study, an initial headway of 15 minutes is assumed.

GO Kitchener Corridor Expansion Implications

There is a good likelihood that at least some portions of the GO Kitchener Corridor may require at least one additional track to support a 15 minute SmartTrack service to and from a new western corridor, in addition to all of the existing UPX and planned GO service improvements, assuming that none of the train services can be altered in terms of their frequency, speed or station stop pattern. Under these physical and operating conditions, it is fair to say that operating a SmartTrack service of *less than* 15 minutes would likely require an almost dedicated two track right-of-way, similar to a subway.

The implications of adding one or more tracks along the corridor may be significant given the narrow corridor right-of-way width and the high number of roadway crossings. Further, given the urban nature of the corridor, existing development runs very close to the corridor property line in some locations which could result in lengthy negotiations with property owners and/or complex engineering solutions to add to or modify existing corridor infrastructure. Further study will be required to identify specific areas of concern along the corridor, additional track required, and potential costs.

Regardless of the level of additional service that might be feasible on the corridor, the ability of Union Station to handle any increase in traffic must be addressed first.

Alternatives to Corridor Expansion

There are a number of alternatives to corridor expansion that could be considered. First, potential changes could be made to existing and planned GO/RER and UP Express services. It may be possible, for instance, to harmonize GO/RER service and SmartTrack services to allow 15 minute combined frequencies between Mount Dennis and Union Station. Under this scenario, travel demand from MACC and Bramalea to Mount Dennis would be accommodated by 30 minute frequencies. If future travel demand forecasts establish that the demand could be met, the need for added corridor capacity would be eliminated. Additional alternative operating scenarios that may be worth investigating to see if they could be operated on the existing/planned four track GO corridor include:

- Harmonizing station stop patterns to maintain consistent train headways along the entire corridor;

- Running more frequent semi-express GO trains making all stops to either a Mount Dennis (Corridor 1) or Woodbine (Corridor 2) transit hub with SmartTrack providing all local service between the transit hub and Union Station;
- Running a 15 minute local GO feeder service only as far as the transit hubs with transfers to fewer express trains to Union station plus the 15 minute local SmartTrack service; or
- Running the SmartTrack service using semi-express trains; making all stops on the Eglinton (or Airport) corridor then running express to Union Station. GO Local service would be expanded to serve the proposed SmartTrack stations on the GO Kitchener Corridor south of the SmartTrack connection.

Finally, if no satisfactory arrangement can be found regarding modifications to level of service, then a corridor-wide train control system upgrade could be considered before increased track capacity. Potential signal upgrade or replacement scenarios include:

- PTC - Positive Train Control
- CBTC - Communications Based Train Control
- ERTMA - European Rail Traffic Management System

Cost Comparison

Construction cost estimates for each of the short-listed alignments were developed for comparison purposes. The “order of magnitude” figures listed in the table below include allowances and contingencies for property acquisition, professional services and various unknowns and risk factors. Costs for the SmartTrack alignments are provided both with and without a line extension and additional station beyond Renforth Gateway so that a proper comparison can be made to the Base Reference Case (between Mount Dennis and Commerce Blvd). More detailed estimates for the various alignments, as well as the derivation of the estimate for the Base Reference Case from data provided by Metrolinx, are provided in Section 7 of this report. These estimates are intended solely for providing an indication of the relative differences in costs between the alignment alternatives and are under no circumstances to be used for project planning or budgeting.

Alignment	Order of Magnitude Estimated Costs ($B) Mount Dennis to *Renforth Gateway*	Order of Magnitude Estimated Costs ($B) Mount Dennis to *Orbitor/Matheson*
1Ae	4.7 – 5.7	5.7 – 6.9
1Aa	4.8 – 5.8	6.3 – 7.7
1Ba	4.3 – 5.2	5.8 – 7.1
1C	3.7 – 4.5	5.1 – 6.3
1D	4.0 – 4.9	5.5 – 6.8
2B	3.1 – 3.8	3.9 – 4.8
2Ca	2.7 – 3.3	3.6 – 4.4
Base Reference Case *(derived from data provided by Metrolinx)*	1.1 – 1.3	N/A

These estimates do not include potential modifications to the Kitchener Corridor between Union Station and St. Clair (or Woodbine) as may be required to support integrated SmartTrack and GO RER services (potentially costing a further $1B to $2B), or other items listed in Section 7.4, such as rolling stock, maintenance and storage facilities upgrades, or train control/communications systems upgrades.

Alignment Evaluation

The evaluation of feasible SmartTrack alignments is based on the three city-building principles developed by the City in the “Feeling Congested?” initiative which, in turn, is part of the City’s larger, on-going Five Year Official Plan Review and Municipal Comprehensive Review process. The principles - Serving People, Strengthening Places and Supporting Prosperity - and their eight associated criteria were used as the backdrop against which this evaluation framework and measures of effectiveness were defined in order to determine the degree to which each of the alignments (and the station stops along their routes) satisfied the criteria.

Principles	**Criteria**
Serving People	Experience
	Choice
	Social Equity
Strengthening Places	Shaping the City
	Healthy Neighbourhoods
	Public Health and the Environment
Supporting Prosperity	Supports Growth
	Affordability

The ECLRT Phase 2 alignment (as defined in the approved EPR) provided the Base Reference Case against which the potential SmartTrack alignment alternatives were compared. The results of the evaluation are summarized below.

	Base Reference Case	*Corridor 1: Eglinton Continuous Service*					*Corridor 2: Airport*	
Criteria	Approved LRT TPAP	1Ae	1Aa	1Ba	1C	1D	2B	2Ca
Choice	●	◕	◕	◔	◕	◕	◑	◑
Experience	◕	◑	◑	◔	◑	◑	◕	◕
Social Equity	●	◕	◕	◑	◕	◕	◕	◕
Shaping the City	●	◑	◑	◑	◑	◑	◔	◔
Healthy Neighbourhoods	◕	◑	◑	◑	◔	○	◕	◕
Public Health and Environment	●	◕	◑	◑	◑	◑	◑	◑
Affordability	●	◑	◔	◑	◑	○	◕	◕
Supports Growth	◕	◑	◑	◑	◔	◔	◕	◑

Each of the heavy rail corridors has unique advantages and disadvantages when compared to one another. By contrast, the Base Reference Case appears to have many advantages, but most notably in terms of projected ridership in 2031, where some

39,500 all day boardings are predicted. This figure is just over twice that of the Corridor 2 alignments (19,500 all day boardings) and more than four times higher than the Corridor 1 alignments (9,400). These numbers are predicted in spite of a longer travel time offered by the Base Reference Case compared to the limited stop, heavy rail SmartTrack alternatives. It is interesting to note that in terms of their ability to attract new transit riders to the overall network, the Base Reference Case and Corridor 2 alignments attract a similar number of new daily riders (25,700 and 24,900, respectively), while Corridor 1 alignments attract between 24 and 28% fewer new riders (20,100). The results suggest that employment areas not already served by higher order transit have the greatest potential to facilitate a mode shift amongst commuters. The specific ridership figures for each alignment are reported in the table below, as well as in Section 9 and Appendix 10.

Model Year: 2031 **Land Use Scenario:** Low population, medium employment with SmartTrack Influence **Key Assumptions:** 15 minute Smart Track Frequency, TTC fares	**Corridor 1:** Continuous via Eglinton Ave West	**Corridor 2:** Continuous via Woodbine	**Base Reference Case:** ECLRT Phase 2
All Day Boardings Western Segment	9,462	19,539	39,536
Daily Net New Riders for Transit System	20,124	24,934	25,746
% Change in Ridership from the "do nothing" scenario on the Yonge Subway south of Bloor	2.6%	2.6%	1.6%
Change in Total VKT (AM Peak Period)	-181,290	-197,310	-200,950
Change in AM Auto Mode Share	-0.19%	-0.22%	-0.23%

The modeling results for 2041 exhibit similar rankings between the options, with noticeable increases in ridership for the Base Reference Case and Corridor 1, 47,800 and 12,500 respectively. Corridor 2 remains almost unchanged, at 20,700. In terms of new system-wide ridership, a doubling of the number of new riders for each option is predicted by 2041 (compared to 2031), with the Base Reference Case, Corridor 2 and Corridor 1 attracting 55,700, 50,700 and 50,100 new riders, respectively.

There are some areas, however, where the Base Reference Case did not score as well as the other alternatives. These include:

- **Supporting Transportation Infrastructure:** the at-grade alignment and extra stations burden the street network and pose constraints for supporting station infrastructure.
- **Travel Time:** The at-grade alignment and number of stops result in longer travel times than the SmartTrack options.
- **Compatibility with Existing Neighbourhoods:** The at-grade alignment and number of stops result in significant construction impacts as well as traffic impacts during operation.
- **Eliminating Barriers within Neighbourhoods:** Traffic is impacted by the transit signal priority measures and turning restrictions.

Key Findings

The terms of reference for this study recognized that there were a number of unknowns for which assumptions would have to be made, and that these would limit the level of detail to which any of the corridor or alignment concepts would be developed. Nevertheless, a number of key findings can be drawn from this exercise.

These include:

- It is technically possible to connect a new heavy rail corridor along either Eglinton Ave West or Highway 427/409 to the existing/proposed GO Kitchener Corridor.
- A continuous connection for any Eglinton Ave alignment would result in significant community impacts and require significant grades and curves that would push the limits of acceptable design and service reliability.
- A western corridor extension via Woodbine would result in a significantly longer travel time between Union Station and the MACC.
- Layering a separate SmartTrack service on top of the proposed GO RER service would likely require additional tracks on the GO Kitchener corridor.
- Grade separated heavy rail alignments would cost 2.5 to 5 times as much as the semi-exclusive at-grade light rail Base Reference Case.
- With some optimization of the Base Reference Case, it may be possible to address community impacts described in the approved EPR, while still maintaining a cost advantage over heavy rail alignment alternatives.
- Despite the longer travel time, the Base Reference Case would attract two to four times as much ridership in 2031 than Corridors 1 or 2. The longer travel time could be reduced through select alignment profile modifications and/or fewer stations.

Next Steps

If heavy rail alternatives are to be given further consideration, a short list will need to be identified and evaluated through a formal EA/TPAP. In addition to further developing the heavy rail alignment options, it is suggested that consideration be given to undertaking additional planning and engineering work to optimize the Base Reference Case alignment. A fully or partially underground alignment (e.g. grade-separated at major intersections only) could reduce temporary or permanent impacts on businesses and decrease travel time and traffic impacts. These effects could be further enhanced by increasing station stop spacing (i.e. fewer stations).

Before undertaking any further effort, however, a number of steps should be taken to clarify some of the "big picture" issues related to SmartTrack, to revisit and confirm the assumptions made, and to investigate certain other issues in greater detail. These include:

- Additional alignment concepts (e.g. a modified ECLRT Phase 2)
- Third Party opportunities and constraints (e.g. GTAA, Canadian Pacific)
- Union Station platform location(s) and configuration
- Kitchener Corridor configuration (e.g. station platforms, interlockings, property)
- Integrated operations, train control methods and track capacity
- Train configuration and load standards
- Passenger convenience and safety
- Train performance and travel times
- Power supply

SmartTrack Western Corridor Feasibility Review

City of Toronto

Final Report

January 2016

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Table of Contents

Appendices

1 Introduction

The SmartTrack Western Corridor Feasibility Study is a component of the overall SmartTrack work being undertaken by the City of Toronto, Metrolinx and the Toronto Transit Commission (TTC). The proposed SmartTrack service would include high frequency, bi-directional rapid transit service, stretching between the far west and northeast corners of the city and beyond. The proposed route occupies existing GO Transit heavy rail corridors for much of the distance, however, the 9 km section along Eglinton Avenue between Mount Dennis station on the GO Kitchener Corridor and the Mississauga Airport Corporate Centre (MACC) would require a new heavy rail corridor to be built where none exists today. Additionally, City Council requested that this study assess another option which would continue SmartTrack service north along the GO Kitchener Corridor to the Woodbine Racetrack area and then connect to the MACC with a new heavy rail link. The purpose of this study is to assess the feasibility of connecting heavy rail track alignments to the GO Kitchener Corridor for SmartTrack service along both of these corridors.

1.1 Feasibility Study Area & Objectives

The project area for this feasibility study is shown in Figure 1 below.

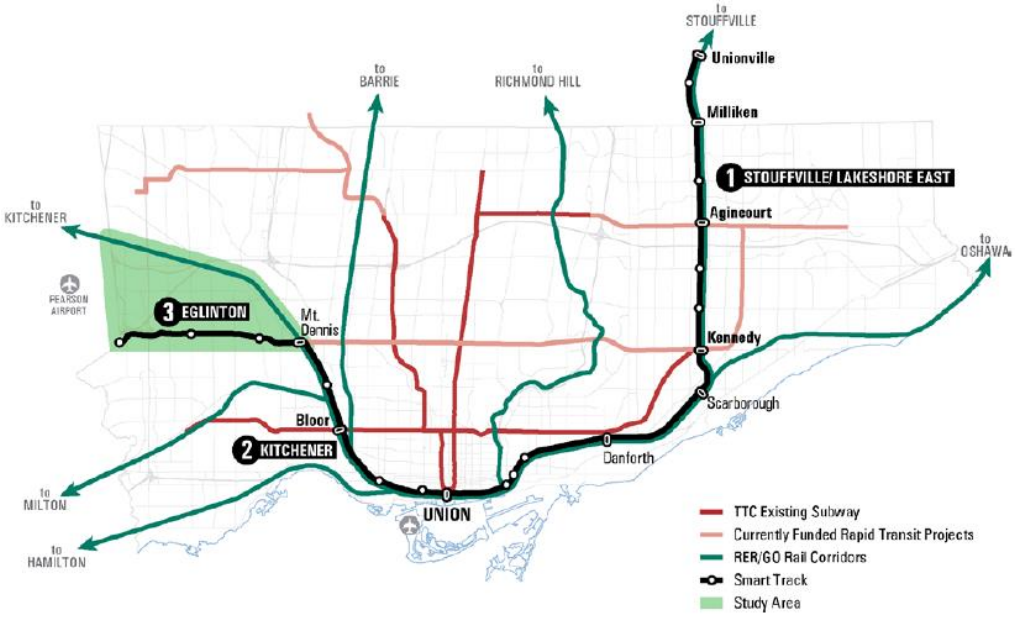


Figure 1: Project Study Area

The primary objectives of this study can be summarized as follows:

- Develop heavy-rail corridor alignments connecting the GO Kitchener Corridor and the Mississauga Airport Corporate Centre and examine their technical feasibility, regulatory constraints/impacts, level of service constraints and impacts, land use impacts and order of magnitude costs.

- Compare the alignments against the previously approved Eglinton Crosstown LRT (ECLRT) Phase 2 Transit Project Assessment Process (TPAP) or Environmental Project Report (EPR) using the planning framework established in the City's "Feeling Congested?" initiative. The ECLRT service between Mount Dennis and the MACC (Commerce Boulevard) will be used as the base reference case.

- Provide input to the Regional Express Rail (RER) and SmartTrack planning process being undertaken jointly by Metrolinx and the City of Toronto, in the form of potential infrastructure requirements and their associated costs, impacts on surrounding public and private properties and the environment and potential mitigation measures, and any constraints or limitations to the level of train service that can be offered.

1.2 Heavy Rail Corridor Alternatives

There are three corridor alternatives being considered – two on Eglinton Avenue one via Woodbine and the Airport, as described below.

1.2.1 Eglinton Continuous Connection (Corridor 1)

SmartTrack service heading northwest from Union Station diverges from the GO Kitchener Corridor onto the Eglinton Corridor without interruption (i.e. single seat service - no transfer). SmartTrack follows Eglinton Avenue West between the Mount Dennis area and the Mississauga Airport Corporate Centre (MACC).

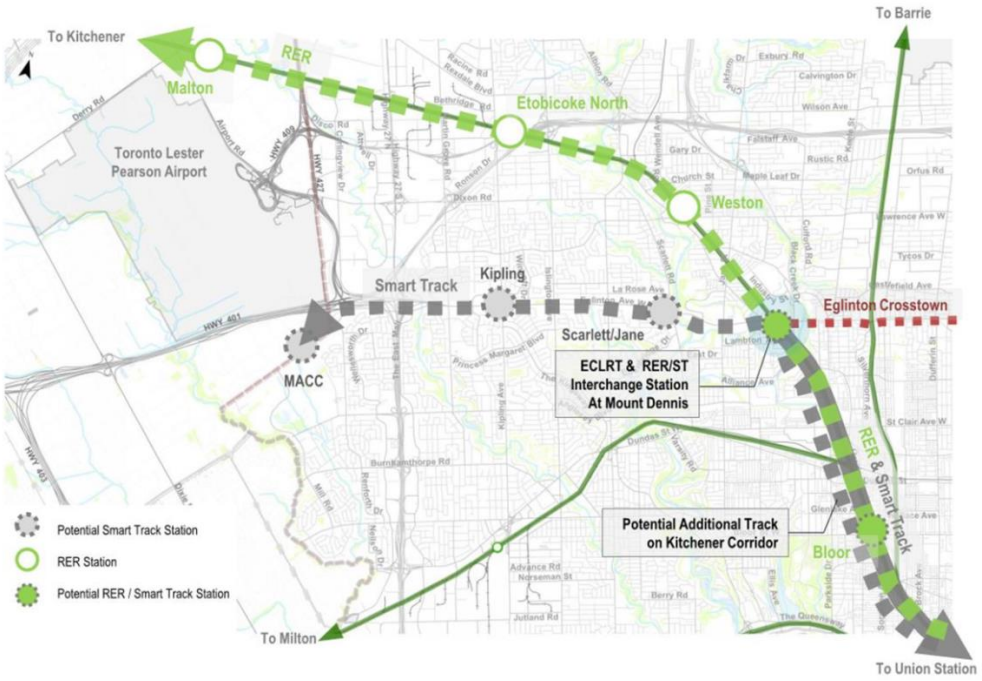


Figure 2: Eglinton Continuous Connection

1.2.2 Woodbine Continuous Connection (Corridor 2)

SmartTrack service heading north along the GO Kitchener Corridor from Union station continues along the GO Kitchener Corridor beyond Mount Dennis to the Woodbine area and then turns south (various alignments are considered) passing through the Pearson International Airport area and continuing to the MACC.

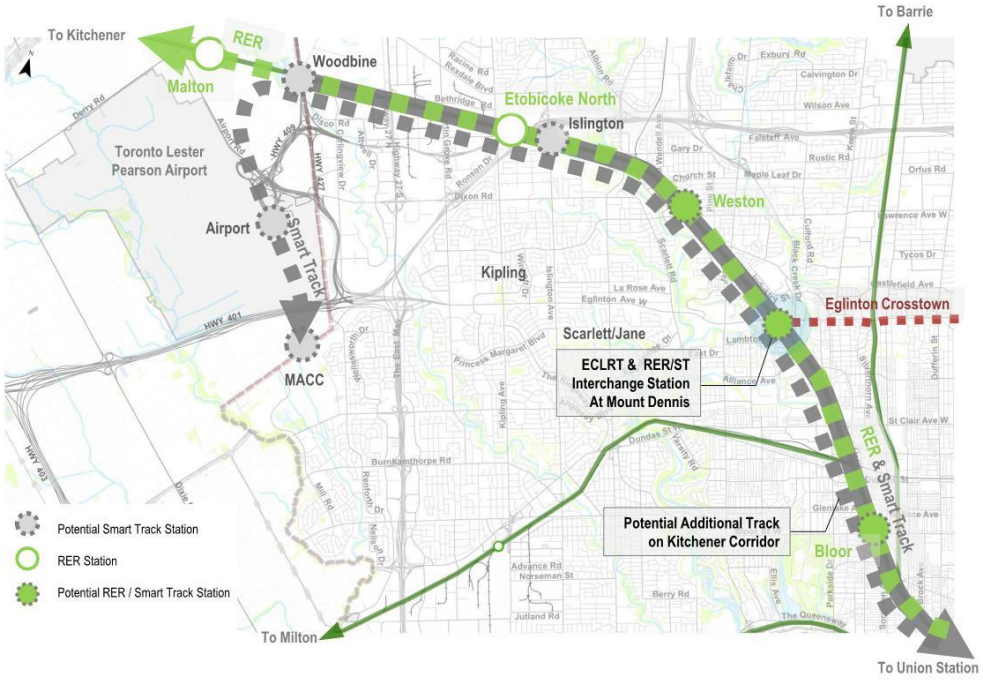


Figure 3: Woodbine Continuous Connection

1.2.3 Eglinton Standalone with Transfer (Corridor 3)

SmartTrack service heads north from Union Station along the GO Kitchener Corridor to Mount Dennis Station. Passengers continuing to the west on the SmartTrack service must transfer here onto a stand-alone SmartTrack rapid transit service that runs along Eglinton Avenue West between Mount Dennis Station and the Mississauga Airport Corporate Centre (MACC).

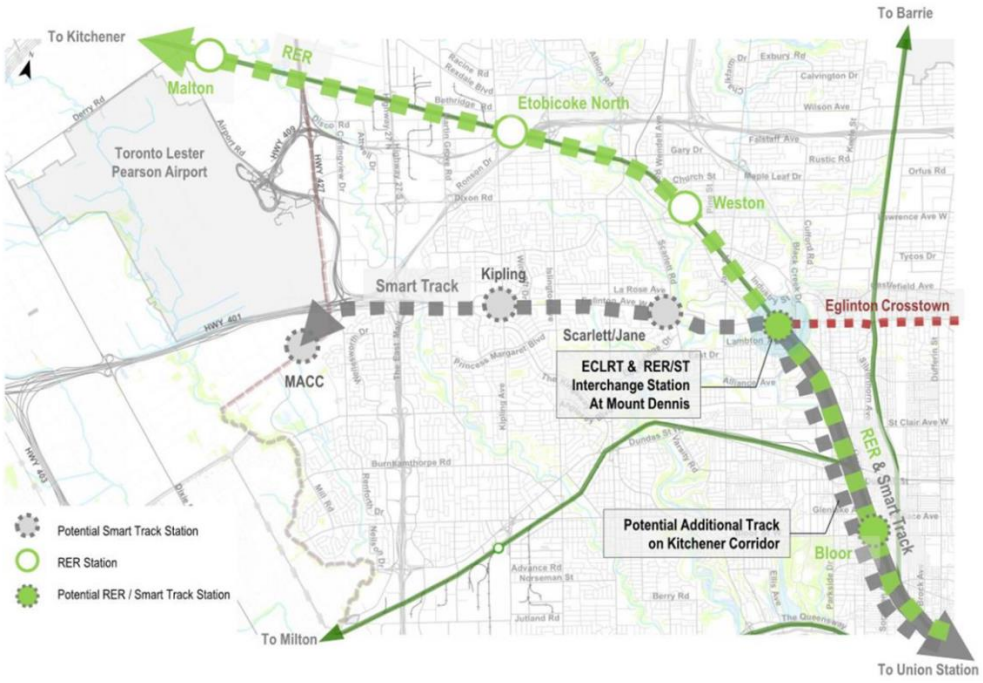


Figure 4: Eglinton Standalone with Transfer

1.3 Base Reference Case

The original EA for the Eglinton Crosstown LRT (ECLRT) covered the entire 33 km between Pearson International Airport (PIA)'s property limits and TTC's Kennedy Station, but was subsequently divided into phases. The first phase is a transit infrastructure project led by Metrolinx, and is now under construction. The ECLRT will add 19 kilometers of new light rail transit along Eglinton Avenue from Mount Dennis to Kennedy subway station. The original environmental assessment (EA) was approved and received the Notice to Proceed from the Minister of the Environment in May 2010. An addendum was prepared to address a change in alignment in a short section of the LRT in the Mount Dennis area and to include the Eglinton Maintenance and Storage Facility; the location where light rail vehicles will be stored and maintained. That addendum was undertaken and received the Minister's Notice to Proceed in December 2013.

It should be noted that in 2008 the Toronto Transit Commission (TTC) decided to investigate the feasibility of extending the ECLRT to include a link to PIA. The Study Area for the study was identified to address the ECLRT connection between Martin Grove Road and Pearson Airport. The purpose of the study was to determine if there was a logical and feasible connection to the airport and if so recommend a preferred alignment. This study resulted in a recommended extension to the ECLRT to reach the airport as shown in the figure below.

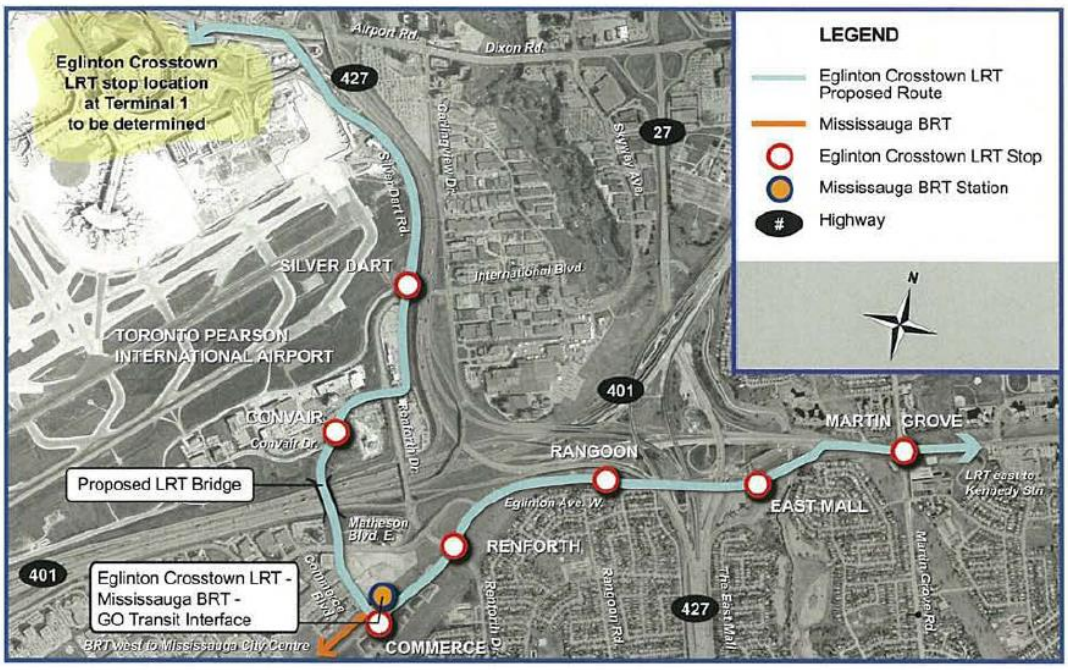


Figure 5: Recommended ECLRT Extension to Pearson Airport

The western portion of the ECLRT alignment between Mount Dennis and the MACC (Commerce Blvd) that was previously assessed in the approved EA is used as the base reference case for this study (See Figure 6 below). All SmartTrack corridors will be assessed against this base reference case for each aspect of the study.

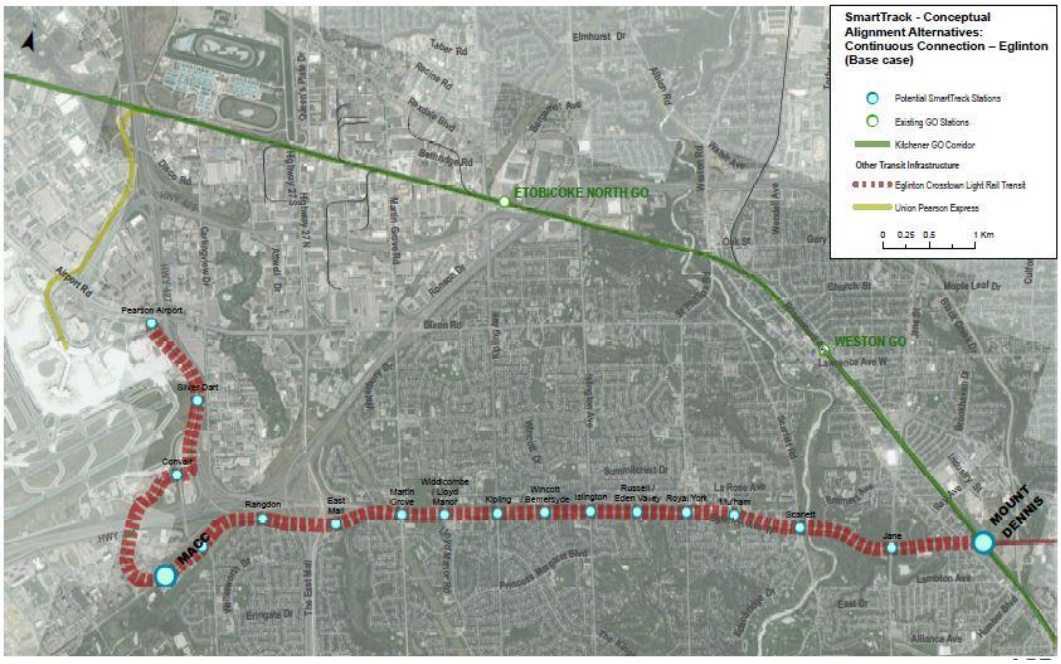


Figure 6: SmartTrack Base Reference Case- ECLRT Western Alignment

1.4 Report Structure

This report is structured as follows:

Section 2: Existing (and Planned) Conditions
This section describes the physical and, in some cases operating characteristics of the existing infrastructure elements that may be impacted by one or more of the proposed SmartTrack alignments.

Section 3: Regulatory & Legislative Considerations
This section summarizes regulatory and legislative rules that may apply to the design, construction and operation of this section of SmartTrack, particularly since it passes through populated urban areas. Key safety or security issues affecting alignment design or train operations are discussed.

Section 4: Basis of Design
This section describes the design guidelines and standards that have been used in the development of alignments. Considerations include heavy rail operating requirements, engineering standards, equipment requirements, alignment design criteria, and station design guidelines.

Section 5: Technical Feasibility of Potential Track Alignments
Individual track alignments within each of the designated corridors are described and the technical feasibility is assessed. Various alignment and profile options for each corridor (e.g. at grade, below grade/tunneled, or above grade on elevated structures) are considered. Combinations of profiles are also considered. The technical feasibility and potential constraints and/or so-called “fatal flaws” are discussed.

Section 6: Service Concept Feasibility Analysis
This section describes the level of service offered on each alignment developed for the corridor alternatives. Each short-listed alignment, by virtue of its length, speed profile and connection with the GO Kitchener Corridor exhibits its own operating characteristics. Using these key features, in concert with some basic assumptions concerning vehicle acceleration and deceleration and station dwell time, time-distance charts have been developed for each to demonstrate potential schedules and impacts to the GO Kitchener Corridor.

Section 7: Cost Comparison
This section provides order of magnitude costs estimates for each of the short-listed alignments to be used to indicate of the relative differences in costs between the alignments. Cost estimates are based on typical industry construction costs for similar works on a unit basis (e.g. per metre or per km). These values vary according to the alignment profile, whether it is at-grade, below grade or elevated, and are adjusted for obvious special items, such as stations, grade separations, high bridges, etc.

Section 8: Community and Land Use Analysis
This section describes the community impacts/benefits and land use analysis applied to the short-listed alignments and the results of that assessment. Each alignment was assessed against the approved criteria falling under the “Feeling Congested?” criteria: Shaping the City, Healthy Neighbourhoods, Public Health and Environment, Supports Growth, as well as a separate section outlining private property impacts.

Section 9: Transit Service Analysis
This section communicates the results of the transit service analysis. Each alternative was assessed against the criteria falling within the Choice and Experience criteria from the City of Toronto’s “Feeling Congested?” report.

Section 10: Summary
This section provides a written and tabular summary of the alignment evaluation within the confines the three city-building principles developed by the City as part of its “Feeling Congested?” initiative - Serving People, Strengthening Places and Supporting Prosperity.

Section 11: Next Steps
This section outlines a number of steps that should be taken to clarify some of the “big picture” issues related to SmartTrack, revisit and confirm the assumptions made, and investigate certain other issues in greater detail.

2 Existing (and Planned) Conditions

This section describes the physical and, in some cases operating characteristics of the existing infrastructure elements that may be impacted by one or more of the proposed SmartTrack alignments. Obvious flaws to potential SmartTrack horizontal alignments or vertical profiles are noted in this section, however, a more specific discussion of alignment feasibilities is provided in Section 5 of this report.

2.1 GO Kitchener Corridor

2.1.1 Property

The GO Kitchener Railway Corridor runs in a north-westerly direction from the vicinity of Bathurst and Front streets, through numerous communities such as King West, Parkdale, Junction, Stockyards, Mount Dennis, Weston and Rexdale on its way toward Brampton, Georgetown, Guelph and ultimately Kitchener. The GO Milton and GO Barrie Corridors run parallel to (without connecting to) the GO Kitchener Corridor at Bloor Station and Lansdowne Avenue, respectively.

The width of the combined railway corridor properties ranges from 43m-63m between Bathurst and Bloor Streets and 27m-31m from Bloor Street to Highway 427 and beyond. Within this narrower section, for a distance of roughly 7 km north of Bloor Station, roughly 10m is occupied by the Canadian Pacific Railway (CP) Mactier Subdivision right-of-way (ROW) that borders the east side of the GO Kitchener Corridor property. Although only one CP track is in service today, sufficient room exists on their property to construct a second track, if and when it is warranted. A connecting track runs between the two corridors from St. Clair Avenue to Black Creek Drive. This track is used at night by Canadian National Railway (CN) and CP as a central location to exchange trains of railway cars destined to each other's customers in the Toronto area.

2.1.2 Stations

There are currently four GO stations either in service or planned to be built along the corridor. They are: Bloor, Mount Dennis (Eglinton Avenue West), Weston and Etobicoke North. Mount Dennis Station is planned to be built, in part, to integrate the GO heavy rail network with the Metrolinx Eglinton Crosstown LRT (ECLRT) now under-construction, and the 15 TTC bus routes that will serve this station. Other GO station modifications/expansions are planned to accommodate increased service on the corridor as part of the proposed GO Regional Express Rail (RER) program. The Union-Pearson Express service (UPX) currently stops at the expanded (three platform) GO Bloor and Weston Stations. Additional potential stations relevant to this study and currently under consideration as part of the City's SmartTrack initiative are discussed in Section 4.3.

2.1.3 Number of Tracks

Within the study area, the GO Kitchener Corridor consists of a minimum of three main tracks, and is also referred to by its previous owners' designation as the CN Weston Subdivision. The design for a fourth track has been completed as far north/west as Highway 427 and has already been constructed on a number of bridge structures and through grade separations. This fourth track is also already in service south/east of Lansdowne Avenue where it is used by GO Barrie Corridor trains to reach the Union Station Rail Corridor (USRC) east of Bathurst Street. A second track is planned for the GO Barrie Corridor and construction has already begun on certain sections of the line. An additional track is in place today between Bloor Street and the USRC for trains serving the GO Milton Corridor, and a second track for this service is also being planned. Ultimately, an eight track corridor is planned for the combined GO Kitchener, Milton and Barrie Corridors south/east of Lansdowne Avenue to feed the USRC.

In addition to the main tracks, there are some isolated freight service tracks along the Weston Subdivision, predominantly to the north/west of Etobicoke North Station, that are used by CN to provide on-going rail service to its customers. Also, a fourth track is in place between Eglinton Avenue and St. Clair Avenue, connecting the GO Kitchener Corridor to the adjacent CP main track.

Schematic track charts of the GO Kitchener Corridor are provided in Appendix 2A.

2.1.4 Structures

There are three major water crossings along the corridor: Black Creek just south of the future Mount Dennis station, Humber River just west of Weston Road and Mimico Creek just beyond Highway 427. The Black Creek and Humber River crossings are accomplished via significant multi-span bridge structures, while the Mimico Creek crossing, although deep, is accomplished with a single span.

The GO Kitchener Corridor also cuts across a dense network of roadways, highways and other railway corridors in the study area. There are 18 locations where the railway corridor spans across a roadway or highway below, and another 12 locations where the railway corridor passes below the road. Of these, five involve significant railway grade changes and supporting retaining wall structures (see Table 1 below and maps in Appendix 2B).

It is worth noting that where property was unavailable for traditional roadway overpasses, railway underpasses have been constructed. These crossing structures take the form of long open trenches (with cross bracing or struts supporting the walls), *up to 1.3 km long and 10m deep*, which can affect train performance and schedules.

Table 1: Railway Crossing Structures

Location	Type	Distance from Union Station
Bathurst Street	Road Over	1.80 km
Strachan Avenue	Road Over Trench	2.60 km (2.00 km – 3.20 km)
King Street	Road Under	3.20 km
Queen/Dufferin Streets	Road Under	4.00 km
Brock Avenue	Road Under	4.55 km
Lansdowne Avenue	Road Under	5.05 km
Dundas Street	Road Over	5.60 km
Bloor Street	Road Under	6.40 km
Dupont Street	Road Under	7.45 km
CP North Toronto Sub.	Track Over Trench	7.80 km (7.50 km – 8.47 km)
St. Clair Avenue	Road Under	8.60 km
Rogers Road	Road Over	9.90 km
Black Creek Drive	Road Under	10.35 km
Eglinton Avenue West	Road Under	11.00 km
Ray Avenue	Road Under	11.58 km
Jane Street	Road Over	12.40 km
Denison Road East	Road Under	12.87 km
Lawrence Avenue West	Road Under	13.62 km
John Street	Road Over Trench	13.90 km (13.68 km – 15.03 km)
King Street	Road Over Trench	14.10 km (13.68 km – 15.03 km)
Church Street	Road Over Trench	14.40 km (13.68 km – 15.03 km)
Weston Road	Road Under	15.35 km
Islington Avenue	Road Over	16.80 km
Highway 401	Road Over	17.10 km – 17.30 km
Kipling Avenue	Road Under	17.84 km
Martin Grove Road	Road Under	18.90 km
Highway 27	Road Under	19.94 km
Carlingview Drive	Road Under	21.04 km
Highway 427	Road Over	21.70 km – 21.78 km
Goreway Drive	Road Under	21.93 km

2.1.5 Electrification (Planned)

The planned electrification of the GO Kitchener Corridor will result in additional infrastructure that must be taken into consideration in any review of the feasibility of adding additional tracks or making connections to new corridors. Of particular concern are the electrical substations, poles and bridge structures (over and beside the tracks) that will provide power to and support the messenger and contact wires and the clearance envelopes associated with them. The relevant design assumptions and their source are described in Section 4 of this report.

2.1.6 Track Geometry

With the recent completion of the GO Georgetown South Project, which included the construction of the third main track and sections of the fourth main track between Bathurst Street and Highway 427 and the construction of several long grade separations near Strachan Avenue, Bloor Station and Weston Road, the GO Kitchener Corridor includes a significant number of grades and curves, both horizontal and vertical. As a result, south of Mount Dennis Station there is now only one +/- 400m long section of tangent, planar track (i.e. without significant vertical curves) at the same level of the surrounding grade where it might be possible to make a partial connection to a new corridor. Additional opportunities and constraints associated with connecting to the GO Kitchener Corridor are explored in Section 5 of this report.

2.1.7 Train Control

Multi-track railway corridors such as the GO Kitchener Corridor are designed to accommodate multiple train movements running at different speeds in either the same or opposing directions at the same time. Operational flexibility is enhanced and the number of tracks minimized through the use of a grid of “interlockings” spaced as evenly as possible along the route, taking into account grades and other restrictions that affect the average speeds of trains using the corridor between them. Interlockings are locations where trains can be switched from one track to another under the authority and control of the Train Dispatcher. This may be necessary for a number of reasons, including train meets and overtakes, access to and from one side of the corridor is required to reach junctions with other corridors, and access to station stops where platforms do not exist on all tracks. Train movements at and between the interlockings are governed by signal indications displayed either via cab signals (in the locomotive) or as on the GO network, through signals installed on (roughly) evenly spaced overhead signal bridges. These signals indicate the occupancy of the track ahead to prevent “face to face” opposing movements on the same track and to maintain adequate spacing (safe braking distance) between trains moving in the same direction on the same track. Their indications provide instructions to the locomotive engineperson regarding maximum allowable speed due to track geometry or occupancy of the track ahead, and provide advance information for up-coming route changes.

Interlockings control the movement of trains through special trackwork (also known as turnouts) that is used to switch trains from one track to another. For safe operations, interlockings must be placed on tangent level track. Full interlockings allow the movement of trains from any track to any track in both directions. The length of tangent required is very much dependent on the number of tracks in a given corridor. A four track interlocking requires approximately 600m of length. Four interlockings exist on the GO Kitchener Corridor between Union Station and Highway 427. They are: **Bathurst**, located between Bathurst Street and Strachan Avenue, **Nickle**, located between Ray Avenue and Jane

Street (immediately north of the future Mount Dennis Station), **Humberview**, located between the Humber River Bridge and Islington Avenue, and **Wice**, located between Carlingview Drive and Goreway Drive, opposite Woodbine Racetrack. Prior to the completion of the West Toronto rail/rail grade separation near Bloor Station, an additional interlocking protected the at-grade crossing of the CP and CN (now GO) tracks. These interlockings were spaced at roughly 4 km intervals. Opportunities for modifying existing or creating new interlockings to connect to new SmartTrack corridors are explored in Section 5 of this report.

As rail traffic density increases, the need for Positive Train Control (PTC) may become more urgent. New services on the GO Kitchener Corridor will have to take into consideration any future plans that GO may have for the implementation of advanced/enhanced train control systems.

2.2 Union-Pearson Express Spur

2.2.1 General Description

UPX trains share the GO Kitchener Corridor with all other trains between Union Station and Wice Interlocking. A dedicated two-track elevated guideway, or spur, diverges from the corridor and runs along the west side of Highways 427 and 409 for a distance of 3.5 km to reach Pearson International Airport (PIA) Terminal 1. The spur has a footprint width that generally ranges from 15m to 25m, with some wider sections on curves to accommodate support structures. It threads its way along Highway 409 and across Airport Road into the Terminal 1 area through some narrow spaces between the highway and adjacent industrial properties and parking lots, and rises to a maximum height of 28m (grade to top of rail) to maintain a minimum clearance of 5m above all of the highway ramps.

2.2.2 Stations

There is only one station on the UPX spur, located at PIA Terminal 1, at the same level as the LINK “People Mover” system station that runs between the two airport terminals and the Viscount Value Parking Facility beyond Airport Road. Due to the location and orientation of this station, and the desire to serve the MACC beyond the airport, the UPX spur was not considered a viable candidate to be used to carry direct SmartTrack services via the GO Kitchener Corridor because it would have to be extended south, directly through the terminal building and airport groundside operations areas, including runway approaches.

2.2.3 Track Geometry

The UPX Spur generally follows the Highway 409 alignment and therefore contains a fair number of curves, some of them quite sharp, *as low as 127m radius or 14 degrees*. The longest tangent is 544m long, but the average tangent excluding the longest is about 100m long. The alignment profile rises and falls on either side of the Highway 409/427 interchange at Airport Road, using 2% grades as long as 1 km in length. As with the station orientation, the geometry of the

spur, while not impossible to use, is not really suited to long trains using typical GO Transit equipment.

2.2.4 Train Control

The only special trackwork between Wice Interlocking and Terminal 1 are the crossovers immediately north of the UPX terminal station platform. Train movements at this control point and along the spur are governed by signal indications displayed through wayside signals installed roughly 800m-1,000m apart. Opportunities for modifying Wice Interlocking to connect to a new SmartTrack corridor alignments are explored in Section 5 of this report.

2.3 Mississauga Airport Corporate Centre

The Mississauga Airport Corporate Centre (MACC) is an employment zone south of Highway 401, between Renforth Avenue and Eastgate Parkway. A new bus terminal, known as the Renforth Gateway, is under construction at its eastern limit to serve both Mississauga's and Toronto's current and future bus transit operations. In order to reduce congestion and improve bus transit times, this entire facility and its approach roadways are grade separated from the surrounding traffic (in open trenches). A description of this project is provided in Appendix 2C. The proposed SmartTrack service is intended to terminate somewhere in the MACC. If a direct platform to platform SmartTrack interchange is desired at the Renforth Gateway, it would have to be constructed beneath the new bus station.

2.4 Eglinton Avenue West (Corridors 1 and 3)

2.4.1 Roadway Geometry

The limits of the proposed Eglinton Avenue West SmartTrack Corridor extend from Black Creek Drive in the east to Commerce Boulevard in the west, a distance of 9.5km. The elevation of the road climbs roughly 60m from its lowest point near the Humber River to its highest point near Renforth Drive. Most of this climb, however, is concentrated between Scarlett Road and Islington Avenue, resulting in steep grades (3% - 4.5%) between these two points. The 3% grade, in particular, is very long (+/-800m) and is part of a continuous 1.8km long grade, which could present a challenge to providing high speed service at grade using heavy rail equipment, even if significant cuts and fills were constructed to create a longer and slightly reduced, but more uniform continuous grade. Additional steep grades exist between Black Creek Drive and Jane Street (4.8% - 5.3%) and between Martin Grove Road and Renforth Drive (2.3% - 3.1%). A plan and profile of the road surface is provided in Appendix 2D.

2.4.2 Property

The municipal ROW associated with Eglinton Avenue West between Black Creek Drive and Renforth Drive varies in width from 21m to 60m. A portion of this property immediately adjacent to the developed roadway was designated several years ago as part of the Richview Transportation Corridor. In the ensuing years these lands have come to be used and regarded by local residents as open green spaces; however several parcels have recently been sold to developers, some of whom have already begun construction of townhomes. A schematic describing the current development applications along Eglinton Avenue West is provided in Appendix 2E.

2.4.3 ECLRT Mount Dennis Station & Tail Tracks

Due to the very steep grades on either side of Weston Road, portions of the ECLRT Mount Dennis Station and associated tail tracks must extend below grade towards Weston Road. Any below grade SmartTrack alignment that includes a direct passenger transfer must be at a lower level, since the GO corridor is directly above the ECLRT. This will constrain the profile of the SmartTrack alignment to the west as demonstrated in Section 5 of this report. The latest available plan and profile of the ECLRT in this area is provided in Appendix 2F.

2.4.4 Eglinton Flats/Humber River Crossing

Between Jane Street and Scarlett Road, Eglinton Avenue West follows the profile of the Humber River floodplain, known as Eglinton Flats. This area is used as public open space and a golf course. Floodplain data was provided by the Toronto and Region Conservation Authority (TRCA). Due to previously described constraints, SmartTrack alignments through this area are most likely to be elevated, varying only in terms of their degree of impact on the continued use of the public spaces. Nevertheless, circumstances may permit or require certain alignments to be below grade through this area, as described in Section 5 of this report. An at-grade heavy rail alignment is not feasible in this area due to the grades on either side of the floodplain.

2.4.5 Hydro Corridor

Immediately west of Martin Grove Road there is a high voltage hydro corridor that cuts across Eglinton Avenue. An elevated SmartTrack alignment through this area would have to either pass over the tall pylons or allow for sufficient vertical clearance between the overhead catenary system and the lowest point of the hydro wires, while maintain standard highway clearance below the elevated guideway. Wire elevation is not fixed. It depends on both ambient temperature and load on the system. Wires tend to sag to their lowest point during the summer months when temperatures are highest and the load on the system is also highest. Within this corridor there are also numerous lower voltage lines mounted to wooden poles. *An elevated alignment would require raising or burying both the high and low voltage lines on either side of Eglinton Ave West.*

2.4.6 Mimico Creek

Mimico Creek crosses Eglinton Avenue about halfway between Martin Grove Road and Highway 427. The low point of the road is roughly at the intersection of The East Mall. The floodplain limits extend to The East Mall but do not cross it. Eglinton Avenue rises from this intersection toward the creek crossing so the length of road itself in the floodplain is reduced. Any at-grade alignment across this area would have to maintain the same road elevation or risk creating an impediment to flood water flow.

2.4.7 Highway 427/27

Eglinton Avenue passes beneath a series of eight bridges and ramps that are part of the Highway 427 and Highway 27 interchanges with Highway 401 and Eglinton Avenue. Vertical clearance beneath these bridges ranges from 4.9m to 9.0m, which would be a limiting factor for any potential at grade SmartTrack alignments along Eglinton Avenue. Excerpts of previous studies identifying these existing conditions are provided in Appendix 2G.

For heavy rail electrification applications, 7.4m is typically specified between top of rail (TOR) to the underside of any overhead structures, although this could be reduced slightly under certain circumstances. It is not likely that an elevated alignment would be feasible above/across the highway infrastructure as the height required would be inconsistent with the hydro corridor immediately to the east and the portal to the below grade alignment required to the west (to serve Renforth Gateway).

2.4.8 Buried Pipelines

A pipeline corridor crosses Eglinton Avenue between Highway 427 and Renforth Drive. Eight gas pipelines, varying in diameter between 200mm and 762mm use this corridor. Data provided by the City of Toronto Technical Services (see Appendix 2H) suggests that these pipelines are located between 1.3m and 3.2m below grade*. This could be a risk to the vertical profile on approach to the below grade Renforth Gateway Station. Consultation with the utility owners is advised to confirm feasibility in terms of minimum vertical separation required between pipelines and tunnels.*

2.5 Airport/Highway 427 (Corridor 2)

2.5.1 Property

Corridor 2 alignments can make substantial use of municipal right-of-ways (Northwest Drive, Airport Road, Carlingview Drive), provincial lands (Highways 401/409/427 and the Mimico Creek floodplain) and federally-owned properties (PIA terminal and parking lots) between Wice Interlocking and the MACC. Notwithstanding this advantage, there would still be some impacts to privately owned industrial properties. These impacts are identified in Section 5 of this report.

2.5.2 UPX Infrastructure Footprint

The elevated UPX guideway is situated in a narrow space between Highway 409 and adjacent industrial properties before rising significantly to pass over the highest highway ramp, as described previously in Section 2.2 above. This presents a potential constraint to developing new corridors immediately adjacent due to concerns about the stability of UPX guideway pier foundations. The placement of these piers at roughly 38m spacing also limits where a potential elevated alignment might be able to be located.

2.5.3 Highways 401/409/427 (including ramps and interchanges)

Notwithstanding the availability of property along existing highway corridors, it is the ramps at each of the interchanges that pose the greatest risk to the feasibility of heavy rail alignments through this area. As with the UPX alignment, it is not feasible to fit an electrified heavy rail alignment cross-section envelope between the multiple ramps of this interchange. A profile of Airport Road, showing the elevations of the overhead ramp structures is provided in Appendix 2J.

New alignments alongside highway ROWs must pass either above the highest ramp or below the lowest infrastructure element (typically the storm water retention ponds). These constraints are noted on each of the alignments discussed in Section 5 of this report.

3 Regulatory & Legislative Considerations

3.1 Current Regulatory Environment

GO Transit has been providing commuter rail service in the Greater Toronto Area since 1967. For many years, GO operated this service under a “landlord-tenant” arrangement with the owners of the railways lines, CN and CP. From a regulatory perspective, GO trains were operated and maintained according to the same rules as any other railway activity undertaken directly by the owner railways. These rules and regulations are described by the Canadian Transportation Act (CTA) and the Railway Safety Act (RSA).

Over the last 20 years, GO, and after 2006 Metrolinx, have built, purchased or leased a significant portion of the railway corridors on which they operate. As a result, Metrolinx is now a railway in its own right and is defined as a “Local Railway” under the RSA. As such Metrolinx, and its GO Transit operating division are subject to the Act’s provisions where it continues to provide services on federally regulated tracks that it does not own.

GO Transit does not differentiate its operations or equipment according to the ownership of the tracks on which it operates, and since some of its services are subject to the RSA by virtue of that ownership (or previous ownership), a memorandum of understanding was drafted between GO Transit and Transport Canada regarding a consistent application of the rules and regulations of the CTA and the RSA to *all* of its infrastructure, equipment and operations. By extension, any SmartTrack services, even those running only partially on Metrolinx-owned infrastructure and *any* rail service operated by GO Transit would also be subject to the RSA.

3.2 Inspection and Compliance

Regardless of track ownership, Local Railways accepting the responsibility of being subject to the RSA means that they are directly responsible for complying with the federal railway safety regime and must submit rules that apply to their operations to Transport Canada (TC) for approval. TC is responsible for monitoring their compliance to these rules by dealing with them directly rather than the host railway company, if applicable.

A Railway Safety Inspector holds a certificate which identifies the matter for which the inspector is qualified to act. He or she monitors the safety of the operations of all companies that operate on federally-regulated railways and verifies their compliance to the RSA and rules that apply to their operations. He or she issues Notices or Notices and Orders to mitigate threats or immediate threats to safety, if threats are caused by a company's operations. GO Transit voluntarily submits to, and, as a Local or Provincial Railway, pays for, regular TC inspections.

Where TC is not contracted to the railway for inspection and compliance services, non-compliance to an Order can be a serious offence under the RSA for which the company can be prosecuted. The Minister can also have this Order made an Order of a Court to be enforced as such. The Local Railway company representatives could be summoned to appear in Court or could ultimately be arrested.

3.3 SmartTrack as a "Standalone" Railway

A SmartTrack service that is "captive" to a non-regulated railway line would not have to comply with the rules and regulations of the RSA. An independent owner/operator could adopt a set of infrastructure and equipment design standards and operating rules appropriate for the local environment in which the new services would operate (such as those used by a subway or LRT operator). However, since this study's terms of reference specify the use of "Heavy-Rail" equipment similar in nature to existing (or future) GO Transit equipment; it is assumed that the RSA *is* applicable in this case as well. This is discussed further in Section 4.1 of this report. *The exclusive use of other types of equipment on the Standalone Corridor, such as LRT or Subway would fully remove the requirement to adhere to the RSA. To do so would raise the obvious question of connectivity with the ECLRT and effectively revert to a review of the Base Reference Case, or some variant of it. This is beyond the scope of this study but may warrant further review.*

3.4 Applicable Railway Regulations

Local Railways are encouraged to file the same rules with TC as their host railway company's rules, unless there is a very specific reason to file different ones. In general, for a commuter rail authority, the Canadian Rail Operating Rules (CROR) would apply, as would equipment rules and rules related to passenger service. Numerous other federal regulations apply to Local Railways when operating on federally-regulated track. A short list of these, along with their URLs is included in Appendix 3A. They have been adopted universally by GO Transit. The following subsections describe the key considerations for evaluating the Alignments identified in this study from a regulatory perspective. They are primarily associated with at-grade alignments.

3.4.1 Bells and Whistles

The CROR requires that trains approaching, passing or moving about station facilities sound their bell to warn anyone standing or moving about on or near the platform. The application of this rule by the recently inaugurated UPX service at Bloor Station has led to significant discomfort for some local residents, and the same should be expected for any at-grade SmartTrack station, unless approved mitigation measures can be implemented that do not compromise the safety of train operators, passengers or other pedestrians.

Trains are also required to sound their whistle, or horn, when they approach public crossings at grade. The CROR prescribes a unique whistle signal to be used for such crossings: two long blasts, one short blast, followed by another long blast. This is known as Rule 14(l), which states:

"Trains exceeding 44 MPH must sound their whistle signal 1/4 mile before the crossing, to be prolonged or repeated, until the crossing is fully occupied, while trains operating at 44 MPH or less must sound their whistle signal to provide 20 seconds warning before entering the crossing and continue to sound the whistle signal until the crossing is fully occupied."

The application of this regulation by the proposed SmartTrack service, with minimum train frequencies of four trains per hour in each direction for up to 20 hours per day in a dense urban environment would likely result in a perception by local residents of unacceptable "constant" noise. Fortunately, the RSA allows municipalities to apply for "Whistling Cessation" as long as safety requirements are met. These requirements are detailed in Section 104 of the Grade Crossings Regulations and Appendix D of the Grade Crossings Standards. Relevant excerpts of these regulations are provided in Appendix 3B.

3.4.2 At-Grade Crossing Considerations

Grade Crossings Regulations enabled under the RSA (http://laws-lois.justice.gc.ca/eng/regulations/sor-2014-275/) make reference to mandatory engineering Grade Crossings Standards (GCS) that are used to ensure and improve safety at level crossings (http://www.tc.gc.ca/eng/railsafety/grade-crossings-standards.htm). Although Local Railways may be regulated by the RSA, the Grade Crossings Regulations do not apply to them; they apply to the host railway on which they run. Although not technically required to, GO Transit complies with these regulations and standards. Regardless of how SmartTrack services are owned or operated, if they use heavy rail equipment and operate on heavy rail infrastructure, it is assumed that they will be similarly governed.

Grade crossing requirements vary based on railway design speed, vehicle and pedestrian use, the number of railway tracks going through the crossing, and the history of trespassing and other incidents at the crossing, among other considerations. The safety requirements may include flashing lights and bells or lights, bells and gates at the crossing. At a minimum, lights and bells would be required to be activated for *at least* 20 seconds in advance of the arrival of every train at the crossing. While a significant improvement over train whistling, the notion of crossing bells being activated in a dense urban environment for this length of time as frequently as every seven minutes would not likely be an acceptable proposition to local residents.

Furthermore, as in the case of Eglinton Avenue, where an at-grade alignment might be considered by some to be a cost effective alternative to a tunneled alignment, the levels of cross traffic at each major intersection (either from through movements or left turns) would have to be factored into the grade

crossing requirements. This traffic, coupled with the number of tracks and an anticipated train speed greater than 25 kph, would result in a requirement to install crossing gates (if not completely grade separated intersections – see Section 3.6.3). Allowing for the time required for vehicles in motion to clear the crossings after activation of the lights and bells, time required to lower the gates and wait for the train to arrive and finally the time required to raise the gates after each train has cleared the crossing, the amount of time that traffic would be brought to a standstill would likely be unacceptable. A similar concern was raised in the Base Reference Case EA, where the traffic impacts from the LRT crossings at major intersections were considered very challenging *without crossing gates*.

Finally, from a physical design perspective, amongst other design criteria, the GCS prescribes minimum separations between level crossings and adjacent roadway intersections. Such setbacks can vary by location due to sightlines, grades, traffic levels, etc., which could result in a unique combination of speed restrictions and mitigation measures for each level crossing along any proposed at-grade alignments. A typical 30m setback would be inconsistent with an alignment where the tracks were placed between the eastbound and westbound lanes of Eglinton Avenue (unless left turns are prohibited) and would be equally inconsistent with the available property between the existing roadway right-of-way and adjacent residential properties.

Ultimately, any at-grade alignment would require that the railway has priority at all crossings. Mitigation methods would depend on planned train speed and could include a combination of grade separations, traffic light pre-emption, closure of cross streets, impact absorbing crossing barriers, elimination of turns towards the crossings, and/or barriers between lanes of traffic. All of these would have a severe impact on local roadway traffic; much more so than an LRT, as described by the ECLRT Phase 2 TPA.

3.4.3 Grade Separations

The formal grade crossing regulations and standards, in combination with the design standards and policies of the corridor owner, address issues such as setbacks, sightlines, train and roadway vehicle speeds, crossing protection, safety and security. While not formally prescribed by any legislation, there are other factors, such as exposure indices that can affect the suitability of an at-grade corridor through an urban area, and could lead to a requirement for a number of road/rail grade separations that may be impractical given the parallel nature and proximity of the transportation corridor along Eglinton Avenue West to adjacent properties.

A crossing exposure index is calculated by multiplying the annual average daily traffic volume by the number of daily train movements at a given crossing. An unofficial figure of 200,000 is often used to *initiate* discussions between railways

and road authorities on the justification for a grade separation. Each crossing is considered unique in terms of its safety risks, resulting in some existing protected crossings having indices in excess of 400,000. However, in the case of new crossings on Eglinton Avenue West, if we assume four trains per hour for 20 hours per day in each direction the rail exposure is 160 trains/day. It would take only 2,500 vehicles crossings *per day* to produce an exposure index of 400,000.

A sampling of City of Toronto traffic counts undertaken at the Scarlett, Royal York, Islington, Kipling and Martin Grove intersections with Eglinton Avenue West at various times between 2010 and 2015 indicates a daytime eight hour vehicular through traffic volume (north-south movements only) that ranges from 4,300 vehicles to just over 11,000 (see Appendix 3C). Allowing for a 24 hour sampling period as well as turn movements that might pass through a level crossing, depending on its location, exposure indices far in excess of any reasonable upper limit would result (e.g. 6,000 x 160 = 960,000) at all intersections along Eglinton Avenue West.

Given the number and spacing of potential grade separations along Eglinton Avenue West, and the limited availability of property within which to construct either elevated or buried roadway intersections (not just simple crossings), and taking into consideration issues raised earlier in Section 2.4 of this report (e.g. highway infrastructure crossing constraints), an at-grade SmartTrack alignment along Eglinton Avenue would be prohibitively expensive.

Similarly, since an undulating rail alignment profile would be detrimental to service levels and would still have a significant impact on both the available public and private properties at grade between the roadway intersections along Eglinton Avenue (e.g. open trenches), the rail alignment should be either fully elevated or fully below grade from Scarlett Road to beyond Martin Grove Road. Ultimately, there are other considerations, as discussed earlier in Section 2.4 of this report, which lead to the conclusion that the alignment can, in fact, only be below grade.

3.5 CEAA 2012

As a result of changes made to federal environmental assessment legislation in the past two years under the auspices of the Canadian Environmental Assessment Agency (CEAA), the requirements for a federal EA are no longer "trigger-based". Previously, an EA could have been triggered by impacts to federal lands, or the fact that the federal government was a sponsor (i.e. a funding partner). Today, the need for a federal EA or the need to specifically address CEAA requirements in an EA are reserved for specific types of very large projects that are included on a prescribed list that can be found at the following website:

http://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-147/page-3.html#docCont.

Relevant rail transportation-related projects that would require a federal EA include a railway line or public highway *in a wildlife area or migratory bird sanctuary*, and any railway line more than 32 km in length *on a new right-of way*.

While none of the train service corridors under consideration are expected to exceed 32 km in length (as measured from Union Station to the MACC), additional investigation would be required to confirm whether any of the alignments that are presented in later sections of this report pass through wildlife areas (or indeed what legally constitutes a wildlife area) or migratory bird sanctuaries before it could be concluded that CEAA requirements need not be followed. *Such work is of a more detailed technical and/or land use planning nature that is beyond the scope of this initial study*.

4 Basis of Design

4.1 Heavy Rail Implications

The terms of reference of this study defined SmartTrack as a “Heavy-Rail” system. The term “heavy-rail” can be used to describe mutually exclusive aspects of a given rail system, depending on the context. It typically refers to the *engineering standards* to be used in the physical design of the track system in conjunction with a particular size and weight of *equipment* that will operate over the system. It can also be used to describe the applicable *regulatory environment*. For the purpose of this study, it is understood to refer to all three.

4.1.1 Engineering Standards

From an engineering perspective, the term “heavy-rail” usually refers to tracks designed to the American Railway Engineering and Maintenance Association (AREMA) standards for railways. These standards are largely based on the characteristics of freight trains, namely, long, slow, heavy vehicles in historically rural areas. The rails themselves have a larger cross-section and are heavier due to the heavy loadings. Ballast and timber ties, etc. are typically used. GO Transit falls into this category but LRT’s, subways and streetcars do not. For the purposes of developing alignments, it is assumed that SmartTrack service and infrastructure will be operated and maintained as an integral part of the GO Transit network, rather than by a separate entity. Therefore, the GO Design Requirements Manual (DRM), which refers to the AREMA standards, will apply. Specific alignment design criteria relevant to this study are discussed in Section 4.2 following.

4.1.2 Equipment

In the context of railway equipment (electric or diesel locomotives with coaches or electric multiple units, or “EMU’s”), the term “heavy-rail” usually means that they must meet crashworthiness rules, as defined by the US Federal Railroad Administration (FRA), for impact in a collision. These rules are generally based on hitting a freight train head-on, which results in a requirement for very solid and heavy equipment. Again, GO Transit equipment falls into this category but LRT’s, subways (even though they are also EMU’s) and streetcars do not. For the purposes of developing alignments, it is assumed that SmartTrack will share the same right-of-way and use the same rail vehicles as are currently used or planned to be used by GO Transit. SmartTrack services are therefore assumed to use electrified train consists in the form of heavy-rail EMU’s (as opposed to lighter weight surface subway vehicles). No passenger carrying capacity specifications are assumed or required for the purpose of this study as the terms of reference only require a train service analysis and not a travel demand or ridership analysis.

4.1.3 Regulatory Environment

Given the extent of integration and commonality with GO Transit's network, for the purposes of developing alignments, it is assumed that the Eglinton West or Woodbine Corridors are extensions of existing and/or future GO Transit corridors and operations. It is also assumed that the future owner of these corridors will voluntarily comply with all the regulations prescribed by the RSA, including, but not limited to Transport Canada Design Standards, Grade Crossing Regulations and Grade Crossing Design Standards, consistent with GO Transit's traditional approach in which the RSA and related regulations are applied to other parts of the GO system. Also, for the purposes of this study the Standalone Eglinton West Corridor Alternative is only being considered in the context of "heavy rail" technology, potentially operated by GO Transit. As such, the assumption above, concerning the RSA, is equally applicable.

4.2 Alignment Design Criteria

Several meetings were held with representatives from CP, GO Transit/Metrolinx, the Greater Toronto Airport Authority (GTAA) and the TRCA, which resulted in the provision of working materials for this study in the form of engineering, operating and planning documents related to the identified corridors, the existing GO Kitchener Corridor, the UPX Spur, Pearson International Airport, the ECLRT and the natural environment through which they all pass. Further discussions with stakeholders, coupled with reviews of other publicly available documents have led to the working assumptions described in the table below for the development of track alignments and the evaluation of their feasibility. Assumptions regarding train service concept feasibility and land use analyses are discussed in Sections 6 and 7, respectively.

As constructed or planned GO Kitchener Corridor track alignments are *generally assumed* to be **fixed**. Minor adjustments to signal bridge locations have been considered to allow access to at least two tracks of the ultimate four track corridor to allow for parallel SmartTrack movements on and off the Eglinton or Woodbine Corridors. The future fourth GO track is assumed to be in place, as is the second CP track and its connection to GO at Nickle Interlocking.

It is assumed that the CP corridor can be shifted east between Eglinton Avenue and St. Clair Avenue to make room for connecting tracks from the Eglinton corridor alignments to reach the nearest tangent track (near St. Clair Avenue) where they can connect to the GO corridor. *The validity of this assumption must be checked against the constraints of the St. Clair Avenue grade separation bridge and the profile of the roadway approaches on either side, which are coincidentally under review as part of an on-going City of Toronto, Transportation Services study*.

Table 2: Preliminary Design Criteria

Criteria	Constraint	Source
Track Horizontal Alignment *Station Platform Length*	**330m** (12 cars plus locomotive)	Current maximum GO train consist size on the Kitchener Corridor (although could be shorter to suit demand)
Track Horizontal Alignment *Side Clearances at grade or in open cut*	**2.74m**	5.5m from track centreline to bridge pier or abutment is quoted in GO DRM and TC Standard Respecting Railway Clearances (TC E-05) however the GO Georgetown South project used 2.74m. This is permitted where approved by authorities having jurisdiction. *Pending further clarification from GO* the project team is using the lesser amount for alignment design and feasibility review.
Track Horizontal Alignment *Side Clearances elevated*	**5m**	Airport Rail Link Spur drawing set OIPC-11-508-P001
Track Horizontal Alignment *Maximum Curvature*	**10** degrees (173m) for Commuter Rail; **250m** for Tunnel Boring Machine (TBM)	AREMA Manual for Railway Engineering, section 2.6.3.4;
Track Horizontal Alignment *Turnout Size*	**#20**	GO Georgetown South project dwgs
Track Vertical Profile *Elevation Restrictions*	Elevated electrified guideway along Carlingview Road is **not** acceptable.	GTAA Flight Path Clearance Zone Drawing
Track Vertical Profile *Maximum Gradient*	**3%** for Commuter Rail is *desirable.*	AREMA Manual for Railway Engineering, section 2.6.3.5 and 3.2.3.10.b. Note that GO/UPX alignments are limited to 2%.
Track Vertical Profile *Clearance Above Roads*	**8m** to TOR	5m per Canadian Highway Bridge Design Code plus a nominal 3m for structure
Track Vertical Profile *Clearance Under ECLRT*	**TBD**	Plan and profile of ECLRT was provided after alignments were completed
Track Vertical Profile *Overhead Clearances*	**6.9m** from TOR	7.4m from TOR at-grade or open cut to underside of structures is quoted in GO and Association of America Railroads (AAR) documents to protect for future electrification, however **6.9m** has been used to limit impact on existing structures on GO Georgetown South project
Track Alignment *Use of CP track*	Use of CP track is **not** permitted; CP's future second track and connection to Nickle Interlocking must be protected	CP
Bored Rail Tunnel Diameter	**8m** approximate outside diameter.	Using the nominal 7.4m clearance envelope and allowing for 1m between TOR and tunnel exterior, plus 0.4m for tunnel liner thickness, *a +/-9m total bore diameter may be required*. However, a different OCS design, using contact rail, with a slightly reduced pantograph height could conceivably allow for an 8m or less tunnel bore diameter. The specific Electric Multiple Unit (EMU) vehicle design eventually selected may also result in a different tunnel diameter.
Bored Rail Tunnel Depth and Separation	one tunnel diameter	Nominal clearance to avoid typical utilities and to ensure tunnel integrity.
Emergency Exit Spacing	**762m**	NFPA 130
MSF Sizing/Footprint (for Standalone Alternative 3)	**6 car** bi-level trains	Based on UPX MS site plan, enlarged to suit 6 car bi-level trains which could provide a capacity of approximately 4,400 pphpd on a 15 minute service headway. Three trainsets, plus a spare should be sufficient for the 20 km round trip at an average speed of 40 kph.
Property Impact Zone	**3m** below grade; **5m** elevated	n/a
Property Safety Setback (for at-grade alignments)	**30m** between rail ROW and adjacent dwellings, with safety berm, noise barrier and fence	GO Transit Principal Mainline Requirements; also Grade Crossing Design Standards

4.3 SmartTrack Stations

The scope of work for this study does not include any design or alignment modifications to suit any of the proposed SmartTrack stations on the GO Kitchener corridor, particularly those that may fall within the area of study on the identified corridor alternatives. That said, a number of observations and assumptions are in order to complete certain elements of this study that may be affected by some of these proposed stations.

4.3.1 St. Clair Avenue

Although outside of the study area, this proposed location directly affects the feasibility of a number of the alignments discussed in Section 5. The geometry of the GO Kitchener Corridor on either side of St. Clair Avenue is very constrained, which limits available tangent length to insert station platforms. This very same geometry makes this the closest suitable location for connecting to the proposed Eglinton Corridor. It is therefore assumed that the proposed St. Clair SmartTrack station is **not** an absolute requirement for the purpose of this study.

4.3.2 Mount Dennis

Mount Dennis Station does not exist today, however it is planned to be constructed in conjunction with the now under construction ECLRT. This station will allow GO, TTC, LRT and potentially UPX passengers to transfer freely between three modes (plus walk-ins, taxi and bicycles). The track alignments designed/built as part of the GO Georgetown South project allow for GO platforms to be constructed beside and between tracks as appropriate. The various SmartTrack alignments affect this station in a number of possible ways, as described later in this report (see Section 5), but from an alignment design perspective, it is assumed that the GO platforms will be located and built as described in the UPX Electrification Transit Project Assessment Environmental Project Report, Chapter 5, and that they are assumed to be **fixed** requirements. SmartTrack alignments that connect to this station from either from above or below are assumed to be feasible from a pedestrian flow perspective. *A more detailed evaluation is recommended regardless of the nature of the connection*.

4.3.3 Islington Ave (SmartTrack) vs Kipling Ave (GO Etobicoke North)

The terms of reference for this study identified a potential station at Islington Avenue. The area immediately to the east of Islington Avenue along the rail corridor has been identified to be used for the future UPX vehicle maintenance and storage facility, leaving little room for a SmartTrack station. In addition, the GO Etobicoke North station is located a short 750m to the west, at Kipling Avenue. As a result, it is assumed that for the purpose of this study, all references to an Islington SmartTrack station will be understood to mean the GO Etobicoke North station. Note that this station currently only serves one track on the south side of the corridor, although a second side platform will serve the future fourth main track. There is no provision in the GO Kitchener Corridor track alignment plans for a future centre platform to serve tracks 2 and 3.

4.3.4 Woodbine Racetrack

A potential station at or near Woodbine Racetrack was identified in the terms of reference for this study. There is no provision in the GO Kitchener Corridor track alignment plans for a future station at this location. The nearby Wice Interlocking would require this station to be located some distance to the east of the actual racetrack, in the vicinity of Highway 27. Due to physical constraints (e.g. bridges, signals, rail-served customer sidings, future Hydro One traction power substation and associated catenary feeding gantries, etc.), access to the station may be limited to only one or two side platforms serving tracks 1 or 4.

4.3.5 Jane Street vs Scarlett Road

A potential station at Scarlett Road/Jane Street was identified in the terms of reference for this study. All Eglinton SmartTrack Corridor alignments except one include a station at Scarlett Road. The exception is an alignment that by-passes Mount Dennis to allow for a more efficient design. This alignment (1B) assumes that a station would be built at Jane Street *instead* of Scarlett Road. No investigation of opportunities to connect this station to Mount Dennis Station either through dedicated pedestrian walkways or a +/- 1km extension of the ECLRT is included in this study, although it may be a valuable exercise should this alignment have other favourable attributes. In either case, mode transfers could be accomplished with the use of Presto Cards. The need for further consideration of a station in this area has been identified by City staff.

4.3.6 Kipling Avenue (at Eglinton Avenue West)

Further to the discussion in Section 3.6 on the viability of at-grade or elevated alignments on or along the Eglinton Corridor, Kipling Station is assumed to be below grade for all alignments on this corridor. For alignment design purposes the station is shown centred on the intersection of Kipling Avenue and Eglinton Avenue West (see Section 5), however there is some flexibility to allow for optimizing station entrances and passenger transfers from other transit modes. The location of the station and its entrances may also be subject to the available properties and potential impacts to the environment, as discussed in Section 7.

4.3.7 Airport

Station locations at or near PIA were not specifically requested in the terms of reference for this study, however in the development of potential corridors during Phase 1 of this study, two potential station sites were identified. These stations not only result in more reasonable average station spacing, but they may respond to a transportation service demand beyond the target market for the somewhat parallel UPX. It is assumed that a link to the airport terminals can be provided either through the existing Airport People Mover or some form of bus shuttle service.

4.3.8 MACC

As discussed in Section 2.3, it is assumed that any new SmartTrack alignment must be tunnelled beneath the planned Renforth Gateway BRT station in order to provide passengers with a direct platform to platform transfer. This alignment constraint is not only due to the planned below grade configuration of the bus terminal, but it is also dictated by the fact that all SmartTrack alignments approach this station below grade, either to stay clear of the airport flight paths or to pass below highway interchanges and hydro corridors. Renforth Gateway has been designed as a key transit hub connecting traditional TTC and Mississauga transit buses as well as higher order BRT services. An additional SmartTrack MACC station has been identified west of Renforth Gateway at the intersection of Orbitor Drive and Matheson Boulevard.

4.4 Other Assumptions

It is assumed that SmartTrack services within the study area will **not** be initiated with diesel powered trains *or coaches hauled by electric engines* and converted later to EMU's. In other words, it is assumed that overhead electric power supply infrastructure and EMU vehicles will be in place at the start of SmartTrack services. This implies higher train performance (see Section 6) and infrastructure requirements, including traction power distribution facilities, but reduced tunnel ventilation systems.

4.4.1 Electric Traction Power Distribution Infrastructure

Traction power distribution facilities' footprints or property requirements have not been addressed as this would require a level of analysis beyond the scope of this study. These have been partially developed (on the GO Kitchener Corridor), as described in the GO Electrification EPR, and include a main traction power substation at Highway 27 and local distribution facilities, called Paralleling Stations, near Strachan Avenue, Ray Avenue and Highway 27. The locations of these facilities, although not yet built are assumed to be **fixed** for the purpose of this study. It is not known whether the traction power substation to be located at Highway 27 could supply power to both the proposed UPX/GO electrified services and a SmartTrack service along either the Eglinton or Woodbine Corridors. At a minimum, additional paralleling stations may be required at a spacing similar to the GO Kitchener Corridor (approximately 9 km). This could result in the paralleling stations being near the MACC for either of the SmartTrack corridors.

4.4.2 Ventilation

Tunnels for electrified train services do not require the same level of ventilation as those for diesel powered trains. The latter would require that exhaust smoke be evacuated on a regular, perhaps continual basis, depending on the level of service. Electric train tunnels still require emergency ventilation systems for smoke generated by potential fires, but passive methods (e.g. piston effect) may be used for general air circulation, as in the case of the TTC subways.

Nevertheless, some allowance for ventilation infrastructure at regular intervals along the route may be required. *The spacing and configuration, however, is beyond the scope of this study*, although it could be assumed that ventilation shafts might be co-located with emergency exit buildings, which we know are required to be located no further than 762m apart.

5 Technical Feasibility of Track Alignments

5.1 Preliminary Alignment Corridors

A number of preliminary alignment concepts were developed during Phase 1 of this study for each of the corridors described below. CADD-based alignments and design variants based on these are described in greater detail in Section 5.2.

5.1.1 Eglinton Continuous Connection Corridor

The Eglinton Corridor is defined as one that includes a direct rail connection to the GO Kitchener rail corridor in the vicinity of GO's proposed new Mount Dennis Station. A direct passenger transfer between SmartTrack, GO, ECLRT, TTC and potentially UPX services is desirable at this location. The alignment concepts described below suggest different ways of accomplishing this rail and passenger transfer, but in all cases, they share the same alignment between Scarlett Road and the MACC for reasons introduced earlier in Sections 3 and 4.

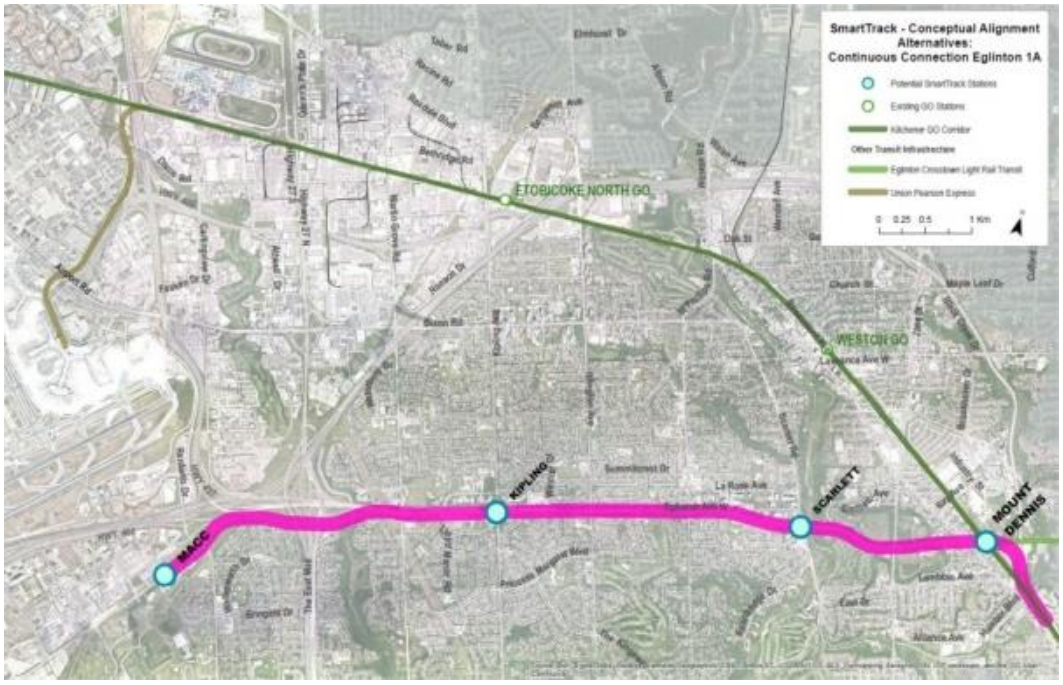


Figure 7: Alignment Concept 1A

Alignment concept 1A describes a scenario where the Mount Dennis SmartTrack station is placed parallel (over or under) the planned ECLRT Mount Dennis station platform, potentially allowing for multiple vertical circulation elements between platforms. In order to orient the station platform in this manner, the alignment must connect to the east side of the GO Corridor and separate from it to allow for a +/-90 degree curve arc immediately before the station.

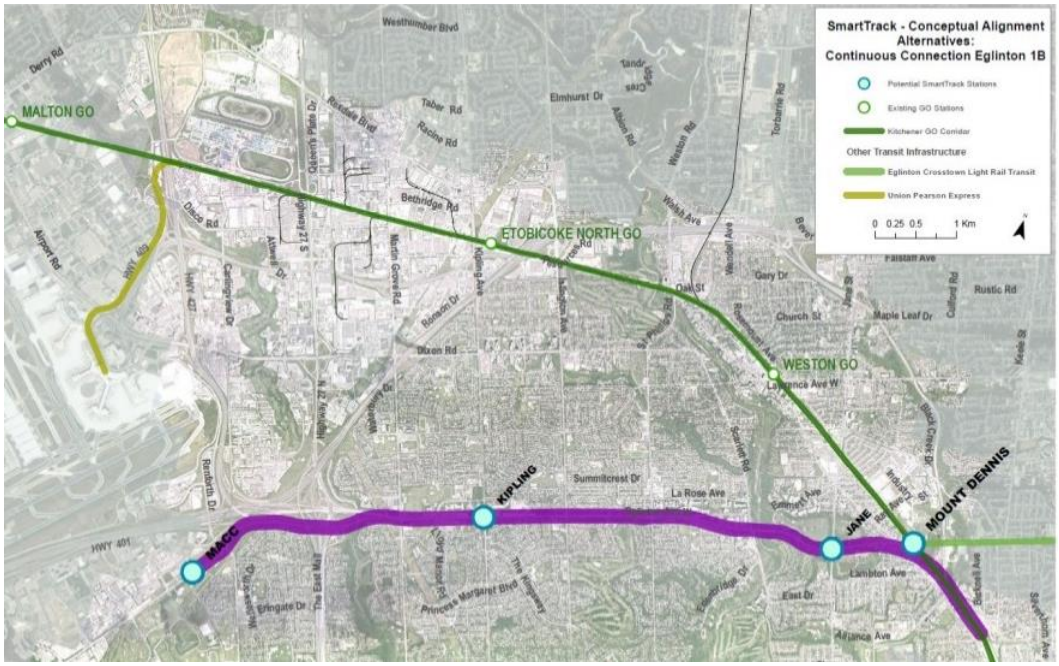


Figure 8: Alignment Concept 1B

Alignment concept 1B describes a scenario where there is no Mount Dennis SmartTrack station, allowing for a faster and more direct alignment connection. In this case (only), the proposed Scarlett Road SmartTrack Station is relocated to Jane Street to provide some measure of connectivity with the ECLRT, albeit at a significant walking distance. As a consequence, this alignment (only) is well positioned to create an interchange with a future Jane Street LRT.

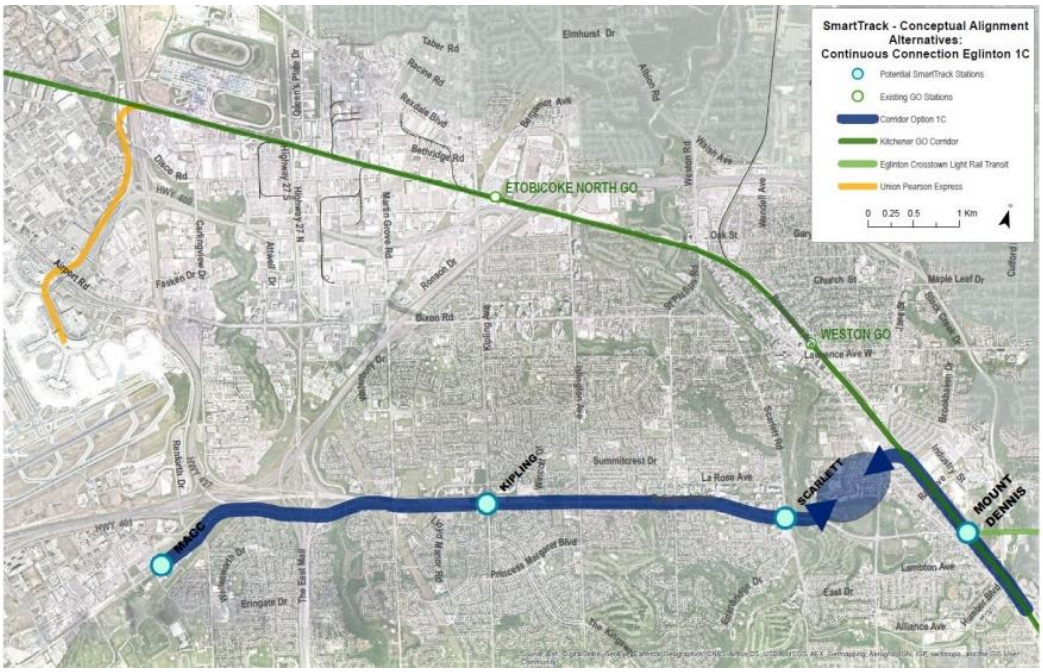


Figure 9: Alignment Concept 1C

Alignment concept 1C describes a scenario where the SmartTrack service shares the proposed GO Mount Dennis Station platform area, thereby minimizing any disruption to the existing GO and CP corridors and providing the most direct passenger transfer between modes at the station. The exact nature of the route was unspecified at this stage. Several alignments were tested for best fit through the community, resulting in Alignments 1C and 1D described in Section 5.2.

5.1.2 Woodbine Continuous Connection Corridor

The Woodbine Corridor is defined as one that includes a direct rail connection to the GO Kitchener rail corridor in the vicinity of Woodbine Racetrack and Highway 427. The original terms of reference for this study suggested SmartTrack services on this corridor would use new stations at Islington Avenue and Woodbine. The existing Etobicoke North GO station at Kipling Avenue has been substituted for the proposed Islington Avenue SmartTrack station due to its proximity. SmartTrack service could also be provided at the proposed GO Mount Dennis Station and the recently expanded GO Weston Station. The terms of reference did not specify any stations at or near the airport; however, discussions with the GTAA identified a potential future transit hub location near Viscount Road that would be suitable for a SmartTrack station. Airport stations are shown on all Woodbine Corridor alignments in order to serve an anticipated airport traveller and employment demand and to reduce what would otherwise be excessively long station spacing for an urban rail transit service.

These corridor concepts do not make any use of the recently inaugurated UPX corridor infrastructure between Woodbine (Wice Interlocking) and Terminal 1. This was considered at a very early stage of the study, but since the UPX line terminates directly in front of Terminal 1 on an elevated platform, and since the terms of reference for this study require a connection to the MACC on the other side of the airport and south of Highway 401, a separate route is required. In order to use the UPX tracks, it would have been necessary to pass through the Terminal 1 building and airport groundside operations areas, including runway approaches.

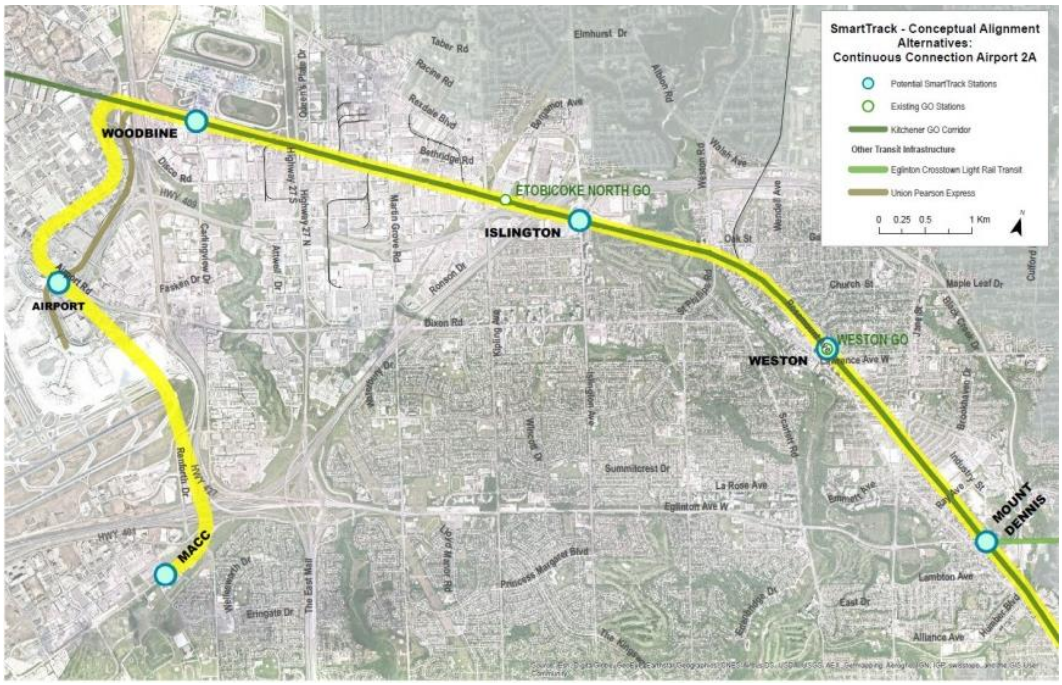


Figure 10: Alignment Concept 2A

Alignment concept 2A follows the west side of Highway 409 as does the UPX, however it parallels municipal roadways and airport parking facilities to allow for a station interface for passengers using or working at the airport. Beyond this the corridor passes beneath airport property to reach the MACC as directly as possible. This corridor was not considered any further as it would require emergency exits and tunnel ventilation shafts within airport groundside operations areas.

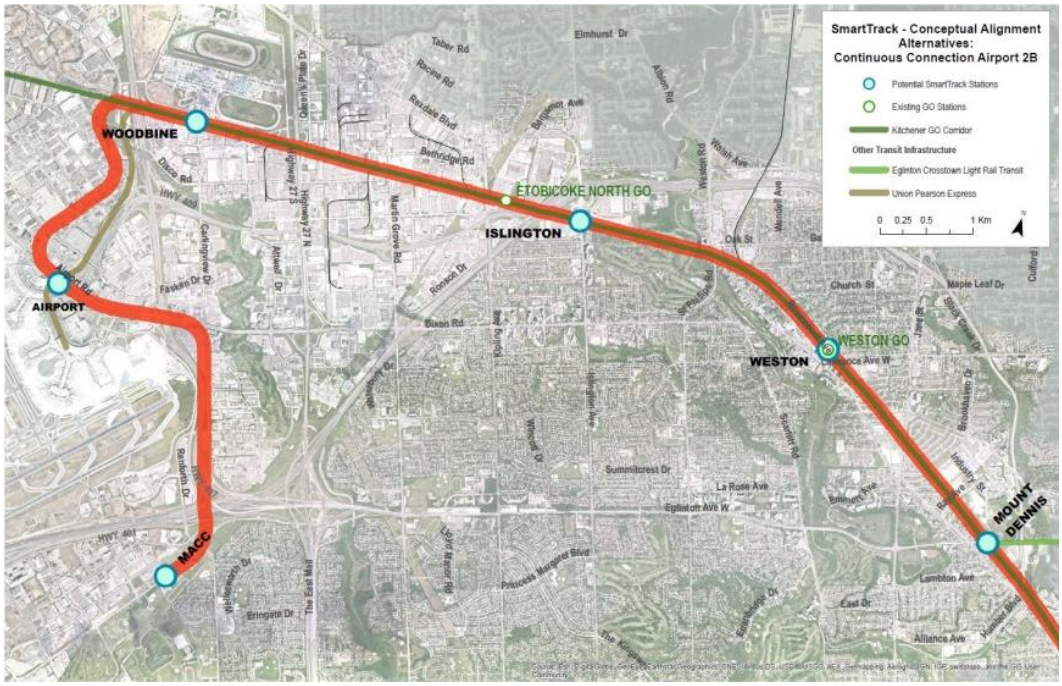


Figure 11: Alignment Concept 2B

Alignment concept 2B is based on concept 2A but removes the fatal flaw by following Airport Road and Carlingview Drive to avoid crossing the airport property. This later portion of the route must remain below grade to avoid any interference with designated flight paths and to pass under the Highway 401/427 interchange and reach the MACC via the below grade Renforth Gateway BRT terminal now under construction.

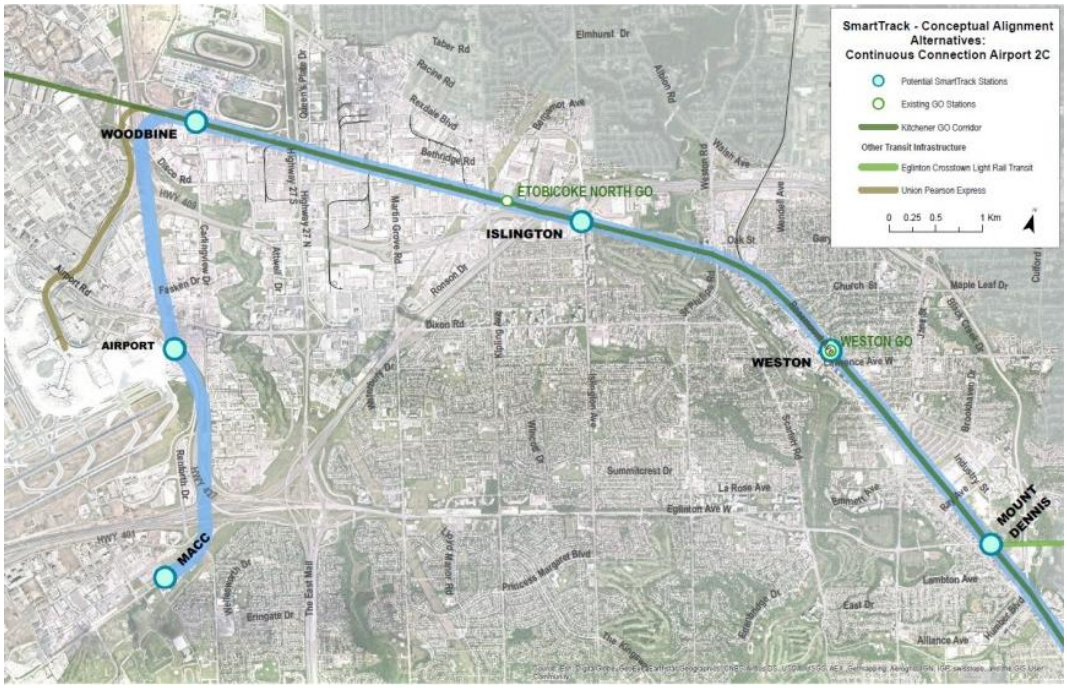


Figure 12: Alignment Concept 2C

Alignment concept 2C creates a more direct route by following the east side of Highway 427 for its entire length. A portion of the route can be elevated, but it has many of the same restrictions as concept 2B and is therefore below grade crossing under Airport Road and along Carlingview Drive. A station is shown near the intersection of these two roadways, but it would be less convenient for airport travellers, requiring some form of bus shuttle.

5.1.3 Eglinton Standalone Corridor

Alignment concept 3A is identical to concept 1A west of Mount Dennis Station. At Mount Dennis there is no rail connection to the GO Kitchener Corridor. East of the station the tracks would simply extend one train length to provide for storage of a disabled train and/or a safe braking distance for platform overruns. Railway equipment used for revenue service and to support maintenance of way activities would be captive to this corridor and therefore require access to an adjacent dedicated maintenance and storage facility.

Figure 13: Alignment Concept 3A

5.2 Track Alignments & Variants

5.2.1 Eglinton Continuous Connection Alignments

Within the context of the design criteria and assumptions described in Section 4, several different alignments were developed and evaluated for the Eglinton Corridor concepts outlined in Section 5.1. Table 3 below provides a brief summary of the purely physical characteristics of these, along with the reference number for the corresponding CADD plan and profile drawings that can be found in Appendix 5. A summary of the technical evaluation of these alignments is provided in

Table 4, located at the end of this section.

Table 3: Physical Characteristics of Eglinton Corridor Alignments

Alignment Variants	New Corridor	Union Station to MACC (Orbitor)
1Ae *Refer to Appendix 5, Drawings SK0001,21*	13.2 km 64% in tunnel 27% elevated	21.7 km
1Aa *Refer to Appendix 5, Drawings SK0004,21*	13.1 km 73% in tunnel 14% elevated	21.6 km
1Ab *Refer to Appendix 5, Drawings SK0003,21*	13.1 km 74% in tunnel 14% elevated	21.6 km
1Ba *Refer to Appendix 5, Drawings SK0002,21*	13.0 km 72% in tunnel 14% elevated	21.5 km
1Bb *Refer to Appendix 5, Drawings SK0013,21*	13.0 km 72% in tunnel 14% elevated	21.5 km
1C *Refer to Appendix 5, Drawings SK0005,21*	11.3 km 84% in tunnel 10% elevated	22.8 km
1D *Refer to Appendix 5, Drawings SK0042,21*	13.5 km 69% in tunnel 10% elevated	21.9 km

5.2.1.1 SCARLETT ROAD TO MACC (TUNNEL BORING MACHINE METHOD)

All of these alignments and their variants share the same track plan and profile between a point just west of Scarlett Road and the Orbitor Drive, a distance of 7.7km (in tunnel – see Figure 14 below and Appendix 5, drawing reference number SK0021). This portion of the route generally follows the undulations of the Eglinton Avenue road profile above, but its grades are held to a maximum of 1.8%. The below grade Kipling SmartTrack Station is located on a plateau between maximum grades that fall away from it in both directions. This allows for trains to take advantage of gravity in both directions by using less energy to accelerate away from the station and less braking effort to slow down on approach to the station. These grades are partially the result of information received from TRCA regarding the base elevation of Mimico Creek, as sufficient clearance should be provided beneath for the Tunnel Boring Machines (TBM).

The alignment also crosses paths with a series of buried pipelines east of Renforth Drive. As it is necessary for the track alignment to climb through this area to achieve a reasonable elevation at the nearby MACC station for convenient passenger transfer to the Renforth Gateway BRT and TTC bus terminal, it will be necessary to confirm the depth of these pipelines before finalizing the track profile. Also, crossovers are typically placed between parallel tracks every 4km+/- to provide a measure of operational flexibility in case of service disruptions due to mechanical failures of the trains or a maintenance issue requiring attention along the tunnel right of way. The alignment on either side of Kipling Station would have to be adjusted to include these crossovers to allow for this flexibility. The exact placement of the station platform to suit availability of property for station entrances, ventilation shafts, etc. will also affect the final track plan and profile.

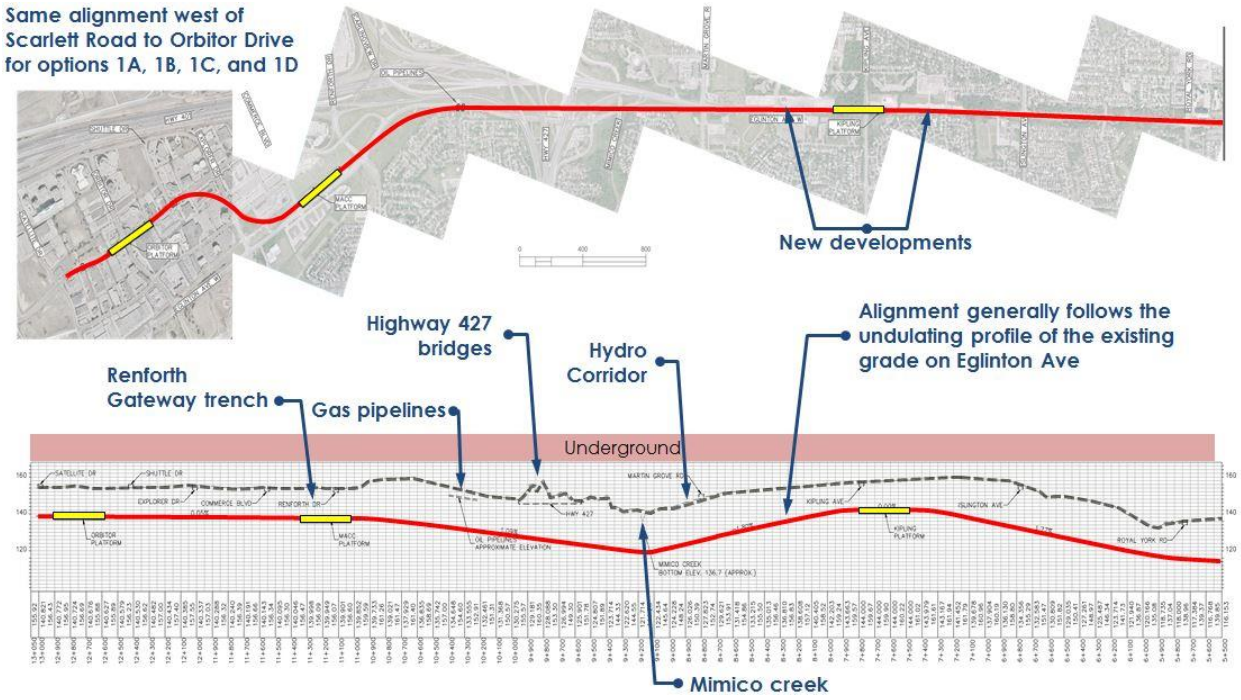


Figure 14: Plan and Profile for all Eglinton Alignments (Scarlett Road – Orbitor Drive)

5.2.1.2 SCARLETT ROAD TO MACC (OPEN CUT AND CUT/COVER METHODS)

A shallower profile can be considered along open spaces adjacent to municipal roadways; however, some significant property, utilities and storm water drainage issues would have to be addressed. Figure 15 below describes the eastern section of this alternative (see also Appendix 5, drawing reference numbers SK0040 and SK0041). These sketches assume an offset of 9m between the current Eglinton Avenue edge of pavement and the eastbound track centreline.

Due to the minimum depth of cut required to pass beneath the seven perpendicular road crossings between Scarlett Road and Martin Grove Road (about 9m), and to avoid the much wider footprint that would be required for typical 1:2.5 earthen side slopes, retaining walls are assumed along the entire length. Between Scarlett Road and Russell Road (+/- 1.4 km), the shallow alignment would allow the cut to remain open. Between Russell Road and Kipling Station (+/- 1.7 km), the cut would be as much as 16m deep, which might suggest a different structure cross-section. Furthermore the open cut would sever some north-south stormwater trunk sewers that drain into Silver Creek, located between Royal York Road and Islington Avenue. An alternate drainage route and/or pumping station from the north side of Eglinton would be required.

West of Kipling Station to Orbitor Drive (+/- 5.5 km), a shallow profile is not feasible, as it is necessary to pass under newly constructed townhomes on Eglinton Avenue, Eglinton Avenue itself, Mimico Creek, Highway 427 and the oil

pipelines before lining up to be below Renforth Gateway. For this portion of the route, the profile would be identical to that described in the previous section, suggesting the need for using a TBM construction method.

Further study can be undertaken to identify opportunities for using potentially less expensive earthen side slopes, the extent of the utilities relocations that would be required (at all street crossings and potentially along Eglinton Avenue where there are subsurface utilities junctions) as well as the impacts to conflicting property developments already underway.

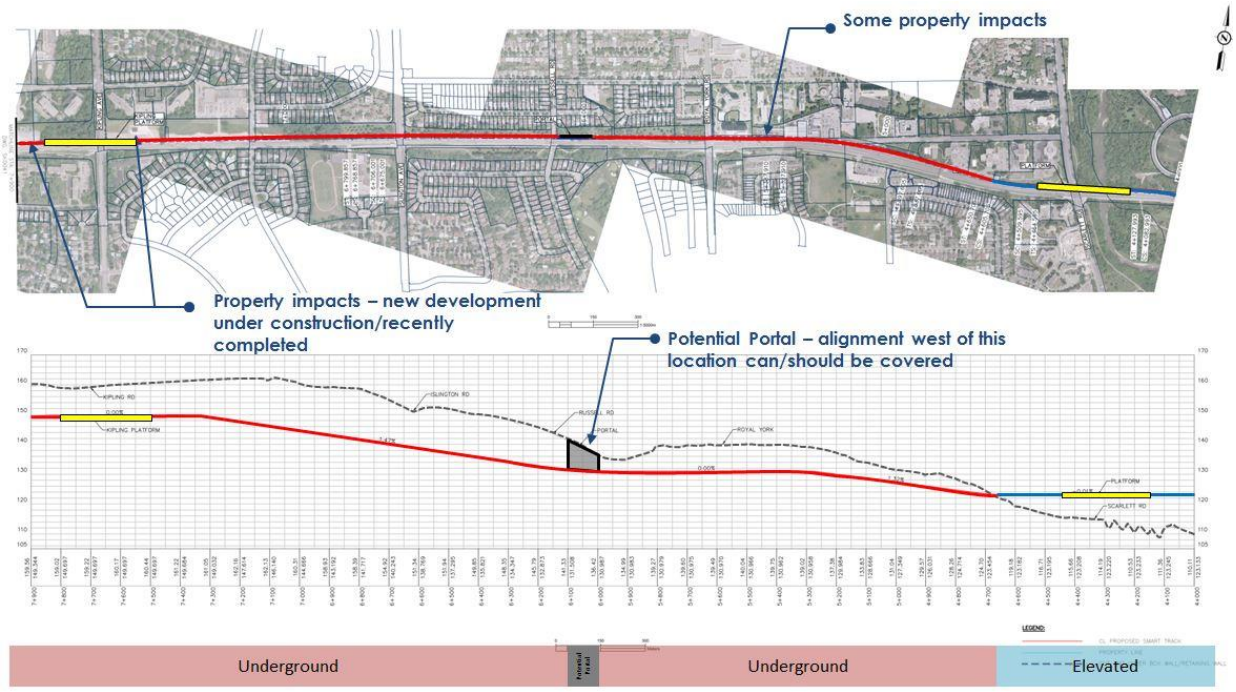


Figure 15: Plan and Profile for Open Cut on Eglinton (Scarlett Road – Kipling)

5.2.1.3 EGLINTON FLATS

All of the Eglinton alignments also share the fact that they are elevated, to varying degrees, through the Eglinton Flats public green space. Guideway height varies amongst the different alignments, but can be as high as 19m above Jane Street. These differences can be seen on Figure 16, Figure 17, Figure 18, Figure 19 and Figure 21, and on the plan and profile view drawings in Appendix 5. For convenience and to reduce the impact on Eglinton Flats, all alignments except 1C and 1D follow the geometry of Eglinton Avenue between Weston Road and Scarlett Road; however this limits train speed. Faster service is possible, but must be weighed against increased encroachment into public spaces.

Scarlett Road SmartTrack Station is elevated as well for all alignments except 1Ba and 1Bb, which have an elevated Jane Street Station instead. In order to transition from an elevated guideway to a tunnel beneath Eglinton Avenue west

of Scarlett Road with the least impact to the surrounding community, a steep grade (2.8%) is used to reduce the length of the tunnel portal. In this initial review, it appears that this portal requires the closure of the Eglinton Avenue driveway to the condominium community northwest of the Scarlett Road intersection. Indirect access to Eglinton Avenue is still available via Richview Road and Scarlett Road. Further consideration of this impact is required.

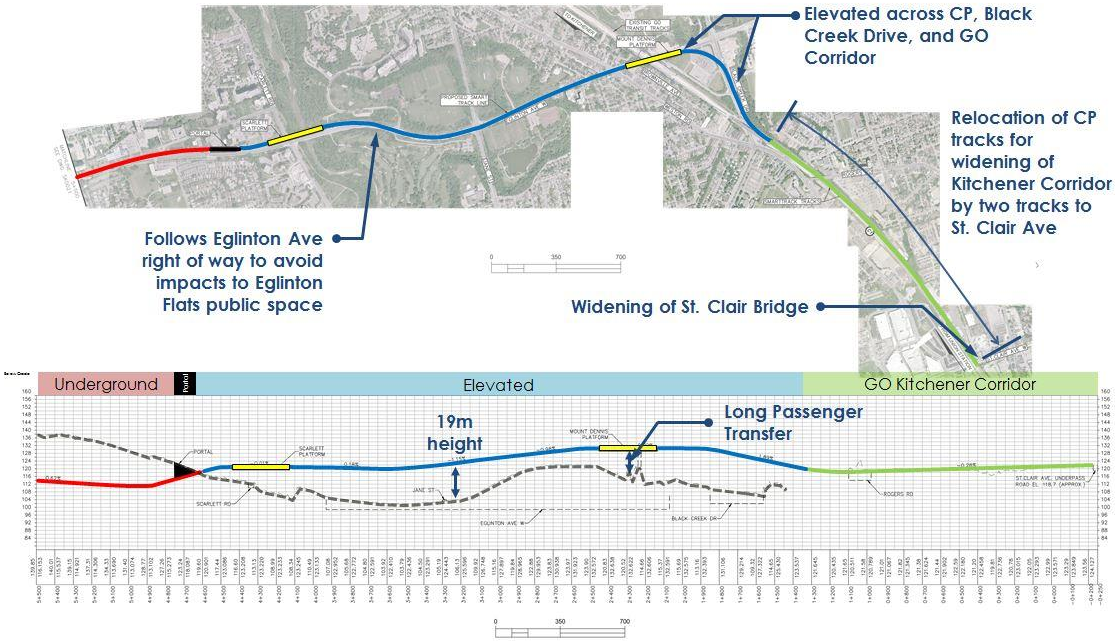


Figure 16: Plan and Profile of Alignment 1Ae

5.2.1.4 RE-ALIGNMENT OF CP CORRIDOR

Alignments 1Ae, 1Aa, 1Ab, 1Ba and 1Bb all require the St. Clair Avenue bridge to be widened for the future CP track and the removal of the CN-CP connecting track in favour of a connection at Nickle Interlocking and new bridge spans (and possibly new piers and abutments) for the Black Creek and Black Creek Drive crossings. The more gentle grade used on the east portal on alignment 1Ba requires a slightly different shift than the others, resulting in the need for a new bridge span across Eglinton Avenue. Further review by CP may yield slightly different results. See Sketches SK0031 – SK0038 in Appendix 5.

5.2.1.5 ST. CLAIR AVENUE RAIL CONNECTION

With the exception of Alignment 1C, all of these alignments share very similar through service rail connection configurations with the GO Kitchener Corridor. The nearest location to Mount Dennis on the GO Kitchener Corridor with a sufficient length of tangent (straight) track to create a minimum two track connection is St. Clair Avenue. This extension of the Eglinton Corridor requires bridges across Black Creek Drive and Black Creek, and the rebuilding of the Rogers Road overpass into a single span structure to remove the existing centre support pier. In most cases, this also requires the adjacent CP railway corridor to

be shifted east, impacting adjacent low density commercial properties and resulting in *additional* new railway bridges, and a further widening of the Rogers Road overpass and a widening of the railway bridge over St. Clair Avenue. It may not be possible to widen this bridge sufficiently as the slope of the road profile below is limited by closely spaced intersections on either side of the corridor. A separate EA is currently being undertaken by City of Toronto, Transportation Services for roadway improvements to this area, including the road profile under the bridge. It should be noted that the changes described above are incompatible with any plans for a future SmartTrack station at this location.

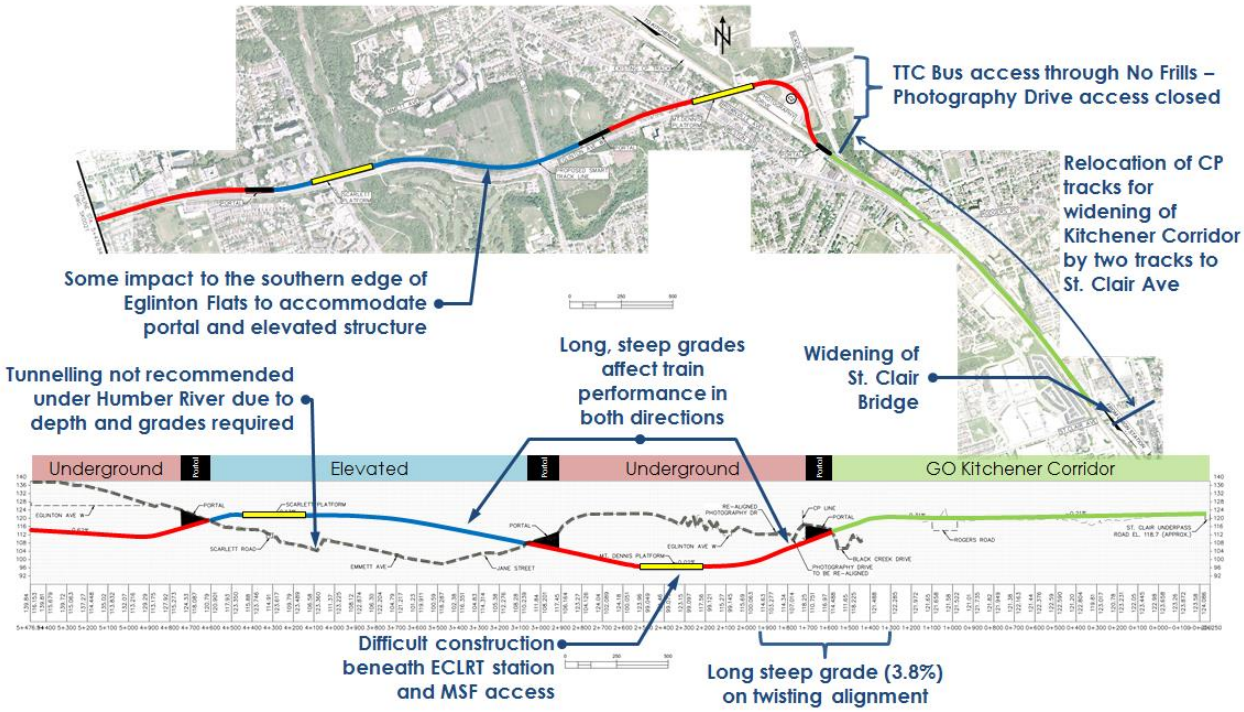


Figure 17: Plan and Profile of Alignment 1Aa

The rail connection to the GO Kitchener Corridor at St. Clair Avenue requires the installation of a new signal interlocking (or junction) where there is only a single intermediate (bi-directional) signal bridge today. Interlockings require separate signal bridges to govern train movements through the interlocking in each direction. An additional signal bridge is therefore required some 400m north of the existing bridge to govern southbound train movements through the new interlocking. The location could affect existing GO (and UPX) train performance due to reduced signal block lengths, which could potentially reduce available safe braking distances and reduce overall corridor speeds. Drawings of the Eglinton Corridor track alignments between Eglinton Avenue and St. Clair Avenue and connections to the GO Kitchener Corridor are provided in Appendix 5 (see drawings SK0012 and SK0013). While this connection may be physically feasible, *further study is required to confirm its operational feasibility as it relates to train performance and/or overall corridor capacity between Union Station and this new interlocking.*

5.2.1.6 ALIGNMENT VARIANTS 1AB AND 1BB

Alignment 1Ab follows the east side of Black Creek Drive in an attempt to have a broader curve and shallower grade approaching the below grade Mount Dennis Station to allow for the use of a TBM. Unfortunately, this conflicts with the TRCA's regulation limit for Black Creek, which would result in flooding of the entire station and tunnel (Figure 18). Alignments 1Ba and 1Bb both lack a direct connection to Mount Dennis station, requiring a +/- 1 km passenger transfer to the ECLRT (Figure 19), which is considered a *potential* fatal flaw. Alignment 1Bb is further disadvantaged by virtue of its significant impacts on residential properties backing on the corridor, the Rogers Road and Weston Road right-of-ways and the properties along them. There is no need to evaluate two otherwise very similar alignments when one has obvious, perhaps unnecessary, disadvantages over the other. Therefore Alignment 1Bb is not carried forward for examination from a land use, cost, and service perspective.

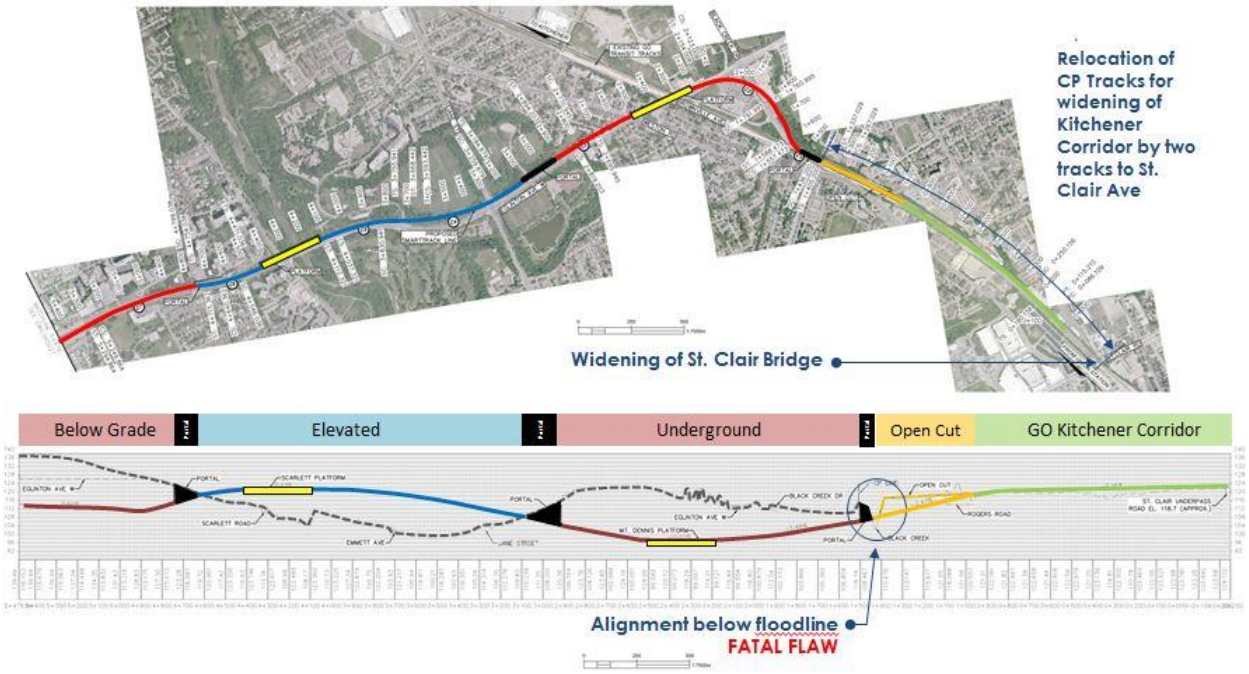


Figure 18: Plan and Profile of Alignment 1Ab

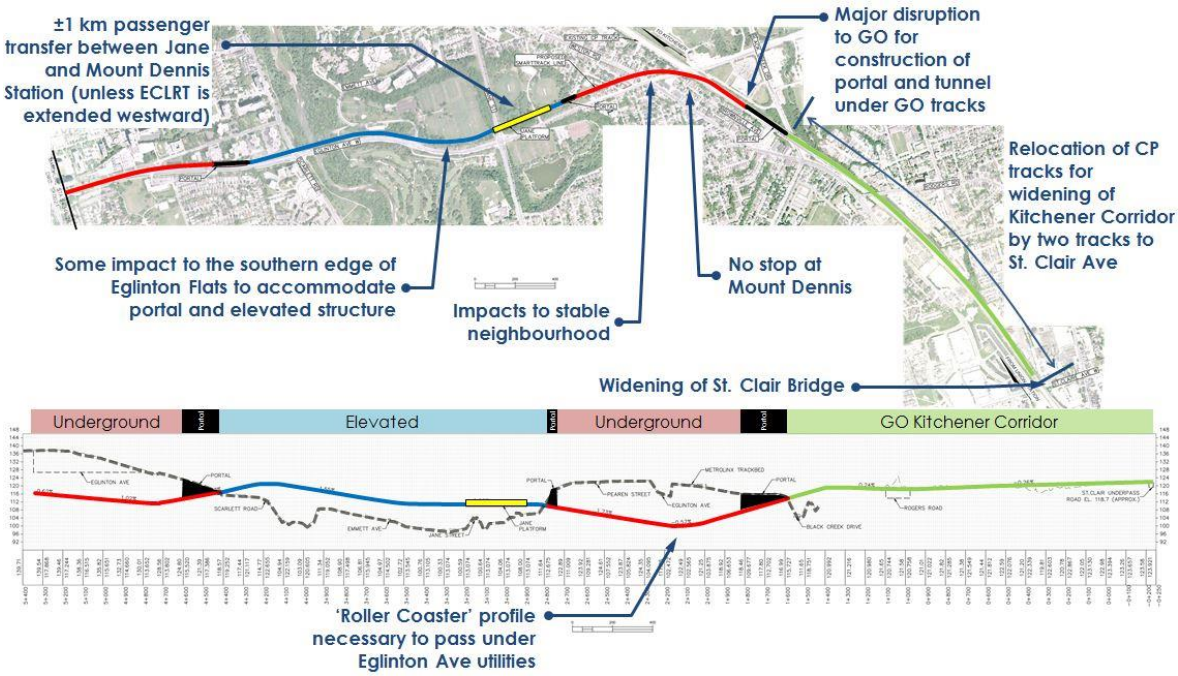


Figure 19: Plan and Profile of Alignment 1Ba

5.2.1.7 ALIGNMENT 1C

Although part of the Eglinton Corridor group of alignments, Alignment 1C features some distinctive characteristics that set it apart from all the others (see Figure 20 below). Most significantly, it does not require a new interlocking, but connects into the existing Nickle Interlocking at Nickle Street. This creates a number of significant advantages, notably:

- No modifications to the GO Kitchener Corridor or adjacent properties south of Eglinton Avenue
- No relocation of CP tracks and associated bridge and roadway works
- No impact on residential properties near Mount Dennis
- Uses the planned GO Mount Dennis Station resulting in the best ECLRT passenger transfer
- Impact on Eglinton Flats is limited to the west end only

Although the length of new construction is reduced, the more northerly connection to the GO Kitchener Corridor results in a longer overall trip from Union Station to the MACC. While the connection at Nickle may be physically feasible (see Appendix 5, drawing SK0011), *further study is required to confirm its operational feasibility as it relates to train performance and/or overall corridor capacity between Union Station and this location*.

Notwithstanding the advantages described above, this alignment could potentially prove to be more challenging than any of the others, as its tunnel portal impacts the Jane Street overpass bridge abutment and several adjacent active industrial

buildings belonging to the Irving Tissue Company. TBM launch or extraction shafts may also require residential property takings. The tunneling route, while deep, passes beneath or adjacent to a significant number of residential properties, a school and the West Park Medical Centre, and will require emergency exit buildings and ventilation shafts within a mature neighbourhood area. Furthermore, Emmett Avenue must be severed at the top of the bluff in order to avoid creating an unsafe level crossing directly in front of a tunnel portal, eliminating direct access to Eglinton Avenue from the West Park community.

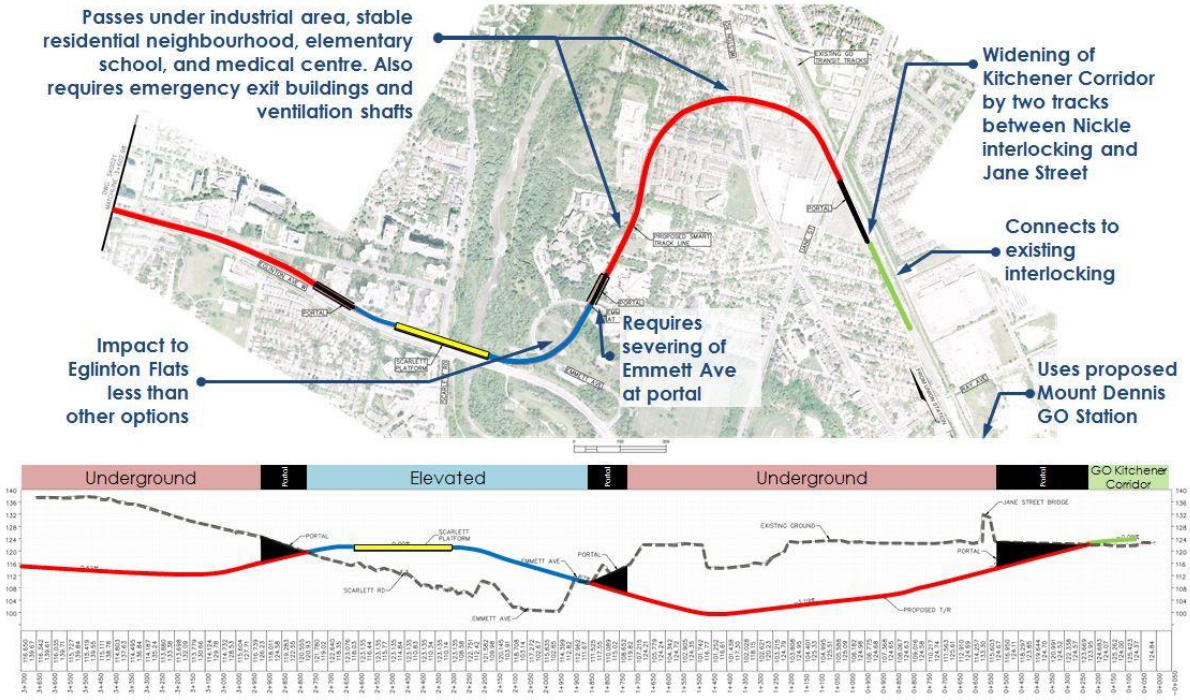


Figure 20: Plan and Profile of Alignment 1C

A cut and cover construction method could be considered as an alternative to tunnelling, however a number of issues would have to be addressed. If the intention is to follow the same alignment as described above (to minimize impacts to residential properties and Eglinton Flats), then an open cut becomes very challenging because of the profile of the existing ground. There is a 300m long, 8m deep hollow between Edmund Avenue and the West Park Health Care Centre. A shallow profile would result in an almost at-grade section through this area, followed by an open trench that rises through and bisects the health care centre to meet the required elevation of Scarlett Station. A more reasonable approach would be to follow an alignment closer to Jane Street, but it would not be without impacts to existing and proposed developments as well as Eglinton Flats.

5.2.1.8 ALIGNMENT 1D

Another concept was identified toward the end of the study, with the objectives of serving the new GO Mount Dennis station at-grade and minimizing the distance and impact of the alignment heading west toward Scarlett Station. Figure 21 below describes its key features. Two high rise residential buildings are located immediately north of the end of the station platforms on the west side of the corridor. Just beyond is the Ray Avenue grade separation underpass. Consequently, the SmartTrack alignment cannot begin to diverge from the corridor until roughly Rutherford Avenue, thereafter descending through an open cut (a portion of which can be covered later) on a steep (+/-4%) grade to drop below Weston Road and Jane Street. The alignment then emerges onto Eglinton Flats (slightly below the TRCA flood line) on the west side of Jane Street. Beyond Jane Street, the alignment runs diagonally across the green space, rising until it reaches the elevated Scarlett Station at Eglinton Ave West. An alternate alignment running along the northern edge of the green space and following the Richview Road right-of-way was considered, but it would have bisected a dense condominium community, requiring a significant re-routing of local traffic and/or construction of public roads on private property.

Since this alignment diverges from the corridor south of Nickle Interlocking, its two tracks must continue south along the corridor, through Mount Dennis station, across Eglinton Avenue and on to St. Clair Avenue, where a new interlocking must be built. The new bridge decks across Eglinton Avenue and the property acquisitions to the south must be wide enough to accommodate not only the two tracks, but two additional platforms through the station. The Eglinton Ave road profile may need to be adjusted to maintain vertical roadway clearance. South of the station and beyond to St. Clair Avenue, this alignment impacts the adjacent properties and roadways much the same as Alignment 1Bb discussed earlier.

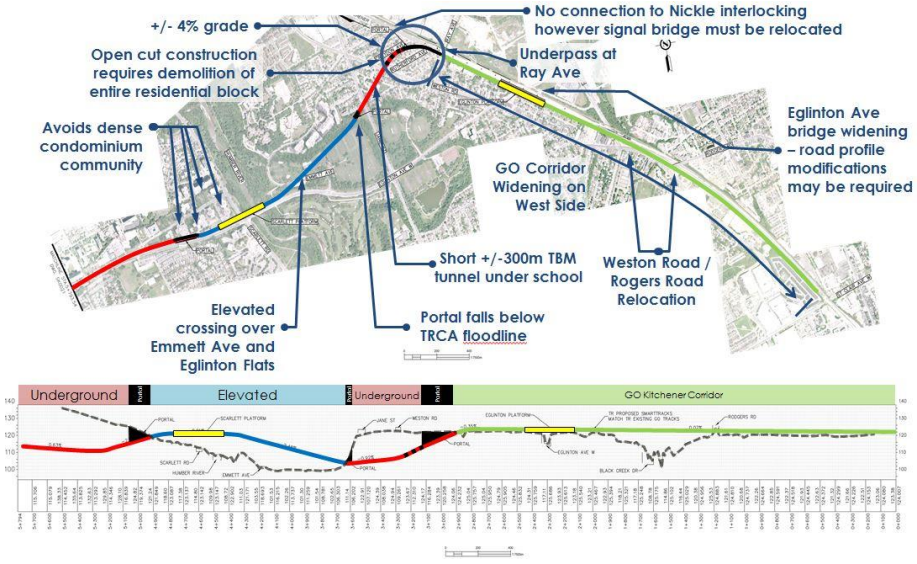


Figure 21: Plan and Profile of Alignment 1D

Table 4: Technical Evaluation of Eglinton Corridor Alignments

Alignment Variant	Differentiating Characteristics (Key Issues, Risks & Concerns)
1Ae *Refer to Appendix 5,SK0001,21*	-Poor passenger transfer at Mount Dennis due to significant vertical distances -Visual Intrusion: 19m above Black Creek Drive and Jane Street -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade -Piers on Widened Road or in Eglinton Flats
1Aa *Refer to Appendix 5,SK0004,21*	-10 degree reverse curve on 3.74% grade and bridge -Difficult construction below ECLRT station & guideway -Tunnel Boring Machine (TBM) extraction conflicts with ECLRT MSF access -Long, steep grades on both sides of Mount Dennis station limit train performance (speed) -Photography Drive is closed; TTC buses must use No Frills driveway -Severe disruption to No Frills during/after construction -"Roller Coaster" track profile affects train performance -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade -Access road to Eglinton Flats east of Jane Street must be relocated -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd
1Ab *Refer to Appendix 5,SK0003,21*	-Long open trench on 2.5% grade extending from south of Rogers Rd to portal under CP bridge -Bridge over Black Creek and portal are below TRCA Regulation limit ***** FATAL FLAW ***** -Floodwaters would fill entire Mount Dennis Station and spill out tunnel portal onto Eglinton Flats -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade
1Ba *Refer to Appendix 5,SK0002,21*	-No station at Mount Dennis, but station at Jane Street creates future connection to Jane LRT -Significant +/- 1 km horizontal passenger transfer distance between Jane and Mount Dennis fare zones. **Potential fatal flaw.** -Portal is a tight fit between Black Creek Drive and proposed GO Mount Dennis platforms -Requires sequential shutdown and excavation across GO tracks *and* Eglinton Avenue for open cut construction OR *additional* CP track shift and sequential shutdown of Eglinton Avenue for TBM -"Roller Coaster" track profile affects train performance -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd -Relocation of CP tracks; impact to adjacent low density commercial properties -Widening St. Clair Bridge/Increased TTC streetcar grade
1Bb *Refer to Appendix 5,SK0013,21*	-No station at Mount Dennis, but station at Jane Street creates future connection to Jane LRT -Significant +/- 1 km horizontal passenger transfer distance between Jane and Mount Dennis fare zones. **Potential fatal flaw.** -No relocation of CP tracks; St. Clair bridge unaffected -Requires re-profiling Rogers Road overpass; raised intersection profile may not fit -Requires realignment of Weston Road between Rogers Road and Black Creek Drive onto front of properties located along Weston Road -Portal requires significant residential property taking -Requires open cut of Eglinton Avenue for TBM extraction -"Roller Coaster" track profile affects train performance -Elevated guideway impacts forested edge of Eglinton Flats between Weston Rd and Scarlett Rd
1C *Refer to Appendix 5,SK0005,21*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -Uses planned GO Mount Dennis Station resulting in best ECLRT passenger transfer -Impact on the west end of Eglinton Flats -Portal along GO Corridor and TBM extraction shafts may conflict with active industrial buildings -Potential rebuilding of Jane Street Bridge -Significant tunnelling beneath residential properties, school and medical facilities in West Park -Deep tunnel (up to 22m) could present a challenge to locating emergency exits and vent shafts -Requires access to Eglinton Avenue via Emmett Avenue to be severed
1D *Refer to Appendix 5,SK0042,21*	-No relocation of CP tracks; St. Clair bridge unaffected -Uses expanded GO Mount Dennis Station resulting in best ECLRT passenger transfer -Requires re-profiling Rogers Road overpass; raised intersection profile may not fit -Requires realignment of Weston Road between Rogers Road and Black Creek Drive onto front of properties located along Weston Road -Portal requires significant residential property taking and tunnelling under school -Impact on the north forested edge as well as the facilities at the west end of Eglinton Flats -"Roller Coaster" track profile affects train performance

The red text in the table above can generally be considered to be describing disadvantages of a particular alignment alternative, while the green text can be considered as advantages.

5.2.2 Woodbine Continuous Connection Alignments

Four alignments for the Woodbine Corridor concepts outlined in Section 5.1 were developed and evaluated. Table 5 below provides a brief summary of the purely physical characteristics of these, along with the reference number for the corresponding plan and profile drawings that can be found in Appendix 5. A summary of the technical evaluation of these alignments is provided in Table 6, located at the end of this section.

Table 5: Physical Characteristics of Woodbine Corridor Alignments

Alignment Variants	New Corridor	Union Station to MACC (Orbitor)
2A *Refer to Section 5.1.2, Figure 10*	9.4 km 69% in tunnel 19% elevated	30.4 km
2B *Refer to Appendix 5, Drawing SK0006*	9.9 km 70% in tunnel 18% elevated	30.9 km
2Ca *Refer to Appendix 5, Drawing SK0008*	7.8 km 69% in tunnel 31% elevated	28.4 km
2Cb *Refer to Appendix 5, Drawing SK0009*	7.8 km 93% in tunnel 0% elevated	28.4 km

5.2.2.1 WOODBINE RAIL CONNECTION

All of the Woodbine Corridor alignments connect to the GO Kitchener Corridor at Wice Interlocking, located opposite Woodbine Racetrack at Carlingview Drive; however, each connects in a different way. Drawing SK0010 in Appendix 5 describes a number of ways that two additional tracks might be connected to the GO Corridor. In all cases one or the other of the Wice Interlocking signal bridges must be relocated. Option “A” on Drawing SK0010 is used on Alignments 2A and 2B to connect to the northern pair of tracks on the corridor, while Option “C” is used on Alignments 2Ca and 2Cb to connect to the southern pair of tracks on the corridor. Option “B” was evaluated but was found to require a curve in excess of 12 degrees (143m radius) to avoid impacting the CN rail-served industries between Northwest Drive and Mimico Creek, and so was dropped from further consideration. While these connections may be physically feasible, *further study is required to confirm their operational feasibility as they relate to overall corridor capacity between Union Station and this location and/or train performance, particularly UPX trains moving to and from the GO Corridor at this same location*.

5.2.2.2 ALIGNMENT 2A

As mentioned in the description of the alignments provided in Section 5.1.2, Alignment Concept 2A was not developed in detail as it would have required *at least two* emergency exit buildings (EEB's) and one pair of tunnel ventilation shafts based on a 2-3 km crossing of the airport groundside operations area. These structures and the possibility of passengers exiting onto airport runways and/or taxiways are considered fatal flaws for this alignment.

5.2.2.3 ALIGNMENT 2B

Working back from the MACC, Alignment 2B (see Figure 22) skirts the airport property by following the municipal ROW under Carlingview Drive and Airport Road. Turning north through a broad 110 degree curve arc the alignment runs parallel to American Drive within the western edge of the airport parking lot property. The tunnel alignment proposes to exit through a short portal structure on a rather steep grade (150m long @ 3.4%), just beyond the northwest corner of the multi-story airport parking structure serving the Airport People Mover. A below-grade but open-air Airport SmartTrack Station is located here. A second similar, but longer grade (250m long @ 3.5%) is required beyond the station to rise up to grade and more to gain sufficient clearance to cross over Northwest Drive. Thereafter the alignment remains elevated, running parallel to the CN spur that serves industries between Northwest Drive and Mimico Creek, crossing over the GO Kitchener Corridor on a sharp (9 degree, 194m radius) 180 degree curve arc. The GO Kitchener Corridor is reached via a reverse curve on a 2.3% grade, bringing the alignment parallel to the north side of the GO Corridor beneath the Highway 427 bridge. Connection to Wice Interlocking is as described above in Section 5.2.2.1.

While this alignment provides separation from UPX trains using Wice Interlocking and provides a somewhat convenient connection to the PIA Value Parking Lot and People Mover, *its geometry would require further study to lessen the impact of sharp grades and curves on train performance*. These issues could be significantly reduced through the acquisition of additional industrial properties on Northwest Drive. Opportunities should be explored to co-ordinate further studies with the GTAA to tie in to their on-going transit hub planning efforts.

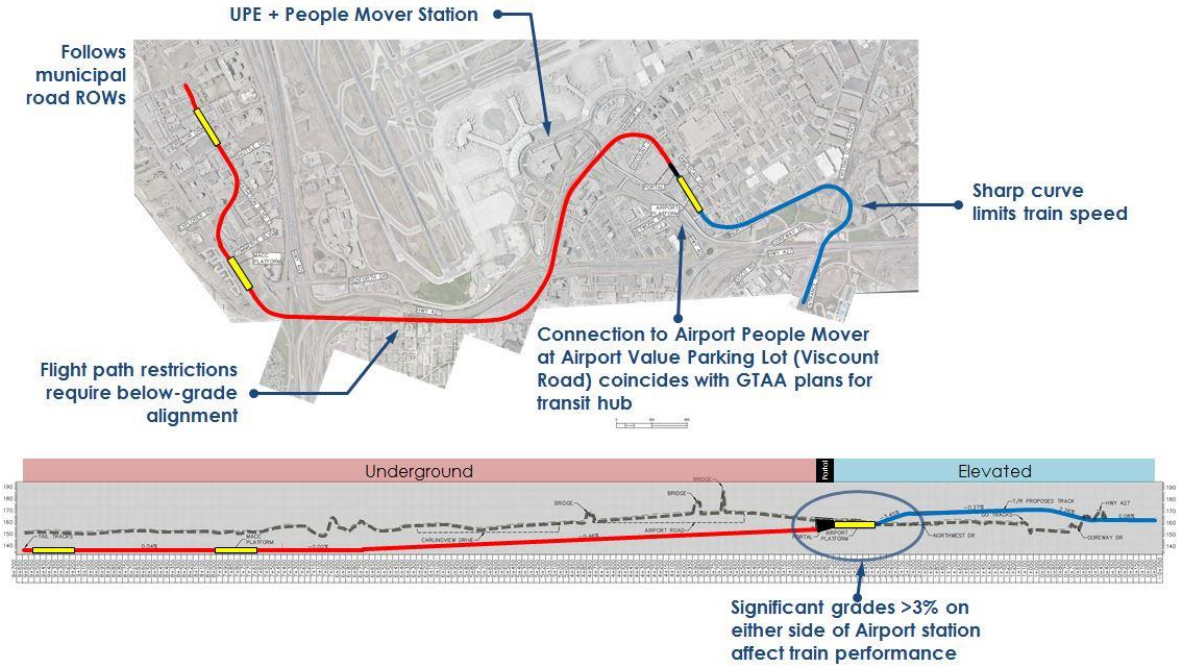


Figure 22: Plan and Profile of Alignment 2B

5.2.2.4 ALIGNMENT 2C

Alignment 2C connects to the south side of the GO Kitchener Corridor at Wice Interlocking, immediately to the east of where the UPX airport spur tracks connect. A sharp curve (9 degrees, 194m radius) sweeps through a 110 degree arc as it diverges from the GO Corridor to run parallel to the east side of Highway 427. This curve is part of a 1.5km long ascent on a 1.3% grade to achieve sufficient clearance above the Highway 427 SB to Highway 409 EB bridge/ramp. Once clear, the alignment descends a 1.2 km long 3% grade to pass under Fasken Drive and Airport Road.

A SmartTrack Station is proposed adjacent to Highway 427, just inside the airport parking lot on the southwest corner of the Airport Road/Carlingview Drive intersection. While not ideally located to serve the airport directly (some form of shuttle bus could perhaps be incorporated with the Park'N'Fly service), this station could serve visitors staying at a number of hotels within walking distance. Beyond the station Alignment 2C follows the same path to the MACC as Alignment 2B. See Figure 23 below.

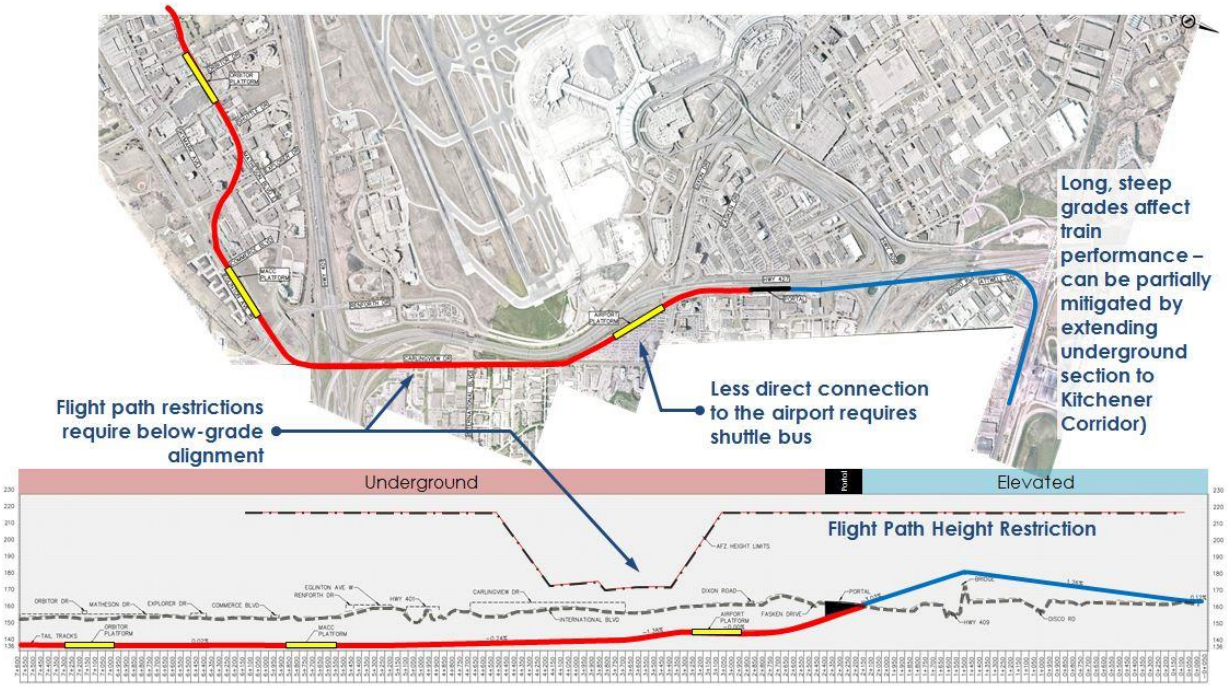


Figure 23: Plan and Profile of Alignment 2Ca

The long steep grades on this alignment could affect train performance. An alternate version of the alignment, where it is almost entirely below grade, would reduce but not eliminate these issues (see Appendix 5, drawing SK0009). A single steep descending grade, but only about half as long (700m @ 2.9%) would still be required in order achieve sufficient depth to pass under the stormwater retention ponds at the Highway 427/409 interchange. The grade is merely shifted north, adjacent to the GO Kitchener Corridor. *Further study would be required to determine whether it would be worth the cost premium to make this change.* A summary comparison of all of the key features of all of the Woodbine Corridor alignments that were evaluated is provided in the table below.

Table 6: Technical Evaluation of Woodbine Corridor Alignments

Alignment Variant	Differentiating Characteristics (Key Issues, Risks & Concerns)
2A *Refer to Section 5.1.2*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Open air below grade station platform serving airport parking lots with access to People Mover -Potential impact to commercial properties at intersection of American Drive and Northwest Drive -Steep grades (+/-3.4%) on either side of Airport station -Reverse curve on a grade >2% -Multiple Emergency Exit Buildings (EEB) and ventilation shafts for long tunnel under PIA would conflict with GTAA groundside operations ***** FATAL FLAW *****
2B *Refer to Appendix 5, SK0006*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Open air below grade station platform serving airport parking lots with access to People Mover -Potential impact to commercial properties at intersection of American Drive and Northwest Drive -Steep grades (+/-3.4%) on either side of Airport station -Long, circuitous route to get to the MACC
2Ca *Refer to Appendix 5, SK0008*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Below grade station platform serving airport hotels -"Roller Coaster" track profile affects train performance -Impact to commercial properties at intersection of GO Corridor and Highway 427 -Long, steep grade (>1km; 3%) required to pass over Hwy 409/427 ramps and under Fasken Dr. -Long, circuitous route to get to the MACC
2Cb *Refer to Appendix 5, SK0009*	-No modifications to GO Kitchener Corridor or adjacent properties south of Eglinton Avenue -No relocation of CP tracks and associated bridge and roadway works -No impact on residential properties near Mount Dennis -No impact to Eglinton Flats -Below grade station platform serving airport hotels -Impact to commercial properties at intersection of GO Corridor and Highway 427 -Long, steep grade (>700m; 2.9%) required to pass under Hwy 409/427 stormwater ponds. -Premium cost for fully below grade alignment -Long, circuitous route to get to the MACC

The red text in the table above can generally be considered to be describing disadvantages of a particular alignment alternative, while the green text can be considered as advantages.

5.2.3 Eglinton Standalone Alignment

Alignment 3A is geometrically identical to Alignment 1Aa described in section 5.2.1 between Mount Dennis Station and the MACC. As a result, separate drawings were not prepared for this alternative. As mentioned previously, east of the station the tracks would simply extend a train length (+/- 330m) beneath Eglinton Avenue. *Further study would be required to confirm that there would be no conflicts with the planned or under-construction ECLRT guideway and tunnels as well as the Black Creek floodplain, particularly where TBM extraction shafts, emergency exits and/or ventilation shafts may be located*.

The key distinguishing feature of this alignment, apart from its lack of a direct connection to the GO Kitchener Corridor, is that it would require a dedicated maintenance and storage facility nearby for all the rail equipment that would be used on the line. A sketch of a typical facility, including approximate dimensions that would be required (roughly 75,000 square metres - about 150m x 735m) to support a captive SmartTrack service, is provided in Figure 24 below. Of significant concern is the lack of suitable property along the route to locate such a facility.

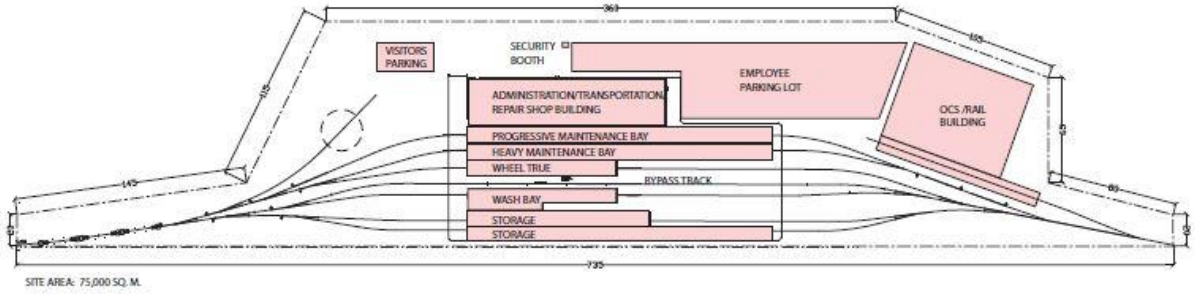


Figure 24: Conceptual MSF Footprint

Appendix 3: SmartTrack Western Corridor Feasibility Review

6 Service Concept Feasibility Analysis

6.1 Overview

The purpose of this analysis is to identify the potential impact to existing or planned GO Kitchener Corridor track infrastructure that could result from the addition of SmartTrack service on the corridor, connecting seamlessly onto either the Eglinton or Airport SmartTrack Corridors. A variety of assumptions are used in the analysis and are described in the following section, however, of singular importance is the assumption that SmartTrack service is being layered on top of already existing and planned services on the GO Kitchener Corridor. As a result, the terms of reference also includes a requirement to identify potential changes that could be made to these other services that would allow the existing and planned corridor track infrastructure to remain unchanged while adding the proposed SmartTrack service.

6.2 Basis of Analysis

6.2.1 Vehicle Technology Assumptions

This analysis reflects a future scenario where the GO Electrification Program has been completed on the Kitchener and UPX Corridors. Based on input received from GO Transit, all GO train consists running between Union Station and GO Bramalea Station are assumed to be EMUs. All GO (and VIA) train consists running on the corridor from Union Station to stations beyond GO Bramalea Station, including the semi-express service to/from GO Kitchener Station and the local service to/from GO Mount Pleasant Station are assumed to be diesel-hauled coaches. UPX train consists are assumed to be EMUs as well, converted from the DMUs (diesel multiple units) currently in service. SmartTrack corridors are also assumed to be electrified, with service provided by GO EMU trainsets.

The distinction between vehicle technologies is important as it affects the maximum acceleration that trains can achieve on departure from station stops. Trains capable of higher acceleration rates (i.e. EMUs) will have higher average speeds on any given route as they have a greater chance of reaching and running at the maximum allowable speed before having to slow down for the next station stop. This has a net effect of increasing corridor train movement capacity.

For the purpose of this analysis, since the actual performance characteristics of either the diesel-powered or EMU trains were not known, a proxy was developed using the acceleration curves found in Figure 6.1 of the 1992 GO Transit Electrification Study (see Appendix 6). In order to simplify the analysis, the same acceleration curve is used for all electrified GO, UPX and SmartTrack trains. EMU trains are also assumed to have slightly better deceleration (braking) characteristics than diesel-powered trains.

6.2.2 Limitations of the Analysis

For the purpose of this analysis, a one minute station stop, or dwell time is used in all cases. This may be an overly conservative assumption, but the analysis is otherwise highly skewed toward ideal conditions. The analysis does not include the effects of grades on acceleration or deceleration, speed penalties for the use of crossovers between tracks to route faster trains around slower trains, to separate trains in opposite directions, or to route trains onto specific tracks with platforms. The performance of each train is calculated independently; no allowances are included for potential speed reductions where trains follow one another too closely for the following train to receive a "clear", or full speed signal indication. Travel time calculations do not include any schedule buffer or recovery time for typical delays associated with weather conditions, mechanical failures or human reaction time (train operator and/or train dispatcher), or signal system response time. Pursuant to the level of analysis possible in this brief study, the current fixed block signal system is assumed to remain in place. As a result, for example, where a current published GO Local service schedule may allow for 38 minutes between Bramalea and Union Station, this analysis indicates a comparable schedule of less than 33 minutes. A nominal "catch-all" contingency of 20% has therefore been to the calculated results to better reflect expected performance. *Due to these approximations, the results of this analysis should be viewed as indicative only, with more emphasis placed on the relative performance of each train type and or schedule*.

6.2.3 Train Service Assumptions

The GO Kitchener Corridor hosts GO and UPX trains between Bathurst and Bramalea, as well as other GO trains from the Milton and Barrie lines. These other GO trains share a common corridor south of Bloor Station but their tracks do not physically connect to the GO Kitchener Corridor until they reach the Bathurst Street interlocking, so for the purpose of analyzing track requirements they are ignored. Both CN and CP also operate trains on portions of the corridor, but since these operations are confined to off-peak hours they are not considered in this high level analysis. Intercity passenger services are provided by VIA Rail Canada. Trains are operated between Toronto and southwestern Ontario via the GO Kitchener Corridor. These trains do not stop at any stations within the area of study, and so for the purpose of this analysis, they are assumed to perform the same as GO semi-express trains. A summary of the current schedule of relevant VIA train services is provided in Table 7, however, due to their current schedules outside of the peak periods, they need not considered in this analysis. *Any plans for additional VIA service should be incorporated in subsequent analyses.*

Table 7: VIA Train Service on the GO Kitchener Corridor

Train #	Direction	Time at Union Station
85	Westbound	10:55 Departure
87	Westbound	17:40 Departure
84	Eastbound	10:53 Arrival
88	Eastbound	23:17 Arrival

GO semi-express trains stop at outlying stations along their route but run non-stop through a portion of their route closest to Toronto. Within the area of study, there is currently only one such; inbound to Toronto, making no stops south of GO Bramalea Station, arriving at 08:00. A regular schedule of peak direction semi-express train service is planned to be added, in addition to (i.e. not an extension of) the planned local service improvements described below. This service is envisaged to run on **30 minute headways** during peak periods only, and will be assumed to be in place. These trains are assumed to be powered by diesel locomotives for the purpose of this analysis.

GO Local service within the area of study on the GO Kitchener Corridor stops only at Bloor, Weston and Etobicoke North Stations. It is assumed that once the planned Mount Dennis Station is constructed, all local GO trains will stop there as well. A regular schedule of peak direction and counter-peak direction local train service is planned to replace all existing local GO Kitchener Corridor service between Union Station and Bramalea Station. This service is envisaged to run on **15 minute headways** for most of the day, and will be assumed to be in place for the purpose of this analysis using EMUs. In addition, a peak direction diesel-powered local service is planned to run **every 30 minutes** between Mount Pleasant Station and Union Station, making all stops.

Taken together, all of these planned GO service improvements translate into an *average headway* of **7.5 minutes** within the area of study, not including VIA, UPX and any SmartTrack trains that may need to use portions of the corridor.

UPX service from Union Station begins at 05:30 and runs every 15 minutes to the airport, stopping only at the Bloor and Weston GO stations. The return trips depart the airport at 12, 27, 42 and 57 minutes past the hour and stop at the same stations. All trips are scheduled to take 25 minutes. At this time it is not known if UPX station stops will be changed upon completion of the ECLRT. For the purpose of this analysis, current station stops are used.

SmartTrack service within the area of study is assumed to stop at each of the stations listed in Table 7 that are included in each alignment. It is assumed that SmartTrack will serve the planned GO Mount Dennis Station and a potential St. Clair SmartTrack Station for Alignments 1C, 2B and 2Ca only. A regular schedule of peak direction and counter-peak direction local train service is planned to be added to the Kitchener Corridor between Union Station and the MACC. Although a variety of SmartTrack headways have been modelled (by others) to determine potential future ridership, for the purpose of this study, an initial headway of 15 minutes is assumed. In the absence of alternative arrangements (see Section 6.6), since the end points of the SmartTrack and electrified GO Local services are not the same and their desired headways are the same along their entire routes, it must be assumed that these services are mutually exclusive.

6.2.4 Station Configuration Assumptions

Earlier in this report (Section 4.3), the assumed physical configurations for a number of stations were described. From an operating perspective, some configurations have a greater impact on corridor capacity and train performance than others. For example, if a station on a corridor with more than two tracks only has side platforms on the outside tracks (as is the case for the planned GO Etobicoke North Station expansion), then all trains using that station must find their way to one or the other of the outside tracks via crossover tracks located at the nearest interlocking. See Figure 25 below for schematics of alternative platform arrangements. If the nearest interlocking is some distance away, then the operating flexibility of the corridor is reduced, as the train dispatcher cannot make full use of any third or fourth track, and trains may suffer a speed penalty if they have to be routed through crossovers to get to the outside tracks. Ideally, only local trains (GO, SmartTrack) would use the outside tracks, and all express and semi-express trains (GO, UPX, VIA) would use the inside tracks, but this may not be possible when there are too many trains passing through the same area at the same time.

It is not known at this time which, if any, of the proposed SmartTrack stations on the GO Kitchener Corridor would be equipped with centre platforms, as significant modifications would be required to the track alignments and corridor width (with inherent impacts on train performance and adjacent properties). For the purpose of this study it is assumed that the only stations with platforms serving all tracks will be those (GO stations) that are already so equipped, or planned to be built as such. Table 8 below summarizes the platform configurations for all existing and potential stations within the study area.

Table 8: Station Platform Assumptions

Station	# Tracks Served by Platforms
Spadina	2
Liberty Village	2
GO Bloor	**4 + GO Milton**
St. Clair	2
Mount Dennis	2
Jane	2
Scarlett	2
Kipling	2
MACC	2
GO Mount Dennis	**4**
GO Weston	**4**
GO Etobicoke North	2
Woodbine	2
Airport	2
Renforth Gateway	2
Orbitor Drive	2

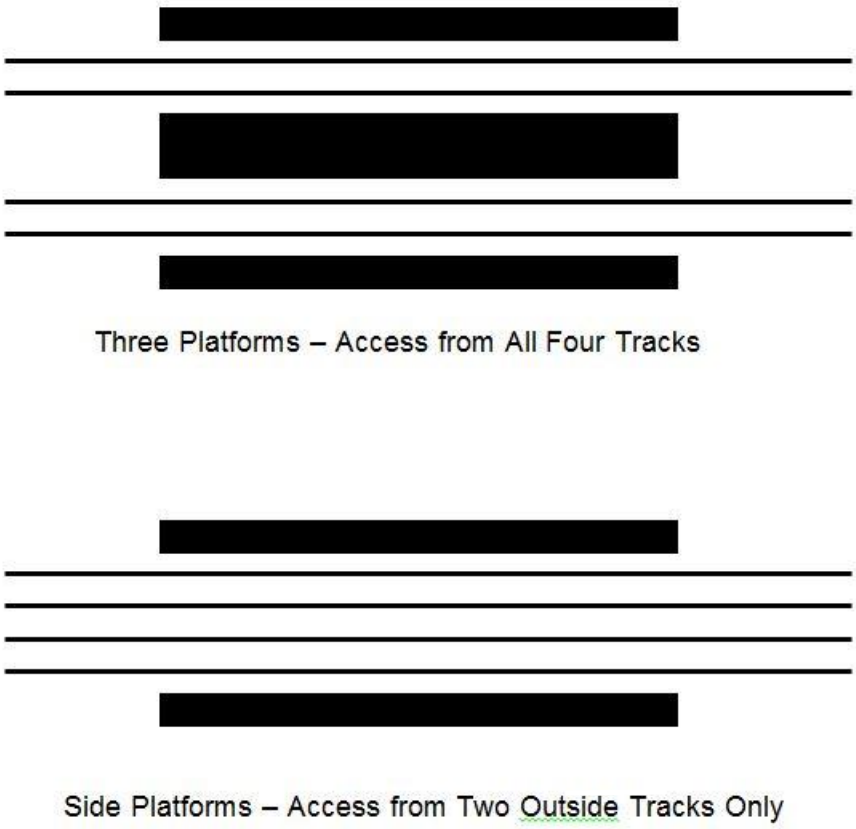


Figure 25: Station Platform Arrangements

6.3 Time-Distance Charts

6.3.1 Chart Format

The Time-Distance charts included in this section of the report are a graphical representation of the movement of all trains along a given route over time. Each train type or schedule is identified by a different coloured line, which is repeated at an interval equal to its headway. Since these headways are relatively short, a one hour period is sufficient to demonstrate the key features and "interference patterns" of all the train schedules of interest. The resulting scale allows for each train line to be seen clearly, particularly where many trains are passing through or stopping at the same locations within a very short timeframe. Major and minor grid lines are provided at 15 and 3 minute intervals, respectively, to help frame any discussions regarding corridor track requirements in areas of congestion. Corridor capacity requirements are determined by the busiest period of the day, therefore all of the charts used in this report describe a typical morning peak hour with peak direction trains running eastbound into Union Station.

Distance in km from Union Station is measured along the left vertical axis and time in hours and minutes along the horizontal axis. The names and locations of stations and interlockings (in red) are indicated on the right vertical axis. The locations of interlocking signals governing train movements in each direction are denoted by faint grey horizontal double lines. The locations of the intermediate (bi-directional) signal bridges are denoted by similar single solid grey lines.

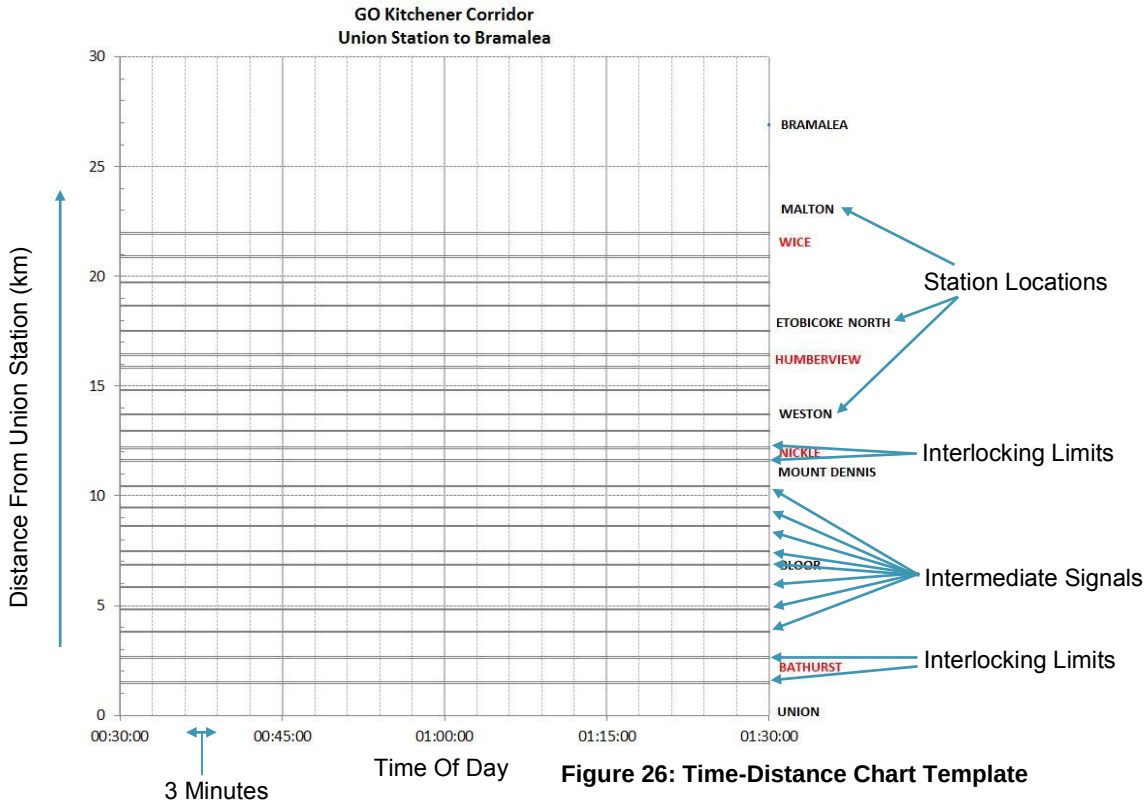


Figure 26: Time-Distance Chart Template

6.3.2 SmartTrack Travel Times

Estimated travel times from Union Station to the Renforth Gateway are listed in the table below for the technically feasible SmartTrack alignments. Blended travel times for theoretical SmartTrack+ECLRT and TTC+ECLRT routes are also provided for comparison purposes. These figures include an assumed 6 minute time transfer penalty at Mount Dennis and Eglinton West Stations, respectively.

These figures should only be used as general performance indicators due to the limitations described in Section 6.2.2. Calculated travel times for the SmartTrack alignments have been increased by a nominal 20% to account for the many unknowns at this time. A more detailed study of travel times should be undertaken using a train performance calculator (TPC), based on defined physical and operating vehicle specifications.

Table 9: Comparison of Estimated SmartTrack Travel Times

Alignment	Distance (km)	# Stops	Travel Time	Relative Ranking
1Ae	20	7	29:52	87
1Aa	20	7	29:17	89
1Ba	20	6	25:57	100
1C	21	8	31:38	82
1D	20	7	29:01	93
2B	29	10	42:03	62
2Ca	27	10	39:29	66
ST-Mt.Dennis+ECLRT	20	19	46:18	56
TTC+ECLRT Phase 2	21	16	53:36	48

6.3.3 Effects of Acceleration and Station Stops on Travel Time

It is important to understand how vehicle technology and service affect travel times over a common corridor. Estimated travel times for the different train types running between Wice Interlocking (Highway 427) and Union Station are listed in Table 10 below. Notwithstanding the limitations of the analysis described in Section 6.2.2, an 19% reduction in travel time was observed due to improved acceleration alone (GO Bramalea vs GO Mount Pleasant), whereas doubling the number of station stops (GO Bramalea vs SmartTrack) accounted for a 34% increase in travel time, even with the benefit of increased acceleration. This last figure is dependent on dwell time, of course, but even if dwell times were half as long (30 sec), the increase in travel time would still be a significant 27%. These differences will ultimately drive the need for multiple tracks along the corridor, as there will not only be trains passing in opposite directions, but trains will be catching up and passing each other *in the same direction*, requiring additional track capacity to allow trains with faster average speeds (semi-express, UPX) to pass slower moving trains and trains making all stops along the corridor.

Table 10: Eastbound GO Kitchener Corridor Travel Times by Train Type

Train Type	Technology	# Stops	Travel Time	Relative Ranking
VIA/GO Semi-Express	Diesel	0	16:24	100
UPX	EMU	2	21:13	77
GO Bramalea	EMU	4	24:53	66
GO Mount Pleasant	Diesel	4	30:47	53
SmartTrack (2B, 2Ca)	EMU	8	33:14	49

Figure 27 below is a graphical representation of the different travel times calculated for each train type. Although the GO Bramalea train (green line) and the GO Mount Pleasant train (orange line) provide the same service to the same stations, the effects of the different acceleration rates (EMU vs Diesel) are clearly visible. Similarly, the effect of adding station stops is visible in comparing the GO Bramalea train (green line) and the SmartTrack train (black line).

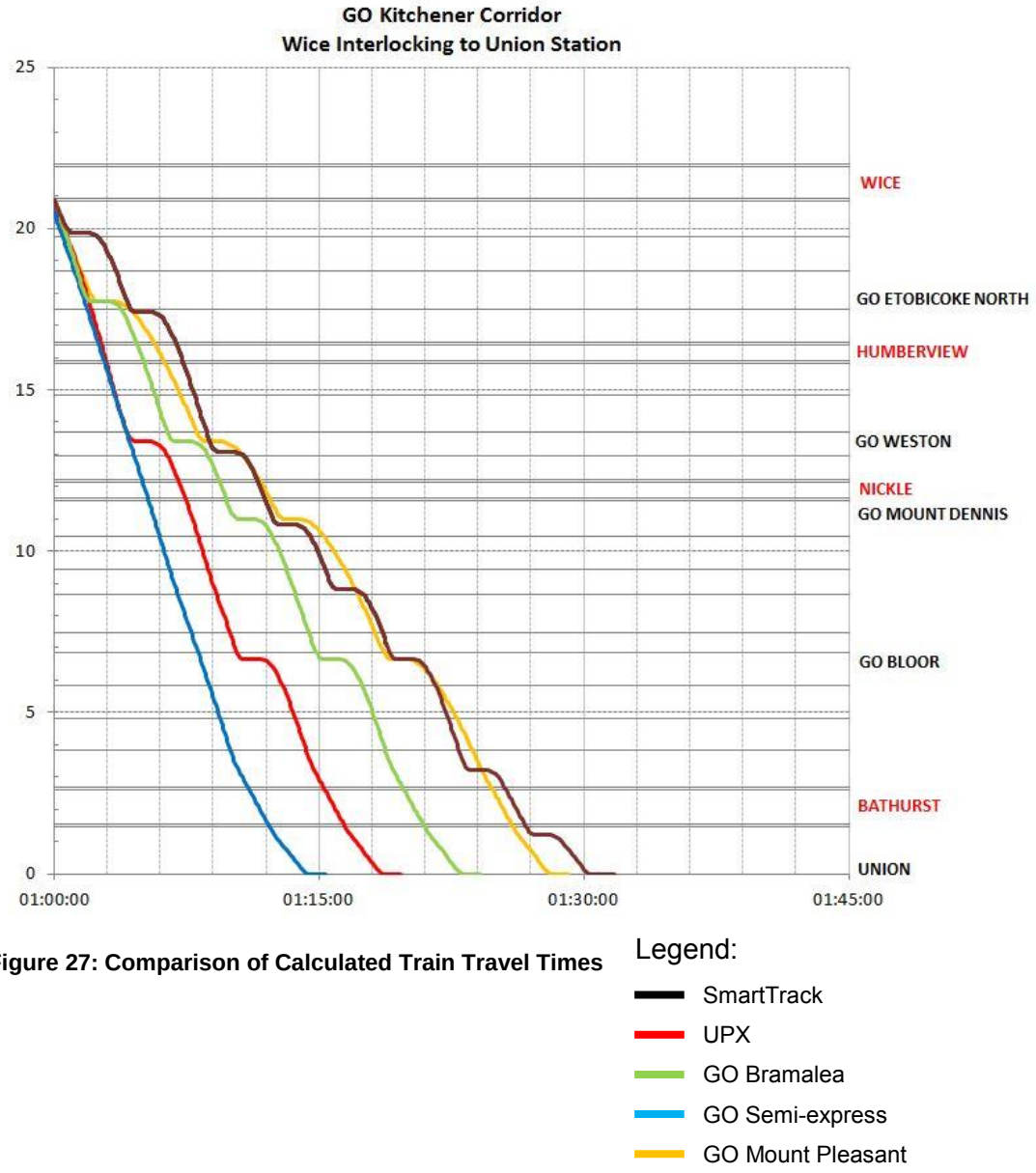


Figure 27: Comparison of Calculated Train Travel Times

6.3.4 Minimum Headway

Notwithstanding the number of tracks that may *appear* to be required by virtue of the number of trains passing through a specific location at or around the same time, the actual number of tracks required is also a function of the maximum allowable speed, the spacing of signal bridges and the location of interlockings where trains may be shifted from one track to another to pass or overtake other trains in their path. These signal bridges and interlockings form the backbone of the current fixed block train control system used to maintain a safe separation between opposing trains as well as trains following one another on the same track, while at the same time maximizing the speed of trains in all directions. Within a given "speed zone", the spacing of the signal bridges is a function of the maximum speed at which trains are permitted to travel (or vice-versa) and the distance required to safely bring a train to a stop from this speed.

In order to maintain train speeds and advertised schedules trains moving in the same direction on the same track must be separated by at least one unoccupied signal block (as defined by any two consecutive signal bridges governing train movements in the same direction). A train following another within two signal blocks may not receive a "clear" signal indication at the signal as it enters the block, which would prevent it from proceeding at full speed until it reaches the next signal located 1-2 km away. The minimum headway or train separation required to operate at maximum speed for any particular signal block is known as the "signal wake". In the absence of fundamental changes or upgrades to the signal system or modifications to the proposed train schedules, trains following too closely may have to be on different tracks.

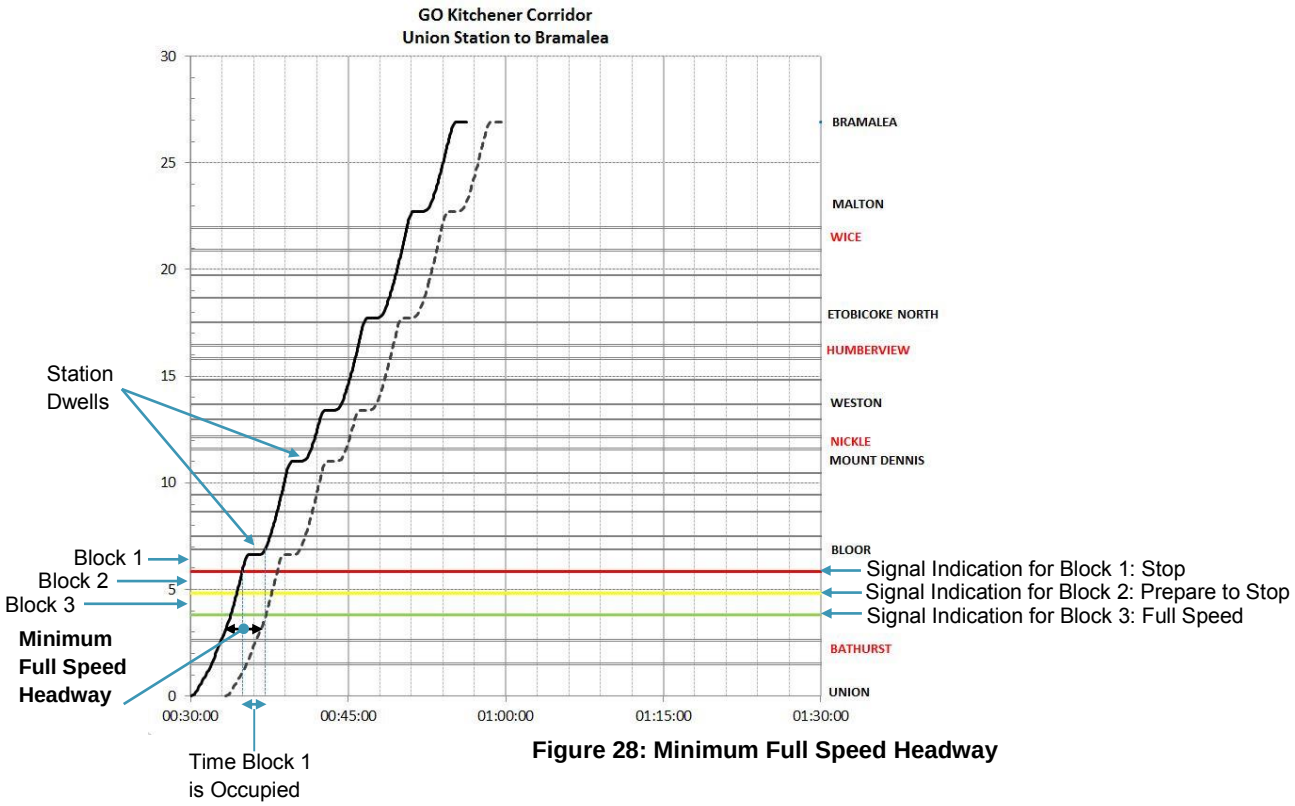


Figure 28: Minimum Full Speed Headway

A train schedule's signal wake is very much dependent on the longest station dwell time on the route. This is because the gap between following trains narrows while the train ahead is stopped at a station. A well known example of this effect is on the TTC's Subway Line 1 where overall line capacity is constrained by excessive dwell times due to passenger congestion at Bloor-Yonge Station.

The charts included in the following sections are only meant to illustrate train operations analysis concepts and should not be taken to represent actual train schedules. Changes to any of the assumptions described in this section and earlier in this document could result in significantly different schedules and infrastructure requirements. In order to confirm the feasibility of any combination of vehicle technology and train service on a particular alignment and corridor configuration (i.e. number of tracks), an industry standard model of the proposed physical alignment, signal system and train consists to be used must be developed and calibrated, followed by a series of simulations to test the relative performance of multiple what-if scenarios and dispatching algorithms against an agreed upon Base Reference Case.

6.4 Observations from Service Concept Analysis

6.4.1 Planned GO+UPX Service

In all cases, the existing published UPX schedules have been used. These are shown as **red** lines on the charts. The planned GO semi-express service from Kitchener is designed to work with the local service from GO Mount Pleasant to create a combined 15 minute headway south of this location. These services are shown on the charts as **blue** and **orange** lines, respectively. It should be noted that although these services are offset from each other by 15 minutes at the GO Mount Pleasant station, the semi-express train eventually catches up and passes the local train at Bloor station, as shown on the charts.

The local electrified GO service from Bramalea is shown on the charts as **green** lines. In the peak direction, these have been placed in such a way that evenly spaced departures of 7.5 minutes occur at GO Bramalea station between the GO semi-express, the GO Mount Pleasant and the GO Bramalea services. In the counter-peak direction the GO service from Union Station to Bramalea is timed to allow for only a single platform to be needed at either terminal station for trains in both directions. The schedule used also minimizes the number of train consists required to maintain the overall schedule. *Further study is required to confirm whether the terminal time used in this analysis (8 minutes) is sufficient for the number of passengers expected to be boarding and alighting the trains at these stations*.

As can be seen in Figure 29 below, there are locations where four trains might meet, suggesting that the planned and partially constructed fourth track on the GO Kitchener Corridor will be needed.

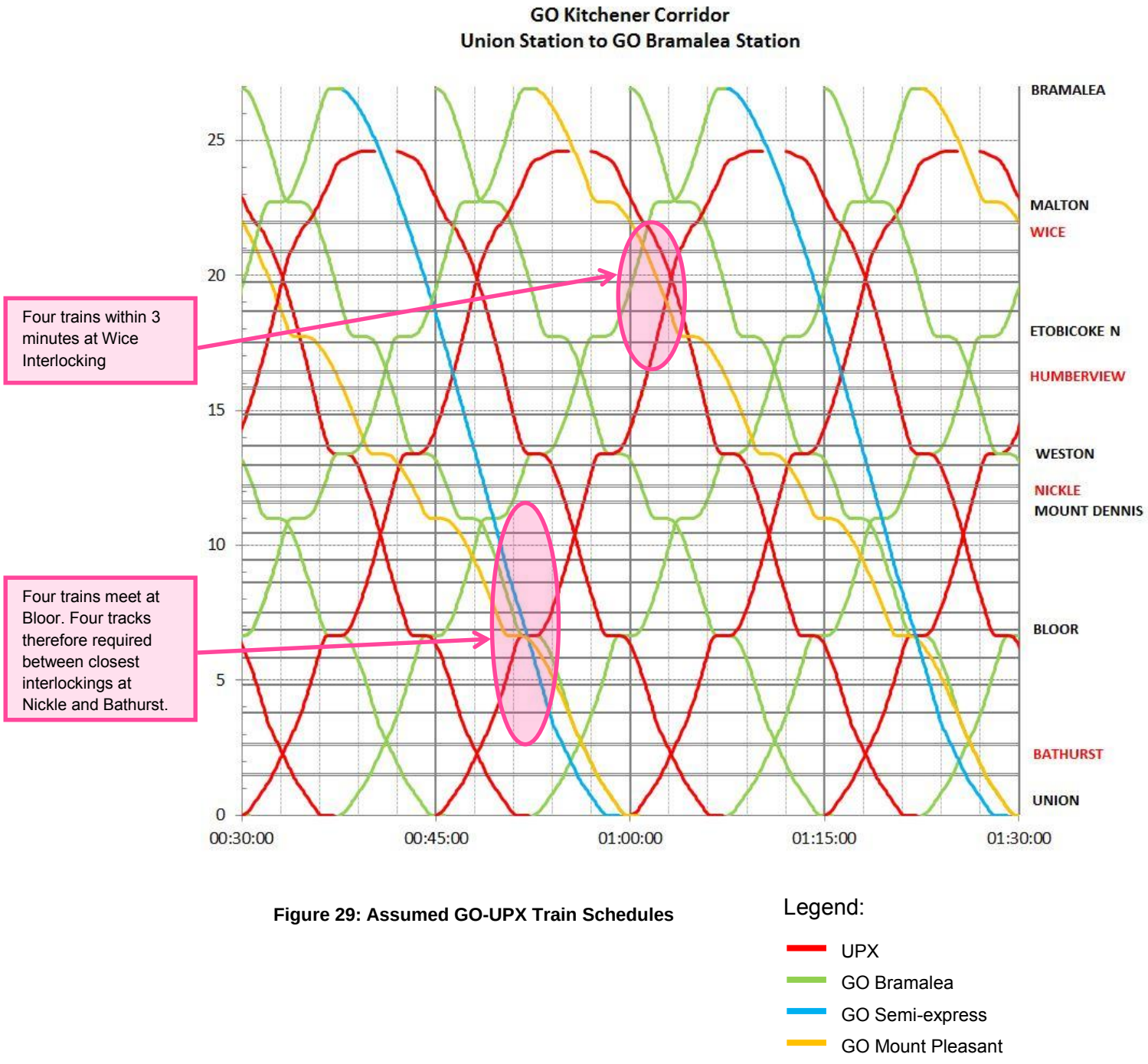


Figure 29: Assumed GO-UPX Train Schedules

6.4.2 GO+UPX+SmartTrack 1Ae

SmartTrack service between Union Station and Orbitor Station is shown on Figure 30 below as **black** lines. GO and UPX services are only shown as far west as the new interlocking at St. Clair. In the counter-peak direction, these lines have been placed in such a way that departures are evenly spaced between GO Local departures at Union. In the peak direction the service from Orbitor Station is timed to avoid conflict by following the faster trains south of St. Clair Interlocking. Only a single platform is needed at either terminal station for trains in both directions. *Further study is required to confirm platform availability, based on the terminal times used (3-5 minutes) and the number of passengers expected to be boarding and alighting the trains at these stations. Two platform tracks may be required.* As can be seen in the chart below, there are locations where five trains might meet, suggesting that the planned fourth track may not be sufficient to handle additional SmartTrack service as defined in Section 6.2.

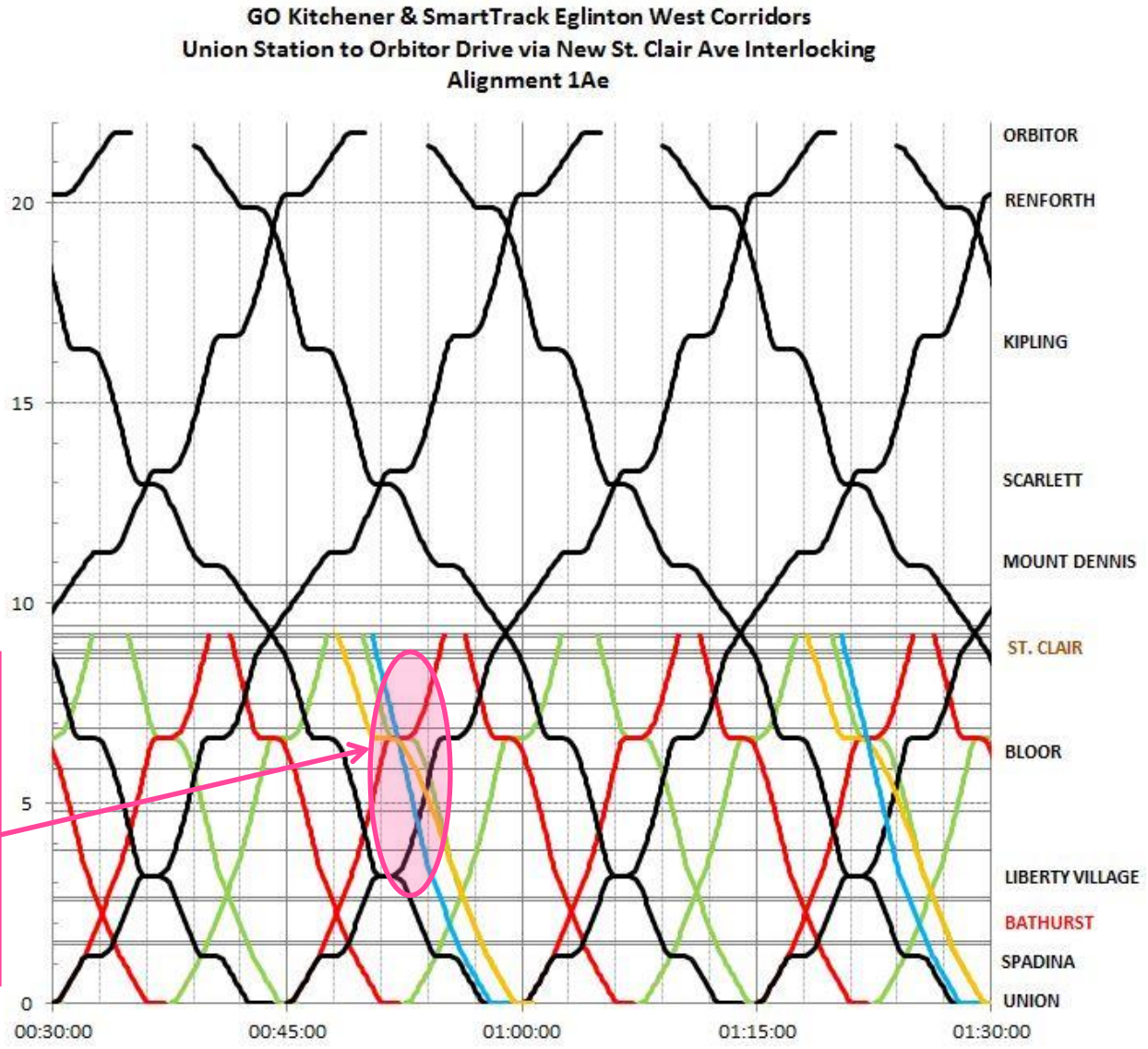


Figure 30: Alignment 1Ae

6.4.3 GO+UPX+SmartTrack 1C

SmartTrack service between Union Station and Orbitor Station is shown on Figure 31 below as **black** lines. GO and UPX services are only shown as far west as Nickle Interlocking. In the counter-peak direction, these lines have been evenly placed to minimize conflict by using the crossovers at Nickle Interlocking between trains travelling in the opposite direction. Similarly, in the peak direction the service from Orbitor Station is timed to avoid conflict by following the faster trains south of Nickle Interlocking. Two platform tracks may not be required at the terminal stations due to the moderate terminal times available (6-12 minutes). *Further study is required to confirm platform availability taking into consideration the number of passengers expected to be boarding and alighting the trains at these stations*. As can be seen in the chart below, there are locations where five trains might meet, suggesting that the planned fourth track may not be sufficient to handle additional SmartTrack service as defined in Section 6.2.

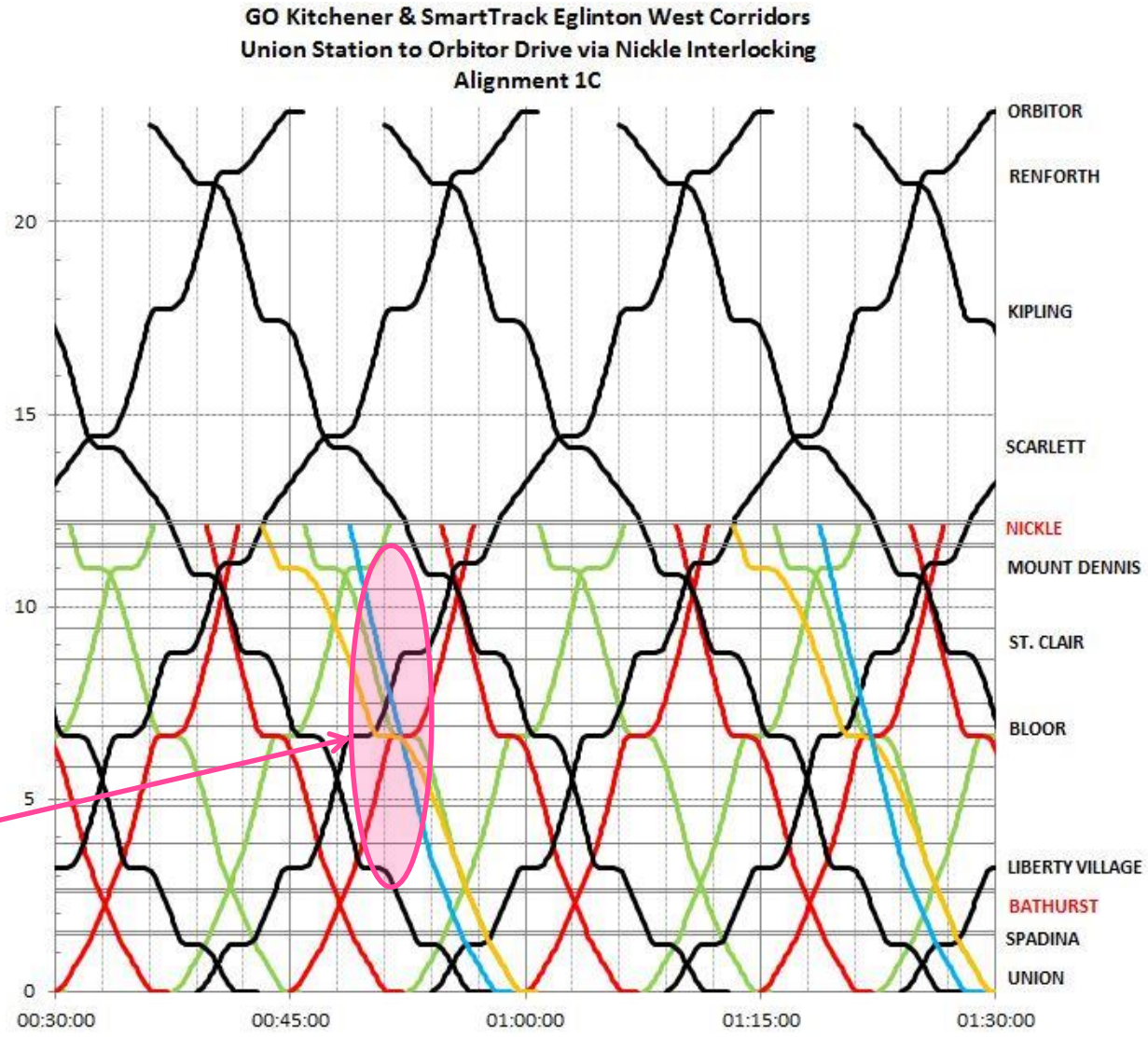
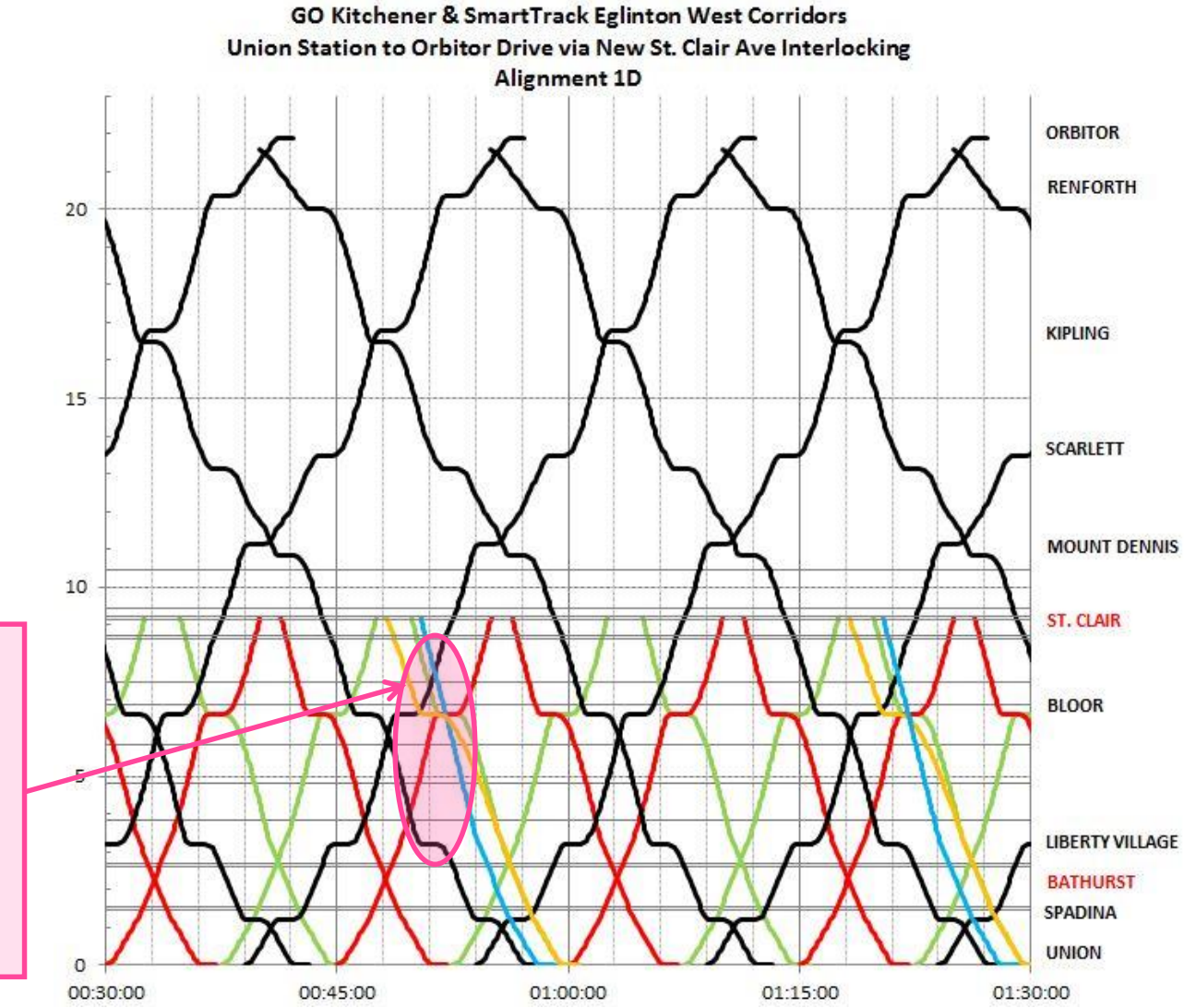


Figure 31: Alignment 1C

6.4.4 GO+UPX+SmartTrack 1D

SmartTrack service between Union Station and Orbitor Station is shown on Figure 32 below as **black** lines. GO/UPX services are only shown as far west as the new St. Clair Interlocking. In the counter-peak direction, these lines have been evenly placed to minimize conflict by using the crossovers at St. Clair Interlocking between trains travelling in the opposite direction. Similarly, in the peak direction the service from Orbitor Station is timed to avoid conflict by following the faster trains south of the Interlocking. Two platform tracks may not be required at the terminal stations due to the 12-13 minute terminal times. *Further study is required to confirm platform availability taking into consideration the number of passengers expected to be boarding and alighting the trains at these stations*. As can be seen in the chart below, there are locations where five trains might meet, suggesting that the planned fourth track may not be sufficient to handle additional SmartTrack service as defined in Section 6.2.



3 eastbound trains meet 2 westbound trains. UPX train following SmartTrack must use 5th track between Bathurst and St. Clair interlockings to maintain safe braking distance for minimum headway.

Figure 32: Alignment 1D

6.4.5 GO+UPX+SmartTrack 2B

SmartTrack service between Union Station and Orbitor Station is shown on Figure 33 below as **black** lines. GO and UPX services are shown as far as Wice Interlocking. These lines have been placed to take advantage of periods of relative inactivity in both directions at Wice Interlocking. Double berthing is required at the terminal stations due to the closely timed arrivals and departures. *Further study is required to evaluate the availability of platform capacity at the terminal stations*. As can be seen in the chart below, there are locations where five to six closely spaced trains may pass by between interlockings where they might otherwise have been able to change tracks, suggesting that at least five tracks may be required.

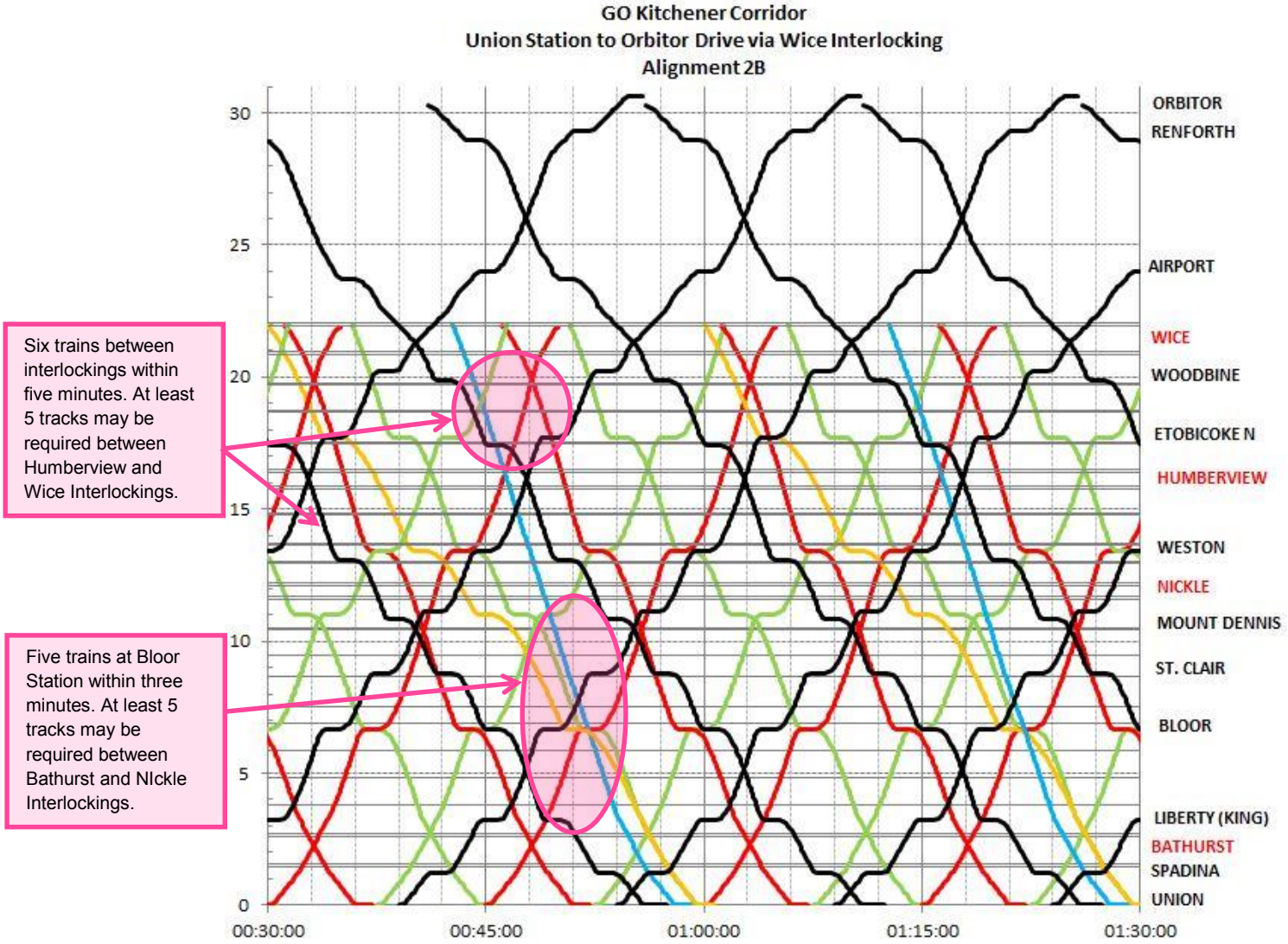


Figure 33: Alignment 2B via AIRPORT

6.5 GO Kitchener Corridor Expansion Implications

The level of analysis completed for this study is insufficient to draw any definitive conclusions. However, the results do suggest that there is a good likelihood that at least some portions of the GO Kitchener Corridor may require at least one additional track to support a 15 minute SmartTrack service to and from a new western corridor, *in addition to* all of the existing UPX and planned GO service improvements, assuming that none of the train services can be altered in terms of their frequency, speed or station stop pattern. Under these physical and operating conditions, it is fair to say that operating a SmartTrack service of *less than* 15 minutes would likely require an almost dedicated two track right-of-way, similar to a subway. The implications of adding one or more tracks may be significant; Sections 2.1.1, 2.1.4 and 2.1.5 identified a narrow corridor width, a very high number of roadway grade crossing structures as well as future electrification infrastructure that would require adjustment. In addition, regardless of the level of additional service that might be feasible on the corridor, *the ability of Union Station to handle any increase in traffic must be addressed*.

Existing development runs very close if not right up to the corridor property line in some locations, which could make for lengthy negotiations with property owners and/or complex engineering solutions to add to or modify existing corridor infrastructure. *Further study is required to identify specific areas of concern along the corridor, the number and locations of additional tracks required and the potential costs of such an undertaking.*

6.6 Alternatives to Corridor Expansion

The terms of reference included a requirement to identify potential changes that could be made to existing and planned GO+UPX services that would allow the existing and planned corridor track infrastructure to remain unchanged while adding the proposed SmartTrack service. While this may indeed be a reasonable question to explore, it is a rather open-ended one, with many possible train service variations to consider. To narrow down the possibilities it may be reasonable to assume that the recently inaugurated UPX service will not be reduced, so the focus of this section will be on the planned GO service expansion, as described in Section 6.2.3.

An important question that should be asked is whether the future travel demand forecast supports having parallel GO and SmartTrack local train services on the Kitchener Corridor. Layering both of these 15 minute headway services on top of the planned 30 minute local service to/from Mount Pleasant creates a combined 6 minute average headway. Using a nominal GO train consist capacity of 1,944 passengers (162 passengers per coach), this translates to a capacity of 19,440 passengers per hour in the peak direction *not including UPX and semi-express services* between Mount Dennis or Woodbine and Union Station, depending on the SmartTrack corridor under consideration.

The same question should be asked about each of the SmartTrack corridors as well, as it may not be necessary to run a 15 minute service or full length train consists to meet the demand. If the demand to both the MACC and Bramalea could each be fulfilled by a 30 minute service, then it may be reasonable to expect that every second train of a 15 minute local service south of the SmartTrack connection could alternate to/from these two nodes, thereby eliminating the need to add corridor capacity.

Additional alternative operating scenarios that may be worth investigating to see if they could be operated on the existing/planned four track GO corridor include:

- Harmonizing station stop patterns to maintain consistent train headways along the entire corridor.

- Running more frequent semi-express GO trains making all stops to either a Mount Dennis or Woodbine (depending on the SmartTrack alignment) transit hub with SmartTrack providing all local service between the transit hub and Union Station,

- Running a 15 minute local GO feeder service only as far as the transit hubs with transfers to fewer express trains to Union station plus the 15 minute local SmartTrack service.

- Running the SmartTrack service using semi-express trains; making all stops on the Eglinton (or Airport) corridor then running express to Union Station. GO Local service would be expanded to serve the proposed SmartTrack stations on the GO Kitchener Corridor south of the SmartTrack connection.

If no satisfactory arrangement can be found regarding modifications to the level of service required/desired, then prior to making any decisions regarding the addition of track capacity, an investigation of the costs/benefits of a corridor-wide train control system upgrade may be in order. This may be something that is already part of GO Transit's long term plan and if so, it may be worth revisiting the timing of its implementation. Potential signal system upgrade or replacement scenarios include:

- PTC - Positive Train Control
- CBTC - Communications Based Train Control
- ERTMA - European Rail Traffic Management System

7 Cost Comparison

7.1 Overview

The objective of this portion of the study was to develop high-level cost estimates for each of the short-listed alignments for *comparison purposes*. These "order of magnitude" estimates are intended solely for providing *an indication of the relative differences in costs between the alignment alternatives and are under no circumstances to be used for project planning or budgeting*. A detailed engineering costing exercise should be neither inferred nor expected from this type of study. This is consistent with other similar high level feasibility studies, where estimates are *not based on a significant amount of engineering or field investigation*.

Estimates have been prepared using available data from similar work previously completed. A summary of this effort is provided in Table 11 below. Note that these estimates do not include potential modifications to the Kitchener Corridor between Union Station and St. Clair (or Woodbine) as may be required to support integrated SmartTrack and GO RER services, nor do they include other items listed in Section 7.4, *all of which could increase the overall cost of any alignment by as much as $2B or more.*

Cost Component		**Alignment**						
		1Ae	**1Aa**	**1Ba**	**1C**	**1D**	**2B**	**2Ca**
Below Grade Infrastructure		1526	1778	1740	1789	1651	1286	996
Stations (Below and Above Grade)		912	1096	815	826	864	600	733
Elevated and At-Grade Structures		430	367	384	38	296	108	127
Track, Systems & Utilities		449	446	442	374	432	325	262
Sub Total - Construction		**3317**	**3687**	**3381**	**3027**	**3242**	**2320**	**2118**
Scope, Pricing, Phasing, Construction (30% - 50%)		995-1659	1106-1843	1014-1691	908-1513	973-1621	696-1160	635-1059
Property (5% - 7%)		216-348	240-387	220-355	197-318	211-341	151-244	138-222
Engineering, Management & Reserve (25% - 30%)		1132-1597	1258-1775	1154-1628	1033-1457	1107-1561	792-1117	723-1020
Allowances & Contingencies		**2343-3604**	**2604-4006**	**2388-3673**	**2138-3289**	**2290-3523**	**1639-2521**	**1496-2301**
Totals	**$Million**	**5660-6921**	**6290-7692**	**5769-7054**	**5164-6315**	**5532-6765**	**3958-4841**	**3614-4419**
	$Million/km	430-525	478-585	443-542	465-568	417-510	411-502	475-581
		1Ae	**1Aa**	**1Ba**	**1C**	**1D**	**2B**	**2Ca**

Table 11: Comparison of Costs for SmartTrack Alignment Alternatives

7.2 Sources of Data & Estimating Framework

In order to provide information that is as current as possible, detailed costing data for very recent and comparable Metrolinx/GO and TTC construction programs, such as the GO Georgetown South (Kitchener Corridor) Program, the UPX Airport Spur and the TTC Toronto-York Spadina Subway Extension was sought as input to this exercise. Unfortunately, due to the nature of the procurement of some of these projects, information regarding their costs was only available at a very high level and/or aggregated with other project elements. Where necessary, other recent construction project data sources were used to supplement this information. Given these conditions, and the limited availability of design details, only very coarse construction cost unit rates (i.e. $ per km) have been be used.

The estimates are based solely on the preliminary track alignment geometry plans and profiles, aerial imagery, and limited field data provided by the TRCA and other stakeholders; mostly related to design constraints. For each alignment, the elements considered were limited to the following, on a cost per km basis:

- length of new guideway and track construction, considering:
  - #km at-grade
  - #km elevated
  - #km tunnelled (including emergency exit buildings where appropriate)
- number of new SmartTrack stations (on new right-of-way only), considering:
  - at-grade site development
  - depth below grade or height above grade
- track components, communications, train control and power systems
- utilities and municipal roadway relocations

In short, the primary differentiators between the alignments are the proportions of each that are at grade, elevated or below grade (in tunnels), the number and locations of SmartTrack-only stations and the modifications required to the GO Kitchener Corridor and adjacent CP Corridor, where necessary, to effectively connect to the new SmartTrack Corridor (specifically between Jane Street and St. Clair Avenue). Other major cost items include the bridge crossings over Black Creek and Black Creek Drive.

Where necessary, available unit costs for certain elements have been pro-rated to account for differences in scale. For example, because tunnelling costs are proportional, in part, to the square of the radius of the bores, the unit costs available to the study team for traditional 5.9m diameter twin bore subway tunnels were nominally increased by a factor of two to account for an assumed heavy rail tunnel diameter 1.4 times larger to allow for double deck coaches equipped with pantographs. Conversely, premiums associated with specialized subway signals and train control systems have *not* been included.

It is assumed that the fourth main track on the GO Kitchener Corridor, that is only partially completed at this time, will be completed and funded as part of the GO RER Program so no costs are included for it in these estimates. Similarly, the GO Electrification Program is assumed to be in place and that no modifications (i.e. additional costs) are required to support SmartTrack on any shared corridors.

The estimates do not include any potential modifications that may be required along the 11 km of the GO Kitchener Corridor between Union Station and Jane Street in the case of the Eglinton SmartTrack Corridor, or the 21 km between Union Station and Highway 427 in the case of the Woodbine SmartTrack Corridor, which could cost *an additional* $1B to $2B more.

7.3 Uncertainty and Other Project Costs

At this very early stage of project development, there are undoubtedly project elements that are missing or that will change significantly. In addition, market forces (supply/demand effects on contractor pricing), currency exchange, construction constraints, seasonal effects, and project phasing can all lead to adjustments to the ultimate project cost. These are all project risks that must be mitigated through the application of contingency factors against the base construction estimates.

Ultimately, the amount of contingency applied is subject to the level of confidence that the estimator has that the base design drawings, specifications, quantities and field data provided are complete and accurate. Given the very limited availability of information on which to base the estimates, the figures shown in Table 12 for this high-level feasibility study reflect allowances of 5% to 7% for property acquisition, 30% to 50% for scope, pricing, phasing and construction risks and 25% to 30% for engineering, project management and a small management reserve. Further adjustments will ultimately be required to reflect the timing of this project (i.e. escalation for inflation to reflect a future project start date and duration), different procurement strategies, as well as the exclusions listed in Section 7.4.

A more thorough conceptual design exercise would typically involve the development of individual probabilities and cost impacts for an exhaustive list of risks to produce *a range of* contingency factors reflecting the amount of money that would be required to address varying levels of confidence in the overall estimate. Such an analysis produces useful insight for budgeting purposes that is unique to each project, but it is well beyond the scope of this feasibility study.

Interestingly, this process was used for the 2010 GO Electrification Study, which included the GO Kitchener Corridor. That analysis suggested a range of construction contingencies between 37% and 59% for the overall electrification program, *in addition to* other soft costs, such as property acquisition, engineering

and project management, etc. The study also suggested an amount of 19% for third-party professional services.

By comparison, order of magnitude estimates typically prepared by or for large TTC programs identify a 25% allowance to cover engineering and project management items, *including the cost of the owner's staff salaries that may be assigned to the project*, plus geotechnical investigations, permits, and insurance. Allowances of 7% for property and 30% for all other project risks are identified as well. Contingencies are applied cumulatively; that is, they are applied not only to the estimated construction costs, but to the professional services and property acquisition costs as well.

7.4 Additional Exclusions

Although not an exhaustive list, the following additional items are not included in the estimates, and will need to be investigated and added to the project scope as conceptual design concepts are firmed up. Costs for these items could range from a few million dollars to several 100 million dollars.

- EMU vehicles, right-of-way maintenance vehicles or TBM equipment
- Off-site MSF modifications/additions to support the SmartTrack vehicle fleet
- Modification of existing or construction of new interlockings and related track and systems costs (including powered turnouts, signal bridges, signal logic/controllers, ATC/ATO etc.)
- Infrastructure modifications or additions associated with Ontario Hydro power supply and transmission requirements
- Station features other than entrances (e.g. bus platforms, pick up/drop off)
- Municipal road profile modifications due to additional bridge spans
- Alternate excavation (e.g. mining) and support of excavation methods
- Environmental remediation/mitigation and storm water management
- Monitoring of existing utilities and structures during construction
- Temporary or permanent business losses
- Underpinning of existing structures
- Operating and maintenance costs, including right-of-way usage
- Premium associated with a compressed schedule
- Harmonized Sales Tax and/or rebates, if any
- Project financing costs

7.5 ECLRT Phase 2

An estimated cost of $1.3 B ($2015), including 5% for property acquisition, 18% for professional services and 28% for construction contingencies, was provided by Metrolinx for the ECLRT Phase 2, extending approximately 11 km from Mount Dennis Station to the boundary of Pearson International Airport (at the proposed Silver Dart Station). This estimate includes the underground alignment from Mount Dennis Station to east of Jane Street, and the following key features:

- 14 surface stations along Eglinton
- 2 surface stations north of Highway 401 (beyond Renforth Gateway)
- Passenger transfer at Renforth Gateway is via an open air covered walkway and stairs, with elevators for accessibility.
- The alignment terminates at Silver Dart Station, consistent with the current approved EA. A connection into the airport is NOT included.
- The TTC bus terminal at Mount Dennis Station will be relocated to Jane Station and will remain the same size (15 bus bays).
- The Eglinton Maintenance and Storage Facility (EMSF) will be expanded to accommodate additional vehicles (A raw construction cost of $54M was estimated by Metrolinx and included in the overall estimate).
- 24 additional vehicles are included, at an estimated cost of $100M.

In order to develop an estimate for the ECLRT Phase 2 that can then be compared to those for the SmartTrack alignments, the $1.3B total estimate provided by Metrolinx was reduced to its raw form by removing the property, professional services and contingencies mark-ups, as well as the estimated MSF and new vehicle costs. This resulted in raw construction cost of $666M. A per-km cost of $60.5M was then calculated, based on the 11 km length.

Using a length of 9km to reflect a comparable route only as far west as Commerce Blvd, the per-km cost, plus contractor overhead and profit (15% and 3%, respectively), results in a revised raw construction cost of $645M. Applying the same contingency ranges used for the SmartTrack estimates (See Table 12), an order of magnitude estimate of $1.1B to $1.3B was calculated.

For an apples-to-apples comparison between the estimates for the SmartTrack alignment alternatives and the Base Reference Case (ECLRT Phase 2), the cost of the line extension and additional station in the MACC must be removed. These reduced figures are shown in the middle column of Table 12.

Alignment	Order of Magnitude Estimated Costs* ($B) Mount Dennis to *Renforth Gateway*	Order of Magnitude Estimated Costs* ($B) Mount Dennis to *Orbitor/Matheson*
1Ae	4.7 – 5.7	5.7 – 6.9
1Aa	4.8 – 5.8	6.3 – 7.7
1Ba	4.3 – 5.2	5.8 – 7.1
1C	3.7 – 4.5	5.1 – 6.3
1D	4.0 – 4.9	5.5 – 6.8
2B	3.1 – 3.8	3.9 – 4.8
2Ca	2.7 – 3.3	3.6 – 4.4
Base Reference Case *(derived from data provided by Metrolinx)*	1.1 – 1.3	N/A

***Note: These totals do not include potential modifications to the Kitchener Corridor between Union Station and St. Clair (or Woodbine) as may be required to support integrated SmartTrack and GO RER services (potentially costing a further $1B to $2B), or other items listed in Section 7.4.**

Table 12: Comparison of SmartTrack and ECLRT Phase 2 Costs

8 Community and Land Use

The evaluation of SmartTrack alignments is based on the three city-building principles developed by the City in the "Feeling Congested?" initiative which, in turn, is part of the City's larger, on-going Five Year Official Plan Review and Municipal Comprehensive Review process. The principles - Serving People, Strengthening Places and Supporting Prosperity - and their eight associated criteria were used as the backdrop against which this evaluation framework and measures of effectiveness were defined in order to determine the degree to which each of the feasible SmartTrack alignments (and the station stops along their routes) satisfied the criteria.

These criteria can be categorized within 2 main categories – Community and Land Use, and Transit Service. The table below indicates which criteria fall within each category and the section in which they are discussed. The remainder of this Section focuses on the assessment of criteria within the Community and Land Use category. The results of this evaluation are summarized in Appendix 10.

Table 13: City Building Principles and Criteria

Principles	Criteria	Section
Serving People	Experience	Section 9: Transit Service
	Choice	
	Social Equity	**Section 8: Community and Land Use**
Strengthening Places	**Shaping the City**	
	Healthy Neighbourhoods	
	Public Health and the Environment	
Supporting Prosperity	**Supports Growth**	
	Affordability	Section 5.2: Track Alignments & Variants Section 7: Cost Comparison Section 8.7: Impacts to Private Property

8.1 Introduction

Construction and operation of any new transportation corridor, especially a heavy-rail one, have implications on existing properties, public infrastructure and future development, as well as existing environmentally sensitive areas. This section summarizes the potential community and land use impacts resulting from implementing the new SmartTrack alignment west of Mount Dennis as identified and evaluated within the context of the city-building principles and criteria established by the City.

The ECLRT Phase 2 alignment (as defined in the approved TPAP) provides the Base Reference Case against which the potential SmartTrack alignment alternatives are compared.

The focus of the Community and Land Use analysis is the compatibility of the local community and the surrounding land uses with the proposed infrastructure. This Section describes the results of this analysis including the identification of potential impacts on sensitive features and land uses, considering both the impacts from construction and operation. Additionally, this analysis considers the opportunity for each alignment to improve the corridor public realm and/or improve development opportunities from a land use perspective. Finally this analysis looks at impacts of each alignment on:

- desirability of existing developable land or opportunities
- property requirements
- stable residential neighbourhoods (i.e. increased noise, vibration, emissions, visual intrusion, or other negative impacts)

This section also offers a summary of potential private property impacts (see section 8.7) and an assessment of the order of magnitude costs (see Section 7 for more detail) for each alignment alternative.

8.1.1 Eglinton Corridor Planning Context

The Eglinton Corridor from Mount Dennis to the MACC is diverse in form, land use and character. It passes through major park spaces, apartment neighbourhoods, low density neighbourhoods, mixed-use nodes and employment areas.

Weston Road serves as the main street for the Weston/Mount Dennis community, supporting shops, services and restaurants. Moving west, the road transitions into a major park space; this includes the Eglinton Flats, Fergy Brown Park, the Scarlett Woods Golf Course, and the Humber River. At Scarlett Road, a collection of high rise residential buildings are set back from both sides of Eglinton Avenue, providing a wide boulevard. From Jane Street to the MACC, the Eglinton West multi-use path is located on a wide right-of-way along the south side of Eglinton Avenue.

Between Scarlett Road and Highway 427, the Eglinton Corridor is characterized by rear-facing low density residential housing punctuated by high-rise residential developments and mixed-use nodes providing neighbourhood services. Between Islington Avenue and Martin Grove Road, Eglinton Avenue is currently experiencing significant change as the large setback on the north side of the street is being redeveloped with a mix of townhouses and higher density developments. Two significant woodlots, at Wincott Drive and Kipling Avenue, provide wide green setbacks on either side of the street. As well, two school properties and Richview Park contribute to the natural character of Eglinton Avenue.

After passing under Highway 427, where it meets Highway 401, Eglinton Avenue transitions into the MACC Employment District in Mississauga. New development

of office and commercial space in this area, as well as the Mississauga Transitway, are transforming this section of Eglinton Avenue, adding new uses and a more street-oriented form of development, particularly along the north side of the street. On the south side of Eglinton, a multi-use trail through the hydro corridor connects to the larger Centennial Park.

Development along the Eglinton Corridor is guided by City of Toronto and City of Mississauga planning policies, as well as provincial policies including The Big Move, Metrolinx' Mobility Hub Guidelines, and the Growth Plan for the Greater Golden Horseshoe. Eglinton Avenue is identified as an *Avenue* by the City of Toronto from east of Black Creek Drive to Martin Grove Road. According to the Official Plan, *Avenues* are "important corridors […] where re-urbanization is anticipated and encouraged to create new housing and job opportunities while improving the look of the street, shopping opportunities and transit service for community residents" (City of Toronto Official Plan, Chapter 2.2.3). Growth is encouraged in *Mixed-Use Areas*, like the nodes at Widdicombe Hill Boulevard/Lloyd Manor Road, Wincott Drive and Weston Road. Other areas, like *Neighbourhoods* and *Apartment Neighbourhoods*, which form the majority of the Eglinton Corridor, are not designated for growth. However, the City does intend to strengthen transit service to these neighbourhoods (Chapter 2.3.1).

The MACC is one of the City of Mississauga's four Corporate Centres, where the majority of lands are designated for *Business Employment* uses. Here, the City plans to "achieve compact transit supportive development and greater employment densities, particularly near higher order transit stations" (Mississauga Official Plan, Chapter 5, 5.3.4.8). The objectives for the MACC include development of a more urban character with street-related buildings, active building entrances particularly on major streets and transit stations, higher density office and commercial development, streetscape improvements and more compact building forms (City of Mississauga Official Plan, Chapter 15.2).

8.1.2 Woodbine Corridor Planning Context

The Woodbine Corridor follows the existing Kitchener GO Rail line from Union Station through Mount Dennis toward the northwest.

The corridor runs nearly parallel to Weston Road and the Humber River from Eglinton Avenue to St. Phillips Road. Throughout this stretch of the corridor, Weston Road functions as an important main street for the community, particularly where it intersects with Eglinton Avenue, Jane Street and Lawrence Avenue, containing street-related retail, office and commercial space, as well as social service providers. Directly adjacent to both sides of the rail corridor, south of St. Phillips Road, are many detached, semi-detached and townhouse units. There are also some commercial and industrial uses of varying sizes. For example, one of the large employers along this portion of the corridor is the Irving Tissue Corporation on Jane Street. The Maintenance and Storage Facility for the

Eglinton Crosstown is under construction at the former Kodak Lands at Eglinton and Black Creek Drive. The rail line poses a significant barrier between the east and west sides of the tracks and few opportunities exist for crossing.

To the northwest, the corridor passes the Weston Golf and Country Club and the Humber River, entering into a major Employment District, where, with the exception of the Woodbine Racetrack near Highway 427, low-scale industrial buildings dominate the landscape until it reaches the airport.

Two GO Transit stations presently exist along the Woodbine Corridor, Weston Station and Etobicoke North Station – the former also services UPX trains.

Planning policies that affect this corridor include the Toronto and Mississauga Official Plans as well as provincial policies including The Big Move, Metrolinx' Mobility Hub Guidelines, and the Growth Plan for the Greater Golden Horseshoe. The majority of Weston Road east of where it crosses the rail line is identified as an *Avenue*. *Mixed-Use Areas* along *Avenues* are intended to intensify in conjunction with transit improvements. Importantly, the neighbourhoods on both sides of this corridor from Eglinton to Highway 401 are identified as Neighbourhood Improvement Areas. These are neighbourhoods that are targeted for receiving additional investment in services, social infrastructure and community facilities.

In Employment Districts, both Toronto and Mississauga focus on retention of lands for office and industrial use, encouraging the growth of jobs through redevelopment and infill, and protecting lands from encroachment of non-employment use. Both municipalities also recognize the need to provide alternative modes of transportation to Employment Districts and enhanced streetscapes and urban design.

8.2 Social Equity

8.2.1 Improving Access to Neighbourhood Improvement Areas

According the City's neighbourhood equity data, Mount Dennis, Jane and Weston stations are located in designated Neighbourhood Improvement Areas (see Appendix 8A). The geographic resolution of the available data makes this metric difficult to judge from the data alone as the boundaries of these neighbourhoods extend to the border of Etobicoke (the Humber River). Site visits reveal a high population density and greater equity needs exist in close proximity to Mount Dennis and Weston stations. On the contrary, the potential station location at Jane (Alignment 1Ba) is immediately surrounded by parkland with residential land uses outside the walking catchment area. Similarly, Etobicoke North GO station exists in a mid-scoring neighbourhood, but the catchment around the station is commercial and industrial.

Given this, Corridor 2 alignments do well for serving Mount Dennis and Weston neighbourhoods; however, all subsequent stops do not serve any population within walking distance. Further, Corridor 2 alignments will overlap with future RER service, therefore resulting in some redundancy for this metric. Corridor 1 alignments beyond Mount Dennis generally serve neighbourhoods with lower equity needs. Alignment 1Ba serves neither Mount Dennis nor any population within the station catchment of Jane Station. Site visits to the area, however, reveal older midrise housing stock proximate to Scarlett and Kipling stations may suggest that the lower equity needs along the corridor may better characterize the single-detached suburbs dominating the residential landscape set back from Eglinton itself. Therefore, the Eglinton corridor may have greater equity needs than the quantitative data suggests. The Base Reference Case scores slightly better than Corridor 1 alignments due to the local orientation of the design and thus increases the number of potential riders served.

8.3 Shaping the City

8.3.1 Serving Areas of Existing Population

Eglinton corridor alignments pass through areas with the greatest number of residents not already served by rapid transit. The Base Reference Case will serve the largest new population with fourteen new stations along the Eglinton corridor (see Appendix 8B). Corridor 1 alignments come second serving the population within the catchment area of two new stations along Eglinton. Corridor 2 provides new rapid transit service only to the airport, which currently has no residential lands within either 2B or 2Ca airport station pedestrian network catchment areas (PNCA).[1]

8.3.2 Serving Areas of Planned Population Growth

Steady population growth is anticipated along the Eglinton Corridor with a 25-30% population increase projected to 2041 within the PNCAs of the Base Case and Corridor 1 station options. The greater number of stations proposed for the Base Reference Case results in an approximately threefold increase in the projected population served in 2041 compared to the Corridor 1 SmartTrack alternatives. Corridor 2 station areas past Weston are predicted to maintain their nearly exclusive employment function into 2041 based in the most recent projections.

8.3.3 Compatibility with City Planning Policies

The Base Reference Case supports City and Regional planning efforts to the greatest extent. Eglinton Avenue from east of Mount Dennis to Martin Grove Road is identified as an Avenue (see Appendix 8C). In *Mixed-Use Areas* along the Avenues, re-urbanization and intensification, along with “high quality transit

[1] A *Pedestrian Network Catchment Area* (PNCAs) is the total area within a given walking distance from a potential station location. Unlike a Euclidean distance (‘as the crow flies’), the PNCA is calculated using the existing pedestrian network including pathways and streets and thus accounts for barriers such as highways, rivers, and rail corridors.

service" and transit supportive measures (City of Toronto Official Plan, Chapter 2.2.3), are encouraged. As these are intended to become more urban corridors, the Base Reference Case offers the most appropriate type of transit service. The Base Reference Case also provides the most access to *Apartment Neighbourhoods*, where higher densities will support rapid transit infrastructure, *Mixed-Use Areas* accessed at 4 stations and a major *Employment District* accessed at two stations. There are also three Mobility Hubs identified along this alignment.

Alignment 2B and 2Ca are ranked slightly below the Base Reference Case. Weston Road, which runs parallel to the rail corridor, is identified as an Avenue for part of its length. These alignments provide access to major *Employment Districts* at 4 stations *and Mixed Use Areas* at 2 stations and they pass through 2 Mobility Hubs.

Alignments 1A, 1C and 1D provide access to an *Employment District* at one station, *Apartment Neighbourhoods* at 2 stations, and a *Mixed-Use Area* at one station. They also pass through 2 Mobility Hubs. Alignment 1B, while otherwise similar to the other corridor 1 alignments, does not provide access to the *Mixed-Use Area*.

There are two listed heritage properties proximate to the Corridor 1 and Base Reference Case alignments. The Mary Reid House (4200 Eglinton Avenue W) is not anticipated to be impacted by 1A, 1B, 1C or 1D underground tunnelling (although it could be affected by an open cut or trench construction scenario). The Base Reference Case will require a partial taking of property for road widening—no impact to the heritage building is expected. Underground easements will be required for The Bank of Nova Scotia building at the corner of Weston and Eglinton (1511 Weston Avenue) for Alignments 1Aa (underground) and 1B. 1Ae (elevated) and Base Reference Case will likely require a partial taking of the property to accommodate anticipated road widening. There are no heritage properties proximate to Corridor 2 alignment options.

8.3.4 Existing Physical Barriers

Generally speaking, Corridor 1 stations have fewer physical barriers than Corridor 2 stations. One exception is the Humber River which constrains eastward movement at Scarlett station on alignments 1A, 1C, and 1D. By comparison the Woodbine corridor stations are constrained by a large number of physical barriers limiting the accessibility of future station catchment areas. Notable barriers include Highways 427, 409 and 401, the hydro and pipeline corridor which passes just to the west of Etobicoke North Station, and the Kitchener GO line itself poses as a significant barrier to all potential stations on that corridor. Additionally, the large block street pattern at stations along the Woodbine corridor is less conducive to pedestrian access in contrast to the

tighter modified grid pattern found around the relatively more urban stations at Mount Dennis and along Eglinton.

A quantitative measure of the percentage of area lost to physical constraints was used to confirm the qualitative observations described above. Appendix 8D presents a map highlighting barriers within the study area.

8.3.5 Supporting City-Building Opportunities

This criterion assesses support for new, planned or proposed development and opportunities for place-making, including connectivity to major amenities such as open spaces. New rapid transit infrastructure will support transit-oriented development and increase ridership.

The Base Reference Case alignment provides the most significant support for city-building, as there is significant development occurring around its 15 stations (from Mount Dennis to Renforth). This includes 12 townhouse and mid- to high-density residential developments either in the application or construction stages between Mount Dennis and Martin Grove Road (see City Planning Eglinton West Development Applications Map, dated January 2015, in Appendix 2E), and additional potential opportunities within the MACC, at Mount Dennis and around Scarlett Road. This alignment also provides access to major open spaces (e.g. Eglinton Flats and Centennial Park) that attract visitors from across the City.

There is less opportunity for city-building around the proposed stations at Etobicoke North, Woodbine, and the Airport along Alignments 2B and 2Ca. However, the opportunities that exist are significant and focus on regional economic growth, rather than residential intensification. There is potential for new development around each station, with major opportunities at Woodbine station, Etobicoke station and both MACC stations.

Alignment 1A, 1Ba, 1C, and 1D support city-building opportunities to a lesser extent than the other alignments, in part because there are fewer stations along these alignments. Where stations are located along Eglinton Avenue and at the MACC, these alignments support ongoing residential redevelopment, and will also provide access to major open spaces (e.g. Eglinton Flats and Centennial Park) that attract visitors from across the City.

8.3.6 Partnership Opportunities for Transit-Oriented Development

This criterion assesses partnership opportunities for TOD at stations. These are opportunities for integrating station entrances or infrastructure with new development. At each station location, the properties adjacent to each stop were identified. Those with development potential are those that:

- contain large amounts of surface parking; or
- are vacant

Alignment 2B and 2Ca were ranked the highest as there is significant opportunity for TOD partnership at all of the station locations.

The Base Reference Case alignment was ranked slightly lower, as there are more stations, but more limited opportunity for integrated development. Some opportunity for TOD partnership does exist at Mount Dennis, Wincott Drive, Widdicombe Hill Blvd, East Mall, Renforth and Commerce Drive. The remaining station sites, however, are already quite built out or are currently under redevelopment.

Alignments 1A, 1Ba, 1C, and 1D were ranked lowest, as there is limited opportunity for new TOD partnership directly adjacent to station entrances. Most station sites are already under redevelopment, or are adjacent to park space. Some opportunity does exist at Mount Dennis and in the MACC, which are common to the Base Reference Case, Corridor 1 and Corridor 2 alignments.

8.4 Healthy Neighbourhoods

8.4.1 Compatibility with Existing Neighbourhoods

This criterion assesses opportunities to enhance existing stable neighbourhoods through improved connectivity or place-making, as well as potential impacts on stable neighbourhoods both in construction and operation phases.

As it has the most stations in the immediate vicinity of stable neighbourhoods, the Base Reference Case scores highest in terms of opportunities to enhance neighbourhood connectivity and place-making, but lowest in terms of minimizing neighbourhood impacts.

Alignments 2B and 2Ca have fewer opportunities for neighbourhood place-making and connectivity, but also significantly minimize impacts of construction and operation on stable neighbourhoods. This is because the alignment runs along an existing rail corridor, and a higher proportion of the alignment is adjacent to employment or mixed-use areas, as opposed to neighbourhood areas.

Alignment 1A, 1B, 1C and 1D contain some opportunity for neighbourhood place-making and connectivity, especially in redeveloping areas and apartment neighbourhoods along the corridor. Stable neighbourhoods along the corridor, however, will also be significantly impacted by construction and operation of transit. 1Aa and 1Ba pass under existing residential properties on the north side of Eglinton between Mount Dennis and the portal in Eglinton Flats.

Alignment 1C has significant property impacts to residential properties in the neighbourhoods north of Eglinton Flats requiring underground easements on a number of properties before the portal between West Park Health Care Centre and York Humber High School properties. In addition, Emmett Avenue will need

to be severed and the private parking lot and recreation facilities of a mid-rise apartment complex would need to be acquired (see Figure 34). There may be opportunities to mitigate the traffic impacts at Emmett during detailed design of the corridor, should this option be carried forward.

Alignment 1D requires significant property takings for construction. South of Eglinton Avenue partial and full takings of private homes are required to accommodate corridor widening. Further, a relocation of Weston Road to the west will impact mixed-use and residential properties, including a Catholic School and Church. North of Eglinton Avenue a partial taking of apartment block lands may be required for corridor widening. Directly west of the Kitchener corridor a full property taking of an entire residential block is required for cut and cover and open trench construction.

A map of potential property impacts is found in Appendix 8E.

Figure 34: Emmett Avenue where Alignment 1C would be severed and require private property taking at driveway entrance to the left

8.4.2 Improving Access to Community Services and Facilities

The Base Reference Case provides the most opportunity for improving access to community services and facilities, as it will introduce 12 new rapid transit stations in locations where community services/facilities are located within the 500 metre PNCA. See Appendix 8F.

Alignment 1A, 1Ba, 1C, and 1D will each introduce 4 new rapid transit stations where community services/facilities are located within the 500 metre PNCA.

Institutions and facilities along the Base Reference Case and Alignments 1A, 1Ba, 1C, and 1D will all likely be impacted during construction, but not during operations.

Alignment 2B will introduce 2 new rapid transit stations, and Alignment 2Ca will introduce 1 new station where community services/facilities are located within the 500 metre PNCA. In both cases, institutions and facilities are not likely to be significantly affected during construction or operations as it is an existing rail corridor.

8.4.3 Eliminating Barriers within Neighbourhoods

Corridor 1 alignments travel through existing neighbourhoods. Construction along Eglinton will have a significant impact, especially during the deployment and extraction of TBMs and station and emergency exit/ventilation system construction. After completion, alignments 1A and 1Ba will pose minimal barriers to existing neighbourhoods. 1C could require the closure of Emmett Avenue north the Eglinton Flats, resulting in a significant barrier to vehicular modes in that neighbourhood. Should 1C be selected as the preferred alignment, alternatives to closing Emmett Avenue could be investigated during design to accommodate active and vehicular traffic. Alignment 1D would require permanent closure of a portion of Nickle Street – a residential side street between Ray and Craydon Avenues – to accommodate a portal in an open cut trench to the west of the Kitchener GO Corridor

Corridor 2 alignments follow the existing Kitchener GO Corridor through existing neighbourhoods and therefore score better on this criterion than the other alignments. The north-south portions of the Corridor 2 alignments travel through industrial properties and therefore have no impact on existing neighbourhoods.

The Base Reference Case will affect traffic on Eglinton with the imposition of transit signal priority and turning restrictions. The pedestrian crossing distances would be lengthened along much of Eglinton; however, depending on how the ROW is designed, crossing distances could be minimized with the incorporation of complete streets elements thus reducing the perception of Eglinton as a barrier from an active transportation perspective.

8.5 Public Health and Environment

8.5.1 Impacts and Compatibility with the Natural Environment

Corridor 2 alignments, by virtue of their route following existing track before heading south through industrial areas near the airport, have the fewest impacts to natural features. Both alignments interact with the Mimico floodplain; however, the impacts are mitigated by the proposed track elevation.

All Corridor 1 alignments impact Eglinton Flats in some way. Alignment 1D presents the greatest impact to the park as the elevated guideway traverses the

park diagonally. Further, construction of the portal at the north-east corner of the park will disrupt a mature forest stand near the corner of Pinehill Crescent and Jane Street. Alignments 1Aa and 1Ba also impact the park with a long elevated crossing distance; however, the impact is confined to the southern edge of the park. Alignment 1C has a shorter crossing distance but cuts directly through the western section of the park. Alignment 1Ae passes to the south of the park in the middle of the Eglinton Ave right-of-way; however, impacts are anticipated during construction and by the potential need for road widening to accommodate the guideway piers. 1A alignments intersect Black Creek, and all Corridor 1 alignments cross the Humber River, Emmett Creek, and Mimico Creek; however, the alignments have been designed to provide adequate below- or above-grade crossing clearance to minimize potential impacts. For all Corridor 1 alignments, station entrances and supporting infrastructure at the proposed Kipling station would impact the mature forest stand on the NW corner of that intersection which has been identified as a community asset.

The Base Reference Case alignment has fewer impacts to natural features as it follows the road ROW throughout its length. Some impacts are anticipated where widening is required.

8.5.2 Compatibility with Parks and Public Spaces

This criterion assesses potential compatibility with parks and public spaces. Parks and/or public spaces that were partially or fully within the 500 metre PNCA of each station were identified and counted.

The Base Reference Case provides the strongest compatibility, with access to many parks and public spaces of varying scales and sizes, including the Eglinton Flats, Keelesdale and Coronation Parks, woodlots at Wincott and Kipling/Eglinton, the hydro corridor to Centennial Park, West Deane Park, Richview Park, Buttonwood Park and several open spaces connected to schools.

Alignments 1A, 1Ba, 1C, and 1D provide less compatibility, as they are connected to fewer parks and public spaces – alignment 1Ba provides slightly better access to the Eglinton Flats as the station location is more central in the park. At the same time, each of these alignments, with the exception of 1Ae, propose an elevated structure through the Eglinton Flats, which would impact the park significantly during construction and operations. Further, the elevated segment proposed for 1D through the Flats would require the relocation or elimination of a number of playing fields. 1Ae poses the least impact with the majority of its elevated section travelling through the Eglinton ROW. Alignment 1C has the shortest crossing distance through the park, but will not follow Eglinton Avenue where a ROW already exists. Alignments 1Aa and 1B pose significant impact to the park, with these elevated portions traversing the park property along the southern border. See the maps of potential property impacts in Appendix 8E.

Alignments 2B and 2Ca are ranked lowest, as they provide limited access to parks and public spaces along the corridor; concurrently, there is no anticipated parkland impact during the construction and operation of these alternatives.

8.5.3 Encouraging People to use Public Transit and Drive Less

A measure of success of a transit network from a Public Health and Environment perspective is its ability to reduce the number and length of trips completed in a private vehicle. This acts as a proxy to help understand each alignment's potential to reduce emissions that contribute to climate change and poor air quality. A representative alignment from each corridor was modelled within the GTA Model V4.0 travel demand forecasting system providing an estimate of the reduction in (a) vehicle kilometers travelled (VKT) and (b) auto mode share.[2] The Jan 18, 2016 modelling results (Release 1) reveal comparatively little differences between the alternatives studied. For the AM auto mode share, all options exhibited similar reductions of between 0.19% and 0.23 %, corresponding to VKT reductions of 181,290, 197,310, and 200,950 for Corridor 1, Corridor 2, and the Base Reference Case, respectively.

8.6 Supports Growth

8.6.1 Serving Areas of Existing Employment

This criterion compares each alignment's potential to provide new rapid transit service to existing (2011) employment within the 500m PNCA of each alignment's proposed stations. Those stations which are planned to receive rapid transit service in the future (e.g. RER) were excluded from the assessment so as to evaluate each alignment's potential to provide *new* rapid transit service to employment areas.

Based on 2011 employment densities, Alignment 2B serves the greatest number of employees currently not served by higher order transit amongst the proposed SmartTrack alignments. Removing the redundancy of Mount Dennis, Weston, and Etobicoke North stations (these station areas are planned to receive future RER service) the high employment densities around the airport station area alone outnumber the lower employment catchment potential of all the stations along the Corridor 1 alignments (see Appendix 8G). Alignment 2Ca has a lower employment catchment compared to 2B due to: (a) lower employment density compared to the sister 2B airport station location east of Highway 427 and (b) the reduced catchment area resulting from the barrier effect of the highway. The Base Reference Case, while having a lower per station employment catchment, would serve an overall higher number of current employees compared to all other SmartTrack alignment options due to the larger number of proposed station stops.

[2] Unless otherwise stated, all modeling results cited in this report and Appendix 10 are based the 2031 "*Low population, Medium employment with SmartTrack Influence*" scenario with an assumed 15 minute SmartTrack headway and TTC fare

8.6.2 Serving Areas of Planned Employment Growth

Overall, the projected 2041 employment along all of the Corridor 1 alignments is expected to come closer to Alignment 2B. Alignment 2Ca with its airport station to the east of Highway 427 is anticipated to serve the lowest employment function amongst all studied alignments. The Base Reference Case nearly doubles the projected employment catchment numbers of Corridor 1 alignments and alignment 2B, serving a predicted 4467 employees in 2041 within its stations' 500m PNCAs.

8.6.3 Supporting and Strengthening Existing Businesses and Industry

This criterion assesses support for local businesses and industry by improving accessibility, as well as assessing the potential impacts of construction and operation on these sectors. Properties containing non-residential land uses that are partially or fully within the 500 metre PNCAs of each station were identified and counted.

Alignments 2B and 2Ca rank highest, as there are significant non-residential uses at all station areas on both alignments, including major business and employment areas. These areas will become much more accessible with either alignment, with minimal impact. There are major non-residential land uses at 6 of 15 stations on the Base Reference Case alignment and at Mount Dennis and the

Figure 35: Irving Tissue Factory (looking north and south)

two MACC station along Alignment 1A, 1B, 1C and 1D. These are of a smaller scale than Alignments 2B and 2Ca. In addition, negative impacts may be more significant with development of a new transit corridor along Eglinton Avenue. Alignment 1C could potentially require property taking of a narrow section of land at the Irving Tissue Factory on the west side of the Kitchener Corridor (see Figure 35). As the recently expanded facility directly abuts the property line, this alignment could potentially pose a significant impact to the business (see Appendix 8E). Further design analysis and evaluation is needed to minimize the potential property impacts at this location.

Alignment 1D will impact a large format retail centre along Weston Road between Gunns Road and Rogers Road. The proposed track centreline runs through a number of existing commercial buildings on that site, with a number of additional businesses potentially affected by the need for additional space alongside the new track.

8.7 Impacts to Private Property

The major property impacts for each corridor accrue in the immediate vicinity of the location where the rail corridor splits off from the Kitchener GO Corridor. For Corridor 1 alignments, this happens in the more established mixed-use, industrial, and residential neighbourhoods around Mount Dennis resulting in some significant impacts to private property. Alignments 1Aa, 1Ae, and 1Ba require the relocation of CP tracks to the east side of the rail corridor. This mainly affects the fringe of low-density industrial properties between St. Clair Ave and Rogers Rd. Temporary impacts are anticipated to the No Frills property at the south-west corner of Black Creek Drive and Eglinton West for 1A alignments; however, footings of the elevated structure required for alignment 1Ae will limit the development potential of the site by limiting building heights. Alignments 1Aa and 1Ba will require below-grade easements underneath existing residential and heritage properties on the north side of Eglinton to the east of the Eglinton Flats, while 1Ae will utilize the existing right-of-way.

Alignment 1C, which diverts from the Kitchener GO Corridor after Nickle Interlocking, requires below-grade construction beneath existing stable residential neighbourhoods before emerging just north of Emmett Ave and travelling elevated through the Eglinton Flats to meet Eglinton just before Scarlett Road. This alignment will also require the partial taking of the north and eastern edge of the Irving Tissue Factory currently occupied by the newly expanded facility.

Alignment 1D, which utilizes the proposed St. Clair interlocking then travelling on new tracks to the west side of the corridor before diverging just north of the Ray Street overpass, presents the greatest impacts to private property. The Kitchener Corridor must be widened to accommodate two new tracks on the west side of the corridor between St. Clair Avenue and Ray Avenue, permanently impacting a number of residential, commercial, and industrial properties fronting the corridor on that side. The alignment also encroaches onto the Weston Road right-of-way and will require the road to be re-located between Rogers Road and Black Creek Drive thus impacting a number of properties including a catholic school and church. In addition to the required property takings, additional properties may be affected by a perceived need to accommodate the 30 m setback typically requested of new developers adjacent to railway property to mitigate for sound, vibration, and derailment risks. North of Ray Avenue where the corridor splits from the main line, open cut and cut-and-cover construction methods through the Weston neighbourhood are necessitated by the sharp turn and steep grade in

that area. Specifically, this option will require the acquisition of a block of homes and tunnelling beneath a number of residential properties and a school before emerging from a portal onto Eglinton Flats on the west side of Jane Street. This option then diagonally traverses the Eglinton Flats before meeting Eglinton Ave just before Scarlett Road.

Corridor 2 alignments have significantly fewer impacts to private property because they divert from the GO Kitchener Corridor after Woodbine Racetrack in a largely low-density industrial area. Some industrial property takings will be required; however, many of these can be avoided by shifting the alignment further within the public right-of-way.

The Base Reference Case, being an extension of the Phase 1 ECLRT, avoids many of the property impacts proposed by any of the Corridor 1 and 2 alignment alternatives by following the public right-of-way along Eglinton Ave and further to the airport. Some property impacts are anticipated where road widening will be required to accommodate the centre tracks at street level.

An annotated map of key property impacts are summarized in Appendix 8E.

9 Transit Service

9.1 Introduction

Section 9 section contains the results of the customer-oriented 'Transit Service' criteria under *Choice* and *Experience*.

9.2 Choice

9.2.1 Connectivity to Surface Transit Routes

All potential Corridor 1 and 2 station locations are currently served by high frequency bus service—five minute or better peak service (see Appendix 9A). Alignment 1Ba is differentiated from the other Corridor 1 alignments by its connection to the high frequency Jane bus (express, local, and night buses) but falls short in its lack of connection with a future Mount Dennis station where future bus reconfigurations will interface with the ECLRT terminus. Corridor 2 alignments connect with five high frequency bus routes, three of which connect at the existing Weston Station. Both the Base Reference Case and Corridor 1 alignments overlap with the existing Eglinton bus, which offers 24 hour bus service with 2 minute peak headways. The Base Reference Case stations also connect with moderate frequency routes – 5 to 10 minute peak service – on Royal York (73), Islington (37), Martin Grove (46) and the East Mall (111).

9.2.2 Connectivity to Higher-Order Transit Services

All alignment alternatives connect with the future Mississauga Transitway at the proposed Renforth Gateway station, providing a dedicated east-west transit corridor from the MACC through to Winston Churchill Boulevard in the west. The Base Reference Case and Corridor 1 and 2 alignments, with the exception of 1Ba, connect with future RER and ECLRT service at Mount Dennis station. From the MACC, the Base Reference Case provides a single seat journey along Eglinton to Kennedy subway station with connections to GO/RER Kitchener, Barrie, and Stouffville lines as well as both legs of the Yonge-University-Spadina subway. Corridor 1 and Corridor 2 would provide a single seat from Union to the MACC with a transfer at Mount Dennis to the ECLRT Phase 1 (exception: 1Ba) and GO RER. The two Corridor 2 alignments are differentiated by their airport connection to the Pearson Airport People Mover; Alignment 2B connects to the People Mover at the Viscount Parking lot while 2Ca falls short.

Alignment 1Ba does not connect to the future Mount Dennis station and thus bypasses a key future rapid transit connection. The proposed station at Jane, however, connects with the planned Jane LRT.

9.2.3 Connectivity to Walking and Cycling Routes

Eglinton West is served by an in-boulevard multi-use trail from Jane Street to Renforth Drive (Figure 36) with an extension to Black Creek Drive planned as part of the Mount Dennis station construction. There is also a north-south multi-use trail connection along the Humber River with trail entrances at Scarlett Road. Alignments 1A, 1C, and 1D connect with this major active transportation intersection at the proposed Scarlett station. All Corridor 1 stations are served by a relatively well-connected sidewalk network along Eglinton and on streets approaching the potential station locations (See Appendices 9B and 9C).

Figure 36: Multiuse trail on south side of Eglinton looking west at Kipling

The Base Reference Case ECLRT connects with the same active transportation infrastructure as Corridor 1 alignments, while also connecting to the existing north-south cycling facilities at its proposed Royal York, Wincott, and Martin Grove stations, with infrastructure upgrades planned for the two latter station stops.

Current pedestrian and cycling infrastructure around Corridor 2 stations beyond Weston is generally limited in comparison to Corridor 1 and the Base Reference Case alignments. The proposed stop at Weston station is the exception with a well-developed pedestrian network. Limited pedestrian and cycling facilities characterizes the largely industrial area of the latter stations. Even considering plans for improved cycling facilities around Etobicoke North and Airport (2Ca) stations along Kipling, Carlingview, and Dixon, Corridor 2 station catchments are and will continue to be predominantly auto-oriented in the medium-term.

9.2.4 Supporting Transportation Infrastructure

With the exception of Alignment 1Ba, all potential alignment alternatives have the potential to share supporting transportation infrastructure at the future Mount Dennis station. Further, Corridor 2 alignments have the potential to share station infrastructure at the existing Weston and Etobicoke North GO stations. Weston station has recently undergone renovations to support the new UPX service to the Airport. Beyond Etobicoke North, potential station locations at Woodbine and the Airport are situated in areas with few space constraints for a future full-service station, although a major electrical substation is planned for the

electrification of the GO Kitchener Corridor in the vicinity of Highway 27, which could limit the design and/or effectiveness of a new Woodbine station.

Compared to Corridor 2, Corridor 1 alignments are generally more constrained past Mount Dennis due to the more urbanized nature of the station catchment areas. Jane Station on alignment 1Ba is constrained by parkland to the north and southeast (Eglinton Flats and Fergy Brown Park), and by city-owned Scarlett Woods Golf Course to the southwest. The proposed Scarlett station on alignments 1A, 1C, and 1D is constrained to the east by the Humber River and parkland (Raymore Park and Scarlett Mills Park) with private greenspace to the north- and southwest. At both Jane and Scarlett stations, there is an approximately 13 m buffer north of the current Eglinton ROW, where the elevated section is proposed to run and where potential supporting infrastructure could be located beneath. Kipling is further constrained by the sale of the northern right-of-way previously held for transportation infrastructure. An undeveloped woodlot exists at the northwest corner of Kipling and Eglinton; however, the site has been identified as an informal community asset.

The Base Reference Case station stops west of Mount Dennis are located mid-street; the EA does not include space intensive supporting facilities such as PPUDOs or bus terminals at most stations. The SmartTrack services considered in this study are more similar to GO Transit services (i.e. longer station spacing, fewer local transit connections), where such infrastructure is more common. If a modified Base Reference Case (e.g. one with fewer stops) is to be considered, then it will be necessary to consider these additional facilities similar to Corridor 1 as discussed above.

9.3 Experience

The criteria which fall under the ‘Experience’ category evaluate each alignment’s ability to improve the overall user experience. The conclusions are largely based on forecasts from Release #1 (Jan 18, 2016) of the GTA Model V4.0 travel demand forecasting system. Forecasts were prepared for both 2031 and 2041 with the key results for 2031 summarized in Table 14 immediately below and in the text following. Unless specified otherwise, all figures reported refer the “Low Population/Medium Employment with SmartTrack Influence” scenario and assume a TTC Fare and 15 Minute SmartTrack service.

Criteria	Corridor 1: Continuous via Eglinton Ave West	Corridor 2: Continuous via Woodbine	Base Reference Case: ECLRT Phase 2
Travel Time (Union Station to Renforth Gateway)	29-32 mins	39-42 mins	54 mins
Ridership (all day boardings in 2041)	9,462	19,539	39,536
Total Transit Riders (Daily net new riders on the system)	20,124	24,934	25,746
Relief to Existing Transit Network (% Change in Ridership from the "do nothing" scenario on the Yonge Subway south of Bloor)	2.6%	2.6%	1.6%

Table 14 Travel time estimates and travel demand forecasts to 2031

9.3.1 Travel Time

From a user experience perspective, Corridor 1 alignments are the most appealing with the shortest estimated travel time compared to the Base Reference Case and Corridor 2 alignments. A trip from Union to the MACC on Corridor 1 alignments is estimated to take between 26 and 32 minutes, with the shortest trip being achieved with alignment 1Ba, which benefits from a travel time perspective by not including a Mount Dennis Station. The Base Reference Case has a predicted travel time of 54 minutes which is based on an assumed 6 minute average transfer time at Eglinton West from a TTC subway train. The trip from Union to MACC via Corridor 2 is estimated at 42 and 39 minutes for alignments 2B and 2Ca, respectively. See section 6.3.2 for further explanation of estimated travel times.

9.3.2 Ridership

This criterion assesses the future ridership potential of each of the proposed alternatives. The highest ridership is anticipated to occur on the Base Reference Case with over 39,500 all day boardings predicted in 2031. This estimate represents an approximate 2- and 4-fold increase compared to the Corridor 2 and 1 alignment options, respectively. These numbers are predicted in spite of a longer travel time offered by the Base Reference Case compared to the limited stop, heavy rail SmartTrack alternatives. Corridor 2 alignments attract over 19,500 all day boardings while Corridor 1 alignments attract the fewest riders (nearly 9,500 all day boardings).

The modeling results for 2041 exhibit similar rankings between the options, with noticeable increases for the Base Reference Case and Corridor 1, 47,800 and 12,500 respectively. Corridor 2 remains almost unchanged, at 20,700.

9.3.3 Total Transit Ridership

This criterion assesses the alignment alternatives based on their ability to attract new transit riders to the system as a whole and speaks to an option's potential to change system-wide travel habits. The Base Reference Case and Corridor 2 alignments offer the greatest potential to attract new riders at around 25,000 for both alternatives in 2031. Corridor 1 alignments are anticipated to have a weaker effect, attracting approximately 20,000 new system riders by the same year. The results suggest that employment areas not already served by higher order transit have the greatest potential to facilitate a mode shift amongst commuters. This trend continues to 2041 roughly doubling the number of new riders for each option, with the Base Reference Case, Corridor 2 and Corridor 1 developing approximate new ridership of 55,700, 50,700 and 50,100, respectively.

9.3.4 Relief to Existing Transit Network

Alternatives were measured against their ability to relieve crowding on the Yonge Line south of Bloor – a critical piece of the transportation network that is currently nearing capacity. Corridor 1 and 2 alignment alternatives are anticipated to have roughly the same 4.8% reduction to ridership south of Bloor during the AM Peak Period compared to the "do nothing" scenario in 2031. The impact of the Base Reference Case option on ridership south of Bloor is slightly lower at 3.7% during the AM Peak Period. Ridership modelling results suggest a greater reduction of 8 to 11% may be achieved with a 10 minute SmartTrack service.

9.3.5 Proximity to Key Destinations

This criterion assesses the ability to enhance access to key destinations that are accessed by people in the community and from across the City and Region, including:

- Hospitals/Colleges/Universities
- Community recreation facilities including arenas and Community Centres
- Customer facing government buildings
- Major attractions like golf courses and entertainment facilities
- Major parks
- Schools
- Libraries
- Community halls
- Places of Worship

Key destinations located within or in close proximity to the 500 metre PNCA of each station were identified and counted (see Appendix 8C).

Alignments 1Ae, 1Aa, 1C, and 1D provide access to only 5 places of worship and no schools within the PNCA.

Alignment 1Ba scores the lowest, as it provides access to only one golf course, Centennial Park and the Eglinton Flats within the PNCA.

Alignments 2B and 2Ca are comparable to each other, providing access to three schools and nine places of worship, as well as Woodbine Racetrack from Woodbine Station.

The Base Reference Case scores slightly higher than Alignments 2B and 2Ca, and provides access within 500 metres walking distance to the greatest number and variety of key destinations, including an arena, community centre, Health Care Centre, 2 golf courses, Centennial Park and the Eglinton Flats. It also provides access to 5 schools and 11 places of worship within the PNCA. The York Civic Centre can also be accessed just outside the Mount Dennis PNCA. As a result of this access, this alignment scores the highest on this criterion.

9.3.6 Interchange Station Design

This criterion was evaluated in the following context: “From a user experience perspective, how would the interchange station at Mount Dennis serve as a connection between SmartTrack and the Phase 1 ECLRT?” This was seen as a function of the number of levels required to transfer between services.

On the other hand, for the Base Reference Case the evaluation needs to consider how efficient the transfer is between the ECLRT and the SmartTrack Service along the Kitchener Corridor.

All alignments require a transfer at some point. Alignments 1C, 1D, 2B, and 2Ca share an at-grade station with the future Mount Dennis station. Passengers would be required to descend one level to the future ECLRT platform. 1Ae and 1Aa alignments are less ideal as they would require a three level interchange station at Mount Dennis. The Mount Dennis Station for 1Aa would be one level below the ECLRT station. Even less ideal, the 1Ae would have an elevated station above and perpendicular to the future GO/RER station at Mount Dennis and would require descending two levels to ECLRT. Alignment 1Ba scores the lowest on this metric as it does not connect with Mount Dennis.

10 Key Findings

The proposed SmartTrack service is intended to provide high frequency, bi-directional rapid transit service, stretching between the far west and northeast corners of the city. The purpose of this study was to assess alternative heavy rail alignment concepts to determine if there are any feasible alignments for a western extension of the SmartTrack service between Mount Dennis and the Mississauga Airport Corporate Centre.

A total of twelve (12) alignments were developed and assessed. Of those, four (4) were deemed to be fatally flawed due to infeasibility or the fact that they did not meet the primary objectives of this study. The remaining seven (7) alignments were evaluated based on the three city-building principles described in the City's "Feeling Congested?" - Serving People, Strengthening Places, and Supporting Prosperity initiative. The results of this evaluation, and a comparison to the Base Reference Case, are summarized in Figure 37 below. Figure 38 provides a summary of key evaluation considerations for each alignment. Appendix 10 contains the evaluation broken down by the approved evaluation sub-criteria.

	Base Reference Case	*Corridor 1: Eglinton Continuous Service*					*Corridor 2: Airport*	
Criteria	Approved LRT TPAP	1Ae	1Aa	1Ba	1C	1D	2B	2Ca
Choice	●	◕	◕	◔	◕	◕	◑	◑
Experience	◕	◑	◑	◔	◑	◑	◕	◕
Social Equity	●	◕	◕	◑	◕	◕	◕	◕
Shaping the City	●	◑	◑	◑	◑	◑	◔	◔
Healthy Neighbourhoods	◕	◑	◑	◑	◔	○	◕	◕
Public Health and Environment	●	◕	◑	◑	◑	◑	◑	◑
Affordability	●	◑	◔	◑	◑	○	◕	◕
Supports Growth	◕	◑	◑	◑	◔	◔	◕	◑

Figure 37: Summary of Alignment Evaluation

All of the corridors have unique advantages and disadvantages when compared to one another. The Base Reference Case appears to have many advantages, most notably a 2- to 4-fold greater projected ridership to 2031. There are some areas, however, where it did not score as well as the other alternatives. These include:

- **Supporting Transportation Infrastructure**: the at-grade alignment and extra stations burden the street network and pose constraints for supporting station infrastructure (PPUDO areas, bicycle racks, etc.).
- **Compatibility with Existing Neighbourhoods:** The at-grade alignment and number of stops result in significant construction impacts as well as traffic impacts during operation.

- **Travel Time:** The at-grade alignment and number of stops result in longer travel times than the SmartTrack options.
- **Eliminating Barriers within Neighbourhoods:** Traffic is impacted by the transit signal priority measures and turning restrictions.

The terms of reference for this study recognized that there were a number of unknowns for which assumptions would have to be made, and that these would limit the level of detail to which any of the corridor or alignment concepts would be developed and evaluated. Nevertheless, a number of key findings can be drawn from this exercise. These include:

- It is technically possible to connect a new heavy rail corridor along either Eglinton Ave West or Highway 427/409 to the existing/proposed GO Kitchener Corridor.
- A continuous connection for any Eglinton Ave alignment would result in significant community impacts and require significant grades and curves that would push the limits of acceptable design and service reliability.
- A western corridor extension via Woodbine would result in a significantly longer travel time between Union Station and the MACC.
- Layering a separate SmartTrack service on top of the proposed GO RER service would likely require additional tracks on the GO Kitchener corridor.
- Grade separated heavy rail alignments would cost 2.5 to 5 times as much as the semi-exclusive at-grade light rail Base Reference Case.
- With some optimization of the Base Reference Case, it may be possible to address community impacts described in the approved EPR, while still maintaining a cost advantage over heavy rail alignment alternatives.
- Despite the longer travel time, the Base Reference Case would attract two to four times as much ridership in 2031 than Corridors 1 or 2. The longer travel time could be reduced through select alignment profile modifications and/or fewer stations.

If heavy rail alternatives are to be given further consideration, a short list will need to be identified and evaluated through a formal EA/TPAP. Further development, optimization and analysis of all alignments, including the Base Reference Case, would be required to develop this list. Optimization of the Base Reference Case could include a fully or partially underground alignment (e.g. grade-separated at major intersections only) with fewer stations and/or stops to minimize temporary or permanent impacts on businesses and decrease travel time and traffic impacts

Before undertaking any further effort, however, a number of steps should be taken to clarify some of the “big picture” issues related to SmartTrack and investigate certain other issues in greater detail. These are discussed in Section 11.

Criteria	Section in Report	Base Reference Case	Corridor 1: Eglinton Corridor					Corridor 2: Airport Corridor	
		Approved TPAP	*1Ae*	*1Aa*	*1Ba*	*1C*	*1D*	*2B*	*2Ca*
Choice	9.2	The Base Reference Case provides the best choice. This option provides the greatest number of connections with existing high-capacity surface transit routes with station stops located within well-connected Active Transportation networks. There is less space available for supporting infrastructure.	Compared to Corridor 2 options, all the stations included in this option have relatively good active transportation connections, which outweigh the space constraints at the proposed station locations.	Compared to Corridor 2 options, all the stations included in this option have relatively good active transportation connections, which outweigh the space constraints at the proposed station locations.	This alignment, with the proposed station at Jane and Eglinton replacing Scarlett and Mount Dennis stations, provides the fewest connections with existing high-capacity surface transit routes, misses connection opportunities at Mount Dennis, and cumulatively has fewer active transportation connections than 1A, 1C, and 1D alignments. Additionally, there is less space for supporting station infrastructure.	Compared to Corridor 2 options, all the stations included in this option have relatively good active transportation connections, which outweigh the space constraints at the proposed station locations.	Compared to Corridor 2 options, all the stations included in this option have relatively good active transportation connections, which outweighs the space constraints at the proposed station locations.	While this alignment excels in its potential to offer supporting transportation infrastructure at most of its stations, this option lacks the critical pedestrian and bicycle connections in the largely industrial areas of the proposed station locations beyond Weston. This option scores marginally better than 2Ca due to its direct connection to Person Airport via the Pearson People Mover.	While this alignment excels in potential to offer supporting transportation infrastructure a most of its stations, this optio lacks the critical pedestrian ar bicycle connections in the largely industrial areas of the proposed station locations beyond Weston. Compared to 2B, this alignment scores marginally worse for its lack o direct connection to the Airpo via the Pearson People Move
Experience	9.3	The local nature of the Base Case concept is both a benefit and a detriment to the user experience. More stops results in a longer journey time between Mount Dennis and the MACC, adding to the time penalty to transfer to RER to Union Station. In contrast, the greater number of stations allows this option to serve the greatest number of 'key destinations.' The interchange design is also a more user-friendly two-level configuration. Overall, the Base Case is anticipated to attract by far the largest ridership during the AM Peak Period. The Base Reference Case is anticipated to have a lesser effect on relieving pressure on the Yonge Subway South of Bloor to 2041, compared to the SmartTrack alignments.	Discounting 1B, this alignment offers the quickest travel times between Union and MACC, while also serving the 'key destinations' surrounding Mount Dennis. A key drawback of this alignment is the complex three-level interchange configuration. Further, Corridor 1 alignments are anticipated to attract the lowest future ridership and fewest new transit riders. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	Discounting 1B, this alignment offers the quickest travel times between Union and MACC, while also serving the 'key destinations' surrounding Mount Dennis. A key drawback of this alignment is the complex three-level interchange configuration. Further, Corridor 1 alignments are anticipated to attract the lowest future ridership and fewest new transit riders. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	The disadvantages caused by the lack of station at Mount Dennis outweighs the benefits. One fewer station allows for the quickest travel time amongst the alternatives; however, not only does missing Mount Dennis eliminate a pivotal transfer opportunity, it also misses the 'key destinations' within the Mount Dennis catchment area, a designated Mobility Hub. Further, Corridor 1 alignments are anticipated to attract the lowest future ridership and fewest new transit riders. Without a station at Mount Dennis, ridership can be assumed to be lower than what is reported. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	Discounting 1B, this alignment offers one of the quickest travel times between Union and MACC, while also serving the 'key destinations' surrounding Mount Dennis. A key advantage of this alignment is the use of the future GO Mount Dennis Station platforms. Further, Corridor 1 alignments are anticipated to attract the lowest future ridership and fewest new transit riders. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	Discounting 1B, this alignment offers one of the quickest travel times between Union and MACC, while also serving the 'key destinations' surrounding Mount Dennis. A key advantage of this alignment is the at-grade platform at the future Mount Dennis GO station. Further, Corridor 1 alignments are anticipated to attract the lowest future ridership and fewest new transit riders. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	The simplified interchange configuration offered by this alignment, as well as the key destinations served--notably the destinations around Weston and Pearson Airport itself—compensates for the relatively longer estimated travel time. Further, the airport alignments are anticipated to experience the largest future ridership and attract the greatest number of new riders to the system, after the Base Case. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.	The simplified interchange configuration offered by this alignment, as well as the key destinations served--notably t destinations around Weston a Pearson Airport itself—compensates for the relatively longer estimated travel time. Further, the airport alignments are anticipated to experience largest future ridership and attract the greatest number of new riders to the system, afte the Base Case. Relief to the Yonge Subway is similar amongst the SmartTrack alternatives studied.

Criteria	Section in Report	Base Reference Case	Corridor 1: Eglinton Corridor					Corridor 2: Airport Corridor	
		Approved TPAP	*1Ae*	*1Aa*	*1Ba*	*1C*	*1D*	*2B*	*2Ca*
Social Equity	8.2	Greatest opportunity to serve a number of neighbourhoods with greater equity needs, specifically at the neighbourhoods immediately proximate to Mount Dennis and those in the vicinity of Jane.	Serves Mount Dennis neighbourhood to the west of the future station, a designated Neighbourhood Improvement Area. Serves areas of potential equity needs around Scarlett and Kipling.	Serves Mount Dennis neighbourhood to the west of the future station, a designated Neighbourhood Improvement Area. Serves areas of potential equity needs around Scarlett and Kipling.	Serves Mount Dennis neighbourhood to the west of the future station, a neighbourhood improvement area. Potential Jane station not within walking distance of any residential. Serves area of potential equity needs around Kipling.	Serves Mount Dennis neighbourhood to the west of the future station, a designated Neighbourhood Improvement Area. Serves areas of potential equity needs around Scarlett and Kipling.	Serves Mount Dennis neighbourhood to the west of the future station, a designated Neighbourhood Improvement Area. Serves areas of potential equity needs around Scarlett and Kipling.	Serves neighbourhood improvement areas around Mount Dennis and Weston stations. No population around stations west of Weston.	Serves neighbourhood improvement areas around Mount Dennis and Weston stations. No population aroun stations west of Weston.
Shaping the City	8.3	The Base Reference Case provides the strongest support for Shaping the City. It provides access to new rapid transit service to the greatest number of people (by a significant amount compared with the other alignments). It also best supports City Building Policies that seek to promote appropriate mixed-use intensification in tandem with transit improvements. The Base Reference Case provides access, via stations, to the greatest number of planned or new developments, and some stations are associated with opportunities for TOD partnerships. This alignment has the least physical barriers obstructing access to stations, although it is comparable on this measure to the Corridor 1 alignments.	Corridor 1 Alignments provide reasonable support for Shaping the City. Along with other Corridor 1 alignments, 1Ae provides access to rapid transit to a moderate number of new riders (though fewer riders than Alignment 1B). It is moderately compatible with City Building policies, when compared with the Base Reference Case and the Corridor 2 Alignments. The presence of physical barriers that may obstruct access to stations is comparable to the Base Reference Case, but a lower number of planned stations results in reduced access to planned or new developments and fewer options for TOD partnerships.	Corridor 1 Alignments provide reasonable support for Shaping the City. Along with other Corridor 1 alignments, 1Aa provides access to rapid transit to a moderate number of new riders (though fewer riders than Alignment 1B). It is moderately compatible with City Building policies, when compared with the Base Reference Case and the Corridor 2 Alignments. The presence of physical barriers that may obstruct access to stations is comparable to the Base Reference Case, but a lower number of planned stations results in reduced access to planned or new developments and fewer options for TOD partnerships.	Corridor 1 Alignments provide reasonable support for Shaping the City. Along with other Corridor 1 alignments, 1B provides access to rapid transit to a moderate number of new riders (though more riders than the other Corridor 1 Alignments). It is moderately compatible with City Building policies, when compared with the Base Reference Case and the Corridor 2 Alignments. The presence of physical barriers that may obstruct access to stations is comparable to the Base Reference Case, but a lower number of planned stations results in reduced access to planned or new developments and fewer options for TOD partnerships.	Corridor 1 Alignments provide reasonable support for Shaping the City. Along with other Corridor 1 alignments, 1C provides access to rapid transit to a moderate number of new riders (though fewer riders than Alignment 1B). It is moderately compatible with City Building policies, when compared with the Base Reference Case and the Corridor 2 Alignments. The presence of physical barriers that may obstruct access to stations is comparable to the Base Reference Case, but a lower number of planned stations results in reduced access to planned or new developments and fewer options for TOD partnerships.	Corridor 1 Alignments provide reasonable support for Shaping the City. Along with other Corridor 1 alignments, 1D provides access to rapid transit to a moderate number of new riders (though fewer riders than Alignment 1B). It is moderately compatible with City Building policies, when compared with the Base Case and the Corridor 2 Alignments. The presence of physical barriers that may obstruct access to stations is comparable to the Base Case, but a lower number of planned stations results in reduced access to planned or new developments and fewer options for TOD partnerships.	Corridor 2 Alignments provide the least support for Shaping the City. Corridor 2B provides very strong opportunities for TOD partnerships, with significant development opportunities at each of the stations. It provides moderate support for City Building Policies, particularly those aimed at encouraging access to Employment Districts. However, with fewer stations, this alignment provides access to fewer planned or new developments. Corridor 2B provides access to new rapid transit service to very few people and there are significant physical barriers obstructing station access.	Corridor 2 Alignments provide the least support for Shaping City. Corridor 2Ca provides ve strong opportunities for TOD partnerships, with significant development opportunities at each of the stations. It provide moderate support for City Building Policies, particularly those aimed at encouraging access to Employment Distric However, with fewer stations, this alignment provides acces to fewer planned or new developments. Corridor 2Ca provides access to new rapid transit service to very few pec and there are significant phys barriers obstructing station access.

Criteria	Section in Report	Base Reference Case	Corridor 1: Eglinton Corridor					Corridor 2: Airport Corridor	
		Approved TPAP	*1Ae*	*1Aa*	*1Ba*	*1C*	*1D*	*2B*	*2Ca*
Healthy Neighbourhoods	8.4	Compared to Corridor 2 alignments, notwithstanding the construction and operational impacts, the potential benefits that the Base Reference Case allows it to score well compared to the others from a healthy neighbourhoods perspective. The impacts are numerous: construction of the LRT right-of-way will cause significant noise and traffic delays; in operation, the at-grade LRT will offer signal priority, thus impacting vehicular traffic flow; a widened Eglinton will result in greater crossing distances and thus the potential to turn Eglinton in to a barrier to active transportation users. Conversely, this option does not involve any tunnelling thus eliminating the impact of cut-and-cover station construction, launch and extraction shafts for TBMs, and the noise and vibration that accompany tunnel boring. Additionally, the increased number of stations through existing mid to low-density residential neighbourhoods offers the greatest place-making opportunity and potential to integrate stations into the existing neighbourhood fabric. Further, LRT can be accompanied by improved streetscaping, thus counteracting the effect on widening Eglinton.	While there are some opportunities for place-making around the proposed stations, the opportunities are more limited compared to the Base Reference Case. Further, the impacts along Eglinton are quite high during and after construction.	While there are some opportunities for place-making around the proposed stations, the opportunities are more limited compared to the Base Reference Case. Further, the impacts along Eglinton are quite high during and after construction.	While there are some opportunities for place-making around the proposed stations, the opportunities are more limited compared to the Base Reference Case. Further, the impacts along Eglinton are quite high during and after construction.	This option scores the lowest under the healthy neighbourhoods criteria, namely due to impact caused by the portal severing Emmett Avenue in the stable residential neighbourhood north of the Eglinton Flats.	This option scores the lowest under the healthy neighbourhoods criteria due to the extensive temporary and permanent impacts to a number of stable residential neighbourhoods north of the Eglinton Flats and to the west of the Kitchener Corridor north of St. Clair.	This alignment passes through residential neighbourhoods on a long-establish rail right-of-way. This alignment serves no residential developments beyond Weston station. The benefits of this--namely limited impacts to stable residential neighbourhoods compared to Corridor 1 alignments--outweighs the lost place-making opportunities of this alignment.	This alignment passes throug residential neighbourhoods o long-establish rail right-of-wa This alignment serves no residential developments beyond Weston station. The benefits of this--namely limite impacts to stable residential neighbourhoods compared to Corridor 1 alignments-- outweighs the lost place-maki opportunities of this alignmen

Criteria	Section in Report	Base Reference Case	Corridor 1: Eglinton Corridor					Corridor 2: Airport Corridor	
		Approved TPAP	*1Ae*	*1Aa*	*1Ba*	*1C*	*1D*	*2B*	*2Ca*
Public Health and Environment	8.5	The Base Reference Case alignment improves access to a number of parks around the proposed station locations. The at-grade orientation of the alignment, accommodated primarily within the Eglinton right-of-way, results in some of the lowest impacts to parks and the natural environment compared to Corridor 1 alignments. However, the impacts are somewhat greater than Corridor 2 alignments.	Corridor 1 alignments, generally, offer improved access to existing parks and public spaces compared to Corridor 2. It provides less access than the Base Reference Case. The impacts to parks and the natural environment, however, reduce the score for this alignment. Specifically, while access may be improved to Eglinton Flats, the potential impacts are greater.	Corridor 1 alignments, generally, offer improved access to existing parks and public spaces compared to Corridor 2. It provides less access than the Base Reference Case. The impacts to parks and the natural environment, however, reduce the score for this alignment. Specifically, while access may be improved to Eglinton Flats, the potential impacts are greater.	Corridor 1 alignments, generally, offer improved access to existing parks and public spaces compared to Corridor 2. It provides less access than the Base Reference Case. The impacts to parks and the natural environment, however, reduce the score for this alignment. Specifically, while access may be improved to Eglinton Flats, the potential impacts are greater.	Corridor 1 alignments, generally, offer improved access to existing parks and public spaces compared to Corridor 2. It provides less access than the Base Reference Case. The impacts to parks and the natural environment, however, reduce the score for this alignment. Specifically, while access may be improved to Eglinton Flats, the potential impacts are greater.	Corridor 1 alignments, generally, offer improved access to existing parks and public spaces compared to Corridor 2. It provides less access than the Base Reference Case. The impacts to parks and the natural environment, however, reduces the score for this alignment. Specifically, this alignment would have a significant visual and functional impact to Eglinton Flats.	The limited impacts to parks and the natural environment on this alignment is due the fact that the alignment passes through primarily industrial areas. This reduces its score in this criteria.	The limited impacts to parks a the natural environment on th alignment is due the fact that alignment passes through primarily industrial areas. This reduces its score in this criter
Affordability	8.7; 7.1; 5.2	The Base Reference Case, by virtue of its at-grade alignment within the existing ROW, is the least complex, least expensive, and has the fewest impacts to private property when compared to Corridor 1 and 2 alignments.	While this scores the highest amongst the Corridor 1 alignments in terms of property impacts and engineering complexity, the high cost of this option result in a low score for this alignment.	This alignment poses significant engineering challenges. The corresponding cost estimate for this alignment is a representation of this.	While this alignment is the least expensive of the Corridor 1 alignments due mainly to its lack of a station at Mount Dennis, the relative engineering complexity and high property impacts results in a low score for this alternative under the Affordability criteria.	This option is less complex from an engineering perspective and estimated to be the least costly amongst Corridor 1 alternatives. This alternative receives an low score overall due to the signficiant property impacts anticipated in the Weston neighbourhood and industrial areas	Beyond the engieering complexity and high estimated cost, this alignment is anticipated to have the largest impact on private residential and commercial properties in Weston and to the west of the rail corridor north from St. Clair.	Notwithstanding any extra track that may be required (beyond the scope of this study), this alignment scores well when compared to the Eglinton alignments under the Affordability criteria. This is mainly due to the location of the spur; the Eglinton spur at Mount Dennis poses significant engineering challenges, as well as higher costs, and property impacts when compared to a spur after the proposed Woodbine station.	Notwithstanding any extra tra that may be required (beyond the scope of this study), this alignment scores well when compared to the Eglinton alignments under the Affordability criteria. This is mainly due to the location of t spur; the Eglinton spur at Mou Dennis poses significant engineering challenges, as we as higher costs, and property impacts when compared to a spur after the proposed Woodbine station. The lower estimated cost pushes this above 2B in this criterion.
Supports Growth	8.6	Although the alignment passes through areas of lower employment intensity compared to Corridor 2 alignments, the number of station stops in areas not already served by higher order transit proposed in the Base Case EA results in a high number of employees served overall. Further, impacts to businesses would be minimal.	Marginally lower potential to serve employment districts at the intermediate stations before the MACC. There are, however, limited impacts to businesses with the exception of low density industrial properties to the east of the tracks after Nickle due to track relocation.	Marginally lower potential to serve employment districts at the intermediate stations before the MACC. There are, however, limited impacts to businesses with the exception of low density industrial properties to the east of the tracks after Nickle due to track relocation.	Marginally lower potential to serve employment districts at the intermediate stations before the MACC. There are, however, limited impacts to businesses with the exception of low density industrial properties to the east of the tracks after Nickle due to track relocation.	In addition to the somewhat limited opportunity to serve employment centres en route to the MACC, there is a significant potential for this alignment to severely impact the operations of the newly expanded Irving Tissue Factory.	In addition to the somewhat limited opportunity to serve employment centres en route to the MACC, this alignment option impacts a number of commercial and industrial businesses along Weston Road where the corridor must be widened to accommodate new tracks on the west side of the corridor north of the proposed St. Clair interlocking.	Corridor 2 alignments score the highest under the Supports Growth criteria due to the high employment accessed by three of the proposed stations. Very high employment density exists around the proposed 2B airport station. Some impacts to established businesses near spur after Woodbine.	Corridor 2 alignments score th highest under the Supports Growth criteria due to the high employment accessed by thre of the proposed stations. Low employment intensity around proposed 2C airport station du to constraints posed by Highw 427 to the proposed airport station. Some impacts to established businesses near spur after Woodbine.

Figure 38: Detailed Alignment Evaluation Summary

11 Next Steps

The terms of reference for this study recognized that there were a number of unknowns for which assumptions would have to be made, and that these would limit the level of detail to which any of the corridor or alignment concepts would be developed. While it was possible to identify fatal flaws and evaluate key criteria for each of alignment alternatives, the planned second round of public consultation did not take place. It is therefore not prudent to draw final conclusions at this time regarding any preferred alignments. If the City chooses to proceed with developing a new heavy rail corridor for SmartTrack, a formal EA/TPAP will be required to evaluate a short list of alternatives and recommend one for approval by the Ministry of the Environment and Climate Change. To assist in the development of this list, there are a number of steps that should be taken to clarify some of the “big picture” issues related to SmartTrack, revisit and confirm the assumptions made, and investigate certain other issues in greater detail.

11.1 Establish Clear Roles & Objectives

11.1.1 Roles & Responsibilities

The SmartTrack initiative represents a significant *and on-going* investment of public resources. As discussed in Section 3, it is essential that the roles and responsibilities of the various private and public agencies be defined so that the regulatory environment in which SmartTrack will operate is understood. Beyond the decisions regarding up-front capital expenditures, such as vehicles, property, infrastructure, control systems, etc., lie the responsibilities for day-to-day operations, maintenance and service planning, as well as the development and execution of five and ten year capital and operating plans. This will become particularly relevant if an integrated solution is selected (as was assumed for this study) as there are other independently developed plans for transit improvement and growth that are already at various stages of implementation. Responsibilities must be clearly laid out for each of the potentially affected parties, including City of Toronto Transportation Services & City Planning Divisions, TTC, MiWay, GO Transit, Metrolinx, CN, CP, and Transport Canada. This is not necessarily a linear process, as roles and responsibilities depend, in part, on the nature of SmartTrack itself, as described below.

11.1.2 SmartTrack Objectives

There is no debate as to the need for better transit options for Torontonians, to serve both existing congested travel routes, as well as to provide integrated higher order transit to currently underserved markets, all at a reasonable cost. What requires some clarification is the means to the end. We must first ask ourselves if we are seeking to provide services to meet existing and projected demand between identified employment nodes or if we are simply trying to develop a transit system that will provide a defined level of service between these same nodes (i.e. “if you build it they will come”).

The answer to this question affects vehicle selection, service frequency and integration (or not) with other existing and planned services.

The first approach does not presuppose any technology or level of service, or even a mode or service provider split to meet the demand. In areas of overlap with other service providers, the development of demand forecasts must take into consideration multi-jurisdictional and level of service based fare policies. If the demand is high enough, it may indeed lead to discussions on technology or separation of services (e.g. local vs express). The second approach, “if you build it, they will come” does not rely on demand forecasts, but requires that discussions on technology and relationships with other transit agencies take place up front to ensure that the ultimate desired level of service can eventually be provided. Of course, that ultimate level of service (e.g. a five minute headway) must also be defined.

The scope of work undertaken by this study closely resembles the latter, but without some notion of the ultimate plan it will remain incomplete. A medium term plan may be proposed using an expansion of existing train control or vehicle technologies and/or infrastructure, but if these cannot continue to grow in a way that will support the ultimate plan, then some of these (significant) costs may turn out to be “throwaway” investments. Another approach would be to invest in different (e.g. exclusive) infrastructure, vehicle technology and/or control systems which might be temporarily underutilised while demand grows. An example of this would be a subway system that is designed and built for 7 car trainsets, with an initial service using only 3 or 4 car trainsets. The number of cars per train can be increased over time as demand warrants.

Either way, the overall transit network must be defined by its nodes (station location areas) and origin-destination pairs and a design year must be selected for travel demand forecasting, so that an implementation plan can be developed to right-size the trains and level of service for each time period up to the design year (e.g. every five years up to 30 years hence).

11.1.3 Quality of Service

Before any discussions on vehicle configuration, train control technology or level of service (or capacity) can take place, the desired *quality of service* needs to be defined. A subway service is different from a regional commuter rail service, just as a bus service is different from an LRT service. The travelling public sets its own level of acceptable travelling experience depending on the length, speed, frequency and cost of the trip, by virtue of the level of crowding to which they are willing to be subjected. The level of service, therefore, cannot be defined without an understanding of the “vehicle load standard” to be used. This is not as simple as counting seats, nor is it an application of a vehicle manufacturer’s “crush capacity”. It is somewhere in between, and can only be developed over time through observation of the ridership habits of passengers in the communities

through which the proposed service will run. There may also be limitations on crowding for safety reasons, particularly where higher speeds may be reached, leading to no standees being allowed at all.

Ultimately, this discussion will result in the development of a methodology for the selection of technology and equipment, taking into consideration the objectives alluded to previously.

If a level of service approach is being taken, is it to be integrated with GO Transit using traditional heavy rail; i.e. an expansion of GO Transit operations (with or without electrified service), or is it a “surface subway” on an exclusive right-of-way similar to the TTC? This speaks to applicability of regulatory requirements as well.

Questions regarding the need for consistency with existing or planned transit services will have to be addressed, particularly as it relates to potential shared corridor infrastructure, design standards and vehicle maintenance facilities.

11.2 Confirm Design & Service Assumptions

Once the service objectives have been established, and the vehicle configuration and technology have been selected, the design and service assumptions used in this study should be revisited. The selection of the vehicle and train configuration will allow for performance specifications to be developed for use in further studies as outlined in Section 11.3.

11.2.1 Design Assumptions

The working assumptions described in Table 2, notably: minimum track curvature and grade, turnout size (all affecting speed or power requirements), structural clearances, etc. should be confirmed for the proposed vehicle. A key assumption that significantly affects [tunneling] cost is the use of double-decker coaches or EMU’s. This should be weighed against any operating efficiencies that may be gained by using a common vehicle with other GO or SmartTrack services. Other key assumptions requiring a second look include:

- The proposed electrification infrastructure requirements as laid out in the GO Electrification EPR should be revisited as well to confirm whether or not there is any flexibility to accommodate potential changes to the GO Kitchener Corridor as may be required for SmartTrack. This is a two stage exercise; first confirm that the proposed connections to the Kitchener Corridor can be physically accommodated and second, confirm that if it becomes necessary to widen the corridor beyond the point of connection for additional tracks that there is also room for the enlarged catenary bridges and power supply systems that would be required.

- The final plan, profile and orientation of the ECLRT at Mount Dennis must be provided for those alignments that include work in that area.

- The minimum separation required between the buried pipelines east of Renforth Drive must be confirmed by utility owners as it may have a material effect on the feasibility of the below-grade alignment into the MACC station. Dialogue with the utility owners is advised.

- If a TBM construction method is proposed, the diameter of the tunnel bores, their spacing and their depth should be confirmed. Seeking input from potential vehicle manufacturers may be appropriate at this time.

- If a cut/cover method is proposed, opportunities for using less expensive earthen side slopes can be explored, subject to available property. The feasibility of expropriating a significant number of mature and/or new developments would have to be well understood (along Eglinton Avenue West for any Corridor 1 alignment and especially on Alignments 1C and 1D). The extent of utilities relocations that would be required, as well as storm water management (i.e. pumping stations, etc.) infrastructure requirements would have to be addressed. The extent of increased noise and vibration impacts would also have to be investigated. Above all, safety concerns due to overhead catenary in close proximity to street or ground level (and unlawful access) would need to be addressed.

  Design standards inconsistencies should be addressed. The 14 degree (124m radius) curve and 2% grades used on the UPX spur are different from the 10 degree and 3% grades suggested by AREMA for heavy-rail passenger service.

  All proposed SmartTrack station locations (on or off the GO Kitchener Corridor) should be confirmed, as well as their platform lengths, depending on ultimate train configurations. The *orientation* of certain stations, notably at the Renforth Gateway, should be confirmed, as there may be other criteria that may need to be considered. The use and configuration of existing GO stations should also be confirmed. As discussed earlier in this report, it was assumed that the existing GO Etobicoke North station would be used in place of the Islington station identified in the terms of reference. This should be confirmed, as should the ultimate station configuration at this and other locations (i.e. platforms for all tracks or side platforms only).

11.2.2 Operating Assumptions

The assumption that SmartTrack service is being layered on top of already existing and planned services on the GO Kitchener Corridor is most significant, in that it implies both a shared and integrated corridor, and to some degree creates a duplication of services (although not necessarily using the same fare structure) that may or may not be warranted. The key driver of this duplication is the

perceived need to have both Bramalea and the MACC served by the same high train frequency. Some discussion on travel demand should take place to assist in developing operating assumptions for each transit provider using the corridor, and, ideally, a more integrated service offering that right-sizes overall level of service and infrastructure requirements. Where there may be competing views regarding the most appropriate plans for transit improvement and growth, they should each be tested as “what if?” scenarios, as discussed in Section 11.3.

Notwithstanding the above, the operating assumptions described in Sections 6.2.3 and 6.4.1 should be reviewed and confirmed to whatever degree possible before any further analysis is undertaken.

Regarding the future GO Mount Dennis Station, there is some uncertainty as to how this station will be served, and by which trains. Will it be served by the UPX instead of or in addition to the GO Weston Station? Will it result in any other changes to GO services on the corridor? Are there any plans to integrate this or any other station with VIA Rail services?

Currently there are no VIA Rail trains operating on the GO Kitchener Corridor within the morning or afternoon peak periods. Consequently, these trains have been ignored in this study. Plans for any additional VIA Rail service during peak periods should be identified and incorporated in subsequent analyses.

Currently, the only SmartTrack travel time “target” that has been suggested is that found on the www.smarttracker.ca website. It suggests a 24 minute travel time between Union Station and the MACC. This compares to the most optimistic estimated travel time of 26 minutes calculated in Section 6.3.2 using Alignment 1Ba, without a station stop at Mount Dennis. If travel time targets are to be used in any subsequent studies, then different targets will be required for the two primary corridors under consideration due to their different lengths. Travel time targets are also a function of the number and/or spacing of station stops, dwell times and any speed restrictions due to track curvature and grades. Minimum speeds could be developed based on these targets, which in turn would set required curve radii and grades. Expectations in this regard need to be explored.

For the purpose of this study, it was assumed that SmartTrack services within the study area would not be initiated with diesel powered trains *or coaches hauled by electric engines* and converted later to EMUs. This assumption affects train performance and infrastructure requirements, including traction power distribution facilities and tunnel ventilation systems. Given the significant existing and on-going investment in non-electric coaches, in a scenario where an expanded GO Transit service is implemented to meet SmartTrack objectives, it may be more likely that only the diesel locomotives will be replaced at first (with electric locomotives) rather than complete replacement of trainsets with EMUs. A transition plan may therefore be required for the trains on the GO Kitchener Corridor. Electric locomotives do not perform as well as EMU’s.

11.3 Issues Requiring Further Study

Notwithstanding all of the efforts to date, and regardless of the assumptions that have been made, there are a number of issues requiring further study and/or more detailed analysis before any recommendations can or should be made.

11.3.1 Geotechnical Investigations

All alignments carried forward for further discussion should be reviewed for potential design constraints or changes due to soil conditions. Tunnelled alignments may be affected by lateral and/or vertical separation requirements from existing structures. *Of particular concern are alignments beneath existing and future planned MTO 400 series highway bridge/ramp foundations and railway lines.* Elevated alignments may be affected by pier size, spacing, depth or foundation adjacencies, all of which require an understanding of soil conditions. A review of previous bore hole data, supplemented by new site investigations where necessary, is required.

11.3.2 Modified ECLRT Phase 2

Although it does not provide one of the key selling features of the SmartTrack concept (a single seat ride from Union Station to the MACC), a modified fully or partially below grade ECLRT Phase 2 with stations at major intersections only could provide a cost-effective service to the local community through which it would pass, without most of the environmental impacts that were raised in the original TPA report. It also could provide a connection to the airport, and would not require any changes to the existing or planned GO Kitchener Corridor infrastructure or services.

11.3.3 CP Relocation

It was assumed that the CP corridor could be shifted east between Eglinton Avenue and St. Clair Avenue to make room for connecting tracks from the Eglinton corridor alignments to reach the nearest tangent track (near St. Clair Avenue) where they can connect to the GO corridor. The validity of this assumption must be checked against the constraints of the St. Clair Avenue grade separation bridge and the profile of the roadway approaches on either side, which are coincidentally under review as part of an on-going City Transportation Services study. Also CP should review and confirm that the proposed re-alignment meets their requirements. Some discussion on cost-sharing might be in order as this could be considered as an improvement to their infrastructure.

11.3.4 GTAA

The GTAA has expressed an interest in developing an integration plan for both the Eglinton West and Airport SmartTrack corridor alignment concepts. Access to the airport terminals using parts of both corridors via a junction immediately east of the MACC station crossovers or through a modification of Alignment 2B should be evaluated. The location and suitability of GTAA-controlled and other nearby industrial properties to be used for new or modified alignments (and potentially

different station locations) should be confirmed. Analysis should include both physical and operational feasibilities, and may include an elevated alternative if a path through the existing elevated highway and UPX structures can be found.

11.3.5 Terminus Stations

This study assumes that SmartTrack trains will be able to access a fully integrated station at the Renforth Gateway BRT Terminal (located at the very east end of the MACC) and a second MACC station roughly 1.2 km further west. The minimum station dwell time at these stations should be developed, based on crew turn time, train cleaning (if required), and forecast boarding and alighting volumes. It was also assumed that there would be sufficient capacity at Union Station to accommodate additional GO RER or SmartTrack trains; however this assumption must be tested. Any exercises that may already be planned or underway by Metrolinx regarding platform capacity at Union Station will be essential input to the definition of SmartTrack.

It was further assumed that the Eglinton West or Woodbine SmartTrack service would be a closed loop; that is, it would not be part of a single seat service to and from Unionville. This represents a simplification to allow for a comparison of the alternatives within the context of the defined area of study, since what happens east of Union Station would be the same for all alternatives. In addition, the SmartTrack train schedules developed for this study may not be consistent with the SmartTrack and/or GO RER schedules planned for the eastern portion of the route, which could result in additional or different infrastructure requirements on either or both corridors. The closed loop also provides some measure of control to ensure that the MACC-Union-MACC loop runs *consistently* on time. It also allows for train consists to be tailored to demand, which could be significantly different on either side of Union Station. Both of these assumptions will need to be tested, which may result in modifications to some of the proposed train services on the GO Kitchener Corridor.

11.3.6 Passenger Convenience & Safety

All SmartTrack alignments that connect to the planned GO Mount Dennis station are assumed to be feasible from a pedestrian flow perspective. A more detailed evaluation is recommended at this and other stations, particularly Kipling, the Renforth Gateway and the Airport to identify potential constraints, mode transfer facilities and/or building code issues that might affect their overall feasibility or ease of use (e.g. entrance/egress locations, bus platforms, passenger pick up and drop off areas, long vertical circulation elements, etc.). Where tunnels in excess of 762m are planned, emergency exit building locations must be identified, with clear and safe means of egress. Allowances for emergency fire ventilation infrastructure at regular intervals along tunnelled sections of the proposed alignments will also be required. Although it could be assumed that ventilation shafts and fan rooms might be co-located with emergency exit buildings, some preliminary work should be undertaken to identify potential

locations for these facilities so that property impacts and potential impacts to the environment (noise, smoke) can be properly understood.

11.3.7 Power Supply

Traction power distribution facilities' footprints or property requirements for the Airport or Eglinton West SmartTrack corridors have not been addressed in this study. The GO Electrification EPR describes these requirements for the GO Kitchener Corridor, which include a main traction power substation at Highway 27 and local distribution facilities, called paralleling stations, near Strachan Avenue, Ray Avenue and Highway 27. The locations of these facilities, although not yet built are assumed to be fixed for the purpose of this study. It is not known whether the traction power substation to be located at Highway 27 could supply power to both the proposed UPX/GO electrified services and a SmartTrack service along either the Eglinton or Woodbine Corridors. At a minimum, additional paralleling stations may be required at a spacing similar to the GO Kitchener Corridor (approximately 9 km). This could result in the paralleling stations being near the MACC for either of the SmartTrack corridors. Further study is required to determine the extent (and feasibility) of any modifications or additions that would be required to the planned works, including the Toronto Hydro, Mississauga Hydro and Hydro One supply networks.

11.3.8 Interlockings

In each case where a connection to the GO Kitchener Corridor is proposed, whether it is at a new interlocking at St. Clair Avenue, or at existing interlockings at Nickle or Wice, the physical and operational feasibility (and costs) of the proposed changes need to be explored. This includes potential impacts to train operations (speed zones, safe braking distances, conflicting train movements) as well as changes that may be required to systems communications and programming. The impact of connecting to less than all four tracks at any of these locations also needs to be understood. The need for crossovers at the Kipling and Airport SmartTrack stations to protect for operational flexibility should also be explored. As these stations are located at roughly the midpoints of their respective alignments and are several kilometres from any other special track work, these crossovers should be given serious consideration. Crossovers require tangent track on shallow grades; the alignments on either side of either station would have to be adjusted to include them.

11.3.9 Train Performance/Travel Times

Following the selection of a "design vehicle" or trainset for SmartTrack services, physical and operating performance specifications should be developed for use in a more detailed study of travel times for each proposed train schedule (as defined by its route, station stops, and trainset specifications) using a train performance calculator (TPC). For the integrated service scenario, similar specifications are also required for all GO Transit schedules (Diesel and EMU). Station dwell times must also be developed for each station stop for all train

types. The resulting TPC output, coupled with terminal dwell times, can be used to develop round trip times for fleet sizing (and acquisition costs), operating costs and potential MSF infrastructure requirements to support a standalone or enlarged integrated fleet.

11.3.10 Train Control

For any given vehicle/schedule combination, the only way to increase the utilization (or capacity) of the available tracks is to reduce the minimum headway between trains. Minimum headways on a given route are a function of average train speeds (a product of the maximum allowable speeds, the number of stops and acceleration characteristics for each train consist) and the crossover locations, coupled with the physical limitations of the fixed block signal system. As an alternative to increasing the number of tracks on the GO Kitchener Corridor (in an integrated service scenario), it may be worth exploring the costs and benefits of any plans that GO Transit may have for a corridor-wide train control system upgrade, or at least the timing of it, as it may not be required in the short term. Potential signal system upgrade or replacement scenarios include:

- PTC - Positive Train Control
- CBTC - Communications Based Train Control
- ERTMA - European Rail Traffic Management System

11.3.11 Integrated Operations & Track Capacity

In order to confirm the feasibility of any combination of vehicle technology and train service on a particular alignment and corridor configuration (i.e. number of tracks), virtual models of the physical and train control attributes of a few short-listed alignments should ultimately be developed, and a series of simulations performed to test the relative performance of multiple what-if train service, vehicle technology and dispatching algorithm scenarios. This would identify train interactions, track occupancies and crossover needs for the ultimate service plan. Subsequent simulations of a preferred Alignment could help develop a phasing plan for any corridor modifications or upgrades.

11.3.12 GO Kitchener Corridor Property

The physical implications of any modifications to or expansion of the GO Kitchener Corridor to support the proposed SmartTrack service must be investigated. The limits and status of all properties adjacent to the corridor should be catalogued assuming a worst case addition of two more tracks between Highway 427 and Bathurst Street. These tracks may be located on one side or split between both sides of the corridor, and may or may not be integrated with existing corridor infrastructure, including structures, tracks, train control systems, power supply systems and platforms.

The implications of adding one or more tracks may be significant, as noted in Sections 2.1.1, 2.1.4 and 2.1.5 of this report, where a narrow corridor width was identified, along with a very high number of roadway grade crossing structures as

well as future electrification infrastructure that would require adjustment. Existing development runs very close if not right up to the corridor property line in some locations, which could make for lengthy negotiations with property owners and/or complex engineering solutions to add to or modify existing corridor infrastructure.

Further study is required to identify specific areas of concern along the corridor, the number and locations of additional track required and the potential costs of such undertakings. Examples of specific property-related concerns identified in the development of the SmartTrack alignments themselves that need to be confirmed include impacts on several Irving Tissue buildings and the Jane Street Bridge in Alignment 1C, significant residential impacts along Alignment 1D and the industrial properties along Alignment 2B. Also, the exact placement of all new SmartTrack station platforms, particularly Kipling, the MACC and the Airport need to be developed further to suit the availability of property for entrances, ventilation shafts, passenger connections, etc., which in turn will affect the final track plan and profile.