

Feasibility Study Subway in Scarborough RT Corridor

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Metrolinx

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Executive Summary

The Study reviewed the feasibility of providing subway technology in the existing Scarborough RT Corridor. The Corridor runs from Kennedy Station to McCowan Station and an extension from McCowan Road to Sheppard Avenue East via Centennial College (Progress Avenue, south of Highway 401).

The Study has determined that an at-grade/elevated subway in the Scarborough RT Corridor is technically feasible. This Corridor warrants further consideration and evaluation as part of the TTC and City studies to advance the planning and implementation of the Scarborough Subway Project.

A number of key issues have been identified during the preparation of this Study. Key issues include the following:

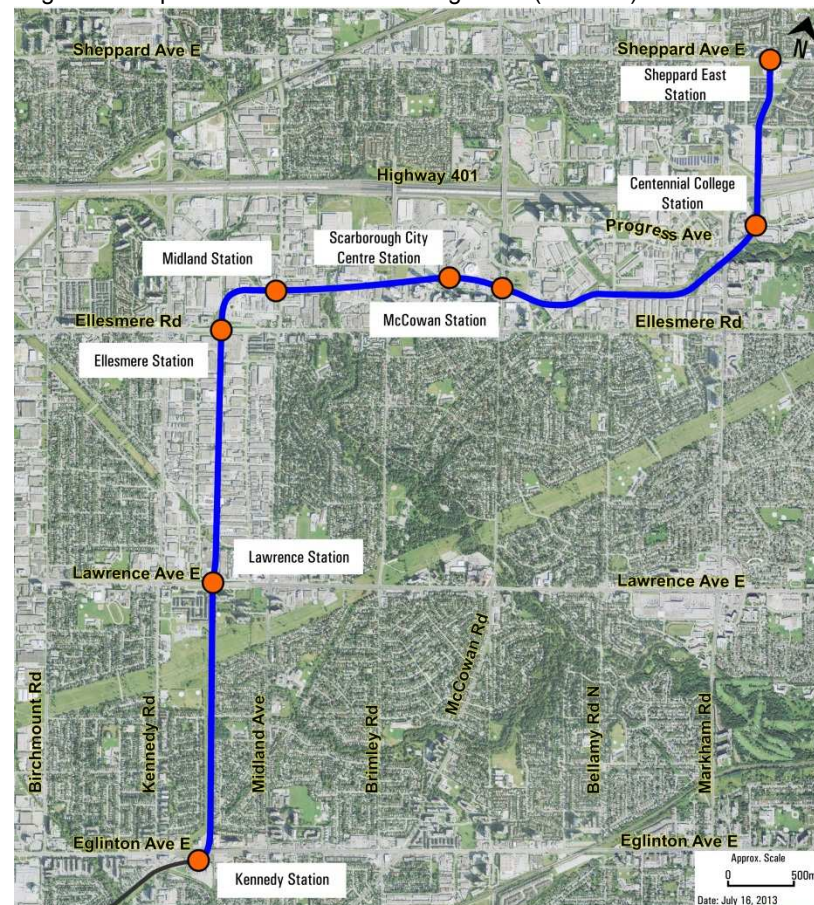
- The subway alignment mimics the vertical and horizontal alignment of the existing Scarborough RT and SLRT extension to Sheppard, variances are due to different alignment design criteria for subway (less steep grades, broader turning radii) compared to LRT and longer station platform lengths (152 metres compared to 97 metres).
- The new stations would be located at Lawrence, Scarborough City Centre, Centennial College and Sheppard. It would be feasible to provide a station in the corridor immediately south of Ellesmere Road.
- New Environmental Assessment under the Transit Project Assessment Process required due to significant departures from the current SLRT design.
- Construction of a Subway in the Scarborough RT Corridor would require the shutdown of the Scarborough RT for a lengthy period of time.
- Construction of the tie-in and special trackwork west of Kennedy Station would require the shutdown of the Bloor-Danforth subway between Warden and Kennedy Stations for a short period of time
- Major redesign would be required for the complex Kennedy interchange station (subway, Eglinton Crosstown LRT, bus terminal and GO Rail) which would present cost and schedule risks for the Eglinton Crosstown LRT project.

The Study describes Alignment and Station Considerations, Land Use and Environment, Implementation Considerations, Order-of-magnitude Cost Estimate and Implementation Schedule.

1. Introduction

This Feasibility Study documents the viability of developing a combination of at-grade/elevated subway line within the existing Scarborough Rapid Transit (SRT) corridor, and beyond to the east and north, ending at a new station at Sheppard Avenue East. The proposed alignment would correspond generally to the route of the new Scarborough Light Rail Transit (SLRT), illustrated in Figure 1. A second phase would ultimately extend the SLRT further north to the Malvern Town Centre.

Figure 1: Proposed Route for Scarborough LRT (Phase 1)



Source: Metrolinx

1.1 Background

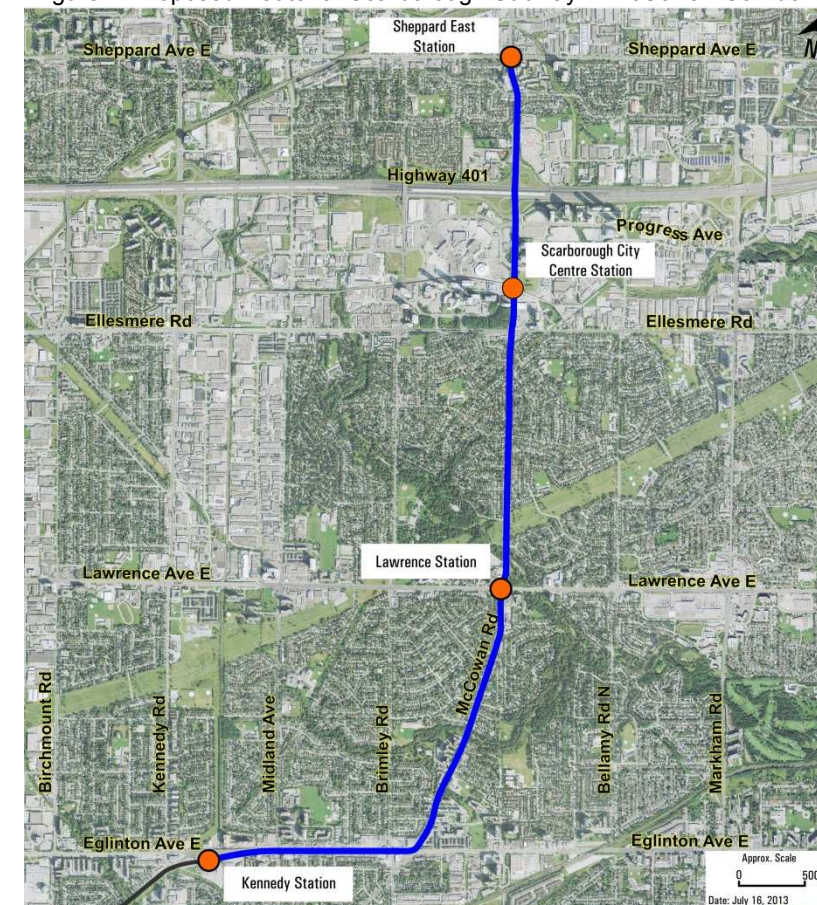
On the authority of a tri-party Master Agreement signed by Metrolinx, the City of Toronto and the Province of Ontario in late 2012, Metrolinx, as the proponent of the subject initiatives, has been proceeding with the development of four priority transit projects in the City. One such project is the Scarborough LRT project which consists of an 11-kilometre long corridor that includes replacement and/or modification of the existing Rapid Transit line and stations between Kennedy and McCowan Stations; and the extension of the line from McCowan Station to Sheppard Avenue East (and ultimately to the Malvern Town Centre).

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The Scarborough LRT project is funded by the Province of Ontario through Metrolinx and is a key part of a 10-year investment strategy to enhance rapid transit in the City of Toronto.

In May 2013, Toronto City Council indicated support for an extension of the existing Bloor-Danforth subway line from Kennedy Station to Scarborough Centre and Sheppard Avenue (the "Scarborough Subway"). In response to a request from Metrolinx to clarify the City's position in light of the conflict between the Master Agreement commitment to LRTs and the more recent statement of support for a subway in Scarborough, at its July 16-17, 2013 Council meeting, City Council voted to remove the Scarborough LRT from the Master Agreement and replace it with a subway. The route proposed for the subway by the City, shown on Figure 2, differs significantly from the Scarborough SRT alignment.

Figure 2: Proposed Route for Scarborough Subway in McCowan Corridor



Source: Metrolinx

The Ontario Minister of Transportation, Honourable Glen Murray, has asked Metrolinx to investigate the possibility of routing a subway extension generally within the existing SRT corridor to better serve the City's identified "Priority Investment Neighbourhoods" which offer greater development potential. Accordingly, Metrolinx has delegated 4Transit to explore the feasibility of developing the "Scarborough Subway" within the proposed SLRT corridor.

1.2 Study Objectives and Scope

The overall goal of the Feasibility Study is to establish if the proposed SLRT route is compatible for use for an at-grade/elevated subway line. The Study is not intended to compare options or to identify a preferred approach for developing a new transit system in Scarborough.

In determining feasibility, the ultimate question to be answered is ... *“Can it be built?”* and that question is the fundamental guidance for the analyses. At the same time, the related issue of ... *“At what cost?”* is also important, therefore, the analyses considers other aspects of potential concern including, but not limited to:

- Route alignment (horizontal and vertical) challenges and constraints;
- Station locations and configuration;
- Land use and property implications;
- Environmental issues and concerns;
- Constructability considerations;
- Impacts on current transit operations;
- Order-of-magnitude cost; and
- Implementation schedule.

1.3 Basis of Study

The following documents have been consulted and form the basis of the feasibility study:

- TTC (Subway) Design Manual, dated August 2011
- SRT (Conversion) Pre-AFP Design Services, Reference Concept Design, dated June 2013
- SRT (Extension) Pre-AFP Design Services, Reference Concept Design, dated June 2013
- Scarborough Rapid Transit Environmental Project Report, September 2010
- The City’s official and future planning frameworks
- Current transit projects (Eglinton Crosstown LRT and Sheppard East LRT)
- Stouffville Corridor Study

1.4 Document Structure

The Feasibility Study presents a first-order assessment of the practicality of developing a subway in the Scarborough LRT corridor, including initial consideration of the realities of doing so. The document is structured as follows:

Section 1 – Introduction

Section 2 – Alignment Considerations

Section 3 – Station Considerations

Section 4 – Land Use and Environment

Section 5 – Implementation Considerations

Section 6 – Order-of-Magnitude Costs

Section 7 – Implementation Schedule

Section 8 – Study Findings

2. Alignment Considerations

2.1 General

The Scarborough LRT Corridor has been laid out on the basis of LRT design criteria - *Transit Expansion Light Rail Transit Projects, Design Criteria Manual (TTC)*, dated September 2012 - whereas the Subway in the SRT Corridor has been designed applying subway design criteria in accordance with the *TTC (Subway) Design Manual*, dated August 2011.

¹Alignment design criteria as outlined in both those documents have been based on the following design priorities, listed in order of importance:

- Safety – protection against derailment.
- Conformity with vehicle clearance envelope.
- Minimizing alignments causing speed reduction, while maintaining a reasonable roadway cross-section.
- Maintainability and performance of the track.
- Compatibility with overhead pole design.

Other design considerations (in no particular order): Vehicle performance and maintainability, impact on adjacent properties, ride quality, economy, aesthetic appearance, ease of use by the public.

2.1.1 Horizontal Alignment

In developing the most desirable horizontal alignment, consideration shall be given, but not limited to, the following factors:

- Passenger comfort and convenience
- Capital and operating costs
- Maximizing train velocity and minimizing running times
- Minimizing noise and vibration (squeal due to curved track)
- Station location and spacing
- Possible future extensions
- Topography, track design
- Property and buildings, both existing and proposed
- Vehicle capabilities

2.1.2 Vertical Alignment

In developing the most desirable vertical alignment, consideration shall be given, but not limited to, the following factors:

- Horizontal alignment
- Building foundations
- Drainage
- Vehicle capabilities
- Adjacent aerial structures

2.1.3 Minimum/maximum criteria

Desired values described in the design manuals are based on industry practices and passenger comfort. Designs that meet or exceed desired values would provide a robust operating environment.

Acceptable values define a limit beyond which a tangible operating benefit is either gained or lost (e.g., acceptable limits for curves may define the radius at which a restraining rail must be installed).

Absolute values are based on safety considerations and have potential impacts in terms of maintenance costs, noise, wheel life and track life. Extensive use of absolute values can result in service problems and unacceptable maintenance costs.

Table 1 below indicates the absolute values for the main alignment criteria for both SLRT and Subway.

Table 1: Comparison of Alignment criteria

Design Criteria	SLRT	Subway
Vertical curve – minimum length	30 x (G2-G1) or (G2-G1) x $v^2 / 215$ (for crest curve) or (G2-G1) x $v^2 / 387$ (for sag curve)	60 x (G2-G1) or (G2-G1) x $v^2 / 400$
Horizontal curve – minimum radius	150m	300m
Maximum Gradient	5% (up to 250m), 4.5%	3.5%
Platform length	97m	152.4m
Track C/L distance	3.72m	4.27m
Minimum size turnout	Not specified, to meet operation requirement and subject to value engineering assessment	AREMA No. 9, or No. 8 with approval
Design Speed	80kph	80kph

Source: Design Criteria Manual and TTC Design Manual

2.1.4 Property implications of alignment

The proposed subway alignment would be located within the existing SRT corridor and the previously identified SLRT extension corridor wherever possible. Additional property requirements are in the vicinity of Kennedy Station and between Ellesmere Road and Midland Avenue (City of Toronto Works Yard). There would be minor property requirements along the at-grade guideway between Lawrence Avenue and Ellesmere Road, along the elevated guideway between Midland Avenue and McCowan and along the elevated guideway from Markham Road to Centennial College Station.

2.1.5 Subway operation

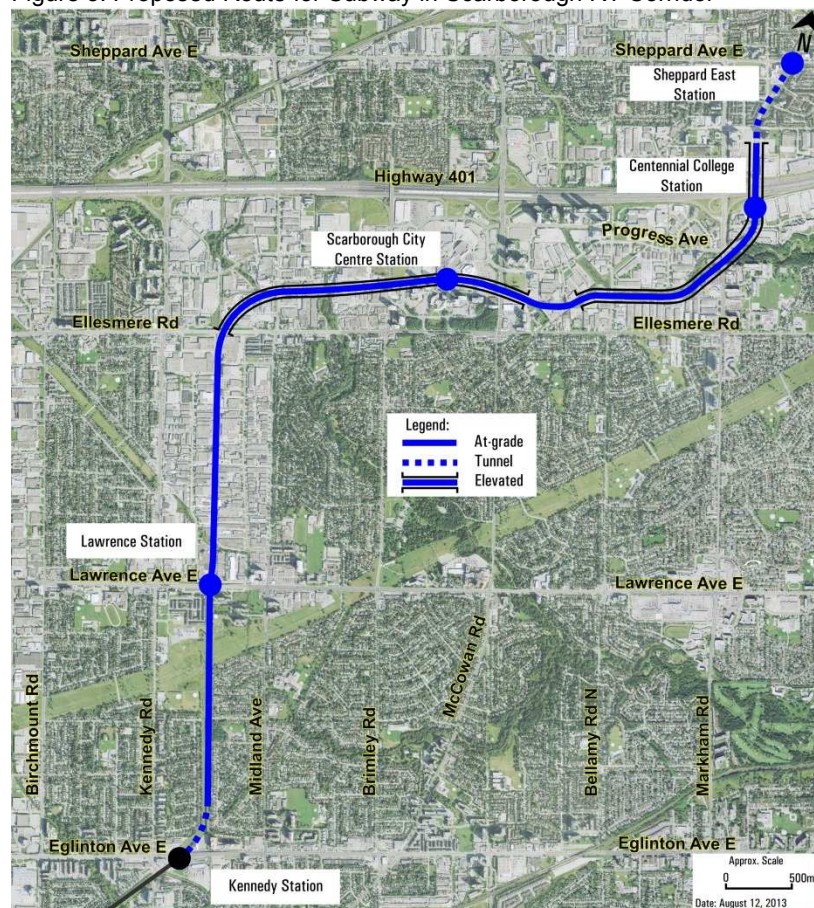
For the purpose of this study it is assumed that all trains would terminate at the new terminus at Sheppard East Station. A new double cross-over would be provided west of Kennedy Station to allow operational flexibility and turnback at Kennedy Station if required. Provision of an additional cross-over west of Scarborough City Centre Station is feasible.

¹ Transit Expansion Light Rail Transit Projects, Design Criteria Manual

2.2 Existing SRT Conversion and Extension Corridor

The existing SRT corridor starts at Kennedy Subway/SRT station and runs in north-south direction for a length of approximately 4km parallel to the GO Stouffville track with stations at Lawrence Avenue East and Ellesmere Road. An Underpass provides a grade-separate crossing of the GO track north of Ellesmere. The SRT corridor continues on in an east-west direction passing over Midland Avenue (Midland Station) and Brimley Road, approaching Scarborough Town Centre Station before terminating at McCowan Station. The proposed SLRT corridor would continue on parallel to Highland Creek before it turns north-east crossing Markham Road and Progress Avenue prior to approaching Centennial College Station. The alignment would cross the 401 elevated and would then run underground to the terminus at Sheppard East Station. Non-revenue service tracks would be installed between the underground tracks and the proposed at-grade Sheppard East LRT to connect the SLRT to the Maintenance and Storage Facility (MSF) at Morningside.

Figure 3: Proposed Route for Subway in Scarborough RT Corridor



Source: 4Transit

The proposed Subway in the SRT corridor would follow that alignment as close as possible, subject to more stringent subway alignment design criteria (refer to Section 2.1.3). Stations along subways are typically spaced further apart compare to LRT systems, it is assumed that the current station locations at Ellesmere and Midland would not be served by the proposed subway, and only one subway station is proposed in the vicinity of the existing Scarborough City Centre and McCowan Stations (refer to Sections 2.2.3 and 2.2.4 below).

2.2.1 Kennedy Station

The existing Kennedy (subway) Station is the current terminus of the Bloor-Danforth Subway. The centre platform is located approximately 14m underground and extends in an east-west direction parallel to Eglinton Avenue between Kennedy Road and the GO Stouffville track. A short tunnel section extends approximately 150m to the east of the GO track.

For the proposed Subway in the SRT corridor to tie-in to the existing Bloor-Danforth subway at Kennedy Station, tying into the tail tracks - which extend to the east from the existing station - would be the first starting point. In fact the subway extension alignment proposed by TTC in the "Toronto Transit Commission Report", dated January 2013 is based on this approach. However, that alignment follows Eglinton Avenue before gradually turning north towards McCowan Road. In order to connect from the tail tracks back to the existing SRT corridor, a significant (underground) loop would be required and the alignment would get back on the SRT corridor just south of Lawrence Avenue. This is not considered practical nor cost effective, hence alternative alignment options were considered as follows:

Option 1 – Hydro Corridor

The existing subway runs along a Hydro Corridor prior to crossing Kennedy Rd and approaching Kennedy Station. Instead of turning towards an east-west direction, the tracks would continue along the Hydro Corridor and would then turn on to the existing north-south SRT corridor.

This Option would comprise the following:

- New underground structure to accommodate tie-in to existing subway tracks
- New underground structure to accommodate crossover
- New underground station (refer to Section 3.2)
- New tunnel section/ramp to connect station to at-grade guideway
- Relocation of hydro towers
- Extensive traffic management during construction on Eglinton Avenue, Kennedy Road and Transway Crescent

The station box and the tunnel section to accommodate the crossover can be built cut-and-cover with only minor disruption to the operation of the existing Kennedy Station. The tie-in to the existing tunnel/tracks would be established immediately prior to the operational switch to the new station. The works associated with the tie-in would require suspension of the subway service between Warden and Kennedy Stations for a limited period of time. Temporary traffic management would be required to maintain access to the existing Bus Terminal at Kennedy Station.

Figure 4: Proposed Alignment in Hydro Corridor with Kennedy Station



Source: 4Transit

The biggest constraint for this Option are three hydro towers which would be required to either be permanently or temporarily re-located or be temporarily supported during construction. In order to avoid these works, Option 2 was developed.

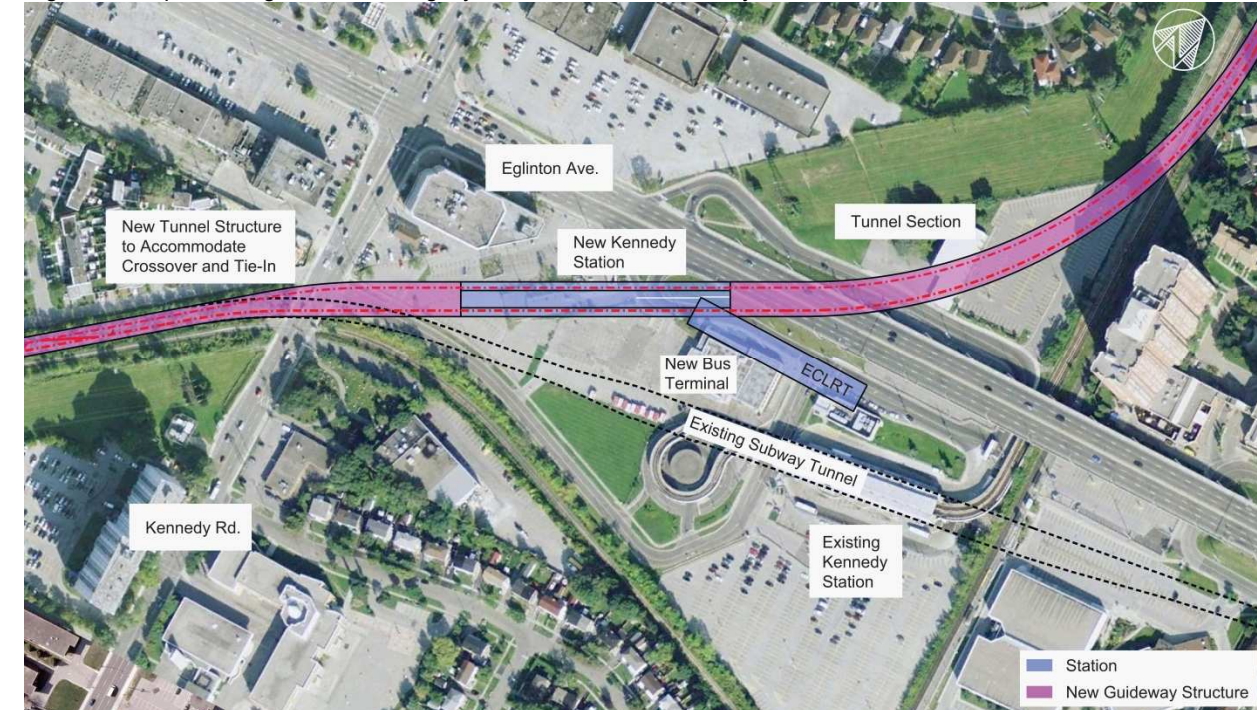
Option 2 – Avoiding Hydro Corridor

For Option 2 the Station box would move slightly to the south, away from the Hydro Corridor. The ramp connecting the Station to the at-grade section would impact the Hydro Corridor only slightly. Due to the re-orientation of the Station box and the associated curve in the alignment it would however no longer be feasible to locate the crossover immediately adjacent to the Station box. The crossover would need to be accommodated within the existing tunnel section, requiring a significantly longer suspension to the subway operation compare to Option 1. The Station box itself is considered to be feasible to be constructed without disruption to the operation of the Bloor-Danforth Subway and the SRT. Similarly to Option 1, temporary traffic management would be required to maintain access to the existing Bus Terminal at Kennedy Station during construction.

The impact on Eglinton Avenue is considered less compare to Option 1. Detailed Station configurations and operational impacts are discussed in Section 3.2.

Option 2 was advanced for the purpose of this Study.

Figure 5: Proposed Alignment avoiding Hydro Corridor with Kennedy Station



Source: 4Transit

2.2.2 At-grade guideway between Kennedy and Ellesmere Road

The SRT runs on an at-grade guideway from north of Kennedy Station to Ellesmere Station, parallel to the GO Stouffville track. The existing Lawrence Station is located between two reverse curves, north of Lawrence Station the alignment generally shifts east by a couple of meters.

Two options for the guideway between Kennedy Station and Ellesmere Road have been studied, mainly to address the required grade-separated crossing of the existing GO track.

Option 1 – Guideway West

The subway tracks would emerge from the underground section approximately 300m north of Eglinton Avenue, following the existing SRT corridor to Ellesmere Road. Due to a required increase of the distance between track centre lines (subway 4.27m vs. LRT 3.72m), a new slab on-grade track structure would be required and the existing corridor may need to be widened at certain locations. There are significant sections with retaining walls located at the western boundary of the corridor, in particularly north of Lawrence Station, hence widening the corridor towards the GO track

appears to be preferred. This would however need to be studied in more detail, specifically taking into account the proposed double-tracking of the GO Stouffville Corridor².

Option 2 – Guideway East

The tunnel section from the new Kennedy Station would extend to approximately 400m north of Eglinton Avenue to facilitate a grade-separated crossing of the GO track at this location. The subway tracks would run in the current GO corridor up to Ellesmere Road whereas the existing GO track would be shifted to the west on to the current SRT corridor. The full width of the combined existing SRT/GO corridor was considered to accommodate two new subway tracks and the proposed double-tracking of the GO Stouffville Corridor. Some local areas were identified where the existing corridor has insufficient width, requiring additional property take. A new slab on-grade track structure would be constructed for the subway tracks, the new GO tracks are assumed to be tie-and-ballast. Confirmation would be required whether the existing three spur lines (sidings) east of the corridor would still need to be connected to the GO track.

Option 2 was developed to address concerns in relation to the alignment between Ellesmere Road and Midland Avenue, refer to Section 2.2.3 below.

Figure 6: Typical at-grade guideway (Bloor-Danforth Subway east of Victoria Park Avenue)



Source: Panoramio, E. Victor C.

2.2.3 Ellesmere Road to Midland Avenue

Between Ellesmere Road and Midland Avenue the SRT alignment changes direction from north-south to east-west, incorporating a very sharp curve located within the Underpass crossing the GO track and the Atlantic Packaging spur line at this location. After emerging from the Underpass a steep gradient lifts the tracks up to the elevated guideway approaching Midland Station.

Option 1 – Guideway West

A grade-separated crossing of the GO track would be required between Ellesmere Road and Midland Avenue, however the underpass would be located significantly closer to Ellesmere Road compared to the existing SLRT alignment due to different horizontal alignment design criteria for subway (300m minimum radius vs. 150m minimum radius for LRT). The subway tracks would run on a ramp approaching the new Underpass. Immediately after crossing the GO track underground, the alignment would run on a steep gradient (3.5%) in order to pass over adjacent Midland Avenue. Both minimum horizontal radius and maximum gradient would be combined at the same section of track. This is not desirable from a Passenger Comfort perspective and would result in higher track maintenance costs due to excessive wear and tear on the tracks. Alternatively the tracks could continue underground until after crossing Midland Avenue and then rise up to run elevated, crossing Highland Creek. The alignment would be considerably improved, however, this would add additional costs due to a significantly longer underground section.

Crossing the GO track elevated at this location would not be feasible due to the close proximity of the crossing point to Ellesmere Road where the subway tracks cross underneath the bridge.

Option 2 – Guideway East

Option 2 was developed to eliminate the constraints of a grade-separated crossing of the GO track by crossing the track at Kennedy Station (refer to Section 2.2.2). The alignment would rise moderately after crossing Ellesmere Road to pass over Midland Avenue. The alignment would cut through the City of Toronto Works Yard, however it can be designed in so that the property on either sides of the alignment can still be utilized.

Option 2 was further advanced for the purpose of this Study.

2.2.4 Midland Avenue to McCowan Road

After leaving Midland Avenue Station, the existing SRT corridor crosses Highland Creek, Brimley Road and Borough Drive before approaching Scarborough City Centre Station and continues on crossing Brorough Drive a second time approaching McCowan Station located just east of McCowan Road. The section between Midland Avenue and McCowan Road is elevated.

The proposed subway alignment would run elevated within the existing corridor. The existing elevated structure is not designed to carry the loads of a subway train, is already 35 years old and the current SRT alignment would not be feasible for the subway trains to navigate. Hence the existing structure would be demolished and replaced with a new elevated guideway. To allow for a higher design speed throughout, the new elevated guideway would depart from the current alignment slightly, at various locations.

² Stouffville Corridor Study, Final Report, Metrolinx (February 4, 2013)

Figure 7: Typical elevated guideway (Seattle, Sound Transit)



Source: Hatch Mott MacDonald

2.2.5 McCowan Road to Hwy 401

The proposed SLRT extension would run through the existing and to-be-decommissioned McCowan Yard at-grade to a point approximately 200m west of Bellamy Road. It would then continue on elevated and parallel to Highland Creek, crossing Bellamy Road, Markham Road and Progress Avenue before approaching Centennial College Station just south to Highway 401. The alignment would cross Highland Creek three times along this section.

The proposed subway alignment would generally be located in the same corridor as the proposed SLRT alignment however due to larger turning radii requirements for the subway, the alignment would shift slightly away from the SLRT alignment, in particular west of Bellamy Road and at the approach to Centennial College. A new elevated guideway would be constructed and pier locations would be selected to avoid impact on the flood plains of Highland Creek.

2.2.6 Hwy 401 to Sheppard Avenue East

The proposed SLRT extension would cross Highway 401 elevated, followed by a steep ramp to bring the tracks underground prior to crossing Milner Avenue. The underground box structure would then stretch all the way to Sheppard Avenue East with tail tracks to the north of Sheppard Avenue.

The proposed subway alignment would generally follow the SLRT extension alignment however incorporating a less steep ramp but still crossing Milner Avenue underground. Connections to the surface Sheppard East LRT tracks at Sheppard Avenue to allow access to the MSF at Morningside would not be required. The cut-and-cover tunnel accommodating the double-cross before approaching Sheppard East Station would be constructed within Rosebank park however the area would be reinstated as park after construction.

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2.3 Extension beyond Sheppard Avenue

At Sheppard Avenue the alignment would utilize an abandoned rail corridor currently owned by Hydro One/City of Toronto which extends from Milner Avenue to McLevin Avenue close to Malvern Town Centre. An extension to the Scarborough Subway to Malvern Town Centre (Phase 2) can be accommodated without major interruption to the subway operation at Sheppard East Station, Phase 2 would tie-in to the box structure which accommodates the tail tracks.

2.4 Alignment Design – Plan and Profile

Alignment Design drawings (Plan and Profile) are included in Appendix A.

The proposed subway alignment is designed in accordance with the *TTC (Subway) Design Manual*, dated August 2011. The design generally tries to avoid absolute maximum/minimum values for design criteria however there are some locations where existing constraints require the design to be close to those absolute limits. At most of those locations speed restrictions and additional measures to address noise are required, such as provision of lubricators. An alternative alignment deviating slightly from the SRT corridor would enhance the conditions:

East of Kennedy Station

Horizontal curve: 310m radius, CH 29+680 to CH 29+990
Gradient: 3%, CH 29+850 to CH 30+090
Design Speed adopted: 50kph (reduced from 80kph)

The TTC Design Manual (DM-0204-04, Section 3.6) states that “Where vertical and horizontal curves are combined and an unbalanced superelevation exceeding 25mm is present, the length of vertical curve shall be increased [...] and subject to approval”. The vertical curve between CH 29+650 and CH 29+850 has been adjusted accordingly. It would be feasible to move the portal further north, thus reducing the maximum gradient. This is considered to be desirable to minimize rail wear and tear in the curved section. In any case noise and vibration measures would need to be considered along the horizontal curve and a speed restriction would be required due to the tight radius. A speed restriction at this particular location would be considered acceptable due to the close proximity of this curve to Kennedy Station.

Ellesmere Road to Midland Avenue

Horizontal curve: 305m radius, CH 33+600 to CH 34+050
Gradient: 2.5%, CH 34+020 to CH 34+110
Design Speed adopted: 55kph (reduced from 80kph)

There is a short overlap of vertical and horizontal curves and thus the length of the vertical curve was adjusted in accordance with TTC DM-0204-04. It is feasible to ascend the tracks using a more moderate gradient. Without the provision of a station at Ellesmere Road (refer to Section 3.4) this section of track is in-between stations and the required speed restriction due to the horizontal radius has an effect on the overall speed profile. This section of track is at-grade/elevated and squeal from trains navigating around the bend is expected. Lubricators would be required at this location.

Midland Avenue to McCowan Road

Horizontal curve: 600m radius, CH 34+690 to CH 34+750
Gradient: 3.0%, CH 34+660 to CH 34+800
Design Speed adopted: 60kph (reduced from 80kph)

A steep gradient of 3.0% would be required due to the topography of the area, overlapping slightly with a horizontal curve. It is feasible to overall lower the gradient, this would however require higher piers between Midland Avenue and Highland Creek.

McCowan Road to Markham Road

Horizontal curve: 310m radius, CH 36+170 to CH 36+420 and 305m radius, CH 36+580 to CH 36+720
Gradient: 2.0%, CH 35+710 to CH 36+900
Design Speed adopted: 55kph (reduced from 80kph)

Horizontal curve: 310m radius, CH 37+200 to CH 37+370
Gradient: 2.0%, CH 37+050 to CH 37+455
Design Speed adopted: 55kph (reduced from 80kph)

The horizontal curve overlaps with the vertical curve only for a short length. The length of the vertical curve was adjusted slightly in accordance with TTC DM-0204-04. This section of track is in-between stations and the required speed restriction due to the horizontal radius has an effect on the overall speed profile. This section of track is at-grade/elevated and squeal from trains navigating around the bend is expected. Lubricators will be required at this location.

Markham Road to Centennial College Station

Horizontal curve: 310m radius, CH 37+750 to CH 38+010
Gradient: 3.5%, CH 37+610 to CH 37+780
Design Speed adopted: 55kph (reduced from 80kph)

There is a short overlap of vertical and horizontal curves and thus the length of the vertical curve was adjusted in accordance with TTC DM-0204-04. Speed restrictions would be required but due to the close proximity of this curve to Centennial College Station trains would slow down approaching the station in any case. This section of track is elevated and squeal from trains navigating around the bend is expected. Lubricators would be required at this location.

Highway 401 to Sheppard East Station

Horizontal curve: 310m radius, CH 38+580 to CH 38+700
Gradient: 3.5%, CH 38+370 to CH 38+590
Design Speed adopted: 55kph (reduced from 80kph)

There is a short overlap of vertical and horizontal curves and thus the length of the vertical curve was adjusted in accordance with TTC DM-0204-04. Speed restrictions would be required, this would have medium impact on the overall speed profile as this location is still some distance away from Sheppard East Station. Lubricators would be required at this location.

3. Station Considerations

3.1 General

3.1.1 General strategy regarding stations

Station locations are proposed with consideration to the following factors:

- Line location
- Forecast ridership
- Operating practices
- Zoning and surrounding land use characteristics
- Transfer to other travel modes (bus)
- Established station locations (existing SRT / proposed SLRT stations)

Figure 8: Priority Investment Neighbourhoods



Source: 4Transit

A total of eight (8) stations were proposed for the SLRT, six (6) existing stations (Kennedy, Lawrence East, Ellesmere Road, Midland Avenue, Scarborough City Centre, McCowan) and two (2) new stations at Centennial College and Sheppard Avenue East. The existing stations at Ellesmere Road and Midland Avenue currently have low ridership numbers and only limited transfer options to other travel modes. Scarborough City Centre and McCowan Stations are located 500m from each other.

For the purpose of this study, four (4) new stations in addition to Kennedy have been considered:

- Lawrence Station – close to residential area, priority investment neighbourhood, bus terminal (bus loop)
- Scarborough City Centre Station – close to residential area, commercial hub and civic centre, important bus terminal
- Centennial College Station – close to Centennial College
- Sheppard East Station – residential area, priority investment neighbourhood, bus terminal, future Sheppard LRT stop

The concept for the Subway in the SRT corridor proposes not to retain stations at Ellesmere Road and Midland Avenue. An additional station can be provided at Ellesmere Road if supported by future ridership numbers (refer to Section 3.4).

Within the Scarborough City Centre/McCowan area only one station would be supported. Options for station locations are discussed in Section 3.5.

3.1.2 Bus terminal requirements

The provision of bus bays in bus terminals associated with the subway concept would be similar to the SLRT project. However a more detailed review would be required at a later stage with input from transit operators to confirm the requirements.

Any bus terminal relocations and reconfigurations associated with the proposed subway should strive to provide direct access both internally and to/from the primary arterial road. The bus terminals should also be positioned to allow for convenient access and transfers between transit providers and travel modes.

3.2 Kennedy Station

Due to the location and orientation of the existing Kennedy subway station and the associated challenges with the alignment connecting back to the SRT corridor, it is proposed to provide a new Kennedy Station incorporating subway, Eglinton Crosstown LRT (ECLRT) and a new bus terminal (refer to Section 0).

The main principles for the design of Kennedy Station include the following:

- Provide convenient access for all travel modes (pedestrian, bus, taxi, etc.),
- Optimize connectivity and transfers between subway, LRT, GO rail and bus facilities,
- Minimize the interaction between automobile and bus traffic,
- Provide a good level of service for bus terminal patrons and
- Ensure highly visible primary station entrance.

Given that Kennedy Station is a mobility hub with long-term development potential, the design of the station and the bus terminal should also attempt to consider the balance of space and should maximize future developable space.

3.2.1 Option 1 – Hydro Corridor

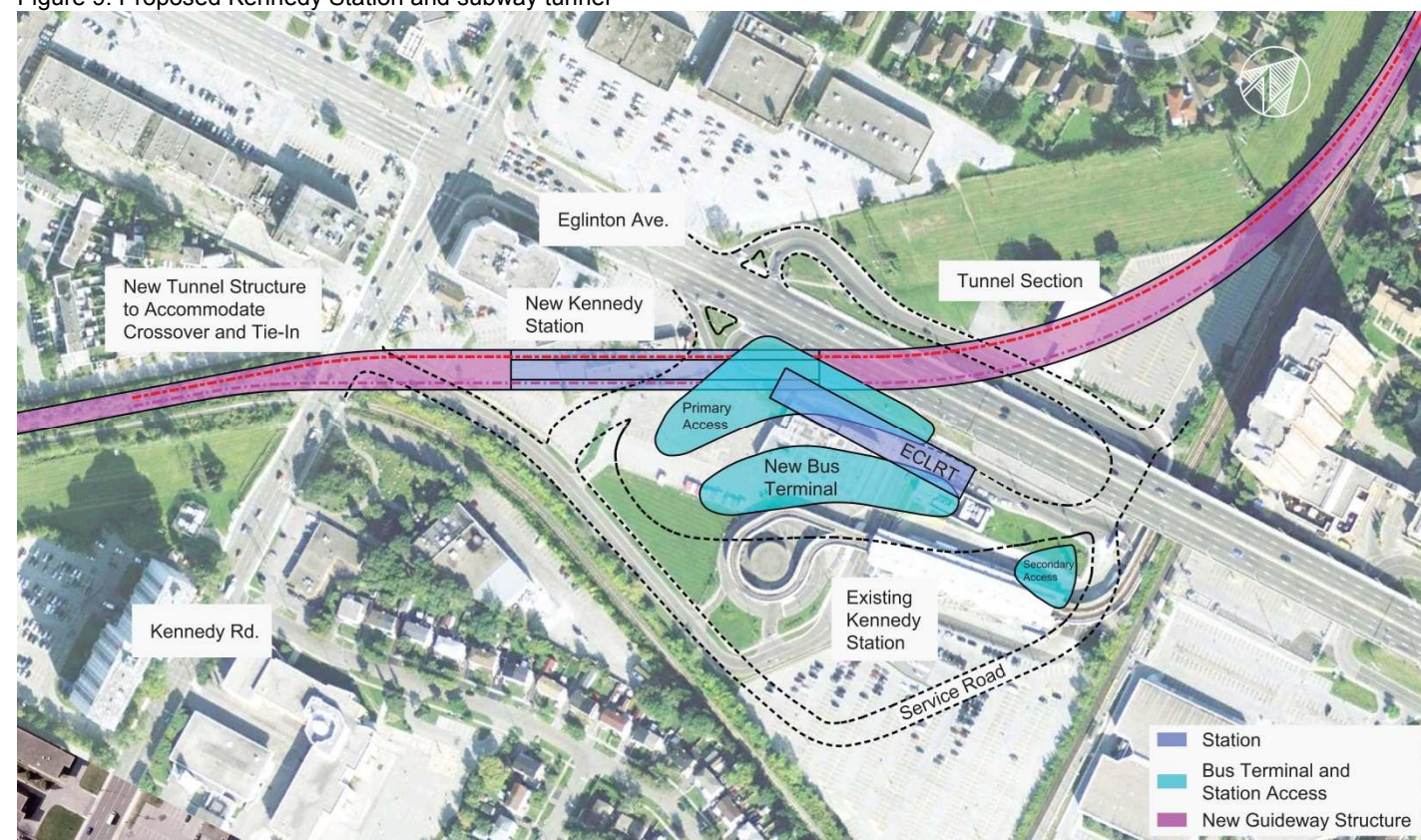
The main station box accommodating the subway platform would be orientated in a north-east direction and located within the hydro corridor. It would extend from Eglinton Avenue to a point approximately 90m north of Eglinton Avenue. Overall the placement of the station along the hydro corridor is considered to result in poor pedestrian transfers between subway and GO Rail, ECLRT and the proposed Scarborough-Malvern LRT.

Option 1 is not recommended to be considered further.

3.2.2 Option 2 – south of Eglinton Avenue (avoiding Hydro Corridor)

The station concept developed for this study attempts a balanced solution between the principles listed above and the site constraints. The key constraints that defined the layout are the location of the subway platforms, which are relatively fixed due to alignment constraints and the required tie-in to the existing Bloor-Danforth subway, close proximity to the hydro corridor, limited ability to shift the ramp access on the south side of Eglinton Avenue, preference to maintain bus access on each side of the bus terminal, prioritization of bus movements to/from the east of Eglinton Avenue and the geographic separation between the Subway/LRT and GO Rail platforms.

Figure 9: Proposed Kennedy Station and subway tunnel



Source: 4Transit

Ideally, the subway and LRT station box structures would line-up with each other, as well as with the Station Primary Access and bus terminal, to allow for convenient vertical circulation and transfers distributed between multiple access points. This however is challenging due to the orientation of the subway station box in a north-east direction whereas the LRT station box would be aligned parallel to Eglinton Avenue in an east-west direction.

Secondary accesses are envisioned to provide surface connectivity and connection to future development and GO Rail.

3.2.2.1 Subway

The preferred location for a new Kennedy subway station is indicated in Figure 9. The location is significantly constrained by the alignment design, in particular the requirement for a sharp curve leading up to the SRT corridor and the tie-in to the existing subway tunnel. The existing subway is approximately 14m below ground level, due to the proximity of the tie-in, the new subway platforms would be approximately at the same level.

The station box would accommodate both northbound and southbound tracks and a centre platform. Access would be provided to the surface and bus terminal via a concourse level and direct access to the platforms of the Eglinton Crosstown LRT (ECLRT). Details of the connection to the ECLRT and details of the concourse level and above ground elements of the station are subject to a more detailed design.

3.2.2.2 Eglinton Crosstown LRT

The proposed Eglinton Crosstown LRT (ECLRT) will terminate at Kennedy Station. A number of different concepts have been developed for the ECLRT and SLRT projects with particular focus on the transfer between the ECLRT, the SLRT, the subway and the bus terminal. Those concepts would need to be revised due to the proposed new Kennedy subway station and the location and depth of the ECLRT station box in context with the subway station is subject to a more detailed design however it is currently assumed that the ECLRT station box might be located parallel to Eglinton Avenue as indicated in Figure 9. A future extension to the east (Scarborough – Malvern LRT) can be accommodated by extending the station box further east.

3.2.2.3 GO Rail

The GO station on the Stouffville corridor is located approximately 250m or a 5 minute walk from the main subway/ECLRT station. It is assumed that underground access to the subway/ECLRT station would be provided via a secondary access located close to the GO station.

3.2.2.4 Bus terminal

The bus terminal should accommodate at least 13 bus bays, eight (8) of which should be sized to accommodate articulated buses. The 13 bus bays represent an increase over the existing 10 bus bays at Kennedy Station. A bus layby area should be provided around the parameter. All but two (2) of the bus routes using the bus terminal arrive from and depart to points east of the station which should be taken into consideration in the access and circulation for the bus terminal. Utilizing a direct access from Eglinton Avenue (as opposed to at Kennedy Road) is preferred.

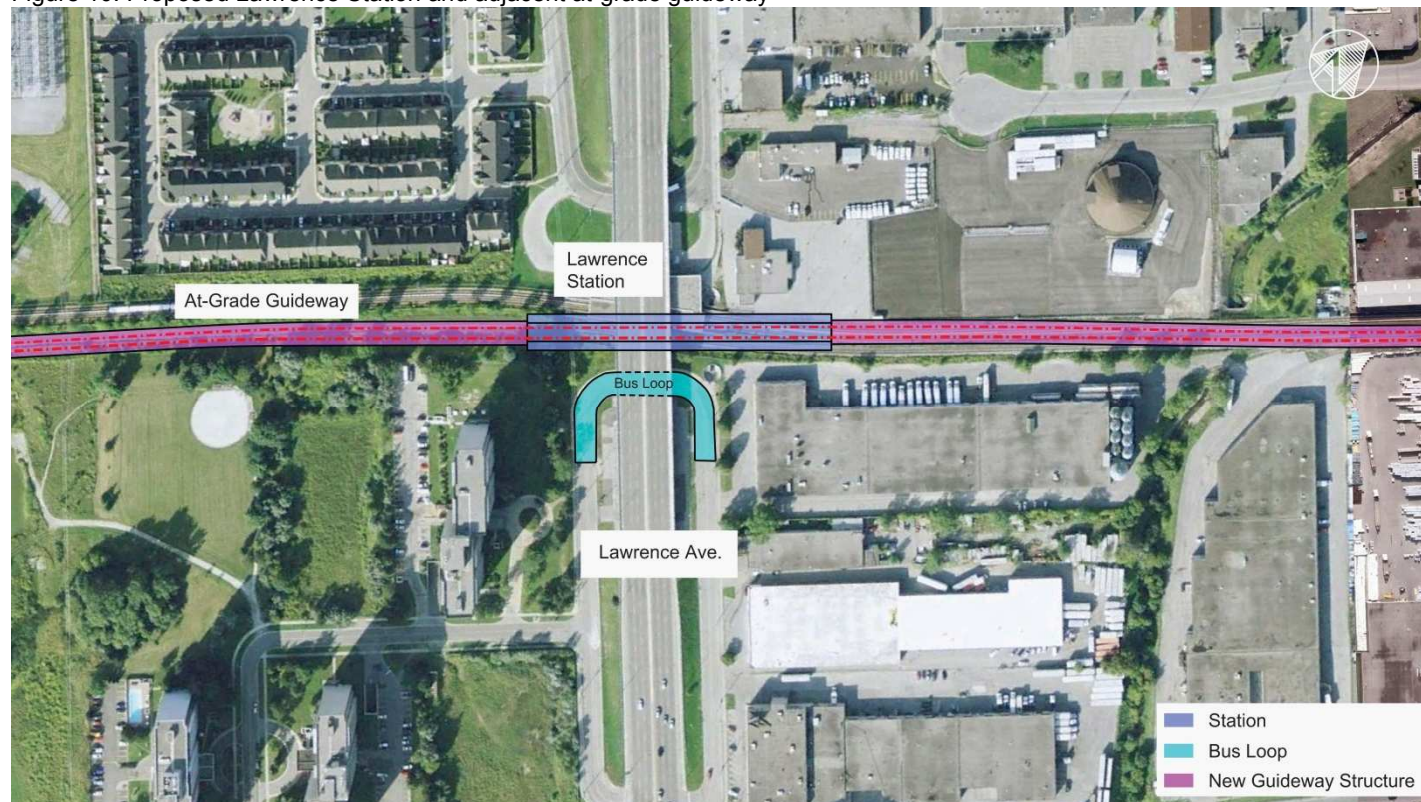
Due to the large volume of buses, interaction between buses and vehicular traffic should be minimized to the extent practicable.

3.3 Lawrence East Station

The proposed Lawrence East subway station would be located at-grade, beneath the Lawrence Avenue overpass, offering convenient, direct access from Lawrence Avenue. The station would consist of two side platforms, an underground concourse level providing access to the bus terminal and a direct access to Lawrence Avenue. It would be located in a north-south direction parallel to the bridge piers of the overpass. Additional property would be required south-east and north-west of the station to facilitate the subway tracks approaching the station and the GO track(s).

Presently, a service road provides access from Lawrence Avenue to the station beneath the overpass, incorporating a bus loop for direct transfers. It is assumed that the subway concept would require four (4) bus bays, two (2) of which would be for articulated buses. By shifting the subway tracks to the east side of the corridor, the bus bays may be re-located, too.

Figure 10: Proposed Lawrence Station and adjacent at-grade guideway



Source: 4Transit

3.4 Ellesmere Station

A station at Ellesmere Road is currently not part of the proposed subway concept, mainly due to low ridership numbers and poor transfers to other modes of travel. The alignment of the subway tracks in particular south of the Ellesmere Road overpass however would facilitate the provision of a station at Ellesmere Road at a later stage. It may be prudent to make some allowance in the design of the guideway for a rough-in, such as increasing the distance between adjacent

subway and GO tracks for platforms and an underground passageway to connect the platforms to the access roads either side of the corridor.

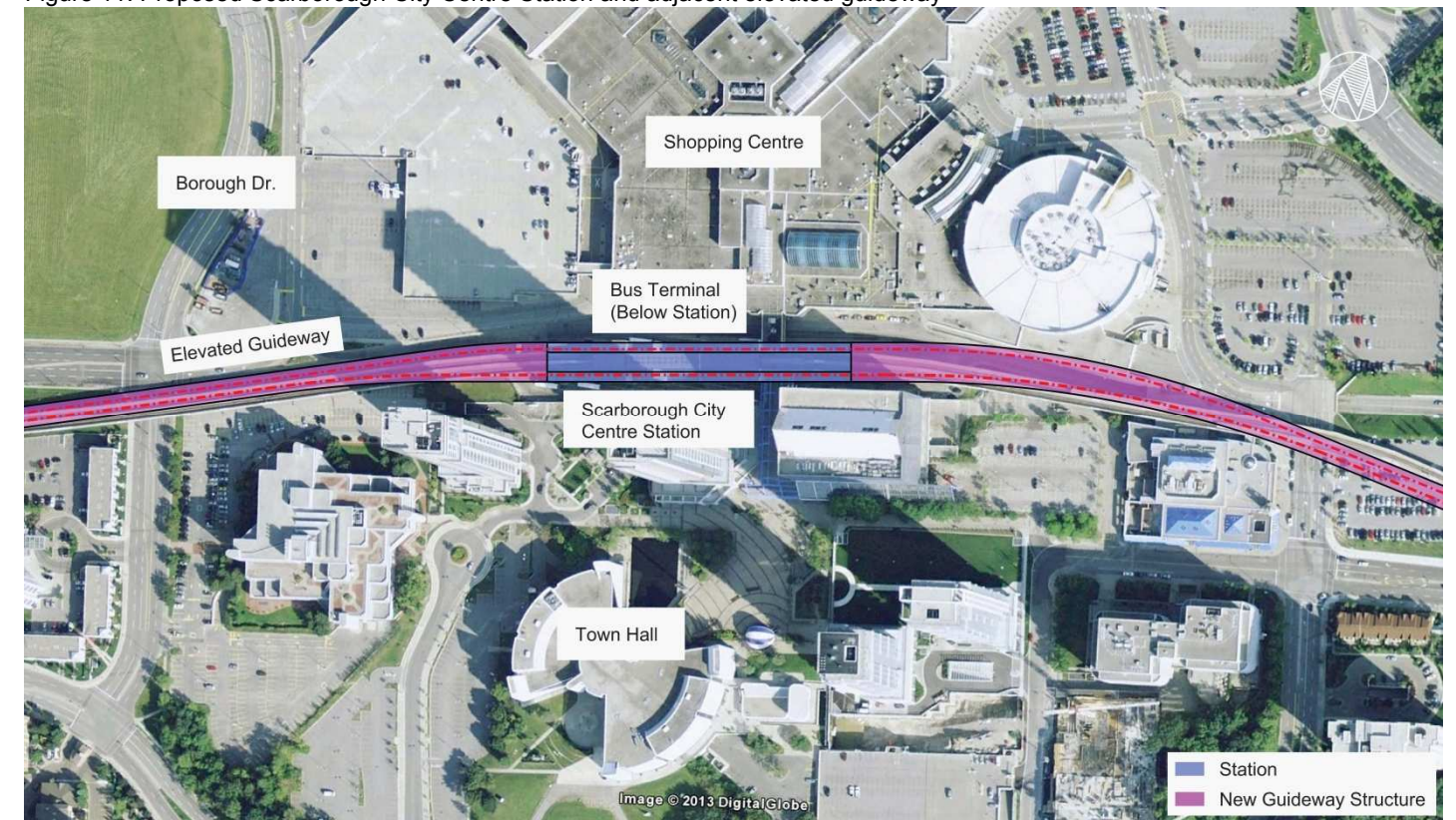
3.5 Scarborough City Centre/McCowan Station

The existing SRT stations at Scarborough City Centre and McCowan Road are only approximately 500m apart. It is proposed to carry only one station for the subway concept. The study has determined that there is sufficient space to provide an elevated station at the current locations of the SRT stations.

3.5.1 Option 1 – Scarborough City Centre Station

The existing elevated SRT station is situated in the Civic Precinct, between the Shopping Mall to the north and the City Centre/Town Hall to the south. A new subway station would be situated at the same location however the provision of a significantly longer platform to facilitate the longer subway trains and the provision of a centre platform instead of side platforms would trigger modification of the guideway alignment approaching the station from both sides. According to the TTC Design Manual, DM 04-02-06, Section 2.2, Centre platform are preferred over side platforms because they allow greater utilization of vertical circulation and greater capacity to accommodate surges in traffic flow.

Figure 11: Proposed Scarborough City Centre Station and adjacent elevated guideway



Source: 4Transit

The existing Scarborough City Centre Station provides a total of 19 bus bays below the SRT station, consisting of 13 TTC (serving WheelTrans vehicles and 14 TTC bus routes) and six (6) Regional transit providers including GO, Greyhound, Casino Roma etc. It is reasonable to assume a higher minimum of 15 TTC bus bays (six (6) for articulated buses) and the existing six (6) bus bays for Regional transit providers, a total of 21 bus bays for a reconfigured Scarborough City Centre Station.

Figure 12: Existing bus bays at Scarborough City Centre Station



Source: Hatch Mott MacDonald

A new elevated and extended Scarborough City Centre Station would provide sufficient space to add those additional bus bays below the station and a reconfigured station structure would also provide access for the GO double decker buses (the existing platforms fall short of double decker bus clearance requirements as the overhanging weather protection canopies are below the required clearance height). It appears beneficial to continue on making use of the existing Triton Road underpass for a bus thru-fare.

3.5.2 Option 2 – McCowan Station

The elevated existing McCowan Station is located between McCowan Road and Bushby Drive, the location would be retained for an alternative new station, however extending on both sides due to longer platforms required for the subway. The station would comprise a centre platform, access to the surface and the adjacent new bus terminal.

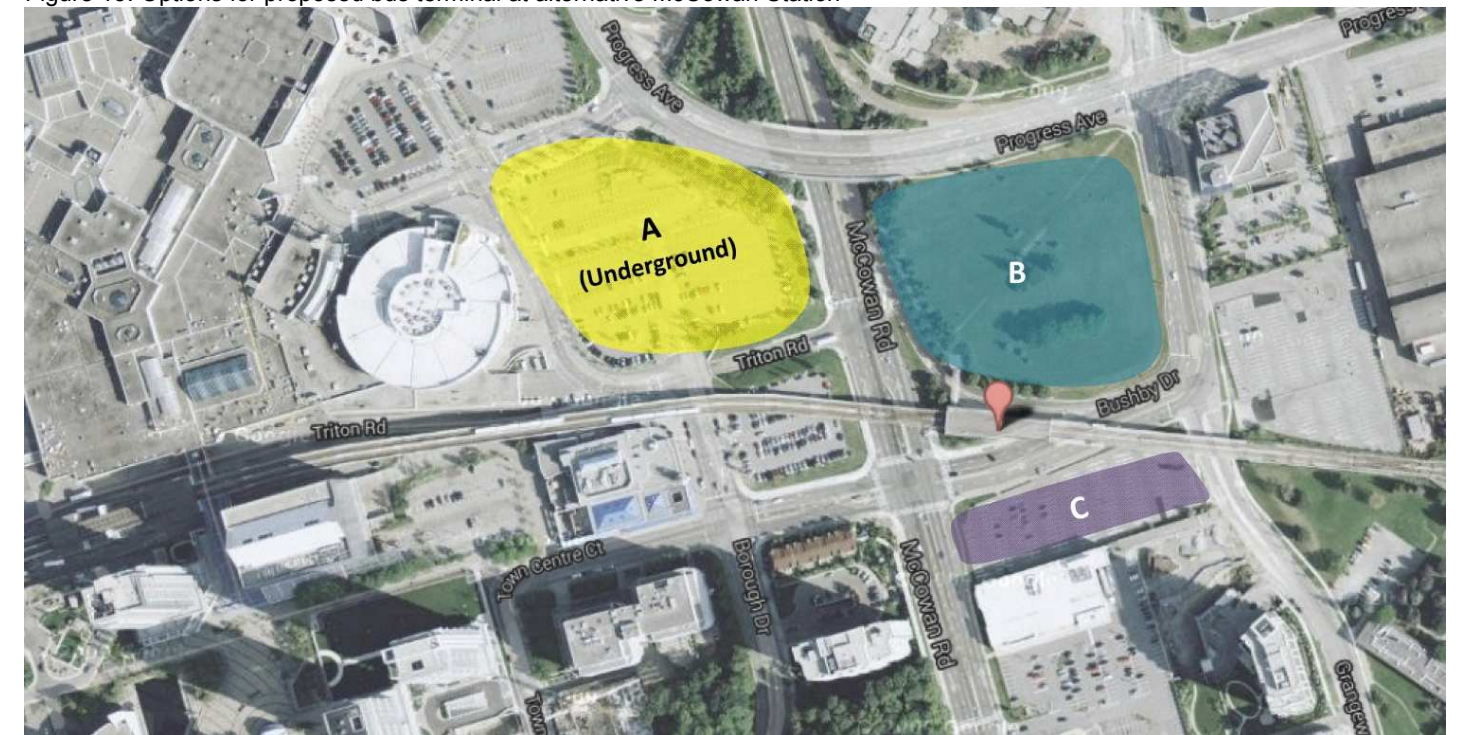
For an alternative new Station at McCowan, the bus bay requirements are similar to a reconfigured Scarborough City Centre Station. Three potential bus terminal locations for an alternative McCowan Station have been identified, based on the local area and existing constraints.

Similar to the existing Don Mills Subway Station, as part of the Sheppard Subway, **Option A** (see Figure 13) is envisioned to be beneath the existing mall parking lot. This could potentially directly utilize the existing thru-fare along Triton Road. The bus terminal would be relatively hidden from the surface. The bus terminal would be approximately 200m away from the nearest station entrance.

Option B would locate the bus terminal just immediately north of the proposed McCowan station, providing convenient transfer between bus and subway. However the location may not be ideal in the context of the McCowan precinct plan.

Located south of Bushby Drive immediately adjacent to the proposed McCowan station, **Option C** would provide convenient transfer between bus and subway but may be less ideal in terms of access for buses. In particular it may not be feasible to take optimal advantage of the existing Triton Road as buses would need to navigate a difficult manoeuvre along McCowan Road between Triton Road and Bushby Drive. Instead some re-routing along Progress Avenue / Ellesmere Road / Borough Drive and/or localized intersection and road reconfigurations may be required. The lot as shown may not be large enough to accommodate all required bus bays.

Figure 13: Options for proposed bus terminal at alternative McCowan Station



Source: 4Transit

While a new station at McCowan might likely act as a catalyst for future development in this area (refer to Section 4.1.4), the current station at Scarborough City Centre draws a large number of transit users (Shopping Mall, Civic Centre) and removing the station there would require passenger to walk a distance of approximately 500m to an alternative station at McCowan Road.

For the purpose of this study, Option 1 providing a re-configured station at Scarborough City Centre has been advanced.

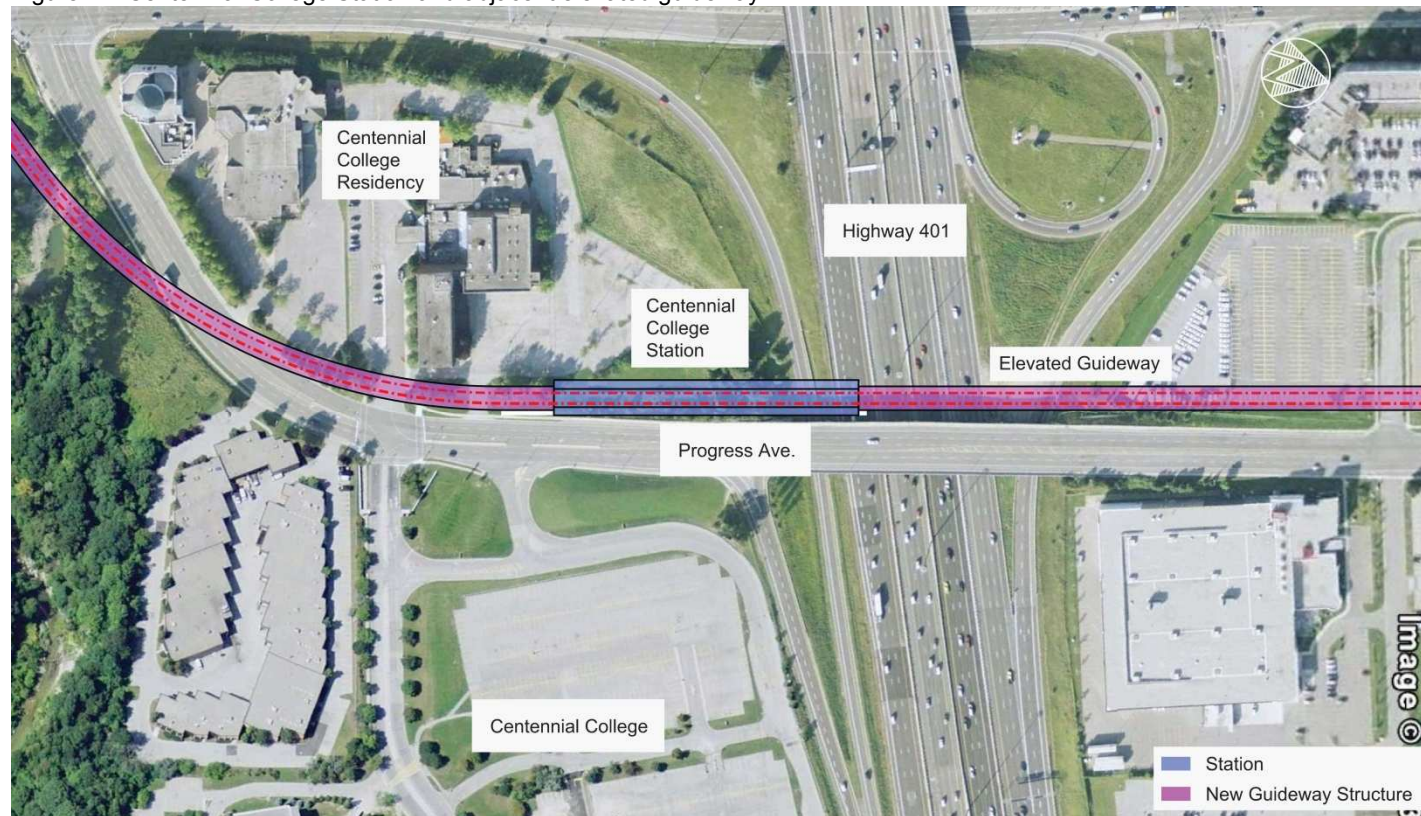
3.6 Centennial College Station

Consistent with the SLRT project, an elevated station would serve the approximately 6,000 full time and 14,000 part-time students enrolled at Centennial College at this location (i.e. at the Progress Avenue Campus). The station is located parallel to Progress Avenue and due to alignment constraints south of the station, the station structure would span over the eastbound on-ramp and partly over the eastbound Collector of Highway 401. The elevated guideway would continue over the Highway 401 towards Sheppard East Station.

The station would comprise side platforms to better facilitate the adjacent crossing of Highway 401. The station entrance would be located approximately 60m north of the intersection.

Similar to the SLRT project, it is assumed that the existing curb configuration would be cut back to provide two (2) bus laybys, one (1) for standard buses and one (1) for articulated buses, adjacent to the station.

Figure 14: Centennial College Station and adjacent elevated guideway



Source: 4Transit

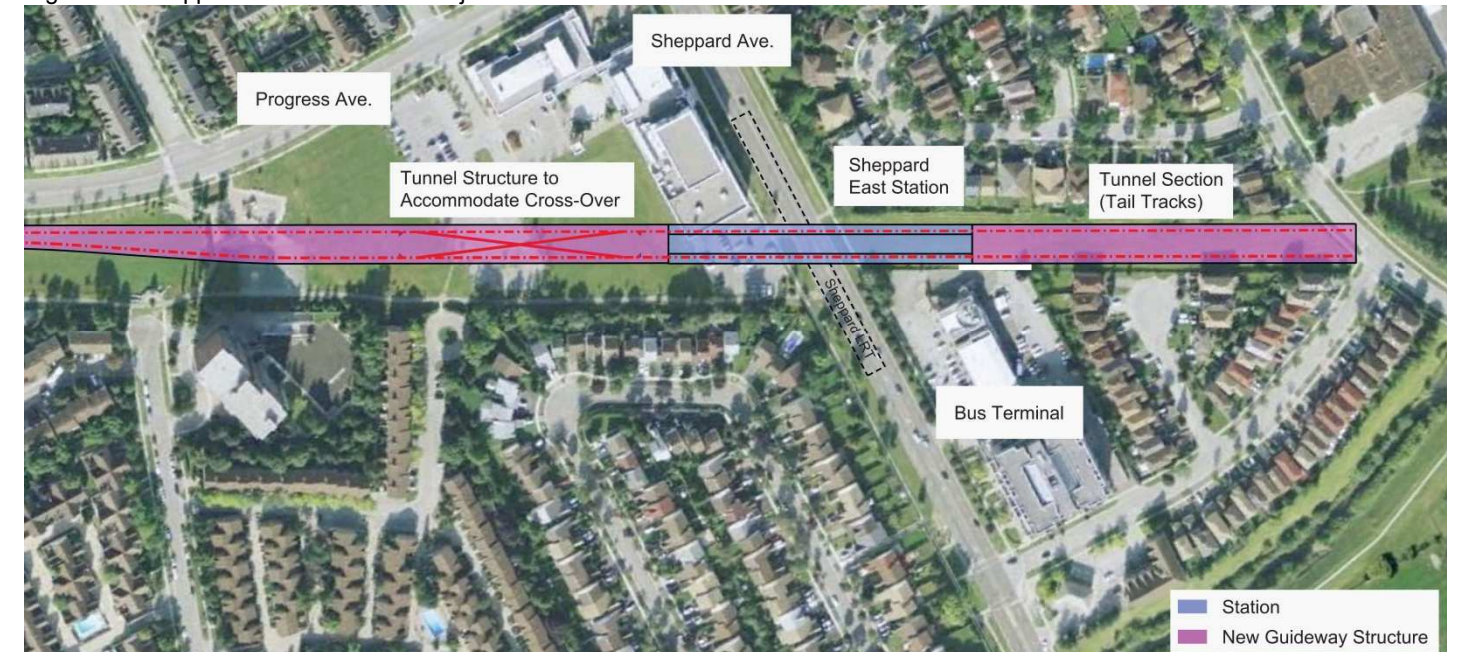
3.7 Sheppard East Station

An underground station would be provided at Sheppard Avenue East, similar to the SLRT project. The cut-and-cover box structure accommodating a centre island platform would cross Sheppard Avenue in an angle of approximately 45 degree and would be located along an abandoned rail corridor which continues on towards Malvern Town Centre. Access to the platforms would be provided from street level and the future Sheppard East LRT platforms via an underground concourse level.

Sheppard East Station would be the new terminus for the extended Bloor-Danforth Subway (at least until a Phase Two extension to Malvern Town Centre is in place). It is therefore required to provide a double cross-over at the southern approach to the station and tail tracks beyond the northern boundary of the station box. The double cross-over would be accommodated in a cut-and-cover box which connects to the station box on its north end and to the running tunnel on its south end. The box structure and the adjacent running tunnel would turn part of Rosebank park into a construction site however would be re-instated afterwards. The two tail tracks, each approximately 160m long, would be accommodated in an underground box structure within the abandoned rail corridor.

Similar to the SLRT project, it is assumed that a total of seven (7) bus bays would be provided in the terminal, consisting of four (4) for regular TTC buses and three (3) for articulated buses. An underground pedestrian passageway provides convenient access from the bus terminal to the underground concourse of the subway station.

Figure 15: Sheppard East Station and adjacent tunnel sections



Source: 4Transit

4. Land Use and Environment

Potential effects on land use and the environment relative to the Scarborough LRT corridor were considered during the Transit Project Assessment conducted in 2008-2010. The Assessment addressed:

- Conversion of the existing SRT between Kennedy and McCowan Stations to accommodate new LRT vehicles;
- Modifications to Kennedy Station to accommodate new LRT vehicles and improve connectivity to the existing subway and to the proposed Eglinton Crosstown LRT; and
- Extension of the system from its current terminus at McCowan Station to Sheppard Avenue East, and ultimately, to the Malvern Town Centre.

The Assessment was carried out within the prescribed regulatory framework (see below) and incorporated extensive consultation with stakeholders, included the City, regulatory agencies, the Aboriginal Community and the public.

Land use concerns were evaluated in terms of the City's planning framework, including the Official Plan, Secondary Plan and associated policies, programs and initiatives pertaining to the long-term vision for the City. Environmental concerns were evaluated in a context of how the SLRT would be likely to interact with the various constituents of the natural and social environment, and the measures that could be taken to mitigate any effects of the interactions. The Transit Project Assessment concluded that any effects of the project on land use and the environment could be effectively mitigated. Mitigation measures and related commitments included that all applicable federal, provincial and municipal permits and approvals would be obtained as necessary. The Minister of the Environment concurred with the Assessment conclusions and authorized the project to proceed.

Aspects related to land use and the environment within and adjacent to the SLRT corridor were reviewed during this Study to consider if and how the conclusions of the previous assessment might differ should the corridor be used for an at-grade/elevated subway.

4.1 Land Use Considerations

From a land use planning perspective, the review focused on the existing stations including Kennedy, Lawrence Avenue East and at Scarborough Centre/McCowan Road; and proposed new stations including Centennial and Sheppard East. The analysis also considered material deviations from the proposed SLRT (i.e., existing SRT) alignment with particular regard for possible impacts on other properties.

Land use-related issues are discussed below for the individual stations and the guideway. Overall, no significant land use issues were identified that would preclude development of the at-grade/elevated subway within the proposed SLRT alignment.

4.1.1 Kennedy Station

Lands in proximity to the existing Kennedy Station are occupied by a mix of uses including residential, office/employment, commercial, and some institutional. The lands are also quite constrained due to the existing rail and spur lines to the east and south, hydro corridor to the west, and the Eglinton Avenue overpass to the north.

The City's Official Plan designates the majority of the lands in proximity to the station as "Mixed Use", which allows for a range of uses and densities. Intensification opportunities at this location are significant due to the availability of land and its proximity to multi-modal transit.

There are little to no restrictions imposed from a land use perspective for relocating Kennedy Station. As a result of the relocation, more land may be theoretically available on the site to develop.

4.1.2 Lawrence East Station

Lands in proximity to the existing Lawrence East Station are predominantly "Employment" to the north of Lawrence and "Residential" to the south. The City's Official Plan indicates that lands to the northwest of the station are designated as "Employment", whereas the balance of the lands in proximity to the station is intended to be "Mixed Use" and "Apartments". However, a portion of the lands identified as Mixed Use are currently Employment uses, which is assumed to change over time to a use appropriate to the Mixed Use designation. Irrespective of the land use designations that identify the intended long term use on the property, uses southeast of the station include high-rise apartments, which may pose some redevelopment challenges and at the southwest, include new townhomes, which are considered low density and would be difficult to intensify over the long term.

Lawrence Avenue in this area is designated in the Official Plan as an "Avenue" and as such, is guided by the City's Avenues and Midrise Study, which encourages regeneration and intensification. However, while this area is designated as an "Avenue", development is only permitted to be upwards of 11 storeys due to the right-of-way width of Lawrence Avenue. As a result, with the land available, intensification may be restricted. The majority of the development, however, could likely occur through redevelopment of the existing apartment buildings at the southeast, albeit potential is small, or employment uses at the northeast. The location of the station should best serve the population that would access it. Therefore, the proposed location, which provides access on either side of Lawrence Avenue, results in an optimal station location.

4.1.3 Scarborough Centre Station

Lands in proximity to the existing Scarborough Centre Station are occupied by large commercial uses (Scarborough Town Centre, grocery store, restaurants, and other retail stores) in the parking lot, institutional uses (Civic Centre), office uses, and high density residential uses (condos). Lands in the vicinity of the station are designated Mixed Use, which permit a variety uses and densities.

Further intensification in proximity to the station may not be significant as the majority of the lands to the south have already been developed and the lands to the north are held privately by Oxford Properties (Scarborough Town Centre). Connections east and west of the station are generally poor; users of the system are required to manoeuvre north/south through the Mall or through the Civic Centre plaza. However, Scarborough Town Centre and Civic Centre are significant trip attractors for the existing Scarborough RT.

4.1.4 McCowan Station

Due to the close proximity of Scarborough Centre and McCowan Stations, a possible McCowan Station was reviewed in the event that the existing Scarborough Centre Station is replaced with a location that would better anchor the McCowan Precinct.

Land uses in proximity to the station include a parking lot at the northwest, a grocery store with associated parking lot at the southeast, greenfield lands to the northeast, and low density townhomes at the southwest.

Based on the City's future plans as they relate to the McCowan Precinct, and considering lands available for development, there is greater potential for the new subway station to act as a catalyst for development in this area of Scarborough Centre.

There is little restriction to development in this area which includes several parking lots and vacant greenfield lands. It is anticipated that the heights of the buildings would be consistent with those developed near Scarborough Town Centre. This scale of development would represent a significant opportunity for intensification of a building from 36-45 storeys based on similar approvals in proximity to McCowan Station, which would be built close to the property line.

4.1.5 Centennial Station

The proposed Centennial Station is located on the west side of Progress Avenue at Highway 401.

Lands in proximity to the proposed station are occupied by the Centennial College Campus, a place of worship, and some office/employment-type uses. The City's Official Plan designates lands in proximity to the station as Institutional Areas and Employment Areas, which is consistent with the uses that occupy the lands.

It is anticipated that this area would not intensify significantly over time; however, the College may expand, which could increase ridership.

4.1.6 Sheppard East Station

The proposed Sheppard East Station is located just east of the intersection of Progress Avenue and Sheppard Avenue East.

Lands in proximity to the proposed station are predominantly residential; the exception being the Chinese Cultural Centre immediately adjacent to the proposed station main entrance and some strip commercial. This area is currently at a very low density.

Land use designations near the station include Mixed Use Areas to the northeast, Neighbourhoods to the southeast, Parks to the west (north and south), and a bit further west at the intersection of Sheppard Avenue East and Progress Avenue, Institutional, Mixed Use and Neighbourhoods.

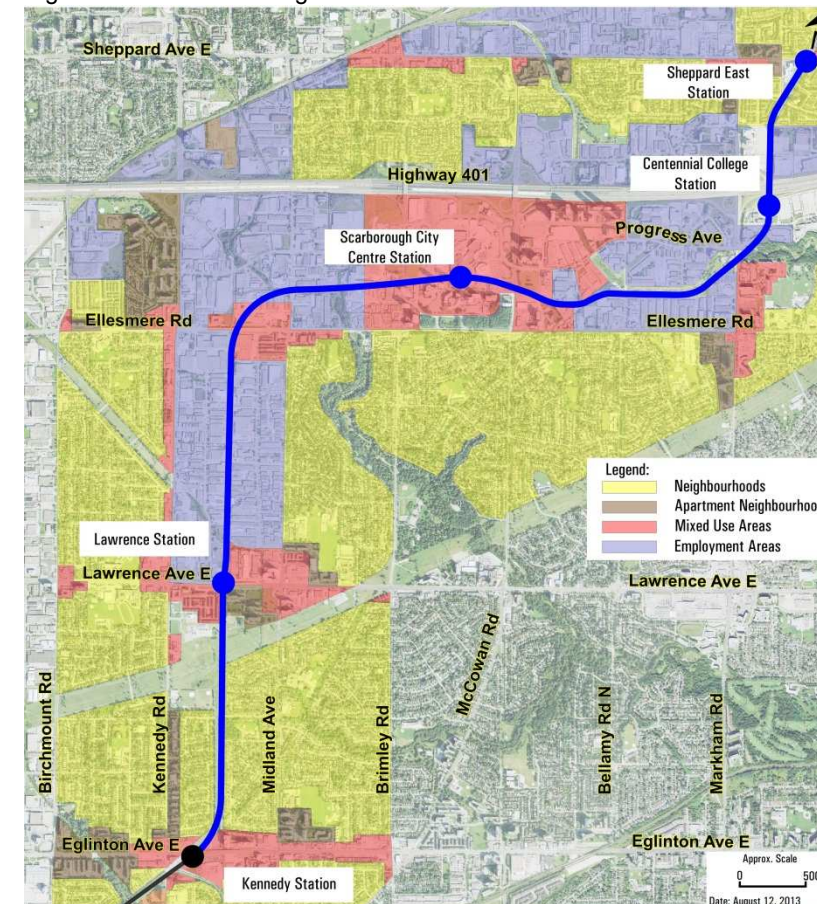
Intensification may be anticipated at the intersection of Sheppard Avenue East and Progress Avenue due to the availability of land and the intended use associated with the Mixed Use Areas designation.

4.1.7 Alignment/Guideway Considerations

While the proposed alignment of the subway is largely consistent with the proposed SLRT (i.e., existing SRT) corridor, there would likely be additional, yet nominal, property takings along the route to account for the larger vehicles and turning radii. However, the proposed route would permanently impact the City works yard at the northwest corner of Ellesmere Road and Midland Avenue, bordering the lands where the SRT travels from east/west to north/south. Due to

the larger turning radii required for the subway, the elevated guideway would need to transect the property. This is likely to have some impact on City operations; however, the guideway could be designed such that the works yard could continue to exist under the structure.

Figure 16: Land Use along the SRT Corridor



Source: City Official Plan (2010 Consolidation of the 2002 approved Official Plan)

4.2 Environmental Considerations

4.2.1 Environmental Assessment Requirements

The proposed Scarborough LRT was the subject of an environmental assessment under Ontario Regulation 231/08 following the Transit Project Assessment Process. The assessment was completed in 2010 and documented in an Environmental Project Report (Scarborough Rapid Transit Environmental Project Report, September 2010). Based on his ministry's review of the Environmental Project Report, the Ontario Minister of the Environment (MOE) concluded that the Scarborough LRT project would not have a negative impact on matters of provincial interest related to the natural environment, cultural heritage value, or to constitutionally-protected Aboriginal or treaty rights, and could proceed.

The Transit Project Assessment Process provides for amendments to the Environmental Project Report by means of addenda in the event that changes to the project are proposed. In theory, it may be possible that the amendment process could be used to assess the effects of the changes associated with developing the transit project as a subway rather than as an LRT. However, because reconfiguration of the transit project as a subway would be a significant departure from the project as it was originally assessed, and it may be accompanied by potential environmental effects and mitigation measures that are also considerably different, we suggest that a new assessment under the Transit Project Assessment Process would be appropriate. As well, a new assessment conducted under the prescribed timelines would offer a greater degree of schedule certainty than would the addendum process which is not subject to the same timing provisions. Schedule certainty was one of the key drivers in establishing the Transit Project Assessment Process and continues to be an important consideration in undertakings of this magnitude and level of public/stakeholder interest.

A new Transit Project Assessment of the subway would begin with the development of a functional design-level description of the project to serve as the subject of the assessment. Concurrently, the environmental baseline characteristics throughout the corridor as they were determined during the original Assessment for the LRT would be re-affirmed as valid for the new assessment. Where necessary, the baseline environment database would be updated to reflect the current conditions by means of desktop studies and focused field programs. A public and stakeholder consultation program would be designed and a Notice of Commencement prepared and distributed by the proponent. The assessment would be documented in a new Environmental Project Report and submitted to the MOE for review. Upon acceptance, the Minister would issue a Notice to Proceed in accordance with the Environmental Project Report or other conditions that may be attached. The assessment process concludes with the proponent's issuance of a Statement of Completion.

The Transit Project Assessment Process prescribes a regulated timeline of not more than six-months for the assessment of potential effects and decision-making by the regulators. In practice, the six-month interval begins at the time the Notice of Commencement is filed, and does not include preliminary studies required for functional design of the project, field programs for baseline characterization, or a "time out" that may be triggered in certain situations. The fundamental steps in conducting a Transit Project Assessment and associated timeframes are:

- Technical studies and analyses, and project functional design to facilitate the assessment (estimated at 12 months);
- Initial consultation with MOE;
- Distribute Notice of Commencement (120-day prescribed timeline begins);
- Stakeholder consultation
- Prepare Environmental Project Report;
- "Time out" provision in event of potential negative effects on matter of provincial importance or on constitutionally-protected aboriginal or treaty rights;
- Distribute Notice of Completion of Environmental Project Report (120-day prescribed timeline concludes);
- Public and regulatory review of Environmental Project Report (30 days); and
- Minister's response (35 days).

With all factors considered, a realistic timeline to complete the Transit Project Assessment Process from the point of confirming the "subway" program to the Minister's acceptance of the Environmental Project Report would be in the range of 18 months. This includes a necessary period of time for functional design activities and technical studies to be carried out in advance of the commencement of the prescribed timeline (technical studies would also continue during the prescribed timeline). Please refer to Section 7 for a preliminary Implementation Schedule.

4.2.2 Environmental Scan

The following sections present a preliminary consideration of the potential environmental implications (i.e., environmental scan) of developing the transit project as a subway generally within the corridor proposed for the Scarborough LRT. As noted above, an assessment of this corridor was previously conducted for the LRT and the information in that report has been the primary source for what follows. Because of the passage of time since the original assessment, the existing environmental conditions in the subway corridor would be updated in support of a new Transit Project Assessment through data collection and additional field work, where necessary. This would be followed by a new impact assessment to evaluate potential effects and identify mitigation measures appropriate for the subway concept.

The environmental scan assumes that all construction activities would incorporate good environmental management practices to preclude or mitigate potential effects on the environment. These practices would include the development of, and adherence to, detailed Environmental Protection Plans (EPPs) that address, among other aspects, air quality and dust management; erosion and sediment control; contaminated soils management; groundwater management; noise and vibration control; and archaeological and built heritage resources management.

The scan also contemplates that the proponent and the contractor would abide by all applicable environmental regulatory, permitting and approval requirements as they might be administered by federal, provincial authorities and other agencies (e.g., Toronto and Region Conservation Authority –TRCA).

4.2.2.1 Natural Environment

Where they exist, the vegetation communities in the corridor are typical of an urban setting. There are no Areas of Natural and Scientific Interest (ANSIs), Environmentally Sensitive Areas (ESAs) or Provincially Significant Wetlands (PSWs). Natural heritage features, including mature vegetation, are present in the vicinity of Highland Creek (regulated by the TRCA) near Markham Road/Progress Avenue. Any removal of mature trees and other vegetation on the slopes of the creek (as well as other water crossings) may result in erosion of the slopes. Accordingly, an Erosion and Sediment Control Plan and other control programs reflecting site-specific requirements of TRCA, would be implemented to mitigate the potential erosion impacts near the creek.

With respect to wildlife, no sensitive or designated species have been recorded in the vicinity of the proposed works. There are, however, bird species in the area that are protected under the Migratory Birds Convention Act (MBCA). To meet the requirements of the MBCA, vegetation removal during the nesting season (generally from April 1 to July 31) should be avoided. No aquatic species at risk have been identified within the water bodies likely to be affected by the works.

No significant impacts to the natural environment are anticipated as a result of the project that cannot be mitigated through known and well-established environmental management practices. Though the development of a detailed Erosion and Sediment Control Plan and an appropriate vegetation preservation and replacement strategy in the vicinity of Highland Creek, slope erosion due to removal of mature vegetation and any down-gradient effects on habitat and plant communities can be effectively mitigated.

4.2.2.2 Geology, Soils and Groundwater

Because the subway would be constructed within the existing SRT right-of-way, the potential for incremental environmental effects as they relate to soils and geology can reasonably be expected to be limited. Environmental site assessments would be conducted for all properties being acquired to identify potential soil or groundwater contamination. Any contaminated soils encountered, and groundwater pumped during construction, would be managed in accordance with provincial regulations which require proper handling and disposal of such soils; and the pumping and disposal of groundwater within the terms of a Permit to Take Water.

Overall, no significant impacts to geology, soils and groundwater are anticipated as a result of the project.

4.2.2.3 Surface Water

The existing SRT corridor crosses West Highland Creek at two locations. The first crossing is in the form of culverts, just north of Lawrence Station. The second crossing is in the form of an overpass, just east of the existing Midland Station. The tracks run parallel to Highland Creek in the vicinity of the existing Midland Station. Compliance with standard erosion and sediment control measures in accordance with TRCA and the City of Toronto guidelines would be required during construction in these areas.

Along the extension section of the subway (i.e., east of McCowan Station), the alignment is anticipated to cross the TRCA-regulated area of Highland Creek. Construction in these areas would require coordination and approvals from the TRCA. Potential construction-related effects on the Highland Creek crossings at this section of the route can be mitigated by implementing good environmental management practices for erosion and sediment control and protection of habitat and plant communities.

Overall, no significant impacts to surface water are anticipated as a result of the project.

4.2.2.4 Air Quality

The proposed subway in the SRT corridor would be electrically powered and, therefore, would have no long-term adverse impacts on the local air quality. Potential localized air quality impacts are anticipated near stations due to increased car and bus activity, however, a net beneficial effect can be expected to result from greater use of the transit system and associated reduced reliance on automobiles.

Short-term, construction-related impacts associated primarily with emissions of Suspended Particulate Matter (SPM) to the atmosphere, and dust fall on surfaces are anticipated. The release of dust and other airborne pollutants during construction can be effectively mitigated through the implementation of good environmental management practices for dust control and air quality monitoring. As a result, no significant impacts to air quality are anticipated as a result of the project.

4.2.2.5 Social Environment

Temporary and permanent property acquisitions would be required for the construction and operation of the subway, however, the detailed property requirements cannot be defined at this time. Property acquisition would be carried out

with the objective of ensuring that individual rights are respected and protected and to provide fair compensation within the framework of the *Ontario Expropriations Act* for any property acquired or affected by civic projects.

The existing parklands within Rosebank Park, located at Milner Avenue and Progress Avenue, would be affected temporarily during construction of the alignment. A construction staging plan would be developed in consultation with the City of Toronto Parks, Forestry and Recreation to mitigate the construction effects at the park. Following construction, the parklands would be restored to normal use. The subway alignment in this area would require open-trench construction and associated good environmental practices (e.g., dust control, noise management) to mitigate potential effects on the adjacent residential areas on Progress Avenue and on the east site of the Rosebank Park.

No built heritage and cultural landscape features are present within the limits of the SRT right-of-way and extension portion of the alignment. The Bethel Cemetery, located at 737 Kennedy Road south of Eglinton Avenue East, is a pioneer cemetery and a cultural heritage resource designated under Part V of the *Ontario Heritage Act*. The Bethel Cemetery is located to the south of the two proposed options for Kennedy Station. If the Station were to be relocated to extend beyond its existing boundary to the south, it would be necessary to address the potential for encroachment onto the Bethel Cemetery lands, including a detailed Heritage Impacts Assessment to develop a conservation strategy for the resource.

With respect to archaeology, there is very limited potential for the presence of archaeological sites within the existing SRT corridor as the lands have been previously disturbed. Based on the Stage 1 and 2 Archaeological Site Assessments previously conducted as part of the Transit Project Assessment along the extension section of the alignment, no archaeological resources have been identified. However, the archaeological potential for the subway alignment would need to be confirmed during the re-visited transit project assessment. In addition, a Stage 1 Archaeological Assessment was conducted for the Kennedy Station lands which determined that no archaeological sites have been registered within the immediate vicinity of the lands and that the majority of the lands have been previously disturbed. However, the hydro corridor, located on the north side of Eglinton Avenue East has remained relatively undisturbed and exhibits archaeological potential. Accordingly, a Stage 2 Archaeological Assessment would be required to confirm that no archaeological sites are present.

Overall, no significant impacts to the social environment are anticipated as a result of the project, however, and as has been noted, a detailed impact assessment would be required to confirm this preliminary conclusion.

5. Implementation Considerations

5.1 General

The implementation of the proposed Subway in the Scarborough RT Corridor would include the following major tasks:

- Construction of new At-Grade and Elevated Guideway and tunnel sections
- Demolition of existing At-Grade and Elevated Guideway and Underpass
- Construction of new At-Grade, Elevated, and Underground stations
- Demolition of existing At-Grade and Elevated stations
- Construction of new bus terminals (both temporary and permanent)
- Shifting of GO track

Construction of the subway system would need to be coordinated with many other priorities, including Eglinton Crosstown LRT project work near Kennedy Station, the operations of the existing SRT system, the operations of GO Transit, and the future operation of the new Kennedy Station.

5.2 Constructability

New guideway and Stations would be constructed along approximately 7km of the existing SRT system (from Kennedy Station to McCowan Yard) and 3km within a new corridor (from McCowan Yard to Sheppard East Station) and would comprise of following sections:

- New at-grade guideway along the existing GO Transit corridor, from north of Kennedy Station to near Midland Ave. including new Lawrence East Station.
- New elevated guideway replacing the existing elevated guideway from Midland to McCowan including new Scarborough City Centre Station.
- New elevated guideway from near Bellamy Road to Milner Ave, including new Station at Centennial College and guideway over Highway 401.
- New tunnels on either side of the new Kennedy Station, including Kennedy Station, and on either side of the new Sheppard East Station including the Station.

5.2.1 At-grade guideway

Demolition of at-grade guideway would be required on the existing SRT system from Kennedy Station to north of Ellesmere Station including the existing at-grade stations at Lawrence and Ellesmere Road.

The new at-grade guideway is proposed to be constructed as slab on-grade track structure to minimize maintenance. The construction site runs parallel to the GO track(s) however outside the GO clearance envelope. Access to the site could be provided from Eglinton Avenue, Lawrence Avenue and Ellesmere Road.

5.2.2 Elevated guideway

Elevated Guideway would be demolished from Midland Station to McCowan Yard as well as existing elevated stations at Midland, Scarborough City Centre, and McCowan.

Elevated guideway construction, which comprises approximately 4 km of the alignment, can efficiently be constructed by the precast segmental concrete technique. The principle of the precast segmental construction technique is as follows:

- the bridge piers are constructed,
- precast concrete segments are fabricated in a casting yard,
- a temporary erection girder is positioned on the piers,
- segments are delivered to the site,
- a segment is lifted onto the erection girder and placed in position as the next segment in the span,
- epoxy is applied at the segments joints,
- post-tensioning cables are fed through the segment,
- post-tensioning force is applied,
- the span is self-supported,
- repeat until span reaches the next pier,
- launch /place the erection girder onto the next set of piers.

Figure 17: Overhead self-launching girder



Source: Hatch Mott MacDonald

Typically the erection cycle, which includes launching the girder, setting the segments, applying epoxy and post-tensioning the span, is about 3 to 4 days.

- Launching and setting the girder - 4h to 6h
- Placing and setting a segment - 30 to 40min
- Applying epoxy and prestressing - 8h.

Traffic would be impacted at several stages during construction of road crossings.

- Road closure is required during launching the girder over a road
- Lane closure is required during lifting and placing the segments
- Epoxy and prestressing operations typically do not require line closures; but a safety net is required under the bridge
- Lane closures would also be required for foundation construction and utility relocations

5.2.3 Tunnel sections

Tunnel sections including underground stations would generally be constructed as cut-and-cover box structures. Construction of the station box at Kennedy Station and adjacent tunnel sections is considered to be very complex, refer to Section 5.3 below for details on Staging and Sequencing.

5.3 Staging and Sequencing

Any construction within the existing SRT corridor would require shut-down of the SRT and operation of temporary replacement bus service to ensure connectivity between Kennedy Station, Lawrence Avenue East and Scarborough Centre Stations. Thus early construction activities were identified which can be carried out prior to the SRT shutdown. Overall the works are likely to be sequenced as follows:

Kennedy Station

The new Kennedy Station can be constructed with only minor disruption to the operation of the existing Kennedy Station. The proposed subway platform/station box would most likely share some common structural features with the proposed ECLRT station box and thus would require some rough-in during construction of the ECLRT station. The ECLRT would commence service in late 2020, the subway operation in and out of Kennedy Station should ideally be shifted to the new platforms at the same time to provide convenient transfer between subway, ECLRT and the relocated bus terminal, also serving temporary bus replacement operation during the SRT shut-down. A more detailed schedule study is required to determine whether it is actually feasible to enhance construction of Kennedy subway station such that it could open parallel to the ECLRT.

In order to facilitate the proposed special trackwork within the existing subway tunnel immediately west of Kennedy Road, a new tunnel structure can be built over the existing box structure to allow demolition of the existing box including centre piers at a later stage. The construction of the tie-in to the existing tunnel would require shut-down of the Bloor-Danforth Subway between Warden and Kennedy Stations for a certain period of time and a temporary replacement bus service between those two stations.

Parts of the subway tunnel leading up to the at-grade section can be constructed without interruption of the SRT operation. This would accommodate the completion of the tunnel at a later stage without affecting the subway operation in and out of the new Kennedy station (once operation is shifted to the new station).

Sheppard East Station

The proposed Sheppard East Station including tail tracks and tunnel section incorporating the double cross-over would be constructed in cut-and-cover. Those works can start early in the construction process, subject to utility relocations in

particular along Sheppard Avenue East. The proposed station box crosses Sheppard Avenue East and would therefore need to be constructed in stages to allow traffic on Sheppard Avenue East to cross the construction site.

Elevated Guideway McCowan Yard to Highway 401

The elevated guideway between McCowan Yard and Highway 401 is a practical starting point for early construction activities. Starting immediately north of Highway 401 and working south towards McCowan Yard, new construction of the elevated guideway would not affect operations on the existing SRT. This section would also include the new Centennial College Station.

Temporary bus terminal

The temporary bus terminal is proposed west of Scarborough City Centre. The bus terminal would be served from buses previously heading towards Scarborough City Centre SRT station and the temporary replacement bus service operating during the SRT shutdown. Hence the temporary bus terminal need to be constructed and made operational prior to the SRT shutdown.

SRT shutdown

The shutdown of the SRT should be kept to an absolutely maximum of three (3) years. During the SRT shutdown a temporary replacement bus service would be in operation from Scarborough City Centre to Kennedy Station.

Demolition of at-grade guideway and construction of GO tracks

Once the SRT ceases operation, the existing at-grade guideway between Kennedy Station and Ellesmere Road can be demolished along with the at-grade stations at Lawrence Avenue East and Ellesmere Road. New GO track(s) would be installed in the SRT corridor and GO service would be re-located to the new tracks.

Demolition of GO track and construction of at-grade guideway

After re-location of the GO service to the new tracks on the west side of the corridor, the existing GO track can be removed and the new at-grade guideway for the subway can be constructed along with the at-grade station at Lawrence and rough-in for a future station at Ellesmere Road, if required.

Demolition of existing elevated guideway and construction of new elevated guideway

The existing elevated guideway and the elevated stations at Midland Avenue, Scarborough City Centre and McCowan Road can be demolished once the SRT is shut down. Construction of the new elevated guideway could start at McCowan proceeding towards Midland, including the construction of the new station at Scarborough City Centre.

Systems

System wide elements would be staged to compliment the staged completion of the facility elements for the installation of track, signal, communications and traction power/OCS element installation. The modification and/or construction of each station would be coordinated to allow early access to the station rooms and areas by systems contractor for

systems installation. Local testing of systems equipment would also similarly be carried out in sequence and subsequently allow the integrated testing and commissioning to start as early as possible.

5.4 Impact on services

Construction of the proposed subway between Kennedy Station and Sheppard East Station needs to be co-ordinated with the operation of the Bloor-Danforth subway, the existing SRT, the proposed ECLRT and to certain extend the proposed Sheppard LRT. The biggest impact to existing services is the shut-down of the SRT operation to facilitate construction of the new guideway and stations. We understand that Metrolinx has agreed to limit the shut-down period for the SRT to three (3) years.

The tie-in to the existing subway tunnel west of Kennedy Road would require the suspension of subway service between Warden and Kennedy Stations. The shut-down period should be limited by facilitating as many activities as possible prior to the shut-down, such as pre-construction of a new tunnel structure surrounding the existing box structure at the proposed location for the special trackwork within the existing tunnel.

Existing bus services would be impacted to various degrees, in particular at Kennedy Station and Scarborough City Centre Station. At both locations temporary bus terminals are proposed.

The proposed ECLRT would commence services ahead of the subway extension to Sheppard East, hence any works required for the subway station at Kennedy adjacent to the ECLRT should be roughed-in during construction of the ECLRT.

The planned Sheppard LRT is proposed to commence service in 2021, ahead of the proposed subway extension. Construction of the station box crossing Sheppard Avenue East needs to be co-ordinated accordingly to avoid conflict with the Sheppard LRT once in service.

6. Order-of-magnitude Cost Estimate

Table 2: Preliminary Order-of-magnitude Cost Estimate (in \$2011)

Task	From	To	Unit	Quantity	Unit Cost	Cost
New Kennedy Tunnel - South, incl. Crossover	29+300	29+468	m	168	\$700,000	\$117,600,000
Demo existing tunnel	29+300	29+420	m	120	\$50,000	\$6,000,000
New Kennedy Station (Underground, for Subway)	29+468	29+628	m	160	\$1,500,000	\$240,000,000
New Kennedy Station (Underground, for LRT)	29+470	29+567	m	97	\$1,500,000	\$145,500,000
New Kennedy Station (At-Grade, for entrance area)			ea	1	\$10,000,000	\$10,000,000
Bus Terminal - Kennedy			ea	1	\$10,000,000	\$10,000,000
New Kennedy Tunnel - North	29+628	30+040	m	412	\$150,000	\$61,800,000
Demo At-Grade Guideway - Kennedy to Lawrence	29+900	33+524	m	3,624	\$5,000	\$18,120,000
New At-Grade Guideway - Kennedy to Elevated	30+040	34+030	m	3,990	\$11,000	\$43,890,000
New Retaining Walls on At-Grade			m	1,000	\$2,000	\$2,000,000
GO Transit Relocation	29+900	33+800	m	3,900	\$7,000	\$27,300,000
Demo Lawrence Station	31+658	31+767	m	109	\$10,000	\$1,090,000
New Lawrence Station (At-Grade)	31+658	31+818	m	160	\$120,000	\$19,200,000
Demo Ellesmere Station	33+524	33+644	m	120	\$10,000	\$1,200,000
Demo Elevated Guideway - Ellesmere to McCowan	34+030	36+129	m	2,099	\$11,250	\$23,613,750
New Elevated Guideway - Midland to McCowan Yard	34+030	36+129	m	2,099	\$35,200	\$73,884,800
Demo Midland Station	34+222	34+319	m	97	\$15,000	\$1,455,000
Demo Scarborough Centre Station	35+406	35+552	m	146	\$15,000	\$2,190,000
New Scarborough Centre Station (Elevated)	35+326	35+486	m	160	\$150,000	\$24,000,000
Bus Bays - Scarborough Centre Station			ea	1	\$1,000,000	\$1,000,000
Demo McCowan Station	35+955	36+071	m	116	\$15,000	\$1,740,000
Demo At Grade Guideway - McCowan Yard	36+129	36+260	m	131	\$5,000	\$655,000
New At-Grade Guideway - McCowan Yard	36+129	36+663	m	534	\$11,000	\$5,874,000
New Elevated Guideway - McCowan to Centennial	36+663	38+051	m	1,388	\$35,200	\$48,857,600
New Centennial Station (Elevated)	38+051	38+211	m	160	\$150,000	\$24,000,000
New Elevated Guideway - Centennial to Tunnel	38+211	38+550	m	339	\$35,200	\$11,932,800
New Sheppard Tunnel - South	38+550	39+030	m	480	\$150,000	\$72,000,000
New Sheppard Tunnel - South, incl. Crossover	39+030	39+175	m	145	\$700,000	\$101,500,000
New Sheppard Station (Underground)	39+175	39+335	m	160	\$1,500,000	\$240,000,000
Bus Terminal - Sheppard			ea	1	\$7,000,000	\$7,000,000
New Sheppard Tunnel - North, incl. Tailtrack	39+335	39+476	m	141	\$400,000	\$56,400,000
Total	29+300	39+476	m	10,176		\$1,399,802,950
TOTAL INCL. CONTINGENCIES/ALLOWANCES						\$2,388,413,783

The preliminary Order-of-magnitude Cost Estimate is based on unit rates from similar recent North American projects. It includes the following standard TTC contingencies and allowances. It should be noted that following an Alternative Financing and Procurement (AFP) approach could result in some savings.

- Property – 5%
- Professional Services – 25%
- Contingency – 30%

Exclusions:

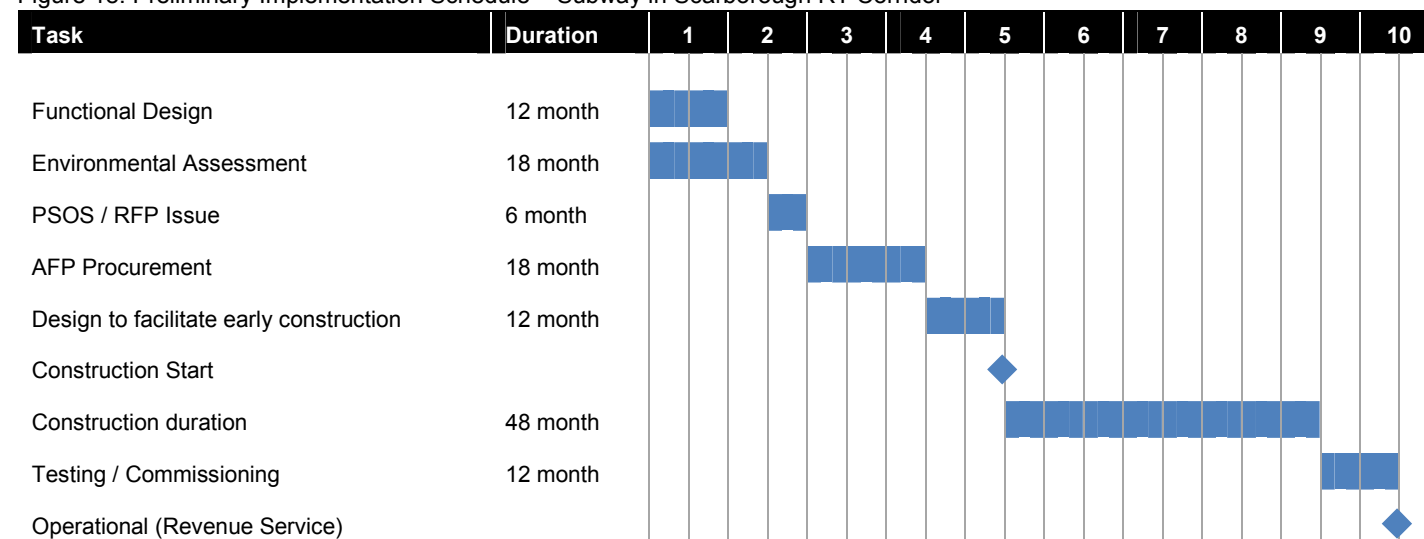
- Costs of interim replacement bus service routing and associated infrastructure
- HST
- Rolling Stock
- Maintenance and Storage Facility
- Traction Power Substations

Systems components are included in the unit rates. The Costs are in \$2011.

7. Implementation Schedule

The Implementation Schedule below is based on the assumption that the project would be delivered as Alternative Financing and Procurement (AFP) project.

Figure 18: Preliminary Implementation Schedule – Subway in Scarborough RT Corridor



Assuming a start date of January 1, 2014 for Functional Design / Environmental Assessment, Construction is assumed to start in Q3 2018 and Operation to start in mid-2023.

Preparation of the Reference Concept Design (RCD) and Project Specific Output Specifications (PSOS) could start earlier than indicated above as some of the work prepared for the SRT RCD can be used for the Subway in the SRT Corridor RCD, hence the start date for the Operation could be moved closer to beginning of 2023.

8. Study findings

8.1 Summary of Key Issues

A number of key issues – which have been described in detail in the foregoing sections - have been identified during the preparation of this Study. Key issues include the following:

- The subway alignment mimics the vertical and horizontal alignment of the existing Scarborough RT and SLRT extension to Sheppard, variances are due to different alignment design criteria for subway (less steep grades, broader turning radii) compared to LRT and longer station platform lengths (152 metres compared to 97 metres).
- The new stations would be located at Lawrence, Scarborough City Centre, Centennial College and Sheppard. It would be feasible to provide a station in the corridor immediately south of Ellesmere Road.
- New Environmental Assessment under the Transit Project Assessment Process required due to significant departures from the current SLRT design.
- Construction of a Subway in the Scarborough RT Corridor would require the shutdown of the Scarborough RT for a lengthy period of time.
- Construction of the tie-in and special trackwork west of Kennedy Station would require the shutdown of the Bloor-Danforth subway between Warden and Kennedy Stations for a short period of time
- Major redesign would be required for the complex Kennedy interchange station (subway, Eglinton Crosstown LRT, bus terminal and GO Rail) which would present cost and schedule risks for the Eglinton Crosstown LRT project.

8.2 Feasibility Statement

The Study reviewed the feasibility of providing subway technology in the existing Scarborough RT Corridor. The Corridor runs from Kennedy Station to McCowan Station and an extension from McCowan Road to Sheppard Avenue East via Centennial College (Progress Avenue, south of Highway 401).

In conclusion the Study has determined that an at-grade/elevated subway in the Scarborough RT Corridor is technically feasible. This Corridor warrants further consideration and evaluation as part of the TTC and City studies to advance the planning and implementation of the Scarborough Subway Project.

Appendices

Appendix A. Drawings	26
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Appendix A. Drawings

Following drawings are included:

315063-G300	Track Alignment – Key Plan
315063-G301	Track Alignment – Northbound Track Plan and Profile, STA. 29+100 to STA. 30+300
315063-G302	Track Alignment – Northbound Track Plan and Profile, STA. 30+300 to STA. 31+840
315063-G303	Track Alignment – Northbound Track Plan and Profile, STA. 31+840 to STA. 33+400
315063-G304	Track Alignment – Northbound Track Plan and Profile, STA. 33+400 to STA. 34+980
315063-G305	Track Alignment – Northbound Track Plan and Profile, STA. 34+980 to STA. 36+560
315063-G306	Track Alignment – Northbound Track Plan and Profile, STA. 36+560 to STA. 38+000
315063-G307	Track Alignment – Northbound Track Plan and Profile, STA. 38+000 to STA. 39+560

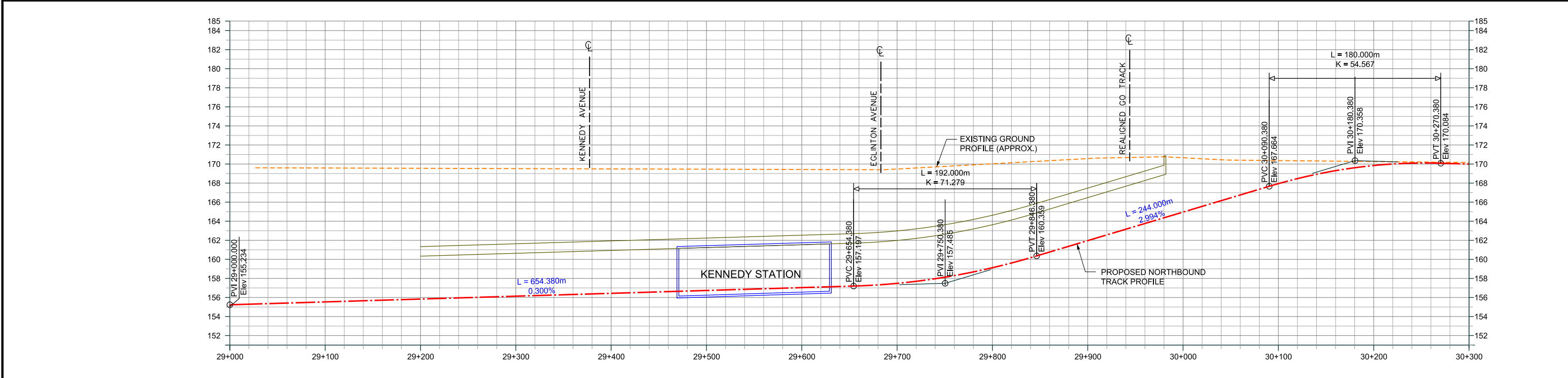
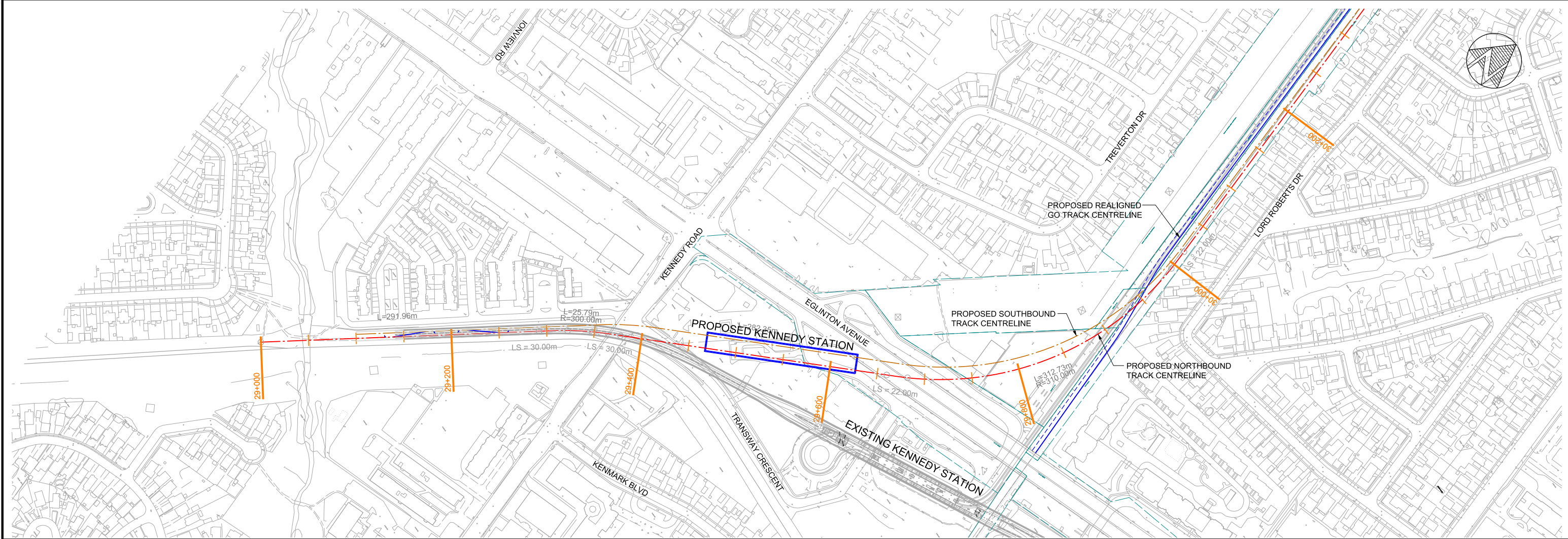
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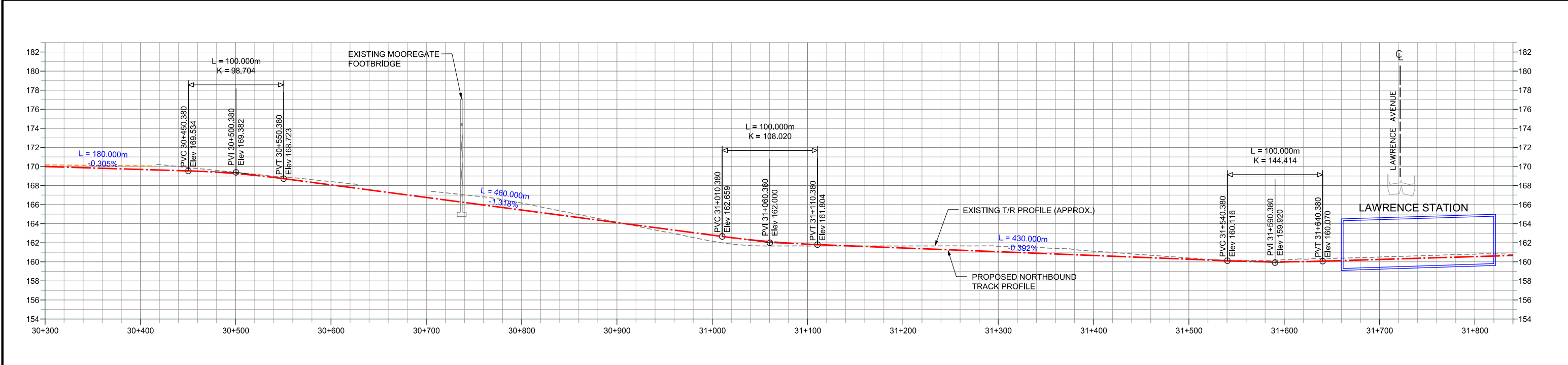
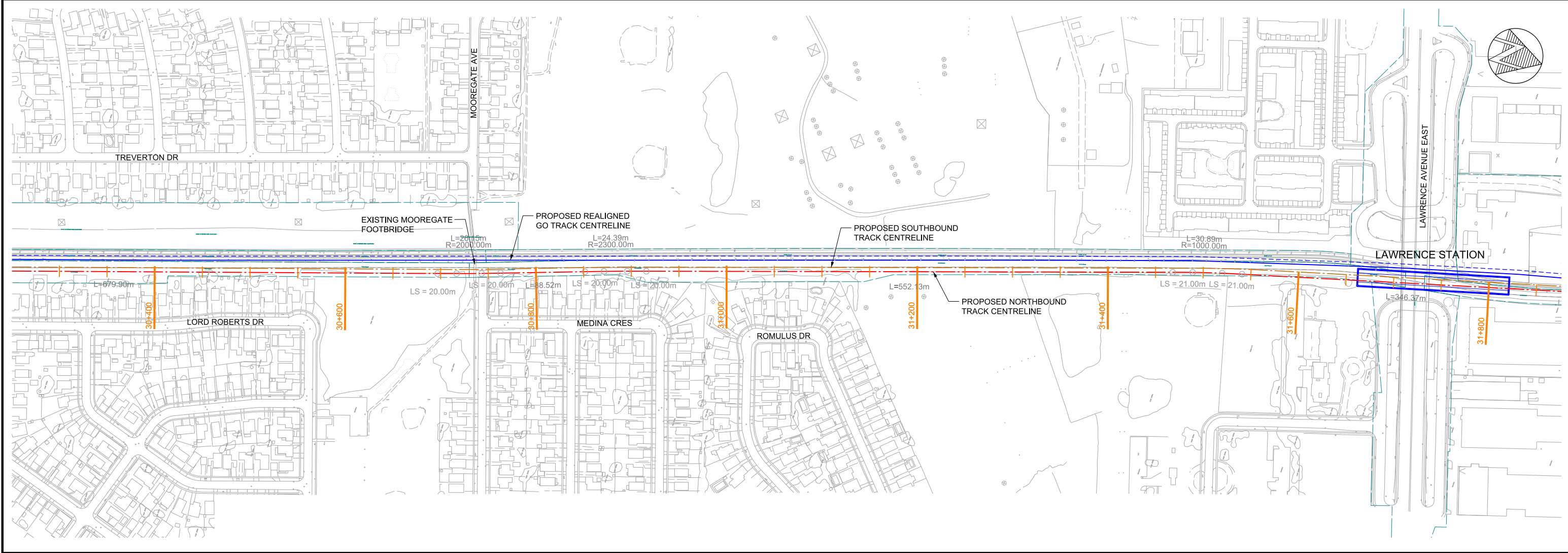
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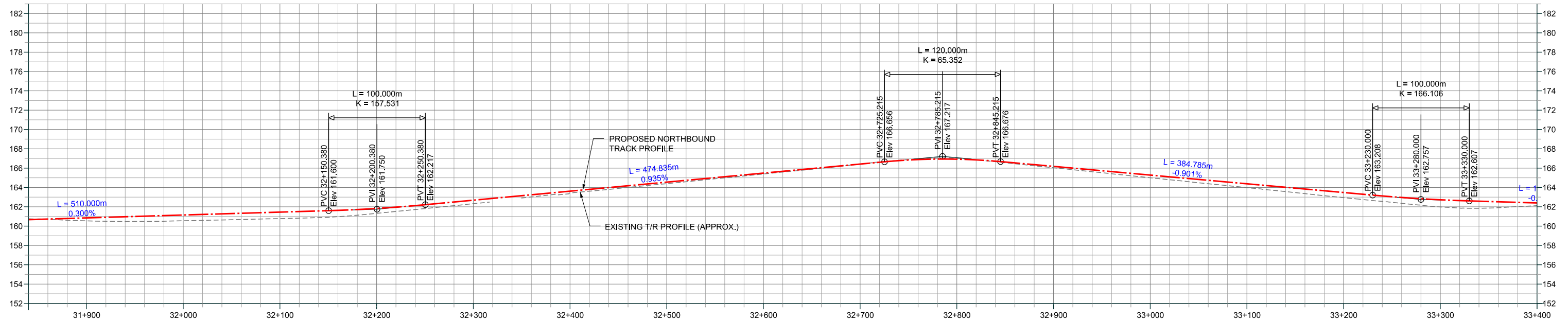




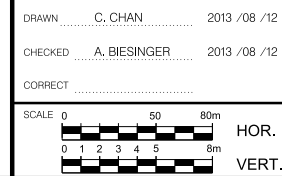
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NORTHBOUND TRACK – PLAN & PROFILE
STA. 31+840 TO STA. 33+400

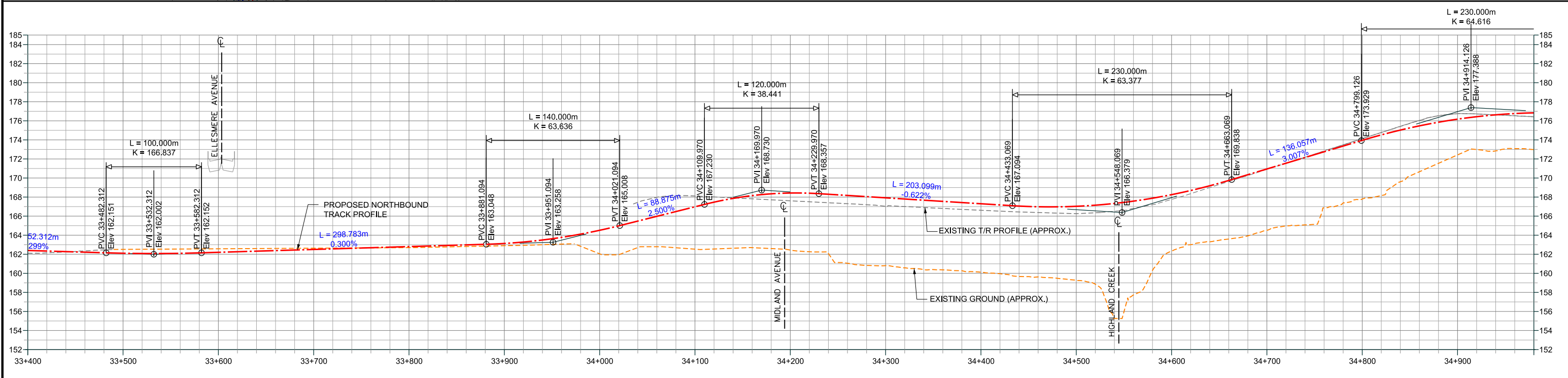
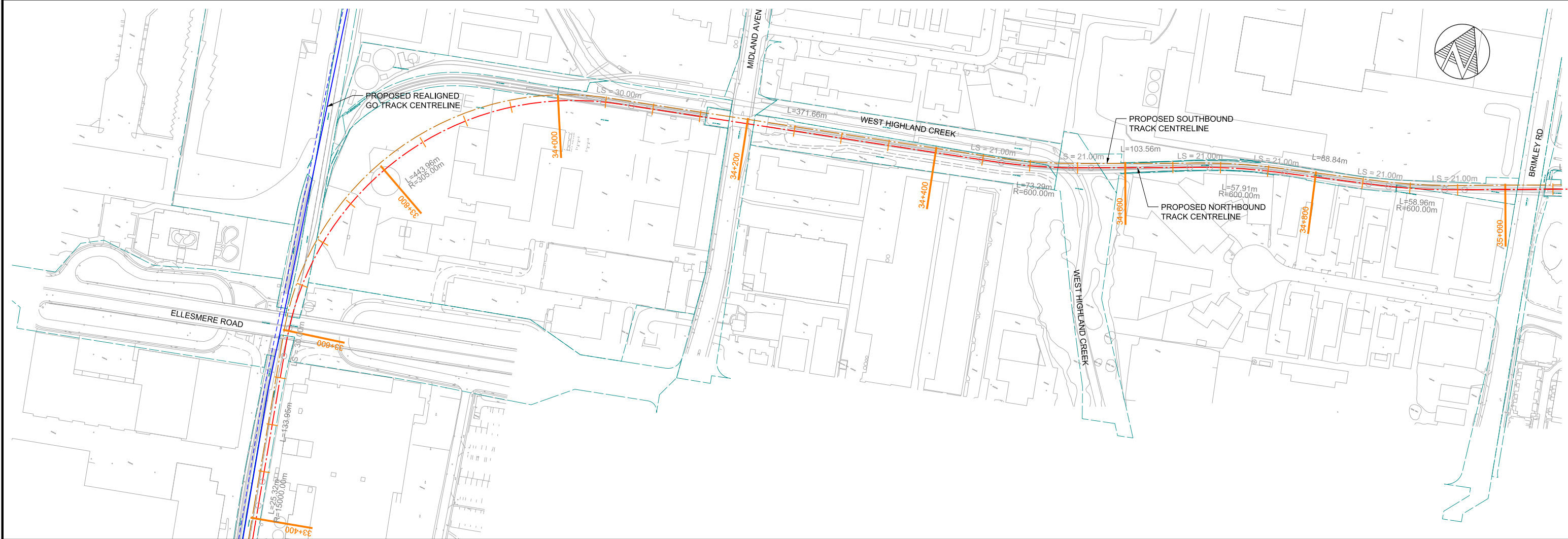


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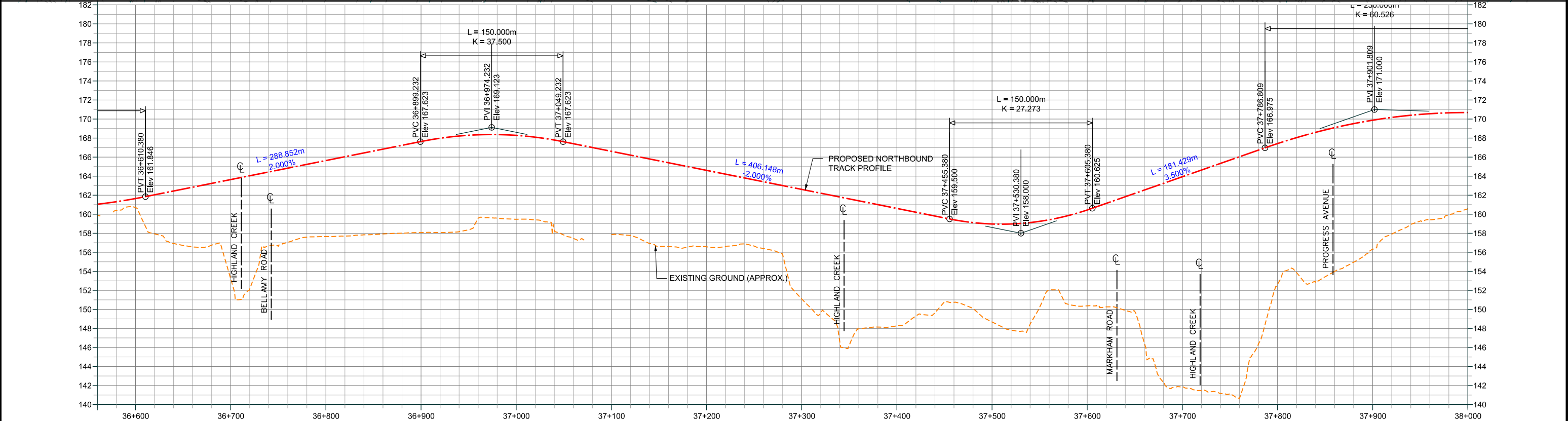
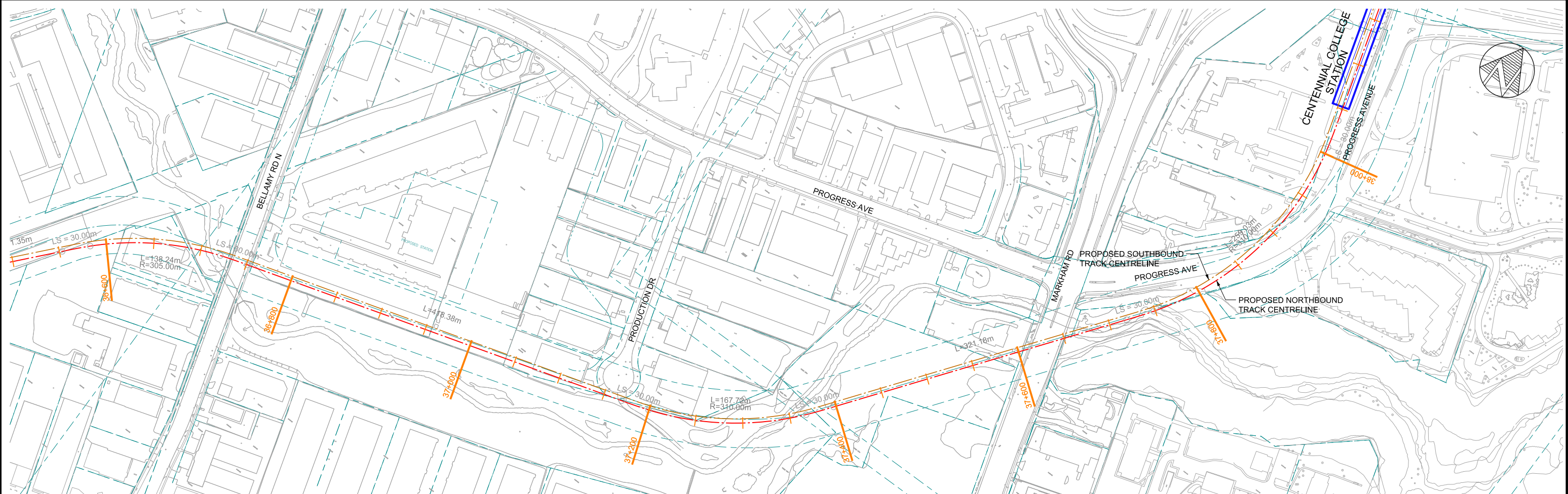


NORTHBOUND TRACK – PLAN & PROFILE
STA. 34+980 TO STA. 36+560

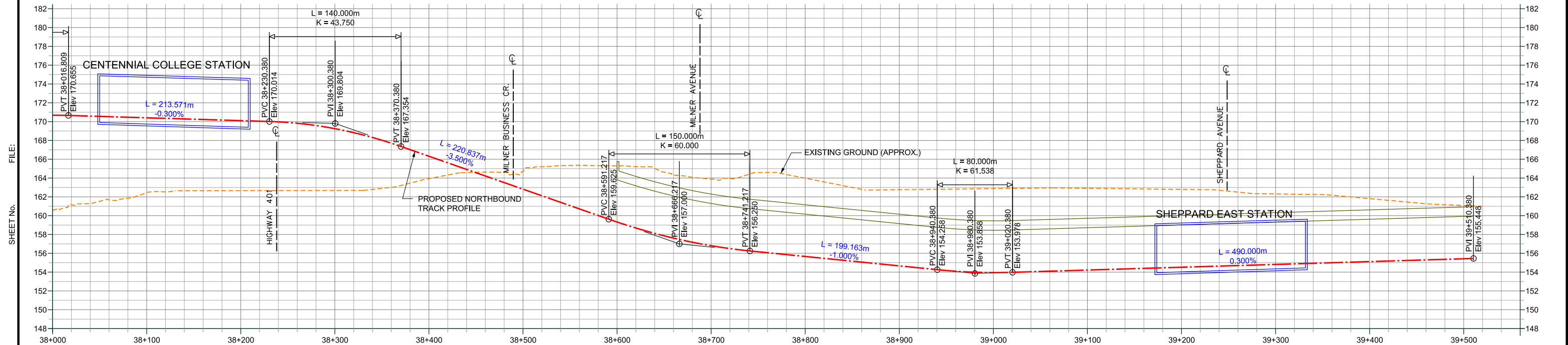
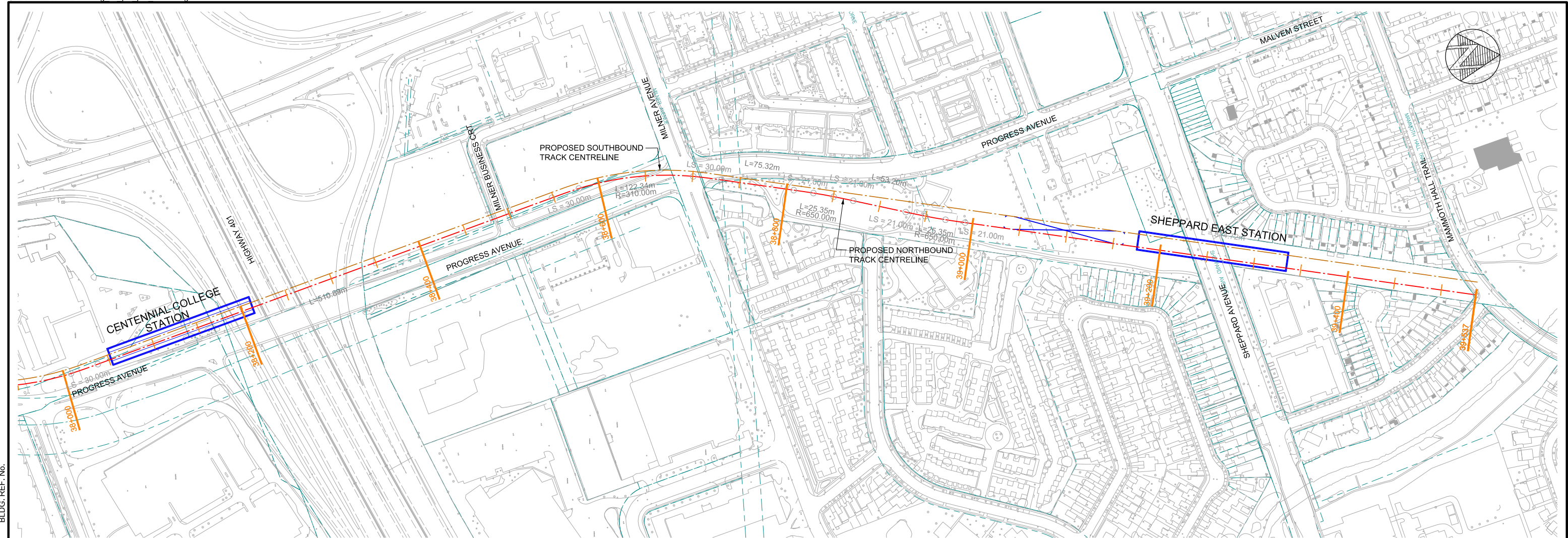


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SUBWAY IN SCARBOROUGH RT CORRIDOR

TRACK ALIGNMENT

NORTHBOUND TRACK – PLAN & PROFILE
STA. 38+000 TO STA. 39+560

Plot Date: 15-Aug-2013



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