yongeTOmorrow Environmental Study Report
March 2021

Appendix N – yongeTOmorrow EA – Short List of Alternatives Aimsun Modelling Report

City of Toronto

Final Report
September 2019

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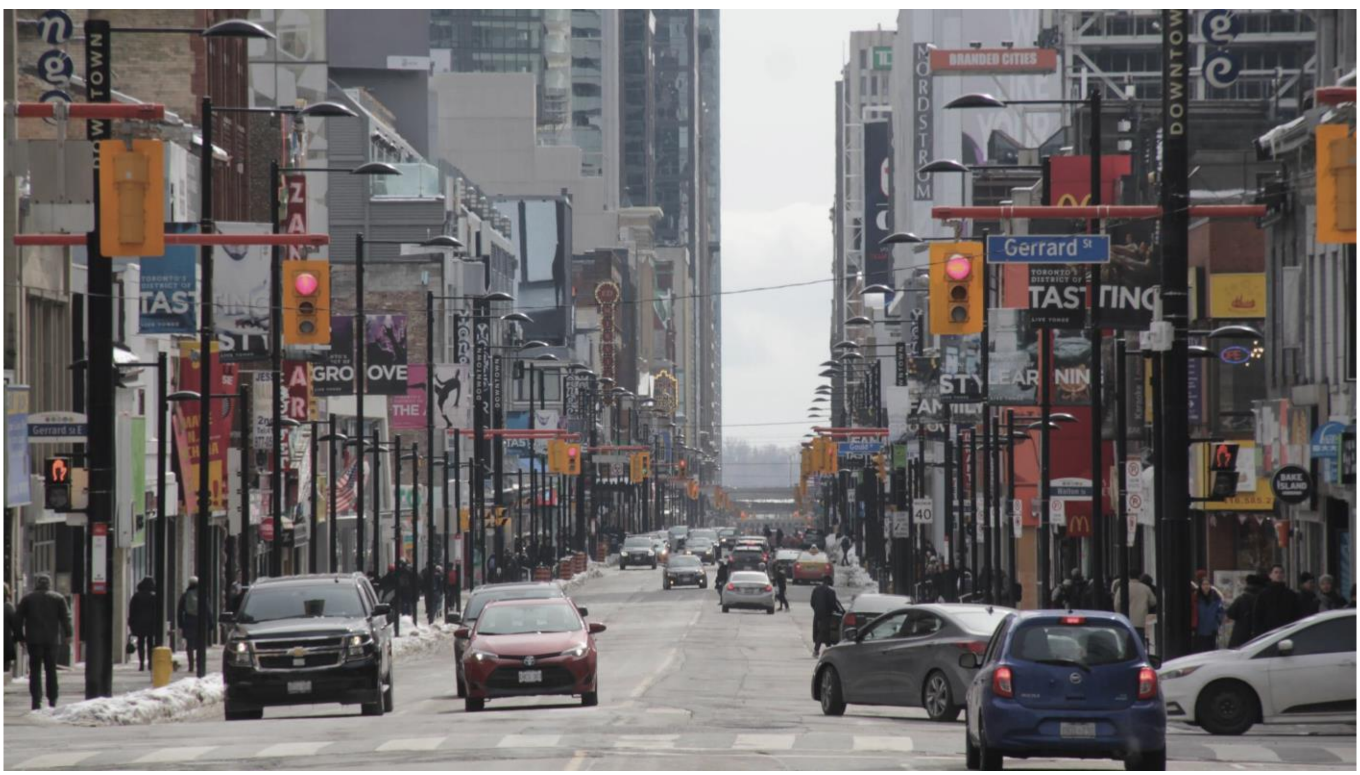

City of Toronto
23079001

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yongeTOmorrow Environmental Assessment – Short List of Alternatives Aimsun Modelling Report

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1 Introduction

The Yonge Street Environmental Assessment (EA) Study ("yongeTOmorrow") is an exciting opportunity to redevelop Yonge Street into an attractive, convenient and compelling destination. Yonge Street needs to encompass a range of travel demands, from pedestrians and vehicles, to special events and goods movement. Each demand type must be adequately assessed to develop holistic solutions that provide functionality for all users. A traffic model helps assess travel demands and traffic operations for vehicles, and their interactions with pedestrians and cyclists.

1.1 Purpose

The purpose of the traffic and transit modelling analysis of this study is to enable a high-level comparison of various proposed concept designs for Phase 1 of the Yonge Street corridor between Queen Street in the south and College Street / Carlton Street in the north.

The proposed alternative solutions are modelled and compared against outputs from the calibrated and validated base case of the existing model, as well as a Do-Nothing future conditions model to inform decisions about potential changes to the layout of Yonge Street. This model will determine impacts of growth, network wide changes, and local network changes, including the interaction between different modes of travel. This is particularly important as some potential options could entail, lane reductions, modal shifts, geometric reconfiguration, and operational improvements.

This report will discuss:

- Model development process;
- Calibration and validation;
- Micro-simulation results; and,
- Testing of alternatives.

1.2 Approach

A hybrid micro-meso traffic simulation model was developed in the Aimsun Next platform. The integrated transport modelling software Aimsun (v8.2.4 2019-01-23 da8d554 x64) in conjunction with the ATC Controller Emulator Extension (v1.0.0) for the accurate representation of Transit Signal Priority (TSP) has been used. TSP was not coded for intersections in the mesoscopic part of the model as the TSP extension API only works within the microscopic part of the model (focus area).

Traversal matrices developed based on the City of Toronto's (City) GTA V4.0 EMME demand model were used to obtain base origin destination matrices. Additional data sets used for calibration and validation include traffic counts, Streetlight location-based data, travel times and queues.

Public transit route details and headways were obtained from the Toronto Transit Commission (TTC) website. Each route was coded in the models individually to allow detailed changes and tests of future scenarios.

Three peak periods were developed for the purposes of this analysis, AM and PM weekday peak hours, and a Saturday peak hour. A Saturday peak was selected due to the significance of commercial and recreational activities along Yonge Street. In conjunction with City staff, the future horizon of 2031 was selected for the analysis.

1.3 Limitations

The Aimsun model is a peak hour model, built from an EMME demand model calibrated to a 2011 databank. As a result, although the Aimsun model provides good comparative results for existing and future traffic and transit operations, there are several limitations including:

- Limited to peak hour (AM, PM, Saturday), further consideration of temporal solutions is not reflected;
- Mixed use cycling traffic is not supported, future modal shifts towards electric and / or shared transportation opportunities are not reflected;
- Taxi services and other loading / unloading operations that block live lanes of traffic are not effectively reflected;
- Results of Saturday Peak model should be used cautiously given the lack of a demand model to provide input; and
- Due to the high number of potential interventions that may be on a block-by-block basis, it is not possible to model each permutation individually, generalized concepts will be modeled for comparative purposes.

1.4 Study Area

As per the needs of the EA study, the project is examined through multiple lenses and scales. The overall study area to be modeled is formed by:

- Roxborough Street / Crescent Avenue in the north;
- Mount Pleasant Road / Jarvis Street in the east;
- King Street in the south; and
- University Avenue / Queens Park / Avenue Road in the west.

A more detailed area was used for micro-simulation. This *focus area* is bound by:

- College Street / Carlton Street in the north;
- Church Street in the east;
- Queen Street in the south; and
- Bay Street in the west.

The Phase 2 extended focus area was used for data collection. Future studies could update the extended focus area into a full micro-simulation area and undertake further calibration. The full extent of the study and focus areas is shown in Figure 1-1. All signalized intersections in the study area were included in the model and unsignalized intersections were included in the focus area. Minor roads in the overall study area that are not within the focus area, were sometimes represented via centroid connectors.

Figure 1-1: Study Area

2 Data Summary

A summary of the data collection efforts and items received is provided below.

2.1 Signal Timing Cards

Weekday signal timing cards in PDF format were received for all signalized intersections within the study area bounded by:

- Roxborough Street to the north;
- Jarvis Street to the east;
- King Street to the south; and
- University Avenue / Queens Park / Avenue Road to the west.

Signal timings were inputted into Synchro Version 10 and imported into Aimsun, with adjustments made for unique geometries and transit signal timing priority.

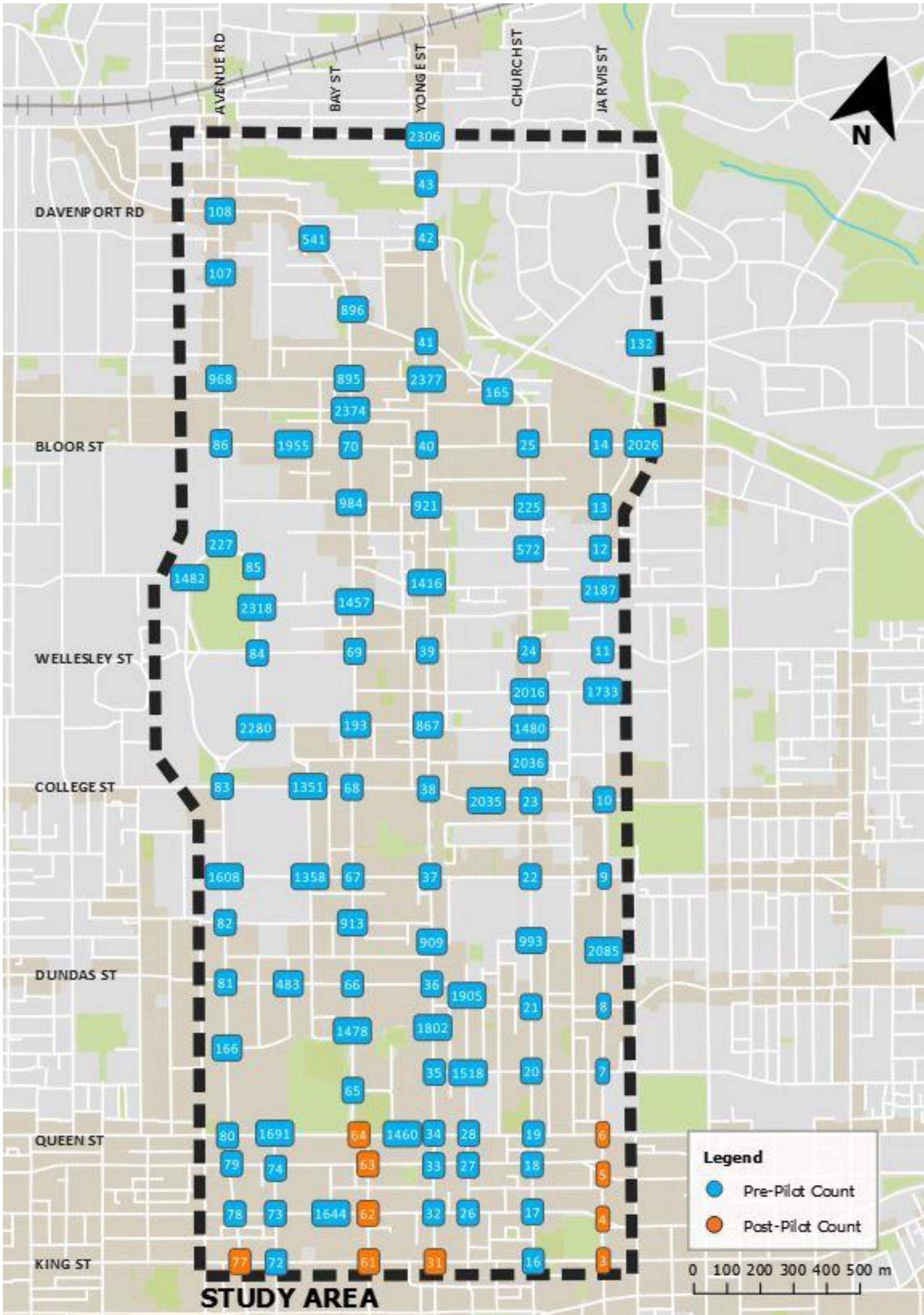
2.2 Turning Movement Counts

Weekday turning movement count (TMC) summaries were received for all signalized intersections within the study area outlined above. The counts were collected between 2008 and 2018 with most of the data collected between 2016 and 2017. To reflect the operation of the King Street Pilot, the City provided updated turning counts from 2018 for intersections within the area bound by:

- Queen Street to the north;
- Jarvis Street to the east;
- King Street to the south; and
- University Avenue to the west.

The locations where turning movement counts were available for the AM and PM peak models are shown in Figure 2-1.

Figure 2-1: Available weekday turning movement counts



Traffic flows within the study area were balanced with a focus on the most recent counts reflecting the King Street Pilot conditions. Due to data availability, the AM and PM peak models have been based on data from September 2018 and the Saturday peak model has been based on data from April 2018.

2.3 Existing Aimsun Next Models

Steer has been provided with a calibrated King Street EA Study Aimsun Next Model (dated 31 October 2017) of the AM peak period only. The model extent only partly overlaps with the yongeTOmorrow EA study area and has only been used for the purposes of base network development and the import of general model parameters.

2.4 EMME Databanks

The City of Toronto has provided Steer with AM and PM peak EMME databanks of the wider yongeTOmorrow EA study area for the following scenarios based on the GTA V4.0 EMME Model:

- 2011 Base Case (existing conditions);
- 2031 Future Baseline ('Do Nothing');
- 2031 Yonge Street reduced to two lanes; and
- 2031 Yonge Street closed / pedestrianized.

The EMME demand model is only reflective of weekday traffic, as a result, EMME databanks for a typical Saturday are not available. The demand from the EMME databanks was used to develop demand sets for the Aimsun Next models. The extent of the databanks is outlined below:

- St Clair Avenue to the north;
- Broadview Avenue / Don Roadway to the east;
- Queens Quay / Commissioners Street to the south; and
- Strachan Avenue / Ossington Avenue to the west.

The extents of the EMME databanks extended beyond the boundaries of the study area to allow for investigation of impacts to adjacent regions and capture wider traffic re-assignment in the proposed options.

2.5 StreetLight Origin-Destination Data

The EMME databanks only provide weekday AM and PM peak hour origin-destination information for passenger vehicles and transit. StreetLight location-based data was used to develop origin-destination matrices for truck traffic and for the Saturday peak period. StreetLight can create origin-destination matrices for the study area for both vehicles and trucks for multiple time periods based on GPS data from multiple navigational sources.

2.6 Public Transit Information

Routes and Frequencies

Transit service data was gathered from the Toronto Transit Commission's (TTC) service summaries corresponding with the dates selected for the traffic flow balancing (which have been outlined in section 2.2 Turning Movement Counts above).

Dwell Times at Stops

The City of Toronto provided boarding and alighting data for all surface transit routes within the study area for the purposes of determining dwell times. Dwell times were implemented for all transit routes within the study area based on calculation formulae provided by the City.

2.7 Pedestrian Flow Data

Pedestrian flow data from the traffic turning movement counts have been implemented within the model at signalized intersections along each cross-walk. Additional pedestrian data was provided by the Downtown Yonge Business Improvement Area for Yonge Street.

2.8 Cyclists

Cyclists in mixed traffic have not been included in the Aimsun Next traffic models. Dedicated bike lanes and tracks have been coded where they exist. Future alternatives with bike lanes based on existing planning documents, including the City's Cycling Network 10-year Plan, will be implemented along with any cycling facilities as part of each alternative. Volumes will be based on existing TMC information and cyclist counts, and separate analysis of the potential future travel demands.

3 Base Model Development

3.1 Base Network

3.1.1 General

The models have been developed for the weekday AM, PM and Saturday peak hours, which have been determined from the TMC counts received from the City of Toronto. The peak hours are:

- AM peak hour: 8:00-9:00;
- PM peak hour: 17:00-18:00; and
- SAT peak hour: 16:00-17:00.

For the purposes of calibration, the base year has been considered 2018 to reflect the implementation of the King Street Pilot. The horizon year will be 2031, in line with the EMME data banks received from the City of Toronto.

The development of the yongeTOmorrow base network was based on the King Street Study model which was provided to Steer by the City of Toronto on 10th November 2017. The following notes should be taken into consideration with regards to the King Street Study model:

- The study areas only partially overlapped;
- The model did not include traffic demand information;
- The model received covered the AM peak period only;
- No Transit Signal Priority (TSP) parameters were included in the model; and
- No information on the model development was received.

To provide as much consistency as possible across the models, most of the parameters have been left unchanged from the King Street model, including lane types, road types, vehicle types and vehicle classes.

It was noted during the calibration process that the vehicle types cars were based on in the King Street model had been modified from the default Aimsun Next parameters. As no documentation was received with the model to provide justification, the parameters were changed back to the default Aimsun Next settings. As these default settings are based on a typical European fleet mix, it became apparent through the calibration process that vehicle lengths would need to be increased to more accurately reflect a typical North American fleet mix. Therefore, the default mean, minimum and maximum vehicle lengths were increased based on previous experience from projects in North America. No other parameters were amended. The adjusted parameters are listed in Table 3.1.

Table 3.1: Adjusted vehicle length parameters for car-based vehicle types

Vehicle Length (m)	Mean	Deviation	Minimum	Maximum
Default	4.00	0.50	3.50	4.50
Adjusted	4.72	0.50	4.27	5.49

Additionally, streetcar type ALRV was added as it had not been included in the King Street model and microscopic model parameters for vehicle acceleration and deceleration for streetcar types CLRV and LFLRV were updated based information provided by the City, as shown in Table 3.2.

Table 3.2: Streetcar parameters

Streetcar Type	LFLRV	CLRV	ALRV
Acceleration (avg to 30 km/h)	1.3	1.2	1.1
Service Brake	-1.2	-1.1	-1.1
Emergency Brake (empty)	-2.75	-1.6	-1.6
Emergency Brake (loaded)	-2.2	-1.5	-1.5

The basic network structure was imported using Aimsun Next's integrated OpenStreetMap (OSM) data importer. All sections, turns and nodes were checked against high resolution satellite imagery and online mapping tools such as Bing Maps and Google Maps, including Google Streetview. Right turn on red (RTOR) bans were implemented in the models where they are prohibited on site and turning bans were implemented in accordance with current restrictions. Turning bans were implemented in the following ways:

- *Attributes Overrides* for static assignments; and,
- *Traffic Conditions* for dynamic assignments.

Where online resources were insufficient or outdated, site visits and local knowledge of the study team assisted in completing the model network. This assisted in accurately representing link and node characteristics, such as the number of lanes, storage lengths, speed limits, turning restrictions and other geometrical details.

3.1.2 Parking

Based on field reviews and available information, parking restrictions have been implemented in the models using traffic conditions (lane closures). The kerbside lanes at the following locations have been identified for the respective peak hours:

- AM Peak:
  – Queens Park Cres E: from Grosvenor Rd to north of St Joseph St.
- PM Peak
  – None.
- SAT Peak:
  – Bay St: College St to Bloor St (both directions);
  – Church St: King St to Gerrard St and Alexander St to Bloor St (both directions);
  – Gerrard St: University Ave to Elizabeth St (both directions);
  – Jarvis St: Isabella St to Queen St (southbound only);
  – Queen St: Church St to Jarvis St (both directions);

– Queens Park Cres E: from Grosvenor Rd to north of St Joseph St; and
– University Avenue: Queen St to College St (both direction).

3.1.3 Reversible Operation of Jarvis Street

The centre reversible lane on Jarvis Street operates in a northbound direction between 3:45pm and 6:30pm from Monday to Friday between Queen Street in the south and Isabella Street in the north. At all other times, the centre lane is available to southbound traffic.

In Aimsun Next, Jarvis Street has been modelled with three lanes in each direction. Two different approaches were used to reflect the reversible operation in the static and dynamic assignments:

- Static assignments: attributes overrides were used to reduce the capacity of relevant sections along Jarvis Street. For the respective sections, the capacity has been reduced from 2,700 PCUs/h (3 lanes of 900 PCUs/h each) to 1,800 PCUs/h. This was done to reflect the respective capacity of Jarvis Street and optimise the static assignments; and
- Dynamic assignments: traffic management strategies were used to close the centre lane of either the northbound or the southbound sections of Jarvis Street during the respective peak hours.

3.1.4 Diamond Lane on Bay Street

The northbound and southbound curbside lanes of Bay Street from Cumberland Street in the north to Front Street in the south are restricted to use by cyclists, taxis and buses only from Monday to Friday between 7:00am and 7:00pm. This restriction has been replicated in the Aimsun Next model by introducing a lane closure. Traffic conditions were used to ensure the restrictions are only applied to the AM and PM peak scenarios.

3.1.5 Dedicated Cycle Lanes

There are several locations within the Focus Area where dedicated cycle lanes are currently present, namely:

- Bay Street, from Dundas Street to College Street;
- Gerrard Street, from Bay Street to Church Street; and
- Shuter Street, from Victoria Street to Church Street.

These cycle lanes were included in Aimsun Next to represent the impact on turning vehicles at intersections. The cycle lanes were coded as separate sections (rather than added lanes to the existing sections) and mixed traffic is therefore not represented in the models. Cyclists are not able to turn left or right at intersections but travel straight ahead only. This approach was outlined to the City and accepted during a modelling workshop help at the City’s offices in November 2018.

Cyclist flows were based on the same TMC traffic counts which were used for the development of the traffic demand. However, for the AM and PM peak models, no flows were available for the intersection of Bay Street / Gerrard Street (TCS67). Flows were therefore based on the adjacent intersections:

- Gerrard Street / Yonge Street (TCS37) for east-west cycle flows; and
- Bay Street / Elm Street (TCS913) for north-south cycle flows.

For the Saturday peak model, cyclist flows were only available for the intersection of Gerrard Street / Yonge Street (TCS37). Those east-west cycle flows were copied to the following intersections:

- Gerrard Street / Bay Street (TCS67); and
- Gerrard Street / Church Street (TCS22).

No further cycle flows were included in the model due to the lack of data.

3.1.6 Locations with Operational Restrictions

The City provided Steer with a list of locations identified to suffer from operational issues and constraints, such as excessive queuing, low pedestrian compliance with provided crossing points or vehicles frequently stopping in the curbside lane for loading. The complete list received from the City is outlined below:

- Significant queuing:
  - Queen Street / Bay Street: northbound queues from Richmond Street to Queen Street;
  - Yonge Street / Dundas Street: east- & westbound queues to Bay Street / Victoria Street;
  - Queens Park Crescent: southbound right turn at Hoskin Avenue (AM Peak);
  - Adelaide Street / University Avenue: eastbound left turn (AM and PM Peak); and
  - Richmond Street / University Avenue: westbound right turn (PM Peak).
- Significant curbside activity:
  - Yonge Street northbound from Queen Street to Dundas Street;
  - Queen Street east- and westbound between Bay Street and Yonge Street; and
  - Area of Shuter Street / O'Keefe Lane / Dundas Square / Victoria Street.
- Low pedestrian compliance:
  - Yonge Street / Gould Street, especially in north-south direction; and
  - Yonge Street from College Street to Gerrard Street: many pedestrians crossing midblock.

Information about significant queuing was used during the calibration process as input for the *Static OD Adjustment Scenarios* to prioritize demand over traffic counts. More information can be found in section 3.7.4 Matrix Adjustment.

Frequent curbside activity was replicated in the hybrid scenarios by traffic management strategies, which were set to periodically cause the curbside lane to be blocked. Field visits were not undertaken as the City provided detailed information about affected locations. Curbside activity was not replicated in the static assignments.

Low pedestrian compliance and a high number of pedestrians crossing midblock on Yonge Street was replicated in the Aimsun Next models through Attributes Overrides, lowering the speed limit of the affected sections from 40km/h to 30km/h to reflect more cautious behaviour of drivers.

3.2 Signal Timings

Signal timing cards for all signalized intersections in the model area were obtained from the City of Toronto. The timing cards are provided separately to this document. These signal timing cards included information about the operation of each intersection, including:

- Stage sequences;

- Average stage lengths where the signals operated based on vehicle actuation (as opposed to a fixed time operation);
- Extension times for side street stages and left turn movements if vehicles are detected;
- Cycle lengths;
- Offset times to adjacent intersections; and
- Details regarding Transit Signal Priority (TSP).

SCOOT settings outlined on the signal timing cards were not implemented in the models.

A Synchro model of the Study Area was developed based on the signal timing data provided by the City of Toronto. The Aimsun Next Synchro Importer / Exporter has been used to import signal timings into Aimsun Next.

In accordance with the signal timing cards received, the following intersections within the Focus Area have been coded to operate with active TSP in the model:

Table 3.3: TSP Locations and Algorithms

TCS #	Location	TSP Algorithm
19	Queen & Church	A
21	Dundas & Church	A

Transit signal priority for streetcars was modelled in line with the corresponding TSP extension API as per City of Toronto guidelines, including accurate representation of flashing don't walk (FDW) times. TSP request and cancel detectors were added and TSP parameters set in accordance with the signal timing cards. Where the signal timing cards did not provide information regarding exact locations of the TSP detectors, they were placed at similar locations to intersections where the information was available. TSP was not coded for intersections in the mesoscopic part of the model as the TSP extension API only works within the microscopic part of the model (focus area).

3.3 Transit

Transit routes were coded into the model based on the information available on the TTTC website. Details for each bus and streetcar service can be queried, including exact routes and stop locations. The TTC Service summary dated 2 September 2018 – 6 October 2018 was used to enter transit information for the AM and PM peaks and the TTC Service summary dated 1 April 2018 – 12 May 2018 was used to enter transit information for the Saturday peak. The information entered from the service summaries includes:

- Transit route and sub-routes (e.g. 510A, 510B);
- Vehicle type used on the route; and
- Average headways during various time periods, including AM and PM peak periods.

Boarding and alighting data was obtained from the TTC for each bus or streetcar route running through the study area, which was used to estimate dwell times for each bus stop. Data was given for the time periods between 0:00-9:00 and 15:00-19:00. This was converted to AM and PM peak hour ridership by applying peak hour factors provided by the City of Toronto:

- 0.55 for AM peak; and

- 0.40 for PM peak.

The ridership at each stop was not separated by route branch. Passengers were assigned to each branch, where applicable, proportionally based on the headway of each branch, as outlined in the service summary. Dwell time per boarding and alighting passenger depends on the vehicle type, as shown in Table 3.4, in addition to a base clearance time at each stop. It was assumed that the current and future streetcar fleet all share the same dwell time assumptions.

Table 3.4: Boarding & Alighting Time Per Passenger

Vehicle Type	Clearance Time	Boarding Time (Per Boarding Passenger)	Alighting Time (Per Alighting Passenger)
Standard Bus	8 seconds	3 seconds	2 seconds
Articulated Bus	8 seconds	3 seconds	1 second
Streetcars	10 seconds	0.6 second	0.6 second

The streetcar routes included in the model are:

- 501 Queen;
- 502 Downtowner;
- 503 Kingston Road;
- 504 King;
- 505 Dundas;
- 506 Carlton; and
- 514 Cherry.

The bus routes included in the model are:

- 5 Avenue Road;
- 6 Bay;
- 94 Wellesley; and,
- 97B Yonge.

The express bus routes included in the model are:

- 141 Downtown / Mt Pleasant Express;
- 142 Downtown / Avenue Road Express;
- 143 Downtown / Beach Express;
- 144 Downtown / Don Valley Express; and
- 145 Downtown / Humber Bay Express.

All branch routes that pass through the study area were also included.

Triggers and Strategies were used in Aimsun Next to accurately replicate driver behaviour at streetcar stops, ensuring that vehicles stop to allow passengers to alight and board the streetcar. This representation is based on the transit vehicle being directly on top of the stop using two detectors, one at the front and on at the rear of the vehicle. Once the transit vehicle is no longer on top of both detectors, regular traffic will be able to queue/pass beside the transit vehicle.

3.4 Pedestrians

Pedestrian counts at all signalized intersections and crossings were received from the City of Toronto TMC information and have been included in the model. These counts measure pedestrian volumes on each crosswalk in 15-Minute intervals. This allows for an accurate representation of signal activations and of delays for turning vehicles at intersections. The traffic counts only show total volume along each cross-walk, and it was assumed that pedestrian traffic on each crosswalk is equal in each direction. The diagonal crosswalks at the intersection of Yonge Street and Dundas Street (TCS36) have been included in the model for an accurate visualisation of pedestrian movements. AM peak counts were used where no Saturday counts data was available.

3.5 Cyclists

Cyclist demands along dedicated bike lanes and tracks have been based on available TMC counts. AM peak counts were used where no Saturday counts data was available.

3.6 Demand Development

3.6.1 EMME Import

The City of Toronto provided EMME databanks for the weekday peak periods (AM and PM) and for the weekday off-peak periods (midday and evening). The databanks were created using the GTA V4.0 EMME model for the following scenarios:

- 2011 Base Case (existing conditions);
- 2031 Future Baseline ('Do Nothing');
- 2031 Yonge Street reduced to two lanes; and
- 2031 Yonge Street closed / pedestrianized.

The outputs included traffic demand in form of origin-destination (OD) matrices and transit demand within the study area. No truck demand is included in the City's GTA V4.0 EMME model. The information from the EMME outputs fed into the development of the demand matrices for the Aimsun models, for both the existing conditions and the 2031 demand.

The extent of the EMME network was cropped to the wider downtown Toronto area and is shown in Figure 3-1. An area significantly larger than the yongeTOmorrow study area has been chosen to capture wider traffic reassignment due to some of the proposed impacts on the capacity along Yonge Street.

There are 21 internal zones in the EMME model within the yongeTOmorrow study area, shown more clearly in Figure 3-2. These zones match those of the Transportation Tomorrow Survey (TTS) 2006. External centroids represent the rest of the Greater Toronto Area.

Figure 3-1: EMME Network

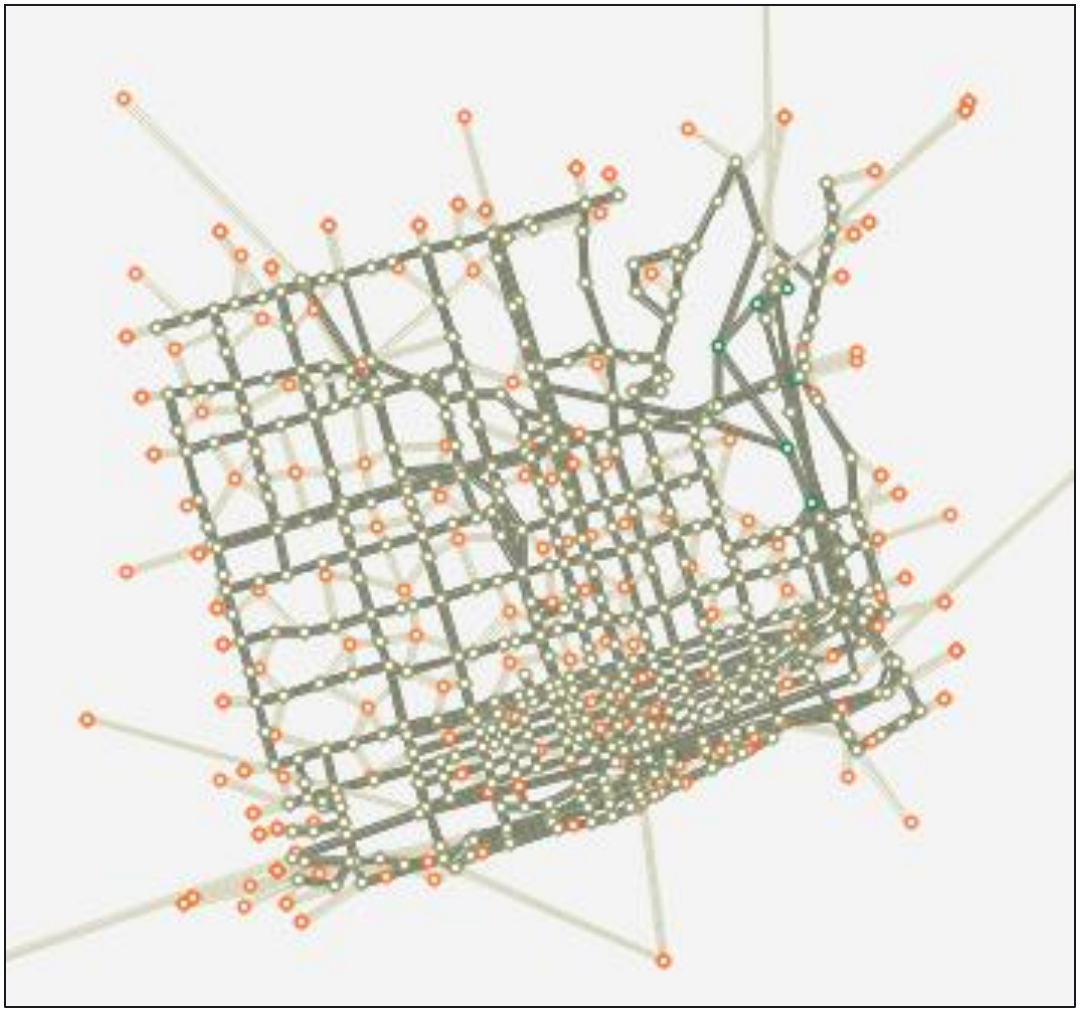
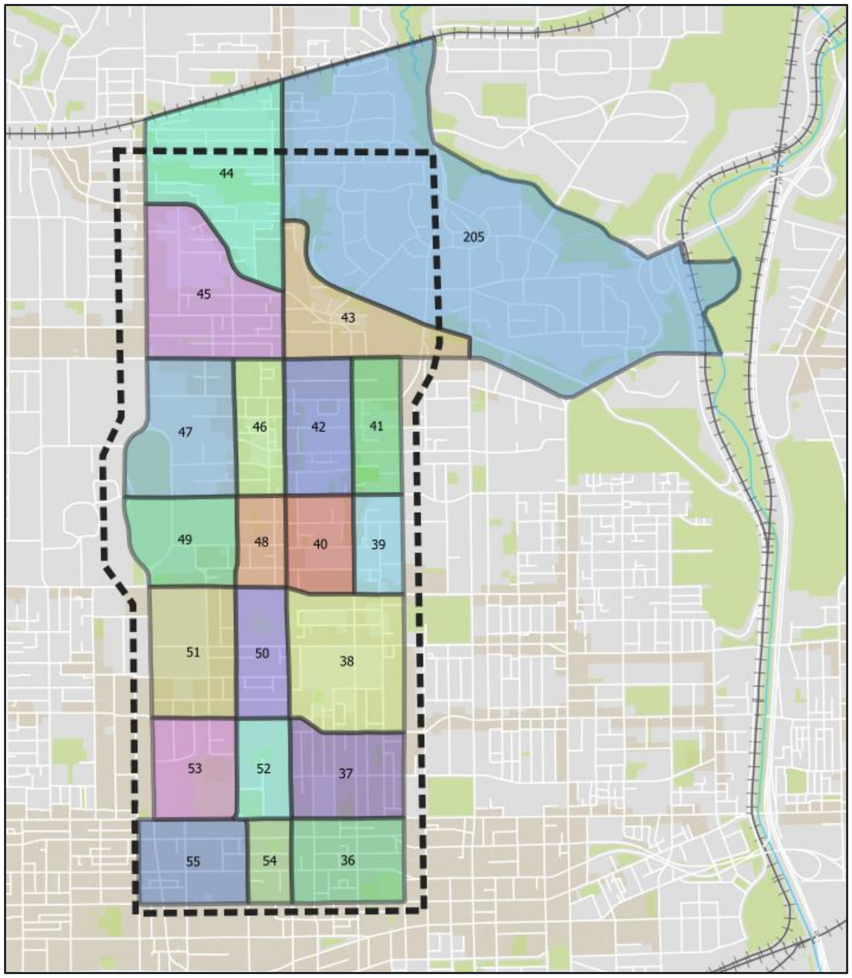


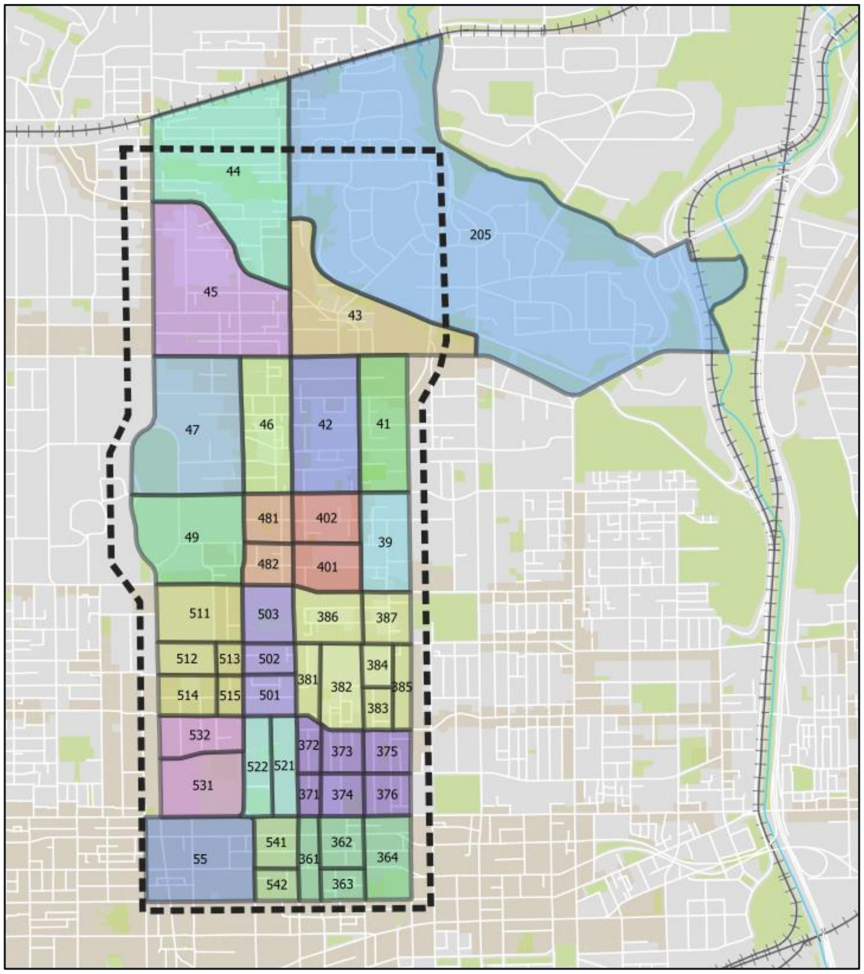
Figure 3-2: Original TTS/EMME Internal Zones



3.6.2 Zone Disaggregation

To have better flexibility in modelling future conditions, the EMME zones within the study area were disaggregated into smaller areas. Disaggregation was conducted mainly for zones in the Phase 1 focus area and the areas immediately adjacent; zones further out were not disaggregated. The disaggregation was done based on current and future expected land use as well as local urban form (building size, amount of parking, etc.), typically along major roads, and ensures that demand can be attributed at a finer level of detail particularly within the focus area. The disaggregated zones are shown in Figure 3-3.

Figure 3-3: Disaggregated TTS/EMME Internal Zones



3.6.3 Traffic Counts

To support more detailed analysis of traffic operations, 15-minute interval vehicular turning movement counts were provided by the City for each intersection within the study area. For each count, AM and PM peak periods were determined. For intersections along the King Street, Adelaide Street, Richmond Street and Queen Street corridors, the City provided Miovision count data from September 2018 to reflect traffic conditions during the King Street Pilot. The Miovision data was converted to match format of the City's 15-minute TMC counts. Therefore, Miovision's vehicle categories *Single-Unit Trucks* and *Articulated Trucks* were combined to a single vehicle class *Duals* to represent trucks in the Aimsun Next model.

Volume balancing was performed at intersections along the major corridors to develop representative existing traffic volumes at signalized intersections as per the City of Toronto's Synchro 9 Guidelines. The balancing process was performed in Microsoft Excel and aimed to reduce discrepancies of counts between intersections. Volumes were balanced using major/major intersections as a reference, adjusting the smaller adjacent intersections to within 10% of the major. In general, volumes were not adjusted by more than 30%, and only through movement volumes were adjusted (in line with the City's guidelines for flow balancing which are outlined in the *City of Toronto's Synchro 9 Guidelines*). Since general traffic is not allowed to go through in the east-west directions at the intersections along King Street (nor are they allowed to turn left), those intersections were excepted from this process. Through movements and left turns were manually set to zero and flows were redistributed to the right turn movements during the balancing. The balanced counts and related documentation have already been provided to the City for review and approval and are provided separately with this document.

The traffic counts were used to create a real data set for all turning movements in the study area, and a cordon that measured volumes on each link into and out of the study area. These data sets were used for the matrix Furness and adjustment processes and for the calibration of the model.

3.6.4 Truck Matrix

The City's EMME model does not include truck traffic. Therefore, StreetLight data was used to determine the distribution of truck traffic through the study area. The software was used to build two OD matrices: personal vehicles and commercial vehicles. These matrices were then compared to determine the amount of truck traffic in each OD pair, given as percentages. These matrices were then applied to the respective adjusted demand matrices within Aimsun Next to obtain initial matrices of truck traffic, which were subsequently adjusted based on the TMC turning counts provided by the City to obtain final matrices used in the Aimsun Next models.

3.7 Matrix Adjustment and Estimation

The EMME databanks were conversed into Aimsun traversal matrices for the purposes of modelling with a two-step process. First a static assignment was completed using the entire imported EMME network, then the traversal demand matrix was completed.

3.7.1 Static Assignment

The initial OD matrices were used in static assignment experiments, which assign flows to the network. Static assignments do not use individual vehicles but are based on trip volumes as well as speeds and flows along road sections and are typically used to define the demand in peak hour OD matrices. The method used was Frank & Wolfe Assignment (as per the approved King Street Pilot model which the City provided to Steer), which is based on the calculation of shortest paths and path percentage usage and uses the cost of the different network elements (i.e. capacity of individual links) to assign flows to the network. The volume delay functions (VDF) which are part of those calculations have been left unchanged from the approved King Street Pilot model.

The results of the static assignments were stored in path files, which contained information about the shortest paths between OD pairs and the percentage of vehicles taking each path. The path files are provided with the model files.

3.7.2 Traversal Demand Matrix

The path files were used as input information for the generation of the traversal matrices for the subnetwork of the study area extent. The traversal matrices were balanced outside of Aimsun using the Furness method, based on a cordon count real data set (RDS) which lists the link flows in and out of the study area. Subsequently, the matrices were adjusted based on the available turning count information. The results were again stored in path files. The settings used for the static OD adjustment scenarios and experiments are outlined in sections 4.2 Static OD Adjustment Scenario Parameters and 4.3 Static OD Adjustment Scenario Parameters.

The dynamic assignments used a combination of vehicles following the input path assignment (60%) and vehicles being dynamically assigned to the shortest path at the time of the them being loaded into the network (40%). The dynamic assignment was based on the past five minutes in the network, therefore taking into consideration recently formed queues. The settings used for the dynamic hybrid scenarios and experiments are outlined in section 4.4 Dynamic Hybrid Experiment Parameters.

The combination of static and dynamic routes assures that not all traffic between a specific OD pair gets assigned to the shortest path at any given moment, as Aimsun Next models with a setting of 100% of vehicles being dynamically assigned to the shortest path tend to create a ‘flip-flop-effect’, where queues jump from one OD-route to another and back multiple times throughout the simulation period.

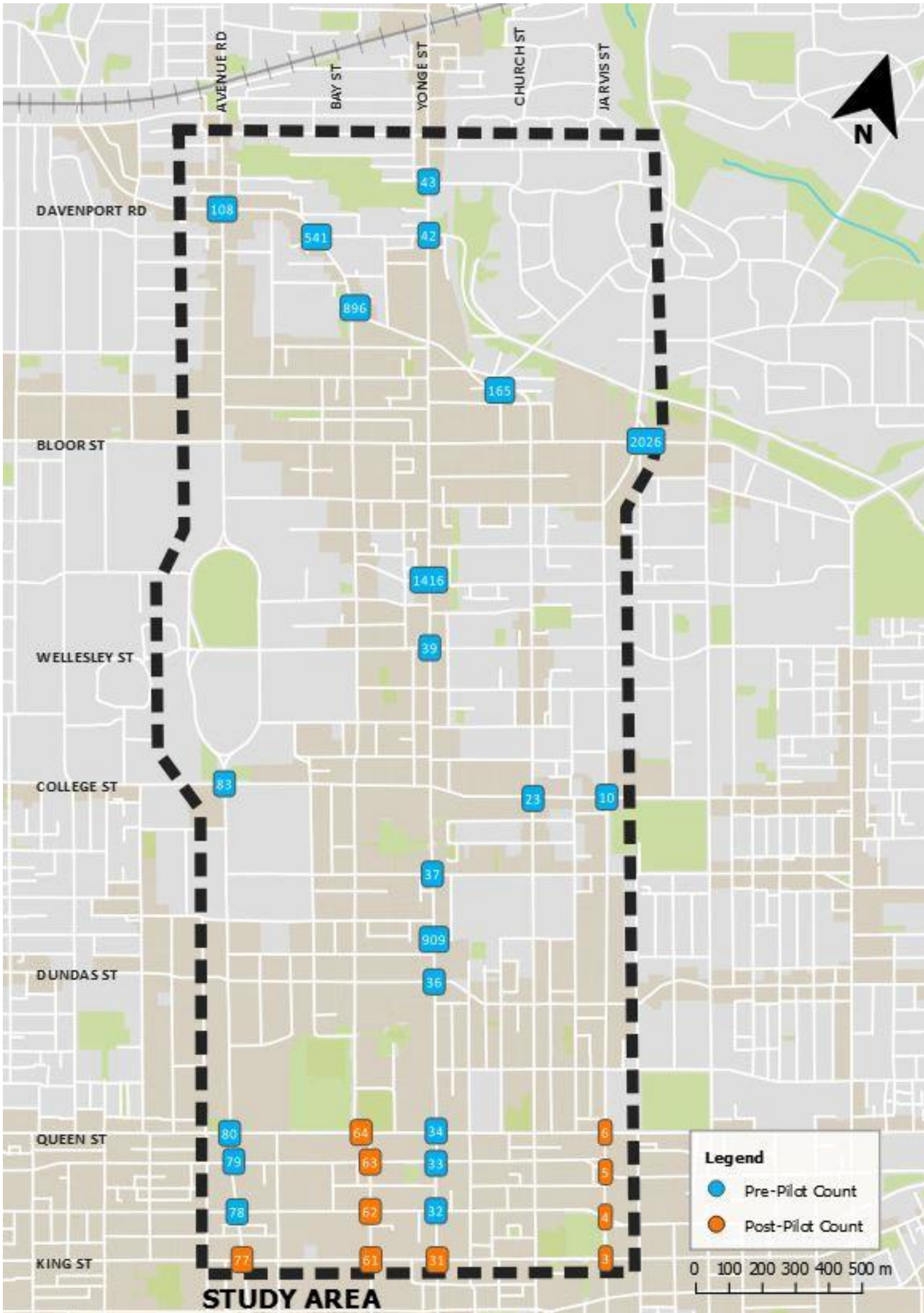
3.7.3 Furness Estimation

The EMME databanks provided by the City are for a 2011 Base year. As a result, they are not reflective of base year (2018) conditions. The key was to determine the differences between the EMME model and traffic counts as a result of travel demands, and as a result of EMME model issues. An EMME model is typically meant for reviewing macroscopic demands, and in the context of the GTA model, the study area for this study would not be calibrated to a high level of accuracy for individual links.

Thus, the first step in the adjustment process was to modify external zones (centroids) of the study area and adjusting them using a Furness estimation process. Furness estimation approximates the demands in these external zones to better reflect actual demands. A cordon of traffic flows across the study area boundaries was created using the balanced traffic count data and used as an input for this process.

Due to the limited amount of data available, no Furness estimation could be undertaken for the Saturday peak. The locations where turning movement counts were available for the Saturday peak model are shown in Figure 3-4.

Figure 3-4: Available Saturday turning movement counts



3.7.4 Matrix Adjustment

A matrix estimation process was completed to adjust the traversal matrices for all centroids, to better reflect the traffic counts within the study area.

Areas with significant queuing were added to *Groupings* and included in the *Static OD Adjustment Scenarios* as *Congested Sections* to prioritize demand over count data. The relevant locations have already been outlined in section 3.1.6 Locations with Operational Restrictions.

The adjusted matrices were used in the hybrid assignments.

4 Model Parameters

This section outlines various parameters and settings used in the Aimsun Next model.

4.1 Static Experiment Parameters

This section outlines parameters of the static assignment experiments. Each sub-section refers to a tab in the experiment settings window.

4.1.1 Main

Engine: Frank and Wolfe Assignment

Assignment Parameters
- Maximum Iterations: 100
- Relative Gap: 0.1%
- Conjugate Frank-Wolfe: deactivate

Quasi-Dynamic Network Loading
- Activate Quasi-Dynamic Network Loading: deactivated

4.2 Static OD Adjustment Scenario Parameters

This section outlines parameters of the static OD adjustment scenarios. Each sub-section refers to a tab in the scenario settings window.

4.2.1 Centroids and Sections

Use Original Matrix as Detection Data
- Matrix Elasticity: 1.00

Use Trip Length Distribution as Detection Data
- Trip Length Distribution Elasticity: 0.50

Use Entrance/Exit Volumes as Detection Data
- Exit from Centroid Reliability Vector: None
- Entrance to Centroid Reliability Vector: None

Maximum Deviation Permitted
- Max Deviation Matrix: None

Weight Function
- Function: None

Congested Sections (Demand over Detection)
- Selected grouping for respective peak hour, listing sections with significant congestion.

- Sections defined based on information provided by the City:
  - S/B right queues Queens Park Cr at Hoskin AM Peak
  - E/B left turn queues Adelaide and University AM and PM Peak
  - W/B right turn queues Richmond and University PM Peak
  - Queen and Bay: Northbound queues from Queen to Richmond
  - Yonge and Dundas: Eastbound/Westbound queues to Bay/Victoria

4.3 Static OD Adjustment Scenario Parameters

This section outlines parameters of the static OD adjustment experiments. Each sub-section refers to a tab in the experiment settings window.

4.3.1 Main

Engine: Frank and Wolfe Assignment

Adjustment Parameters

- Iterations: 100
- Gradient Descent Iterations: 1

Assignment Parameters

- Maximum Iterations: 50
- Relative Gap: 0.1%
- Conjugate Frank-Wolfe: deactivate

Quasi-Dynamic Network Loading

- Activate Quasi-Dynamic Network Loading: deactivated

4.4 Dynamic Hybrid Experiment Parameters

This section outlines parameters of the dynamic hybrid assignment experiments. Each sub-section refers to a tab in the experiment settings window.

4.4.1 Main

Dynamic Traffic Assignment

- Network Loading: Hybrid Simulator
- Assignment Approach: Stochastic Route Choice (SRC)

Warm-Up

- Warm-up demands have been specified based on the respective peak hour demands:
  - 1-hour duration
  - 80% of respective peak hour demand

Performance Settings

- Simulation Threads: 4
- Route Choice Threads: 4

4.4.2 Behaviour

Micro Parameters

- Car Following

- Two-Lane Car-Following Model: deactivated
- Lane Changing
  - Two-Way Two-Lane Overtaking Model: deactivated
- Queue Speeds
  - Queue Entry Speed: 1.00 m/s
  - Queue Exit Speed: 4.00 m/s
- Behavioural Models
  - Activate External Behavioural Models: deactivated

Hybrid Parameters

- Car Following
  - Apply Slope Model: deactivated
- Lane Changing
  - Distance Zone and Look-Ahead Distance Variability: 40%

4.4.3 Reaction Time

Simulation Step

- Simulation Step: 0.80 sec

Reaction Time Settings

- Fixed
- Values
  - Micro Reaction Time: (Same as Simulation Step)
  - Micro Reaction Time at Stop: 1.10 sec
  - Micro Reaction Time at Traffic Light: 1.60 sec
  - Meso Reaction Time: 1.10 sec
  - Meso Reaction Time at Traffic Light: 1.60 sec

4.4.4 Arrivals

Global Arrivals

- Uniform

4.4.5 Dynamic Traffic Assignment

Costs

- Cycle: 00:05:00
- Number if Intervals: 2
- Attractiveness Weight: 5.00
- User-Defined Cost Weight: 0.00
- Use Link Costs from replication: None
- Use Profiles RC: deactivated

Fixed Routes

Vehicle Type	Following OD Routes *	Following Input Path Assignment
53: SOV Compliant	100%	60%
302271: Medium Trucks	100%	60%
996303368: Pedestrian	100%	100%
996813646: Bicycles	100%	100%

* Please note that no OD routes have been defined in the models and therefore this setting does not impact on any routes or results.

- Maximum Paths to Use from Input Path Assignment: All

Stochastic Route Choice

- Model: C-Logit
  - Enroute: deactivated
  - Enroute After Virtual Queue: deactivated
- Basic

Source	Maximum Number of Initial Paths to Consider
K-SP	1

  - Maximum Paths per Interval (For All the Vehicles): 5
- Parameters

Origin	Destination	Scale	Beta	Gamma
All	All	6	0.15	1

5 Calibration, Validation & Results

5.1 GEH Calibration

The criteria selected for the base model calibration was based on thresholds of the *City of Toronto's Methodology for Aimsun Modeling*, as shown in Table 5.1 below.

Table 5.1: Calibration criteria (*City of Toronto Methodology for Aimsun Modeling*)

Criteria & Measures		Calibration Target
Individual Link Hourly Flow Rates	% counts where GEH < 5	> 85% of counts
	% counts where GEH < 10	> 95% of counts

The GEH Statistic is a widely accepted formula allowing the comparison of two sets of traffic volumes – in this case balanced flows against modelled flows in the base case scenario – to represent goodness-of-fit of a model. Including both absolute and percentage differences between modelled and observed flows, it puts emphasis on links or turns with higher flows.

The model calibration was done against the balanced flows which were based on the turning counts obtained from the city. Summaries of the calibration criteria and results of the base model are outlined in Table 5.2.

Table 5.2: GEH calibration results

Criteria & Measures		AM Results	PM Results	SAT Results
Individual Turn Hourly Flow Rates	% counts where GEH < 5	79%	74%	77%
	% counts where GEH < 10	96%	96%	92%

Due to the significant extent of the model and wide range of dates the TMC turning counts data was provided for (2008-2018), as well as the closely spaced grid network in the model area leading to a significant amount of route choice, the GEH calibration results outlined above are considered acceptable for the purpose of the models.

Tables and maps outlining all turns with a GEH larger than 5 can be found in Appendix A.

5.2 Travel Time Validation

Two sets of travel times were collected:

- **In-house Google API Tool by Steer**: the tool captures average speeds of traffic during the respective peak hours by using an API to extract Google's travel time information between two points (individually specified sections); and
- **StreetLight (SL) dataset**: average speed information from the dataset, extracted for the respective peak hours.

Modelled travel times of general traffic have been validated along the key north-south corridors (Bay Street, Yonge Street, Church Street) and key east-west corridors (College St / Carlton Street, Dundas Street, Queen Street) in the Focus Area, against the average observed values of the two data sets outlined above.

Travel times of transit routes were validated against AVL data provided by the City.

The *City of Toronto's Methodology for Aimsun Modeling* does not provide a target criterion for travel time validation. Therefore, the criterion set out in Transport for London's (TfL) Model Auditing Process (MAP) has been used for the study. The criterion is outlined in Table 5.3.

Table 5.3: Travel time validation criteria (*TfL MAP*)

Criteria	Calibration Target
20 seed average modelled corridor travel time	Within 15% of observed travel time

The results are outlined in the sections below.

5.2.1 AM Travel Time Validation

The comparison of observed travel times and modelled travel times (in seconds) for the AM peak is shown below. Table 5.4 and Table 5.5 show the comparison for general traffic and Table 5.6 and Table 5.7 below show the comparison for transit routes.

Table 5.4: AM base general traffic travel time validation (north-south)

	Northbound							Southbound						
Corridor	Start	End	Google	SL	Avg	Model	Diff	Start	End	Google	SL	Avg	Model	Diff
Bay Street	Richmond Street	Grenville Street	268	260	264	248	-6%	Grenville Street	Richmond Street	277	231	254	268	5%
Yonge Street	Richmond Street	Wood Street	293	237	265	271	2%	Wood Street	Richmond Street	294	225	260	275	6%
Church Street	Richmond Street	Wood Street	329	211	270	284	5%	Wood Street	Richmond Street	308	223	266	251	-6%

Table 5.5: AM base general traffic travel time validation (east-west)

	Eastbound							Westbound						
Corridor	Start	End	Google	SL	Avg	Model	Diff	Start	End	Google	SL	Avg	Model	Diff
Queen Street	Bay Street	Church Street	162	102	132	129	-2%	Church Street	Bay Street	151	105	128	154	20%
Dundas Street	Bay Street	Church Street	154	116	135	125	-7%	Church Street	Bay Street	157	128	142	160	13%
College Street	Bay Street	Church Street	114	109	111	114	2%	Church Street	Bay Street	108	135	121	144	19%

Table 5.6: AM base transit travel time validation (north-south)

Route	Corridor	Northbound					Southbound				
		Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
5A	University Ave	College St	Davenport Ave	05:31	05:55	7%	Davenport Ave	College St	06:17	06:42	7%
6A	Bay St	King St	Avenue Ave	17:26	16:40	-4%	Avenue Ave	King St	17:36	16:42	-5%
6B	Bay St	King St	Davenport Ave	15:36	14:16	-9%	Davenport Ave	King St	14:31	15:29	7%

Table 5.7: AM base transit travel time validation (east-west)

Route	Corridor	Eastbound					Westbound				
		Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
501/502	Queen St	University Ave	Jarvis St	07:20	08:08	11%	Jarvis St	University Ave	05:36	09:20	67%
505	Dundas St	University Ave	Jarvis St	06:34	07:31	14%	Jarvis St	University Ave	07:44	08:14	6%
506	College St	University Ave	Jarvis St	07:14	07:55	9%	Jarvis St	University Ave	07:59	08:02	1%

5.2.2 PM Travel Time Validation

The comparison of observed travel times and modelled travel times (in seconds) for the PM peak is shown below. Table 5.8 and Table 5.9 show the comparison for general traffic and Table 5.10 and Table 5.11 below show the comparison for transit routes.

Table 5.8: PM base general traffic travel time validation (north-south)

	Northbound							Southbound						
Corridor	Start	End	Google	SL	Avg	Model	Diff	Start	End	Google	SL	Avg	Model	Diff
Bay Street	Richmond Street	Grenville Street	05:00	04:10	04:35	04:52	6%	Grenville Street	Richmond Street	05:06	04:21	04:44	04:31	-5%
Yonge Street	Richmond Street	Wood Street	05:17	04:31	04:54	04:37	-6%	Wood Street	Richmond Street	05:33	04:30	05:02	04:39	-7%
Church Street	Richmond Street	Wood Street	04:46	04:03	04:24	04:48	9%	Wood Street	Richmond Street	04:56	04:34	04:45	04:38	-3%

Table 5.9: PM base general traffic travel time validation (east-west)

	Eastbound							Westbound						
Corridor	Start	End	Google	SL	Avg	Model	Diff	Start	End	Google	SL	Avg	Model	Diff
Queen Street	Bay Street	Church Street	02:35	02:09	02:22	02:08	-10%	Church Street	Bay Street	02:23	01:39	02:01	01:53	-6%
Dundas Street	Bay Street	Church Street	03:50	02:54	03:22	04:01	20%	Church Street	Bay Street	02:53	02:29	02:41	03:00	12%
College Street	Bay Street	Church Street	02:38	02:47	02:42	02:10	-20%	Church Street	Bay Street	01:45	02:09	01:57	01:43	-12%

Table 5.10: PM base transit travel time validation (north-south)

		Northbound					Southbound				
Route	Corridor	Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
5A	University Ave	College St	Davenport Ave	10:25	05:35	-46%	Davenport Ave	College St	07:03	05:01	-29%
6A	Bay St	King St	Avenue Ave	21:24	17:39	-18%	Avenue Ave	King St	23:27	14:47	-37%
6B	Bay St	King St	Davenport Ave	19:44	15:38	-21%	Davenport Ave	King St	16:49	14:12	-16%

Table 5.11: PM base transit travel time validation (east-west)

		Eastbound					Westbound				
Route	Corridor	Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
501/502	Queen St	University Ave	Jarvis St	10:36	09:20	-12%	Jarvis St	University Ave	09:51	07:32	-23%
505	Dundas St	University Ave	Jarvis St	10:32	10:10	-3%	Jarvis St	University Ave	08:25	10:33	25%
506	College St	University Ave	Jarvis St	08:59	08:30	-5%	Jarvis St	University Ave	08:50	07:19	-17%

5.2.3 SAT Travel Time Validation

The comparison of observed travel times and modelled travel times (in seconds) for the AM peak is shown below. Table 5.12 and Table 5.13 show the comparison for general traffic and Table 5.14 and Table 5.15 below show the comparison for transit routes.

Google data was not available for the Saturday peak and modelled values have therefore been validated against the StreetLight dataset only.

Table 5.12: SAT base general traffic travel time validation (north-south)

	Northbound					Southbound				
Corridor	Start	End	Observed	Modelled	Diff	Start	End	Observed	Modelled	Diff
Bay St	Richmond St	Grenville St	04:03	03:17	-19%	Grenville St	Richmond St	04:04	03:27	-15%
Yonge St	Richmond St	Wood St	04:47	04:13	-12%	Wood St	Richmond St	04:30	04:47	6%
Church St	Richmond St	Wood St	03:39	03:48	4%	Wood St	Richmond St	03:43	04:14	14%

Table 5.13: SAT base general traffic travel time validation (east-west)

	Eastbound					Westbound				
Corridor	Start	End	Observed	Modelled	Diff	Start	End	Observed	Modelled	Diff
Queen St	Bay St	Church St	02:04	01:59	-5%	Church St	Bay St	01:59	02:12	11%
Dundas St	Bay St	Church St	02:03	01:49	-11%	Church St	Bay St	02:08	02:29	17%
College	Bay St	Church St	02:03	01:39	-20%	Church St	Bay St	01:59	01:49	-8%

Table 5.14: SAT base transit travel time validation (north-south)

		Northbound					Southbound				
Route	Corridor	Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
5A	University Ave	College St	Davenport Ave	07:35	04:05	-46%	Davenport Ave	College St	05:40	04:09	-27%
6A	Bay St	King St	Avenue Ave	17:58	13:36	-24%	Avenue Ave	King St	16:21	13:22	-18%

Table 5.15: SAT base transit travel time validation (east-west)

		Eastbound					Westbound				
Route	Corridor	Start	End	Obs	Model	Diff	Start	End	Obs	Model	Diff
505	Dundas St	University Ave	Jarvis St	07:32	05:59	-21%	Jarvis St	University Ave	07:31	06:50	-9%

5.3 Queue Length Validation

Field reviews were conducted at 17 intersections within the focus area to validate the modelled queue lengths. A minimum of ten minutes was spent at each intersection during the AM and PM peak periods. Photos were taken of each movement which are provided with this report. The results are outlined in the sections below.

5.3.1 AM Queues

Table 5.16: AM queue length validation (# of vehicles in queue)

TCS #	Street 1	Street 2	Direction	Observed Avg	Model AM (Qmax)	Difference
68	Bay St	College St	NBT	4	10	6
			SBT	4	7	2
			EBT	4	6	2
			WBT	10	15	6
38	Yonge St	College St	NBT	1	5	5
			SBT	4	7	3
			EBT	2	8	6
			WBT	7	15	8
23	Church St	College St	NBT	6	8	2
			SBT	6	9	2
			EBT	6	8	2
			WBT	11	15	5
67	Bay St	Gerrard St	NBT	6	4	-2
			SBT	4	7	2
			EBT	5	8	3
			WBL	0	5	4
			WBT	20	5	-15
37	Yonge St	Gerrard St	NBT	3	6	3
			SBT	3	6	3
			EBT	5	11	5
			WBT	17	8	-9
22	Church St	Gerrard St	NBT	2	10	7
			SBT	3	7	5
			EBL	1	3	2
			EBT	1	4	3
			WBL	2	3	1
			WBT	11	18	7
66	Bay St	Dundas St	NBT	4	8	4
			SBT	6	4	-2
			EBT	5	9	4
			WBT	10	9	-1
36	Yonge St	Dundas St	NBT	16	7	-9
			SBT	9	6	-3
			EBT	8	12	4
			WBT	10	12	2
21	Church St	Dundas St	NBT	3	6	3
			SBT	3	10	7

TCS #	Street 1	Street 2	Direction	Observed Avg	Model AM (Qmax)	Difference
			EBT	2	6	4
			WBT	5	6	0
1905	Victoria St	Dundas St	NBT	3	2	-1
			SBT	0	3	3
			EBT	3	6	3
			WBT	6	6	0
20	Church St	Shuter St	NBT	5	6	1
			SBT	2	8	6
			EBL	1	2	2
			EBT	1	3	2
			WBL	1	3	2
			WBT	8	3	-5
1518	Victoria St	Shuter St	NBT	2	7	5
			SBT	2	5	3
			EBT	2	6	4
			WBT	9	8	-1
35	Yonge St	Shuter St	NBT	2	7	5
			SBT	0	4	4
			EBT	0	5	5
			WBL	1	2	1
			WBT	7	3	-4
28	Victoria St	Queen St	NBT	2	6	4
			SBT	5	3	-2
			EBT	3	8	5
			WBT	5	7	2
19	Church St	Queen St	NBT	8	5	-3
			SBT	5	14	9
			EBT	6	6	0
			WBT	8	6	-2
64	Bay St	Queen St	NBT	2	8	6
			SBT	5	4	-1
			EBT	4	7	3
			WBT	5	11	6
34	Yonge St	Queen St	NBT	5	4	-1
			SBT	7	7	-1
			EBT	2	7	5
			WBT	6	12	7

5.3.2 PM Queues

Table 5.17: PM queue length validation (# of vehicles in queue)

TCS #	Street 1	Street 2	Direction	Observed Avg	Model AM (Qmax)	Difference
68	Bay St	College St	NBT	8	11	3
			SBT	4	8	4
			EBT	16	8	-8
			WBT	4	9	4
38	Yonge St	College St	NBT	2	6	4
			SBT	3	6	2
			EBT	10	14	4
			WBT	6	8	2
23	Church St	College St	NBT	9	8	-1
			SBT	10	12	2
			EBT	15	11	-4
			WBT	15	7	-8
67	Bay St	Gerrard St	NBT	6	4	-2
			SBT	3	7	4
			EBT	13	8	-5
			WBL	0	4	4
			WBT	4	5	1
37	Yonge St	Gerrard St	NBT	1	8	7
			SBT	2	6	4
			EBT	5	16	11
			WBT	4	8	4
22	Church St	Gerrard St	NBT	5	10	5
			SBT	7	9	2
			EBL	1	3	2
			EBT	7	4	-3
			WBL	1	3	3
			WBT	16	17	1
66	Bay St	Dundas St	NBT	5	10	5
			SBT	5	4	-1
			EBT	5	9	4
			WBT	5	8	3
36	Yonge St	Dundas St	NBT	11	7	-4
			SBT	4	6	2
			EBT	7	18	11
			WBT	10	13	3
21	Church St	Dundas St	NBT	3	6	3
			SBT	3	13	10

TCS #	Street 1	Street 2	Direction	Observed Avg	Model AM (Qmax)	Difference
			EBT	8	7	-1
			WBT	5	6	1
1905	Victoria St	Dundas St	NBT	3	2	-1
			SBT	1	4	3
			EBT	4	9	5
			WBT	2	6	4
20	Church St	Shuter St	NBT	2	6	4
			SBT	2	8	6
			EBL	1	3	2
			EBT	8	3	-5
			WBL	1	3	2
			WBT	3	3	0
1518	Victoria St	Shuter St	NBT	4	10	6
			SBT	2	7	5
			EBT	6	7	1
			WBT	2	8	6
35	Yonge St	Shuter St	NBT	11	8	-3
			SBT	3	6	3
			EBT	2	64	62
			WBL	1	2	1
			WBT	1	3	2
28	Victoria St	Queen St	NBT	5	7	2
			SBT	7	3	-4
			EBT	7	12	5
			WBT	3	7	4
19	Church St	Queen St	NBT	4	5	2
			SBT	5	13	8
			EBT	12	10	-2
			WBT	4	5	1
64	Bay St	Queen St	NBT	5	7	2
			SBT	10	4	-7
			EBT	4	7	3
			WBT	3	7	4
34	Yonge St	Queen St	NBT	6	4	-2
			SBT	6	7	1
			EBT	5	10	4
			WBT	5	10	5

5.3.3 SAT Queues

No on-site queuing information is available for the Saturday peak period.

5.4 Model Stability

To ensure that the model exhibits a consistent behavior for a range of arrival patterns based on the model seed, the following tests were conducted on the base model to test model stability in the AM and PM peak periods. For each test, a total of 20 runs were conducted.

- Test 1 – Travel time standard deviations for each corridor and transit route in the focus area are provided below.

Figure 5-1: Base AM Travel Time Standard Deviations

Direction	Northbound			Southbound			Westbound			Westbound		
Street	Bay St	Yonge St	Church St	Bay St	Yonge St	Church St	Queen St	Dundas St	College St	Queen St	Dundas St	College St
AM	00:19	00:03	00:20	00:20	00:03	00:24	00:05	00:03	00:05	00:09	00:05	00:04
PM	00:14	00:03	00:27	00:05	00:07	00:26	00:05	00:17	00:08	00:05	00:09	00:04

Figure 5-2: Base PM Travel Time Standard Deviations

Direction	Northbound			Southbound			Westbound			Westbound		
Route	5A	6A	6B	5A	6A	6B	501	505	506	501	505	506
AM	00:14	00:23	00:12	00:21	00:28	00:23	00:20	00:11	00:26	00:29	00:08	00:18
PM	00:14	00:33	00:28	00:14	00:20	00:28	00:24	00:34	00:23	00:25	00:32	00:11

- Test 2 - The total vehicle kilometres travelled in the model was recorded in each run. An acceptable limit of two standard deviations was agreed upon with the City.

Figure 5-3: Base AM Stability

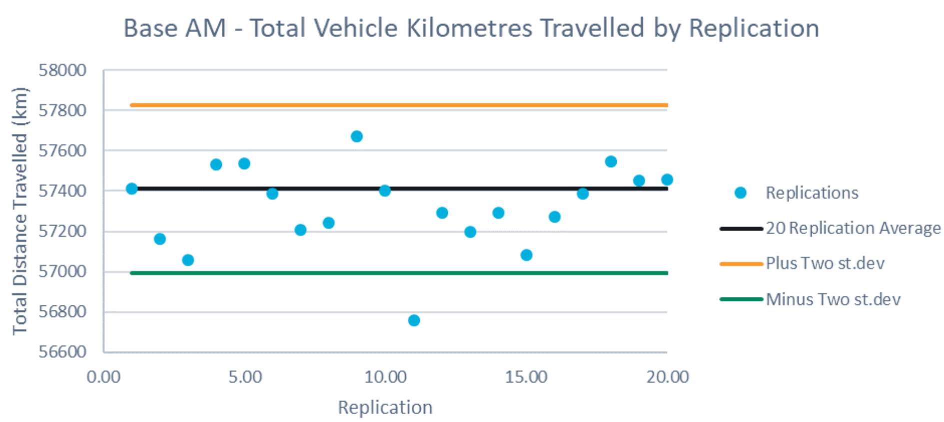
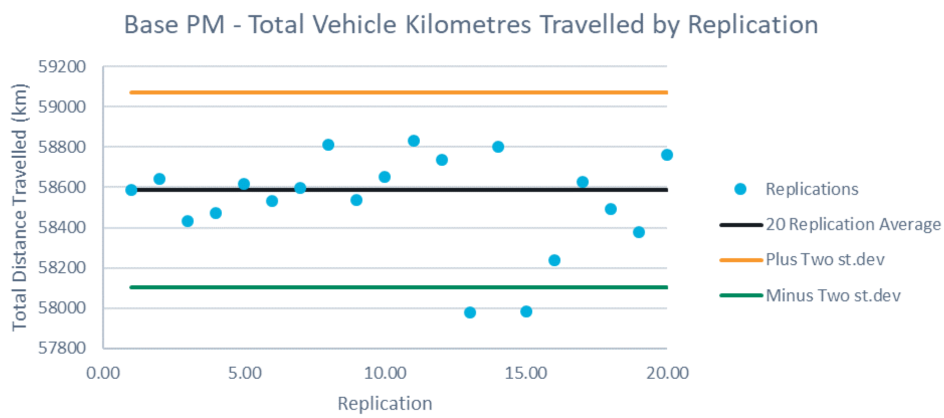


Figure 5-4: Base PM Stability



5.5 Network Wide Performance

Performance statistics have been extracted from the completed model runs for the entire study area as it is currently not possible to extract this information for the microsimulation only. The tables below show the results of the averages of 20 seeds. Mean virtual queue results are almost entirely composed of queues on pedestrian links due to those links being very short. In particular, pedestrian links at thee intersections in the mesoscopic simulation area (outside the focus area) show high mean virtual queues: TCS13, TCS61 and TCS107.

5.5.1 AM Network Performance

Table 5.18: AM network performance results

Measure	Value
Delay Time - SOV Compliant	1:22 min/km
Density - SOV Compliant	8 veh/km
Flow - SOV Compliant	34119 veh/h
Input Flow - SOV Compliant	34846 veh/h
Mean Virtual Queue - SOV Compliant	4 veh
Mean Virtual Queue - MediumTrucks	0 veh
Mean Virtual Queue - Bus	0 veh
Mean Virtual Queue - Pedestrian	2836 veh
Mean Virtual Queue - Bicycles	0 veh
Missed Turns - SOV Compliant	51 0
Stop Time - SOV Compliant	26 veh
Total Distance Travelled - SOV Compliant	51268 km
Total Travel Time (Vehicles Inside) - SOV Compliant	144 h

Travel Time - SOV Compliant	2:47 min/km
Vehicles Lost Inside - All	0 veh

5.5.2 PM Network Performance

Table 5.19: PM network performance results

Measure	Value
Delay Time - SOV Compliant	1:28 min/km
Density - SOV Compliant	8 veh/km
Flow - SOV Compliant	35993 veh/h
Input Flow - SOV Compliant	36841 veh/h
Mean Virtual Queue - SOV Compliant	14 veh
Mean Virtual Queue - MediumTrucks	0 veh
Mean Virtual Queue - Bus	0 veh
Mean Virtual Queue - Pedestrian	1521 veh
Mean Virtual Queue - Bicycles	0 veh
Missed Turns - SOV Compliant	73 0
Stop Time - SOV Compliant	34 veh
Total Distance Travelled - SOV Compliant	53135 km
Total Travel Time (Vehicles Inside) - SOV Compliant	182 h
Travel Time - SOV Compliant	2:54 min/km
Vehicles Lost Inside - All	0 veh

5.5.3 SAT Network Performance

Table 5.20: AM network performance results

Measure	Value
Delay Time - SOV Compliant	1:14 min/km
Density - SOV Compliant	5 veh/km
Flow - SOV Compliant	24245 veh/h
Input Flow - SOV Compliant	24694 veh/h
Mean Virtual Queue - SOV Compliant	45 veh
Mean Virtual Queue - MediumTrucks	0 veh
Mean Virtual Queue - Bus	0 veh
Mean Virtual Queue - Pedestrian	564 veh
Mean Virtual Queue - Bicycles	0 veh
Missed Turns - SOV Compliant	30 0
Stop Time - SOV Compliant	23 veh
Total Distance Travelled - SOV Compliant	39268 km
Total Travel Time (Vehicles Inside) - SOV Compliant	100 h
Travel Time - SOV Compliant	2:40 min/km
Vehicles Lost Inside - All	0 veh

6 Future Model Development

6.1 Demand

Future car demand has been developed based on the 2031 EMME databanks provided to Steer by the City. Adjustments made during the 2018 base year calibration and validation have been replicated in the future demand. The process is outlined in more detail below:

- Import 2031 EMME databanks into Aimsun Next;
- Re-run static assignment (taking into consideration updated transit information);
- Create traversal matrices for study area; and
- Apply factors to traversal matrices which replicate the adjustments undertaken during the 2018 base year calibration and validation and include matrix furness and static OD adjustment scenarios.

6.2 Trucks

The City's EMME model does not include truck traffic. Therefore, StreetLight data was used to determine the distribution of truck traffic through the study area. The software was used to build two OD matrices: personal vehicles and commercial vehicles. These matrices were then compared to determine the amount of truck traffic in each OD pair, given as percentages. These matrices were then applied to the respective adjusted demand matrices within Aimsun Next to obtain matrices of truck traffic which were used in the model.

The factors used to derive the 2018 base year model truck demand have been used to calculate the 2031 truck demand from the final 2031 car matrices. More information on this process has already been highlighted in section 3.6.4.

6.3 Transit

The City provided Steer with the following information:

- A future year service summary for all TTC routes which included service intervals and vehicle types for each transit route; and
- Advice that growth on transit trips destined to Planning District 1 (which roughly equates to the Toronto downtown area) was similar to pedestrian trip growth at about 29% between the 2011 and 2031 EMME models.

The information was used to update boarding and alighting data using a 1.5% annual growth rate and re-calculate dwell times based on the updated numbers of boarders and alighters at each stop.

Transit routes in the models have been amended to reflect updated service intervals, dwell times and vehicle types.

6.4 Pedestrians

The City provided Steer with the growth in walk trips in the 2011 and 2031 EMME models within Planning District 1 (which roughly equates to the Toronto downtown area). The growth for this area is approximately 28% over the 20 years. Based on this figure and to provide consistency with similar assumptions made by the City on other projects, the growth rate has been assumed to be 1.5% per year between the 2018 base model and the 2031 future base model. The annual factor of 1.5% resulted in a growth of roughly 21.4% between 2018 and 2031 which has been applied on a cell-by cell basis to the 2018 base model pedestrian matrices to calculate the future pedestrian demand.

6.5 Cyclists

In absence of predicted growth rates or other information, the rate of growth in line with growth in the EMME demand models provided by transportations services has been applied to the cycle demand (as instructed by the City).

7 Future Base Model

The future base models ("Do Nothing") assess the operation of the existing network with the future demand. No changes to the physical road network have been undertaken, however the signal timings have been optimised to cater for changes in traffic flows.

The results from the future base models have been compared to the results of the base models.

7.1 Signal Optimisation

This section outlines locations where significant issues were identified in the future base models and signal timings have been adjusted.

7.1.1 AM Peak

- TCS9 (Jarvis St & Gerrard St):
  – Cycle length increased from 70s to 80s.
- TCS10 (Jarvis St & Carlton St):
  – Cycle length increased from 70s to 80s
- TCS22 (Church St & Gerrard St):
  – Cycle length increased from 70s to 80s.
  – Additional stage added for left turn from north.
- TCS23 (Church St & Carlton St):
  – Cycle length increased from 70s to 80s;
- TCS36 (Yonge St & Dundas St):
  – Slight adjustment of green time split.
- TCS993 (Church St & Gould St):
  – Cycle length increased from 70s to 76s.
- TCS2035 (Carlton St & 108m West of Church St):
  – Cycle length increased from 70s to 80s.
- TCS2036 (Church St & Gould St):
  – Cycle length increased from 70s to 80s.
- TCS2085 (Jarvis St 170m North of Dundas St):
  – Cycle length increased from 70s to 76s.

7.1.2 PM Peak

- TCS22 (Church St & Gerrard St):
  – Cycle length increased from 70s to 75s.
- TCS23 (Church St & Carlton St):
  – Cycle length increased from 70s to 75s;
  – Additional stage added for left turn from south.

- TCS36 (Yonge St & Dundas St):
  - Slight adjustment of green time split.
- TCS37 (Yonge St & Gerrard St):
  - Slight adjustment of green time split.
- TCS993 (Church St & Gould St):
  - Cycle length increased from 70s to 75s.
- TCS2035 (Carlton St 108m West of Church St):
  - Cycle length increased from 70s to 75s.

7.1.3 SAT Peak

- TCS7 (Jarvis St & Shuter St)
  - Cycle length increased from 60s to 70s.
- TCS36 (Yonge St & Dundas St):
  - Slight adjustment of green time split.
- TCS66 (Bay St & Dundas St)
  - Cycle length increased from 70s to 80s;
  - Additional stage added for left turns.

7.2 Travel Time Results

7.2.1 AM Peak

Table 7.1: AM base vs. future base general traffic travel time comparison (north-south)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Bay St	Richmond St	Grenville St	04:08	04:11	1%	Grenville St	Richmond St	04:28	04:43	6%
Yonge St	Richmond St	Wood St	04:31	04:35	1%	Wood St	Richmond St	04:35	04:57	8%
Church St	Richmond St	Wood St	04:44	05:15	11%	Wood St	Richmond St	04:11	05:10	24%

Table 7.2: AM base vs. future base general traffic travel time comparison (east-west)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Queen St	Bay St	Church St	02:09	02:45	28%	Church St	Bay St	02:34	02:30	-2%
Dundas St	Bay St	Church St	02:05	03:11	52%	Church St	Bay St	02:40	03:05	16%
College	Bay St	Church St	01:54	02:06	11%	Church St	Bay St	02:24	02:17	-4%

Table 7.3: AM base vs. future base transit travel time comparison (north-south)

Route	Corridor	Northbound					Southbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
5A	University Ave	College St	Davenport Ave	05:55	05:51	-1%	Davenport Ave	College St	06:42	07:12	8%
6A	Bay St	King St	Avenue Ave	16:40	16:40	0%	Avenue Ave	King St	16:42	16:34	-1%
6B	Bay St	King St	Davenport Ave	14:16	14:26	1%	Davenport Ave	King St	15:29	15:37	1%

Table 7.4: AM base vs. future base transit travel time comparison (east-west)

Route	Corridor	Eastbound					Westbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
501/502	Queen St	University Ave	Jarvis St	08:08	08:03	-1%	Jarvis St	University Ave	09:20	11:04	19%
505	Dundas St	University Ave	Jarvis St	07:31	07:34	1%	Jarvis St	University Ave	08:14	07:45	-6%
506	College St	University Ave	Jarvis St	07:55	09:12	16%	Jarvis St	University Ave	08:02	08:01	0%

7.2.2 PM Peak

Table 7.5: PM base vs. future base general traffic travel time comparison (north-south)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Bay St	Richmond St	Grenville St	04:52	05:24	11%	Grenville St	Richmond St	04:31	04:39	3%
Yonge St	Richmond St	Wood St	04:37	04:53	6%	Wood St	Richmond St	04:39	05:01	8%
Church St	Richmond St	Wood St	04:48	05:55	23%	Wood St	Richmond St	04:38	05:15	14%

Table 7.6: PM base vs. future base general traffic travel time comparison (east-west)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Queen St	Bay St	Church St	02:08	02:16	6%	Church St	Bay St	01:53	02:04	9%
Dundas St	Bay St	Church St	04:01	03:41	-8%	Church St	Bay St	03:00	03:50	28%
College	Bay St	Church St	02:10	02:37	20%	Church St	Bay St	01:43	02:14	30%

Table 7.7: PM base vs. future base transit travel time comparison (north-south)

Route	Corridor	Northbound					Southbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
5A	University Ave	College St	Davenport Ave	05:35	05:35	0%	Davenport Ave	College St	05:01	05:31	10%
6A	Bay St	King St	Avenue Ave	17:39	17:52	1%	Avenue Ave	King St	14:47	14:28	-2%
6B	Bay St	King St	Davenport Ave	15:38	15:49	1%	Davenport Ave	King St	14:12	14:12	0%

Table 7.8: PM base vs. future base transit travel time comparison (east-west)

Route	Corridor	Eastbound					Westbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
501/502	Queen St	University Ave	Jarvis St	09:20	07:42	-18%	Jarvis St	University Ave	07:32	07:48	3%
505	Dundas St	University Ave	Jarvis St	10:10	08:51	-13%	Jarvis St	University Ave	10:33	10:00	-5%
506	College St	University Ave	Jarvis St	08:30	09:00	6%	Jarvis St	University Ave	07:19	07:48	7%

7.2.3 SAT Peak

Table 7.9: SAT base vs. future base general traffic travel time comparison (north-south)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Bay St	Richmond St	Grenville St	03:17	03:26	5%	Grenville St	Richmond St	03:27	04:02	17%
Yonge St	Richmond St	Wood St	04:13	04:25	5%	Wood St	Richmond St	04:47	05:03	6%
Church St	Richmond St	Wood St	03:48	06:32	72%	Wood St	Richmond St	04:14	04:37	9%

Table 7.10: SAT base vs. future base general traffic travel time comparison (east-west)

Corridor	Northbound					Southbound				
	Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
Queen St	Bay St	Church St	01:59	02:07	7%	Church St	Bay St	02:12	02:04	-6%
Dundas St	Bay St	Church St	01:49	02:01	11%	Church St	Bay St	02:29	02:49	14%
College	Bay St	Church St	01:39	01:47	8%	Church St	Bay St	01:49	01:45	-4%

Table 7.11: SAT base vs. future base transit travel time comparison (north-south)

Route	Corridor	Northbound					Southbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
5A	University Ave	College St	Davenport Ave	04:05	04:08	1%	Davenport Ave	College St	04:09	04:13	2%
6A	Bay St	King St	Avenue Ave	13:36	13:47	1%	Avenue Ave	King St	13:22	13:31	1%

Table 7.12: SAT base vs. future base transit travel time comparison (east-west)

Route	Corridor	Eastbound					Westbound				
		Start	End	Base	FB	Diff	Start	End	Base	FB	Diff
505	Dundas St	University Ave	Jarvis St	05:59	06:00	0%	Jarvis St	University Ave	06:50	06:48	0%

7.3 Queue Lengths

7.3.1 AM Peak

Table 7.13: AM base vs. future base queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Difference
68	Bay St	College St	NBT	10	10	1
			SBT	7	7	0
			EBT	6	7	0
			WBT	15	17	2
38	Yonge St	College St	NBT	5	6	0
			SBT	7	8	2
			EBT	8	13	5
			WBT	15	13	-2
23	Church St	College St	NBT	8	9	1
			SBT	9	13	4
			EBT	8	9	2
			WBT	15	15	0
67	Bay St	Gerrard St	NBT	4	4	0
			SBT	7	7	0
			EBT	8	8	0
			WBL	5	5	0
			WBT	5	5	0
37	Yonge St	Gerrard St	NBT	6	7	1
			SBT	6	9	2
			EBT	11	13	2
			WBT	8	8	0
22	Church St	Gerrard St	NBT	10	12	3
			SBT	7	9	2
			EBL	3	3	1
			EBT	4	4	0
			WBL	3	3	0
			WBT	18	19	0
66	Bay St	Dundas St	NBT	8	7	-1
			SBT	4	4	0
			EBT	9	13	4
			WBT	9	10	1
36	Yonge St	Dundas St	NBT	7	7	0
			SBT	6	6	0
			EBT	12	18	7
			WBT	12	15	3
21	Church St	Dundas St	NBT	6	6	0

TCS #	Street 1	Street 2	Direction	Base	FB	Difference
			SBT	10	12	2
			EBT	6	7	1
			WBT	6	6	0
1905	Victoria St	Dundas St	NBT	2	2	0
			SBT	3	3	0
			EBT	6	9	2
			WBT	6	8	1
20	Church St	Shuter St	NBT	6	6	0
			SBT	8	8	1
			EBL	2	2	0
			EBT	3	3	0
			WBL	3	3	0
			WBT	3	3	0
1518	Victoria St	Shuter St	NBT	7	8	1
			SBT	5	7	1
			EBT	6	6	0
			WBT	8	8	0
35	Yonge St	Shuter St	NBT	7	7	0
			SBT	4	5	1
			EBT	5	8	3
			WBL	2	2	0
			WBT	3	3	0
28	Victoria St	Queen St	NBT	6	7	1
			SBT	3	3	0
			EBT	8	11	3
			WBT	7	7	0
19	Church St	Queen St	NBT	5	5	0
			SBT	14	16	2
			EBT	6	8	2
			WBT	6	6	0
64	Bay St	Queen St	NBT	8	8	0
			SBT	4	4	0
			EBT	7	7	0
			WBT	11	12	1
34	Yonge St	Queen St	NBT	4	4	0
			SBT	7	7	1
			EBT	7	8	1
			WBT	12	12	-1

7.3.2 PM Peak

Table 7.14: PM base vs. future base queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Difference
68	Bay St	College St	NBT	11	11	0
			SBT	8	8	0
			EBT	8	8	0
			WBT	9	16	8
38	Yonge St	College St	NBT	6	7	1
			SBT	6	6	1
			EBT	14	16	2
			WBT	8	14	6
23	Church St	College St	NBT	8	9	1
			SBT	12	14	2
			EBT	11	13	2
			WBT	7	11	5
67	Bay St	Gerrard St	NBT	4	4	0
			SBT	7	6	0
			EBT	8	8	0
			WBL	4	5	0
			WBT	5	5	0
37	Yonge St	Gerrard St	NBT	8	11	3
			SBT	6	7	1
			EBT	16	15	-1
			WBT	8	8	0
22	Church St	Gerrard St	NBT	10	11	0
			SBT	9	10	1
			EBL	3	2	0
			EBT	4	4	0
			WBL	3	3	0
			WBT	17	18	2
66	Bay St	Dundas St	NBT	10	10	0
			SBT	4	4	0
			EBT	9	12	3
			WBT	8	12	4
36	Yonge St	Dundas St	NBT	7	8	1
			SBT	6	6	0
			EBT	18	18	0
			WBT	13	16	4
21	Church St	Dundas St	NBT	6	6	0
			SBT	13	13	0

TCS #	Street 1	Street 2	Direction	Base	FB	Difference
			EBT	7	7	0
			WBT	6	6	0
1905	Victoria St	Dundas St	NBT	2	2	0
			SBT	4	4	0
			EBT	9	13	4
			WBT	6	8	2
20	Church St	Shuter St	NBT	6	6	0
			SBT	8	9	1
			EBL	3	3	0
			EBT	3	3	0
			WBL	3	3	0
			WBT	3	3	0
1518	Victoria St	Shuter St	NBT	10	11	1
			SBT	7	8	1
			EBT	7	7	0
			WBT	8	8	0
35	Yonge St	Shuter St	NBT	8	9	1
			SBT	6	6	0
			EBT	64	57	-7
			WBL	2	2	1
			WBT	3	3	0
28	Victoria St	Queen St	NBT	7	6	0
			SBT	3	3	0
			EBT	12	12	0
			WBT	7	7	0
19	Church St	Queen St	NBT	5	6	0
			SBT	13	16	3
			EBT	10	10	0
			WBT	5	5	0
64	Bay St	Queen St	NBT	7	7	0
			SBT	4	4	0
			EBT	7	7	0
			WBT	7	8	1
34	Yonge St	Queen St	NBT	4	5	1
			SBT	7	6	-1
			EBT	10	10	0
			WBT	10	11	1

7.3.3 SAT Peak

Table 7.15: SAT base vs. future base queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Difference
68	Bay St	College St	NBT	12	12	1
			SBT	9	9	0
			EBT	5	6	1
			WBT	8	8	0
38	Yonge St	College St	NBT	2	3	1
			SBT	6	8	2
			EBT	7	9	2
			WBT	4	6	2
23	Church St	College St	NBT	6	6	0
			SBT	6	6	0
			EBT	6	8	2
			WBT	5	8	2
67	Bay St	Gerrard St	NBT	4	4	0
			SBT	7	7	0
			EBT	7	5	-2
			WBL	5	4	0
			WBT	5	5	0
37	Yonge St	Gerrard St	NBT	5	7	2
			SBT	5	6	1
			EBT	10	9	-1
			WBT	8	8	0
22	Church St	Gerrard St	NBT	7	7	-1
			SBT	7	7	0
			EBL	2	2	0
			EBT	4	4	0
			WBL	3	3	0
			WBT	10	11	1
66	Bay St	Dundas St	NBT	7	8	1
			SBT	6	7	1
			EBT	6	9	3
			WBT	8	10	1
36	Yonge St	Dundas St	NBT	7	8	1
			SBT	6	6	0
			EBT	9	13	5
			WBT	10	13	3
21	Church St	Dundas St	NBT	5	5	0
			SBT	10	10	0

			EBT	7	7	0
			WBT	5	5	0
1905	Victoria St	Dundas St	NBT	2	2	0
			SBT	3	3	0
			EBT	4	5	1
			WBT	6	7	1
20	Church St	Shuter St	NBT	5	4	-1
			SBT	6	6	0
			EBL	1	2	0
			EBT	3	3	0
			WBL	3	3	0
			WBT	3	3	0
1518	Victoria St	Shuter St	NBT	5	8	3
			SBT	4	4	0
			EBT	6	6	0
			WBT	8	7	0
35	Yonge St	Shuter St	NBT	8	11	3
			SBT	5	5	1
			EBT	6	5	0
			WBL	0	2	1
			WBT	3	3	0
28	Victoria St	Queen St	NBT	7	7	0
			SBT	3	3	0
			EBT	7	8	1
			WBT	6	6	0
19	Church St	Queen St	NBT	5	6	0
			SBT	7	11	4
			EBT	6	7	2
			WBT	5	6	1
64	Bay St	Queen St	NBT	8	11	3
			SBT	7	7	0
			EBT	7	7	0
			WBT	5	6	1
34	Yonge St	Queen St	NBT	7	9	2
			SBT	4	5	1
			EBT	9	9	0
			WBT	10	8	-2

7.4 Network Wide Performance

7.4.1 AM Peak

Table 7.16: AM base vs. future base network wide performance comparison

Measure	Base	FB	Difference
Delay Time - SOV Compliant	1:22 min/km	1:36 min/km	0:14 min/km
Density - SOV Compliant	8 veh/km	9 veh/km	1 veh/km
Flow - SOV Compliant	34119 veh/h	35378 veh/h	1259 veh/h
Input Flow - SOV Compliant	34846 veh/h	36505 veh/h	1659 veh/h
Mean Virtual Queue - SOV Compliant	4 veh	10 veh	6 veh
Mean Virtual Queue - MediumTrucks	0 veh	0 veh	0 veh
Mean Virtual Queue - Bus	0 veh	0 veh	0 veh
Mean Virtual Queue - Pedestrian	2836 veh	7193 veh	4357 veh
Mean Virtual Queue - Bicycles	0 veh	0 veh	0 veh
Missed Turns - SOV Compliant	51	54 0	3 0
Stop Time - SOV Compliant	26 veh	35	9 veh
Total Distance Travelled - SOV Compliant	51268 km	55330 km	4062 km
Total Travel Time (Vehicles Inside) - SOV Compliant	144 h	225 h	80 h
Travel Time - SOV Compliant	2:47 min/km	3:01 min/km	0:14 min/km
Vehicles Lost Inside - All	0 veh	0 veh	0 veh

7.4.2 PM Peak

Table 7.17: PM base vs. future base network wide performance comparison

Measure	Base	FB	Difference
Delay Time - SOV Compliant	1:28 min/km	1:41 min/km	0:12 min/km
Density - SOV Compliant	8 veh/km	10 veh/km	1 veh/km
Flow - SOV Compliant	35993 veh/h	36970 veh/h	977 veh/h
Input Flow - SOV Compliant	36841 veh/h	38245 veh/h	1404 veh/h
Mean Virtual Queue - SOV Compliant	14 veh	55 veh	42 veh
Mean Virtual Queue - MediumTrucks	0 veh	0 veh	0 veh
Mean Virtual Queue - Bus	0 veh	0 veh	0 veh
Mean Virtual Queue - Pedestrian	1521 veh	3622 veh	2101 veh
Mean Virtual Queue - Bicycles	0 veh	0 veh	0 veh
Missed Turns - SOV Compliant	73	79 0	6 0
Stop Time - SOV Compliant	34 veh	40	6 veh
Total Distance Travelled - SOV Compliant	53135 km	57280 km	4145 km
Total Travel Time (Vehicles Inside) - SOV Compliant	182 h	280 h	98 h
Travel Time - SOV Compliant	2:54 min/km	3:06 min/km	0:12 min/km
Vehicles Lost Inside - All	0 veh	0 veh	0 veh

7.4.3 SAT Peak

Table 7.18: SAT base vs. future base network wide performance comparison

Measure	Base	FB	Difference
Delay Time - SOV Compliant	1:14 min/km	1:29 min/km	0:14 min/km
Density - SOV Compliant	5 veh/km	6 veh/km	1 veh/km
Flow - SOV Compliant	24245 veh/h	25360 veh/h	1115 veh/h
Input Flow - SOV Compliant	24694 veh/h	25870 veh/h	1175 veh/h
Mean Virtual Queue - SOV Compliant	45 veh	365 veh	320 veh
Mean Virtual Queue - MediumTrucks	0 veh	0 veh	0 veh
Mean Virtual Queue - Bus	0 veh	0 veh	0 veh
Mean Virtual Queue - Pedestrian	564 veh	1282 veh	717 veh
Mean Virtual Queue - Bicycles	0 veh	0 veh	0 veh
Missed Turns - SOV Compliant	30	33 0	3 0
Stop Time - SOV Compliant	23 veh	27	4 veh
Total Distance Travelled - SOV Compliant	39268 km	41118 km	1850 km
Total Travel Time (Vehicles Inside) - SOV Compliant	100 h	132 h	31 h
Travel Time - SOV Compliant	2:40 min/km	2:54 min/km	0:14 min/km
Vehicles Lost Inside - All	0 veh	0 veh	0 veh

8 Future Alternatives Analysis

8.1 Alternatives

Four alternatives were tested to assess the re-assignment of traffic and the impact on the local and wider road network. The four tested alternatives are listed below and shown in Figure 8-1:

1. *Alternative 1*:
   i. Reduction of Yonge Street to a single lane in each direction from College Street / Carlton Street to Queen Street.
   ii. Reduction of one lane in each direction on University Ave between Adelaide Street and College Street.
2. *Alternative 2*:
   i. Full pedestrianization of Yonge Street from Dundas Square to Elm Street.
   ii. Reduction of Yonge Street to a single lane in the northbound direction from Queen Street to Dundas Square.
   iii. Reduction of Yonge Street to a single lane in the southbound direction from Gerrard Street to Elm Street.
   iv. Reduction of Yonge Street to a single lane in each direction from College Street / Carlton Street to Gerrard Street.
   v. Reduction of one lane in each direction on University Ave between Adelaide Street and College Street.
3. *Alternative 3:*
   i. Full pedestrianization of Yonge Street from Gerrard Street to Richmond Street.
   ii. Reduction of Yonge Street to a single lane in each direction from College Street / Carlton Street to Gerrard Street.
   iii. Reduction of one lane in each direction on University Ave between Adelaide Street and College Street.
4. *Alternative 4*:
   i. Full pedestrianization of Yonge Street from Dundas Square to Gerrard Street.
   ii. Reduction of Yonge Street to a single lane in the northbound direction from Shuter Street to Dundas Square.
   iii. Reduction of Yonge Street to a single lane in each direction from Queen Street to Shuter Street.
   iv. Reduction of Yonge Street to a single lane in each direction from College Street / Carlton Street to Gerrard Street.
   v. Reduction of one lane in each direction on University Ave between Adelaide Street and College Street.

Figure 8-1: Alternative Options

A separate revision has been created for each of the alternatives so that changes required in the base model are carried forward to the alternatives, whilst the physical network changes required for the alternatives are not impacting on the calibrated and validated base model.

For all alternatives, two different approaches were used for the static and dynamic assignments to ensure the physical changes are modelled accurately:

- **Static assignments:** attributes overrides were used to reduce the capacity of relevant sections along Yonge Street. For the respective sections, the capacity has been reduced from 1,800 PCUs/h (2 lanes of 900 PCUs/h each) to 900 PCUs/h where Yonge St was reduced to one lane in each direction, and to 0.01 PCUs/hr where Yonge St was closed entirely. This was done to reflect the respective capacity of Yonge Street and ensure traffic is re-assigned accordingly in the static assignments. Additionally, University Ave was also reduced by 900 PCUs/hr in both directions between Adelaide St and College St, to reflect the recommendation of cycling facilities on that street, in all alternatives; and
- **Dynamic assignments:** traffic management strategies (turn closures and lane closures) were used to close the required lanes during the hybrid simulation itself. The lane closures matched those of the static assignment capacity adjustments in all cases. Turning movements currently using the center lane have been amended to go from and to the kerbside lane.

Methods of control at affected intersections have been adjusted to cater for the amended traffic conditions. Modifications or bans of turning movements into Yonge Street were required at the signalized intersections between College Street / Carlton Street and Richmond Street in all four alternatives.

For Alternative 2, 3 and 4, bus route 97B has been re-routed from Yonge Street to Church Street, between College Street / Carlton Street in the north and Richmond Street (southbound direction) / Adelaide Street (northbound direction) in the south. Due to the low frequency of this route (once every half hour), should the TTC decide to discontinue the route, or choose a different deviation, the impacts on the model will be negligible.

Results were produced to compare alternatives and identify issues that should be mitigated. At this stage, they do not reflect an optimal and final design. When examining the changes in travel times for individual corridors or transit routes, there is some degree of randomization in the relative results between the alternatives. For instance, small changes in travel times (<10s) are not likely to be indicative of fundamental differences (between alternatives).

8.2 Excluded Seeds

After all 20 runs were completed, the runs were checked for outliers using VKT as a metric, based on the limit of plus or minus two standard deviations. Individual seeds beyond this limit have been excluded from the analysis to not impact on the results. The affected seeds are:

- **Alternative 1:** 5 (AM), 12 (PM), 4 (SAT)
- **Alternative 2:** 11 (AM), 9 (PM), 14 (SAT)
- **Alternative 3:** 10 and 17 (AM), 1 (PM), 6 (SAT)
- **Alternative 4:** 16 (AM), 12 (PM), 18 (SAT)

8.3 Travel Time

8.3.1 AM Peak

Table 8.1: AM General traffic travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Bay St	Richmond St	Grenville St	04:08	04:11	04:29	05:19	05:27	05:08	Grenville St	Richmond St	04:28	04:43	05:17	05:41	05:59	06:04
Yonge St	Richmond St	Wood St	04:31	04:35	06:13	-	-	-	Wood St	Richmond St	04:35	04:57	07:15	-	-	-
Church St	Richmond St	Wood St	04:44	05:15	05:18	05:28	05:26	05:00	Wood St	Richmond St	04:11	05:10	05:22	05:51	06:19	05:19

Table 8.2: AM General traffic travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen St	Bay St	Church St	02:09	02:45	02:48	03:25	03:17	03:17	Church St	Bay St	02:34	02:30	02:50	03:06	01:56	02:56
Dundas St	Bay St	Church St	02:05	03:11	03:04	02:20	02:24	02:28	Church St	Bay St	02:40	03:05	03:09	02:40	03:00	02:44
College	Bay St	Church St	01:54	02:06	02:12	02:04	02:19	02:03	Church St	Bay St	02:24	02:17	02:10	02:11	02:38	02:31

Table 8.3: AM transit travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
University Ave	College St	Davenport Ave	05:55	05:51	05:55	05:50	05:51	05:49	Davenport Ave	College St	06:42	07:12	08:06	08:27	08:15	09:01
Bay St	King St	Avenue Ave	16:40	16:40	16:45	16:53	17:07	16:38	Avenue Ave	King St	16:42	16:34	16:37	17:02	17:32	17:14
Bay St	King St	Davenport Ave	14:16	14:26	14:37	14:46	14:56	14:33	Davenport Ave	King St	15:29	15:37	15:55	16:36	17:17	16:53

Table 8.4: AM transit travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen Street	Bay Street	Church Street	08:08	08:03	07:38	08:01	08:17	08:06	Church St	Bay St	09:20	11:04	11:33	12:00	11:52	13:39
Dundas Street	Bay Street	Church Street	07:31	07:34	07:34	07:24	07:28	07:10	Church St	Bay St	08:14	07:45	07:50	07:47	08:04	07:53
College Street	Bay Street	Church Street	07:55	09:12	09:21	09:39	10:28	10:30	Church St	Bay St	08:02	08:01	07:47	08:01	08:45	08:33

8.3.2 PM Peak

Table 8.5: PM General traffic travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Bay St	Richmond St	Grenville St	04:52	05:24	06:20	08:14	09:36	06:59	Grenville St	Richmond St	04:31	04:39	05:20	05:03	05:07	04:59
Yonge St	Richmond St	Wood St	04:37	04:53	09:15	-	-	-	Wood St	Richmond St	04:39	05:01	07:53	-	-	-
Church St	Richmond St	Wood St	04:48	05:55	05:24	05:31	05:35	05:00	Wood St	Richmond St	04:38	05:15	05:26	05:58	06:45	05:20

Table 8.6: PM General traffic travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen St	Bay St	Church St	02:08	02:16	02:28	02:42	03:02	02:30	Church St	Bay St	01:53	02:04	02:09	02:27	02:56	02:11
Dundas St	Bay St	Church St	04:01	03:41	03:19	02:57	03:23	02:52	Church St	Bay St	03:00	03:50	04:17	04:10	05:30	03:12
College	Bay St	Church St	02:10	02:37	02:29	02:28	02:58	02:23	Church St	Bay St	01:43	02:14	02:02	02:04	02:10	02:04

Table 8.7: PM transit travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
University Ave	College St	Davenport Ave	05:35	05:35	05:33	05:33	05:33	05:32	Davenport Ave	College St	05:01	05:31	05:44	05:49	05:36	05:39
Bay St	King St	Avenue Ave	17:39	17:52	18:14	18:48	19:11	18:22	Avenue Ave	King St	14:47	14:28	14:44	14:53	15:09	14:34
Bay St	King St	Davenport Ave	15:38	15:49	16:31	16:46	17:12	16:20	Davenport Ave	King St	14:12	14:12	14:33	14:17	14:47	14:17

Table 8.8: PM transit travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen Street	Bay Street	Church Street	09:20	07:42	07:50	08:02	08:35	07:56	Church St	Bay St	07:32	07:48	07:35	07:33	08:05	07:35
Dundas Street	Bay Street	Church Street	10:10	08:51	10:39	10:56	11:28	10:31	Church St	Bay St	10:33	10:00	11:08	10:13	11:14	09:22
College Street	Bay Street	Church Street	08:30	09:00	09:20	09:34	09:46	10:25	Church St	Bay St	07:19	07:48	07:46	07:50	08:00	08:00

8.3.3 SAT Peak

Table 8.9: SAT General traffic travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Bay St	Richmond St	Grenville St	03:17	03:26	03:32	04:13	04:31	04:08	Grenville St	Richmond St	03:27	04:02	04:10	05:15	05:12	05:08
Yonge St	Richmond St	Wood St	04:13	04:25	05:36	-	-	-	Wood St	Richmond St	04:47	05:03	06:20	-	-	-
Church St	Richmond St	Wood St	03:48	06:32	06:51	06:07	06:05	06:08	Wood St	Richmond St	04:14	04:37	04:24	04:31	04:24	04:01

Table 8.10: SAT General traffic travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen St	Bay St	Church St	01:59	02:07	02:17	02:22	01:58	02:17	Church St	Bay St	02:12	02:04	02:00	02:14	01:23	02:06
Dundas St	Bay St	Church St	01:49	02:01	02:05	01:38	01:38	01:39	Church St	Bay St	02:29	02:49	02:45	02:22	02:25	02:21
College	Bay St	Church St	01:39	01:47	01:47	01:45	01:44	01:44	Church St	Bay St	01:49	01:45	01:42	01:45	01:57	01:52

Table 8.11: SAT transit travel time comparison (north-south)

Corridor	Northbound								Southbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
University Ave	College St	Davenport Ave	04:05	04:08	04:11	04:11	04:10	04:12	Davenport Ave	College St	04:09	04:13	04:20	04:22	04:25	04:23
Bay St	King St	Avenue Ave	13:36	13:47	13:42	14:22	15:51	14:28	Avenue Ave	King St	13:22	13:31	13:28	13:58	13:52	13:45
Bay St	King St	Davenport Ave	-	-	-	-	-	-	Davenport Ave	King St	-	-	-	-	-	-

Table 8.12: SAT transit travel time comparison (east-west)

Corridor	Eastbound								Westbound							
	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4	Start	End	Base	FB	Alt1	Alt2	Alt3	Alt4
Queen Street	Bay Street	Church Street	05:30	05:36	05:42	05:41	05:36	05:39	Church St	Bay St	06:09	06:40	07:20	07:32	06:29	06:54
Dundas Street	Bay Street	Church Street	05:59	06:00	05:58	05:41	05:41	05:42	Church St	Bay St	06:50	06:48	06:50	06:15	06:11	06:16
College Street	Bay Street	Church Street	06:15	08:16	08:07	07:57	08:02	08:08	Church St	Bay St	07:50	07:50	06:41	06:39	06:45	06:37

Figure 8-2: Travel Time Estimates per Scenario | Weekday AM Peak Hour

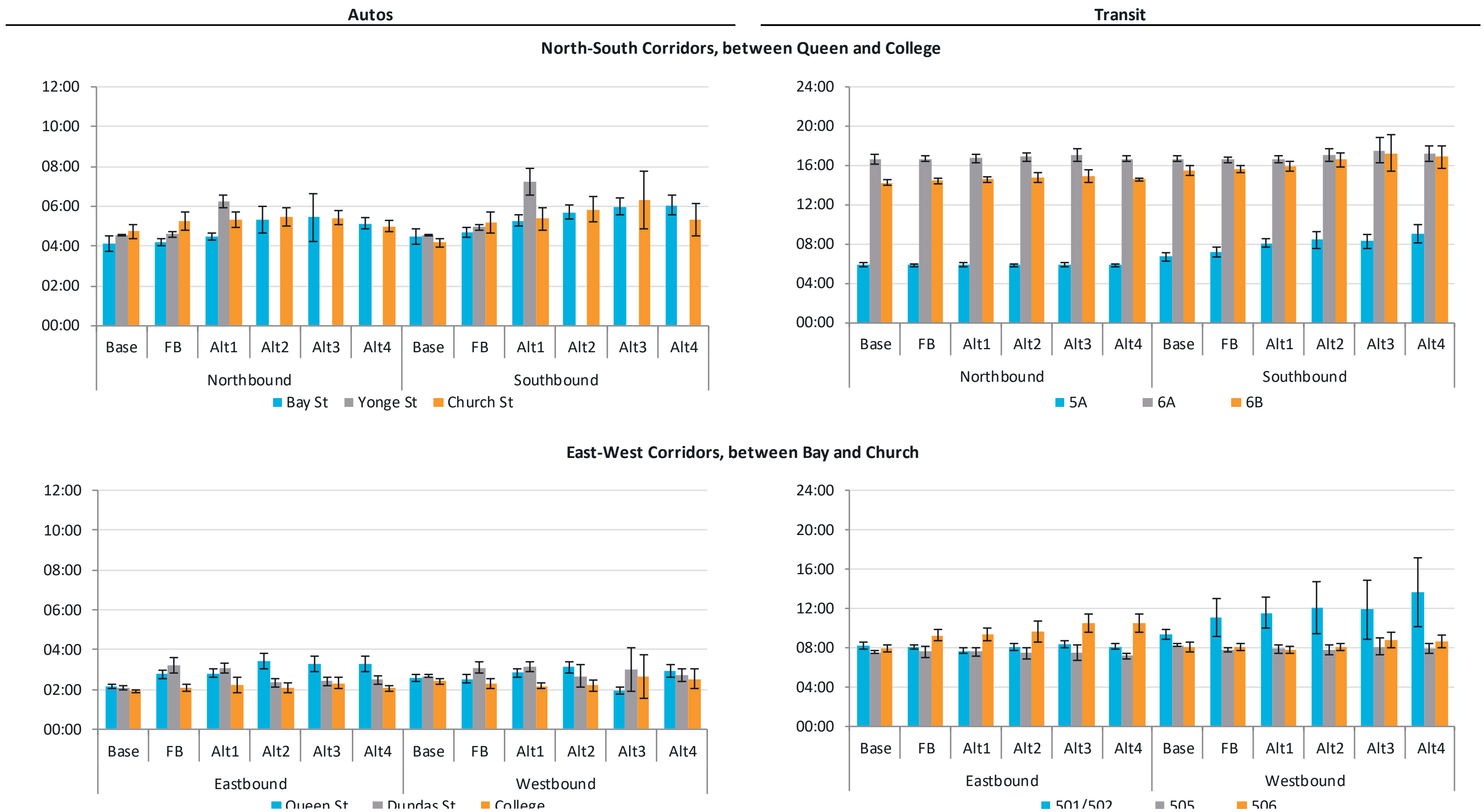


Figure 8-3: Travel Time Estimates per Scenario | Weekday PM Peak Hour

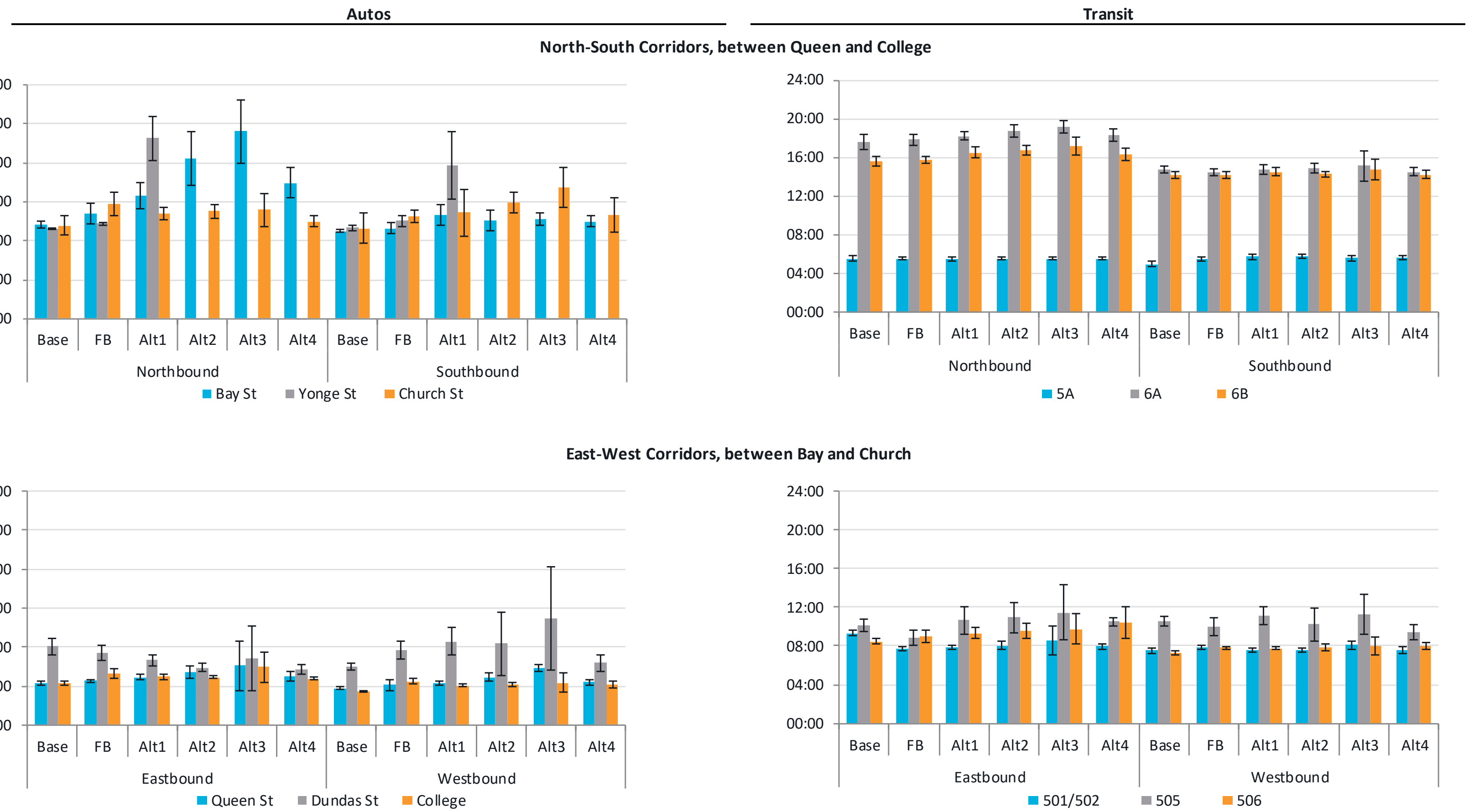


Figure 8-4: Travel Time Estimates per Scenario | Saturday Peak Hour

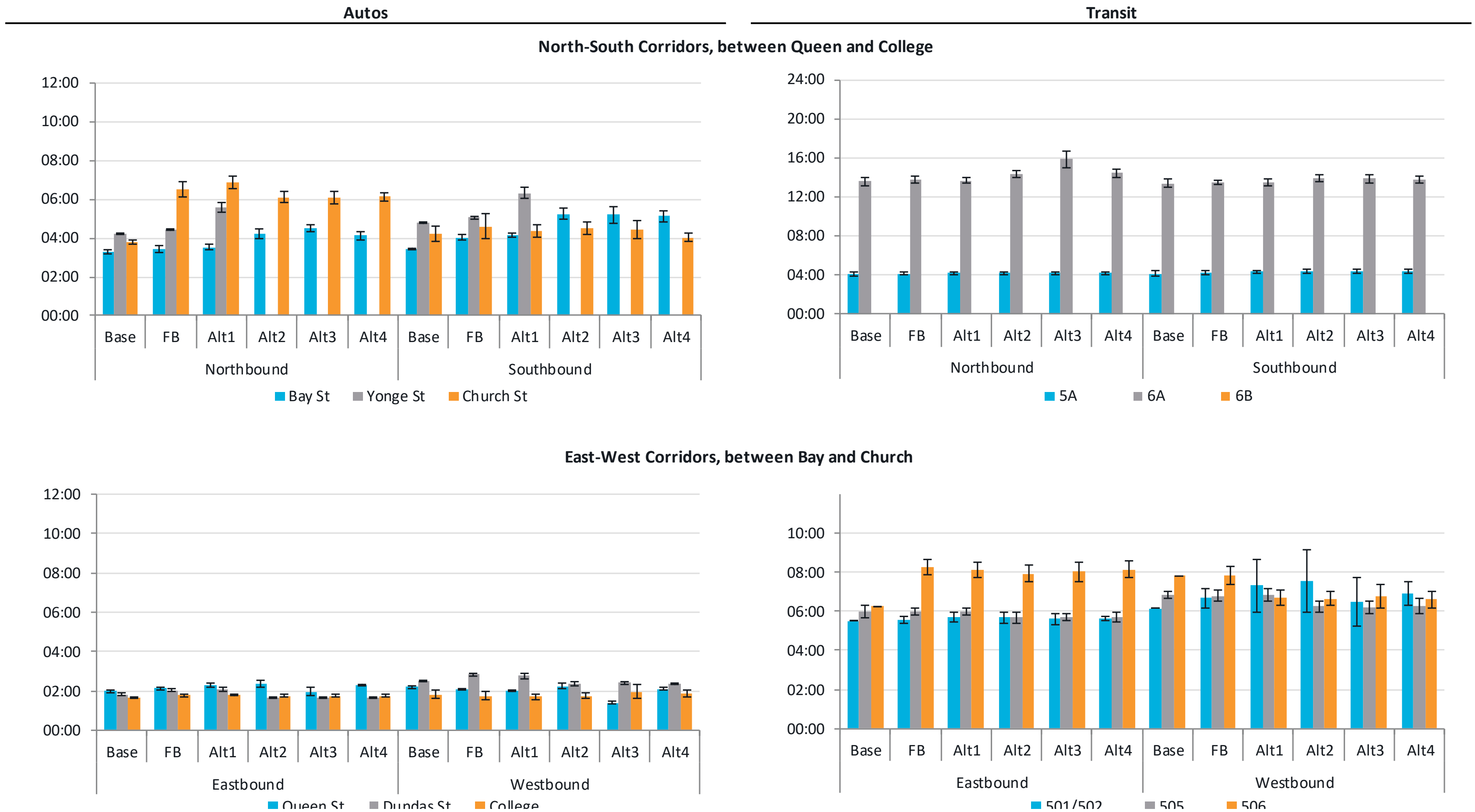
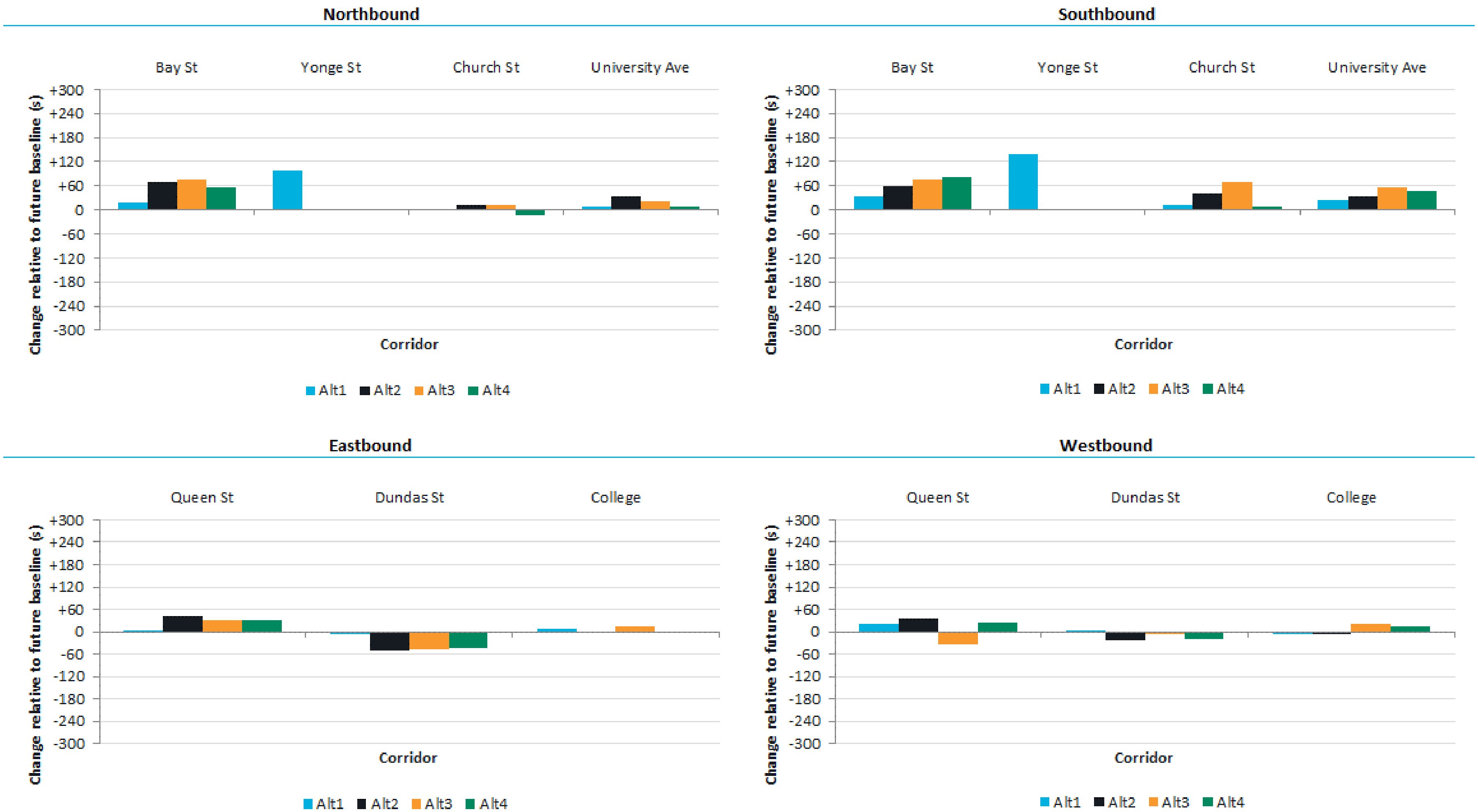


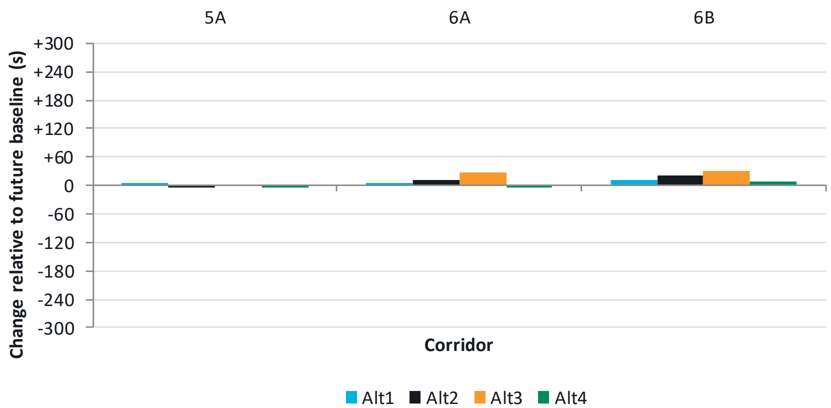
Figure 8-5: Travel Time Difference with Future Baseline - General Traffic | Weekday AM Peak Hour



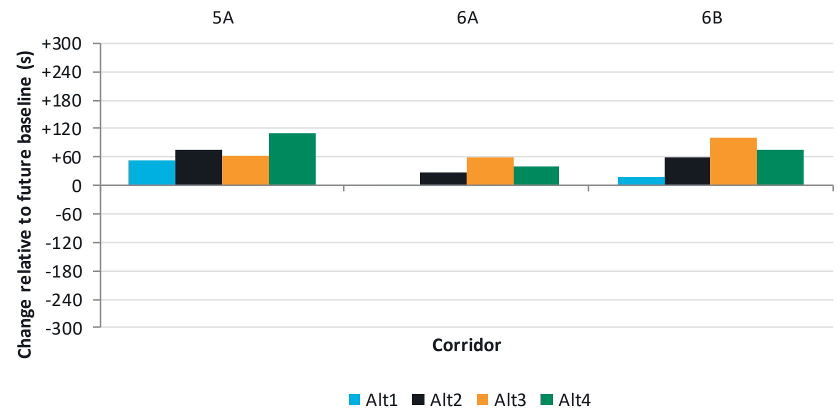
steer

Figure 8-6: Travel Time Difference with Future Baseline - Transit | Weekday AM Peak Hour

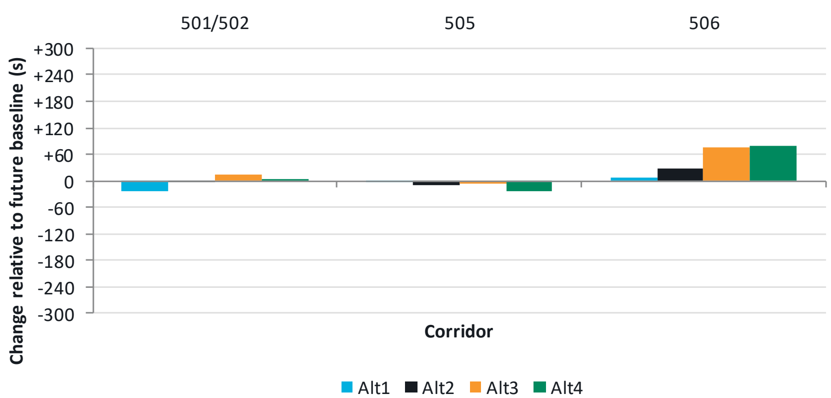
Northbound



Southbound



Eastbound



Westbound

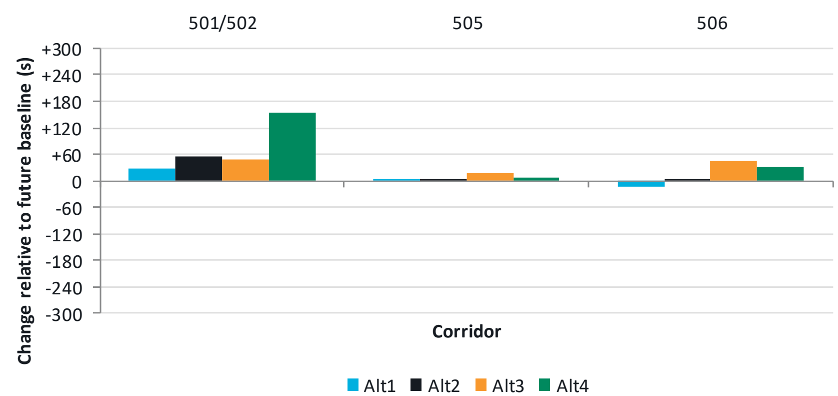


Figure 8-7: Travel Time Difference with Future Baseline - General Traffic | Weekday PM Peak Hour

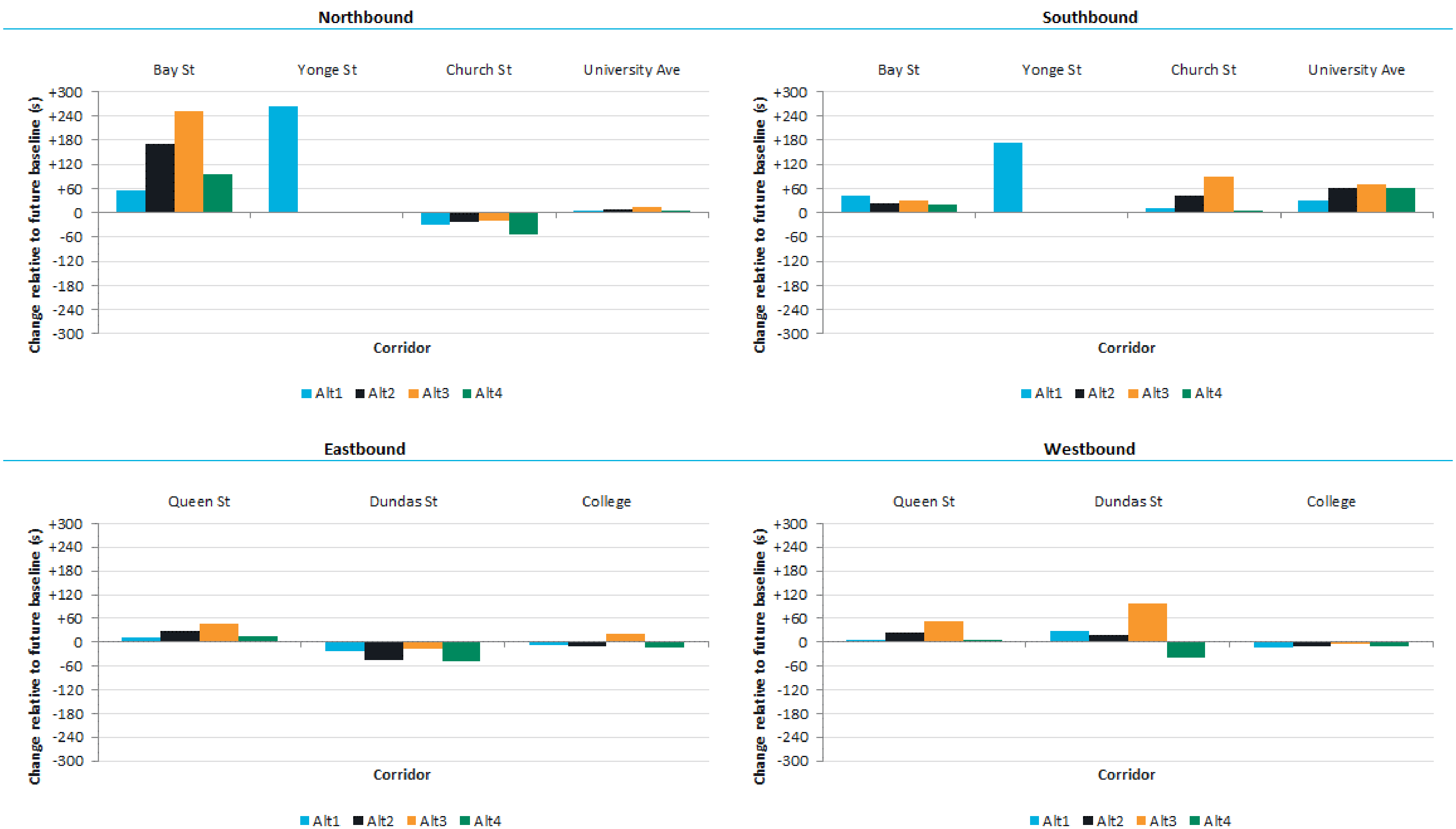


Figure 8-8: Travel Time Difference with Future Baseline - Transit | Weekday PM Peak Hour

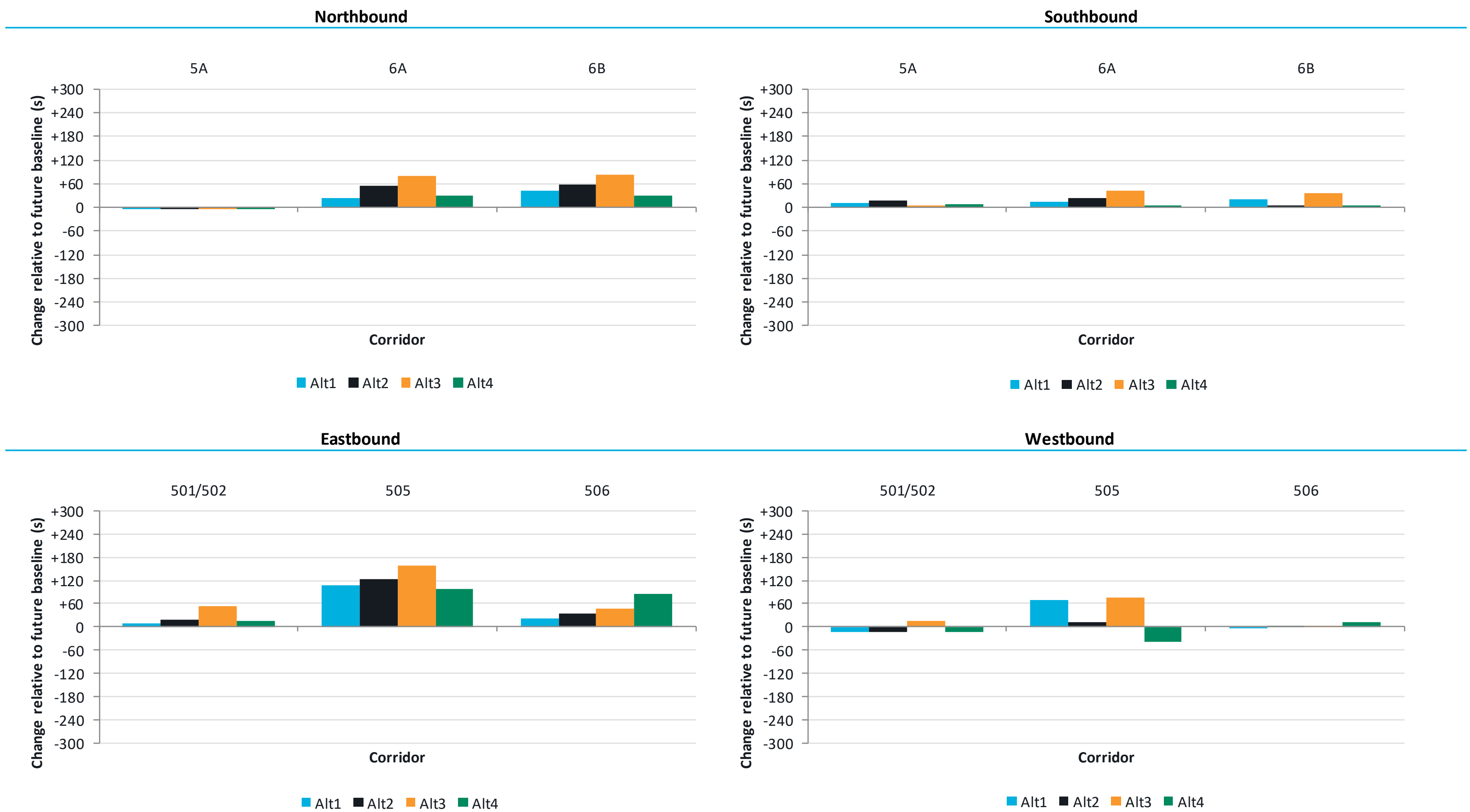


Figure 8-9: Travel Time Difference with Future Baseline - General Traffic | Saturday Peak Hour

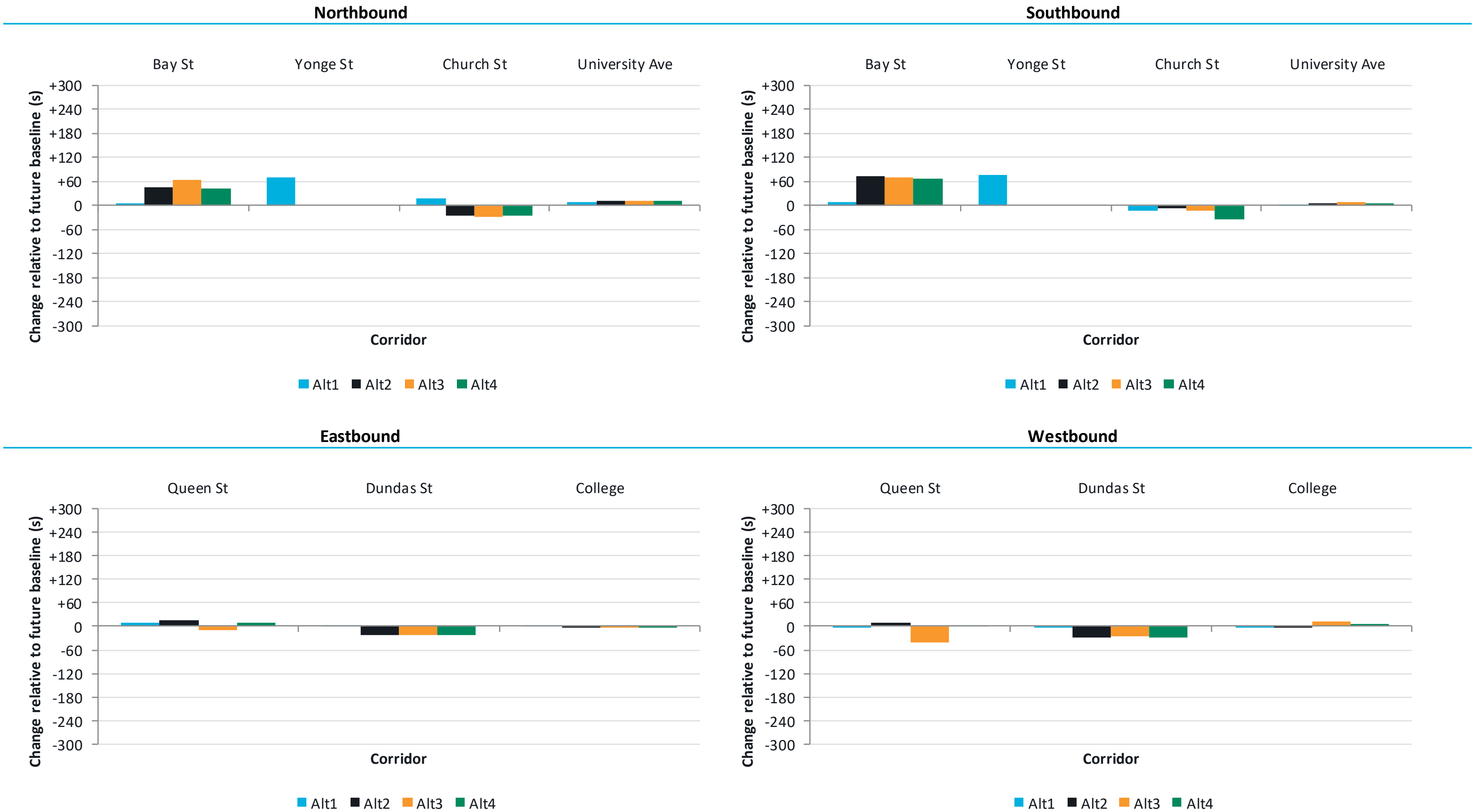
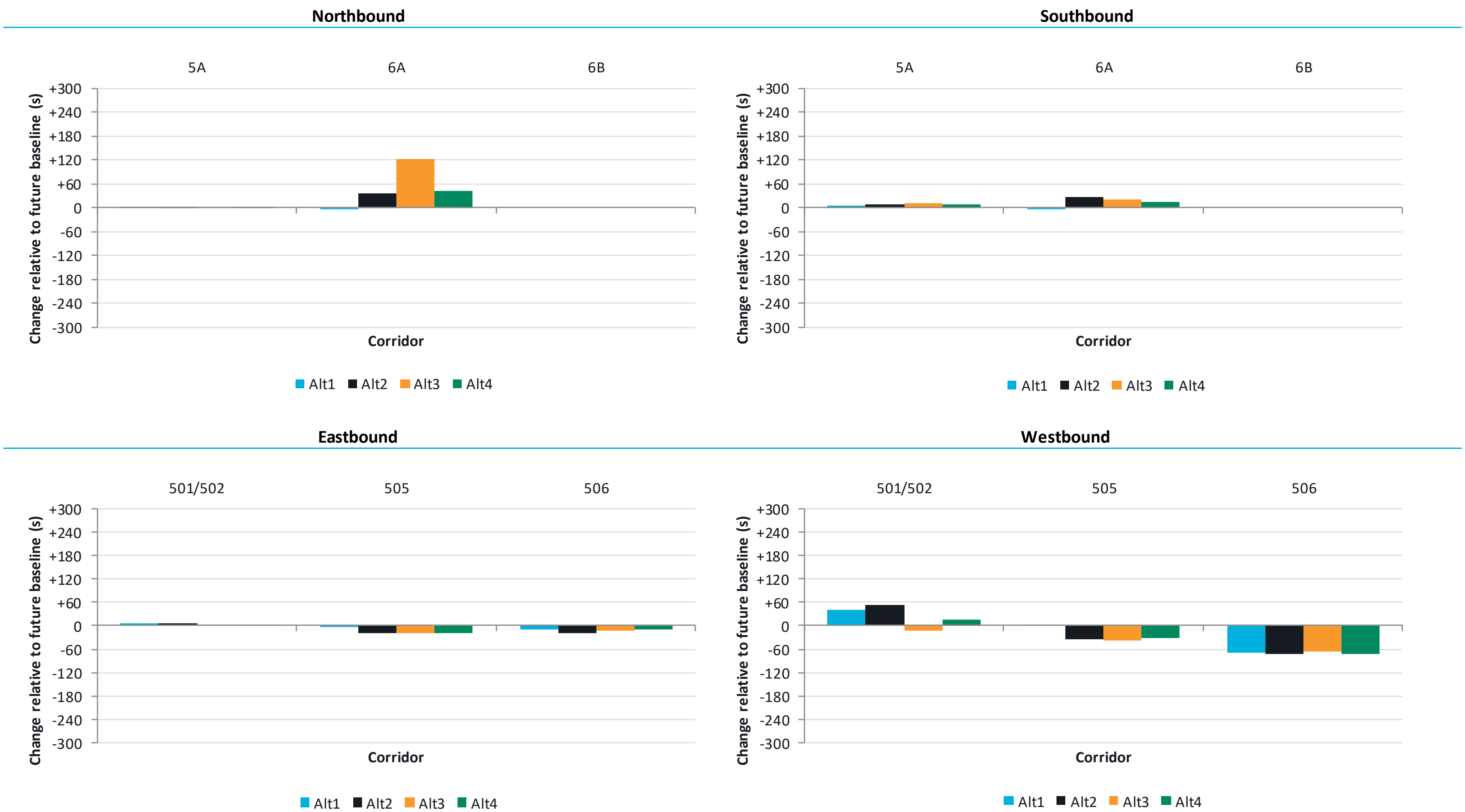


Figure 8-10: Travel Time Difference with Future Baseline - Transit | Saturday Peak Hour



8.4 Queues

8.4.1 AM Peak

Table 8.13: AM queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
68	Bay St	College St	NBT	10	10	10	11	11	11
			SBT	7	7	7	8	7	7
			EBT	6	7	6	6	6	6
			WBT	15	17	18	22	25	24
38	Yonge St	College St	NBT	5	6	4	1	2	2
			SBT	7	8	9	9	10	10
			EBT	8	13	12	9	9	9
			WBT	15	13	12	12	12	12
23	Church St	College St	NBT	8	9	9	9	9	9
			SBT	9	13	13	12	12	13
			EBT	8	9	11	12	13	11
			WBT	15	15	14	14	14	13
67	Bay St	Gerrard St	NBT	4	4	4	4	4	4
			SBT	7	7	7	7	7	7
			EBT	8	8	8	8	8	8
			WBL	5	5	5	5	5	5
			WBT	5	5	5	5	5	5
37	Yonge St	Gerrard St	NBT	6	7	5	0	0	0
			SBT	6	9	7	7	5	3
			EBT	11	13	12	11	10	10
			WBT	8	8	8	8	8	8
22	Church St	Gerrard St	NBT	10	12	11	14	12	12
			SBT	7	9	10	10	11	11
			EBL	3	3	4	4	4	4
			EBT	4	4	4	4	4	4
			WBL	3	3	11	11	11	11
			WBT	18	19	11	11	11	11
66	Bay St	Dundas St	NBT	8	7	9	9	9	9

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			SBT	4	4	4	4	3	4
			EBT	9	13	13	15	16	15
			WBT	9	10	12	18	18	18
36	Yonge St	Dundas St	NBT	7	7	4	0	0	0
			SBT	6	6	3	0	0	0
			EBT	12	18	18	15	16	14
			WBT	12	15	15	14	14	14
21	Church St	Dundas St	NBT	6	6	6	6	6	5
			SBT	10	12	13	14	14	14
			EBT	6	7	7	7	7	7
			WBT	6	6	6	6	6	6
1905	Victoria St	Dundas St	NBT	2	2	2	2	2	2
			SBT	3	3	3	3	3	3
			EBT	6	9	9	14	14	13
			WBT	6	8	8	8	8	8
20	Church St	Shuter St	NBT	6	6	6	6	6	6
			SBT	8	8	9	10	9	10
			EBL	2	2	3	3	3	3
			EBT	3	3	3	3	3	3
			WBL	3	3	3	3	3	3
			WBT	3	3	3	3	3	3
1518	Victoria St	Shuter St	NBT	7	8	11	9	10	11
			SBT	5	7	7	7	8	7
			EBT	6	6	5	6	6	5
			WBT	8	8	8	8	8	8
35	Yonge St	Shuter St	NBT	7	7	6	4	0	7
			SBT	4	5	4	0	0	0
			EBT	5	8	8	5	4	7
			WBL	2	2	3	2	2	3
			WBT	3	3	3	2	2	3
28	Victoria St	Queen St	NBT	6	7	7	6	7	6

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			SBT	3	3	3	3	3	3
			EBT	8	11	12	12	12	12
			WBT	7	7	7	7	7	7
19	Church St	Queen St	NBT	5	5	6	5	6	6
			SBT	14	16	17	19	18	18
			EBT	6	8	9	10	9	9
			WBT	6	6	6	6	6	6
64	Bay St	Queen St	NBT	8	8	8	8	8	8
			SBT	4	4	4	4	4	4
			EBT	7	7	7	7	7	7
			WBT	11	12	10	10	12	10
34	Yonge St	Queen St	NBT	4	4	8	8	0	9
			SBT	7	7	7	0	0	6
			EBT	7	8	10	10	9	10
			WBT	12	12	12	13	11	13

8.4.2 PM Peak

Table 8.14: PM queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
68	Bay St	College St	NBT	11	11	11	11	11	11
			SBT	8	8	9	9	9	9
			EBT	8	8	8	8	8	7
			WBT	9	16	18	20	19	20
38	Yonge St	College St	NBT	6	7	6	2	2	2
			SBT	6	6	8	6	7	6
			EBT	14	16	13	16	22	13
			WBT	8	14	13	13	12	13
23	Church St	College St	NBT	8	9	9	9	10	9
			SBT	12	14	13	13	15	13
			EBT	11	13	13	13	14	12
			WBT	7	11	11	11	13	11
67	Bay St	Gerrard St	NBT	4	4	4	4	4	4
			SBT	7	6	7	6	7	6
			EBT	8	8	8	8	8	8
			WBL	4	5	5	5	5	5
			WBT	5	5	5	5	5	5
37	Yonge St	Gerrard St	NBT	8	11	10	0	0	0
			SBT	6	7	7	6	6	3
			EBT	16	15	15	14	16	14
			WBT	8	8	8	8	8	8
22	Church St	Gerrard St	NBT	10	11	7	12	12	8
			SBT	9	10	11	12	14	12
			EBL	3	2	3	3	4	3
			EBT	4	4	3	3	4	3
			WBL	3	3	11	11	11	11
			WBT	17	18	11	11	11	11
66	Bay St	Dundas St	NBT	10	10	10	10	10	10
			SBT	4	4	4	4	4	4

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			EBT	9	12	16	17	16	15
			WBT	8	12	17	19	20	18
36	Yonge St	Dundas St	NBT	7	8	4	0	0	0
			SBT	6	6	3	0	0	0
			EBT	18	18	18	16	16	16
			WBT	13	16	16	15	16	14
21	Church St	Dundas St	NBT	6	6	6	6	6	5
			SBT	13	13	13	14	14	14
			EBT	7	7	7	7	7	7
			WBT	6	6	6	6	6	6
1905	Victoria St	Dundas St	NBT	2	2	2	2	3	2
			SBT	4	4	3	5	5	3
			EBT	9	13	13	15	16	15
			WBT	6	8	8	8	8	8
20	Church St	Shuter St	NBT	6	6	6	6	6	6
			SBT	8	9	9	10	11	11
			EBL	3	3	3	3	3	3
			EBT	3	3	3	3	3	3
			WBL	3	3	3	3	3	3
			WBT	3	3	3	3	3	3
1518	Victoria St	Shuter St	NBT	10	11	12	9	13	11
			SBT	7	8	6	7	9	6
			EBT	7	7	6	6	7	6
			WBT	8	8	8	8	8	8
35	Yonge St	Shuter St	NBT	8	9	5	3	0	6
			SBT	6	6	4	0	0	0
			EBT	64	57	54	85	73	15
			WBL	2	2	3	1	1	3
			WBT	3	3	3	1	1	3
28	Victoria St	Queen St	NBT	7	6	7	6	7	7
			SBT	3	3	3	3	3	3

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			EBT	12	12	13	13	12	13
			WBT	7	7	7	7	7	7
19	Church St	Queen St	NBT	5	6	6	6	6	6
			SBT	13	16	14	18	16	17
			EBT	10	10	10	10	10	10
			WBT	5	5	5	5	5	5
64	Bay St	Queen St	NBT	7	7	7	8	8	8
			SBT	4	4	4	4	4	4
			EBT	7	7	7	7	7	7
			WBT	7	8	8	10	8	8
34	Yonge St	Queen St	NBT	4	5	9	9	0	10
			SBT	7	6	7	0	0	7
			EBT	10	10	10	10	10	10
			WBT	10	11	10	12	13	11

8.4.3 SAT Peak

Table 8.15: SAT queue length comparison

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
68	Bay St	College St	NBT	12	12	12	13	13	13
			SBT	9	9	9	9	10	9
			EBT	5	6	6	6	6	6
			WBT	8	8	8	9	11	10
38	Yonge St	College St	NBT	2	3	2	2	1	1
			SBT	6	8	7	7	5	7
			EBT	7	9	8	8	8	8
			WBT	4	6	5	6	6	6
23	Church St	College St	NBT	6	6	6	7	7	7
			SBT	6	6	6	7	6	7
			EBT	6	8	9	9	7	9
			WBT	5	8	8	7	7	6
67	Bay St	Gerrard St	NBT	4	4	5	5	5	5
			SBT	7	7	8	9	10	9
			EBT	7	5	6	6	6	6
			WBL	5	4	5	5	5	5
			WBT	5	5	5	5	5	5
37	Yonge St	Gerrard St	NBT	5	7	5	0	0	0
			SBT	5	6	6	5	7	4
			EBT	10	9	8	8	8	9
			WBT	8	8	8	8	8	8
22	Church St	Gerrard St	NBT	7	7	6	8	7	7
			SBT	7	7	7	8	8	8
			EBL	2	2	3	3	3	3
			EBT	4	4	3	3	3	3
			WBL	3	3	8	8	9	8
			WBT	10	11	8	8	9	8
66	Bay St	Dundas St	NBT	7	8	9	9	9	9
			SBT	6	7	7	7	7	7

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			EBT	6	9	10	16	16	17
			WBT	8	10	9	13	14	13
36	Yonge St	Dundas St	NBT	7	8	4	0	0	0
			SBT	6	6	3	0	0	0
			EBT	9	13	15	13	12	13
			WBT	10	13	13	13	14	13
21	Church St	Dundas St	NBT	5	5	5	5	5	5
			SBT	10	10	10	11	10	10
			EBT	7	7	7	7	7	7
			WBT	5	5	5	6	6	6
1905	Victoria St	Dundas St	NBT	2	2	2	2	2	2
			SBT	3	3	3	3	3	3
			EBT	4	5	6	11	11	11
			WBT	6	7	7	7	8	7
20	Church St	Shuter St	NBT	5	4	4	5	5	4
			SBT	6	6	6	7	7	7
			EBL	1	2	3	3	3	3
			EBT	3	3	3	3	3	3
			WBL	3	3	3	3	3	3
			WBT	3	3	3	3	3	3
1518	Victoria St	Shuter St	NBT	5	8	7	8	9	8
			SBT	4	4	4	5	6	6
			EBT	6	6	5	6	5	5
			WBT	8	7	8	8	8	8
35	Yonge St	Shuter St	NBT	8	11	7	2	0	5
			SBT	5	5	3	0	0	0
			EBT	6	5	5	5	4	5
			WBL	0	2	2	2	2	2
			WBT	3	3	2	2	2	2
28	Victoria St	Queen St	NBT	7	7	7	7	7	7
			SBT	3	3	3	3	3	2

TCS #	Street 1	Street 2	Direction	Base	FB	Alt1	Alt2	Alt3	Alt4
			EBT	7	8	11	10	11	10
			WBT	6	6	6	7	7	7
19	Church St	Queen St	NBT	5	6	6	6	6	6
			SBT	7	11	9	11	9	10
			EBT	6	7	8	8	7	8
			WBT	5	6	6	6	6	6
64	Bay St	Queen St	NBT	8	11	10	11	12	12
			SBT	7	7	7	7	7	7
			EBT	7	7	7	7	7	7
			WBT	5	6	6	10	7	9
34	Yonge St	Queen St	NBT	7	9	8	8	0	9
			SBT	4	5	4	0	0	2
			EBT	9	9	10	10	6	10
			WBT	10	8	8	10	8	9

8.5 Network Wide Performance

8.5.1 AM Peak

Table 8.16: AM network wide performance comparison

Measure	Base	FB	Alt1	Alt2	Alt3	Alt4
Delay Time - SOV Compliant (sec/km)	82	96	110	116	128	118
Density - SOV Compliant (veh/km)	8	9	10	10	11	10
Flow - SOV Compliant (veh/h)	34119	35378	35040	35110	33988	35089
Input Flow - SOV Compliant (veh/h)	34846	36505	36534	36730	36486	36735
Mean Virtual Queue - SOV Compliant (veh)	4	10	85	163	217	141
Mean Virtual Queue - MediumTrucks (veh)	0	0	1	3	5	2
Mean Virtual Queue - Bus (veh)	0	0	0	0	0	0
Mean Virtual Queue - Pedestrian (veh)	2836	7193	7222	9386	9415	9287
Mean Virtual Queue - Bicycles (veh)	0	0	0	0	0	0
Missed Turns - SOV Compliant (veh)	51	54	66	73	78	99
Stop Time - SOV Compliant (veh)	26	35	37	38	37	37
Total Distance Travelled - SOV Compliant (km)	51268	55330	54264	54738	52805	54647
Total Travel Time (Vehicles Inside) - SOV Compliant (h)	144	225	301	345	531	339
Travel Time - SOV Compliant (sec/km)	167	181	195	200	212	203
Vehicles Lost Inside - All (veh)	0	0	0	0	0	0

8.5.2 PM Peak

Table 8.17: PM network wide performance comparison

Measure	Base	FB	Alt1	Alt2	Alt3	Alt4
Delay Time - SOV Compliant (sec/km)	88	101	114	114	123	113
Density - SOV Compliant (veh/km)	8	10	10	11	13	10
Flow - SOV Compliant (veh/h)	35993	36970	36940	35653	33058	37325
Input Flow - SOV Compliant (veh/h)	36841	38245	38611	38345	37305	39080
Mean Virtual Queue - SOV Compliant (veh)	14	55	126	291	540	130
Mean Virtual Queue - MediumTrucks (veh)	0	0	1	2	3	1
Mean Virtual Queue - Bus (veh)	0	0	0	0	0	0
Mean Virtual Queue - Pedestrian (veh)	1521	3622	3595	13446	16103	14793
Mean Virtual Queue - Bicycles (veh)	0	0	0	1	0	0
Missed Turns - SOV Compliant (veh)	73	79	86	70	70	77
Stop Time - SOV Compliant (veh)	34	40	43	42	46	37
Total Distance Travelled - SOV Compliant (km)	53135	57280	56567	54449	50008	57131
Total Travel Time (Vehicles Inside) - SOV Compliant (h)	182	280	363	639	1051	369
Travel Time - SOV Compliant (sec/km)	174	186	199	199	208	198
Vehicles Lost Inside - All (veh)	0	0	0	0	0	0

8.5.3 SAT Peak

Table 8.18: SAT network wide performance comparison

Measure	Base	FB	Alt1	Alt2	Alt3	Alt4
Delay Time - SOV Compliant (sec/km)	74	89	94	95	101	97
Density - SOV Compliant (veh/km)	5	6	6	7	7	7
Flow - SOV Compliant (veh/h)	24245	25360	25009	25327	25050	25325
Input Flow - SOV Compliant (veh/h)	24694	25870	25654	26122	26017	26069
Mean Virtual Queue - SOV Compliant (veh)	45	365	336	183	238	238
Mean Virtual Queue - MediumTrucks (veh)	0	0	0	1	0	0
Mean Virtual Queue - Bus (veh)	0	0	0	0	0	0
Mean Virtual Queue - Pedestrian (veh)	564	1282	1279	3503	3508	3515
Mean Virtual Queue - Bicycles (veh)	0	0	0	0	0	0
Missed Turns - SOV Compliant (veh)	30	33	35	32	26	31
Stop Time - SOV Compliant (veh)	23	27	28	31	32	30
Total Distance Travelled - SOV Compliant (km)	39268	41118	40671	41635	41355	41665
Total Travel Time (Vehicles Inside) - SOV Compliant (h)	100	132	158	175	211	163
Travel Time - SOV Compliant (sec/km)	160	174	179	180	186	181
Vehicles Lost Inside - All (veh)	0	0	0	0	0	0

8.6 Delays

8.6.1 AM Peak

Table 8.19: AM intersection delay comparison

			AM Peak Hour Average Approach Delay (s)					
TCS #	**Street 1**	**Street 2**	**Base**	**FB**	**Alt1**	**Alt2**	**Alt3**	**Alt4**
34	Yonge St	Queen St	19	18	24	21	13	22
36	Yonge St	Dundas St	25	30	29	23	24	23
37	Yonge St	Gerrard St	22	22	22	23	23	21
38	Yonge St	College St	23	22	23	22	23	24
64	Bay St	Queen St	24	25	23	24	25	24
66	Bay St	Dundas St	21	21	23	27	28	26
67	Bay St	Gerrard St	23	23	25	26	27	25
68	Bay St	College St	23	23	22	25	28	27
19	Church St	Queen St	26	31	33	34	35	34
21	Church St	Dundas St	24	26	27	30	31	26
22	Church St	Gerrard St	23	29	27	31	30	29
23	Church St	College St	26	29	27	28	28	26

8.6.2 PM Peak

Table 8.20: PM intersection delay comparison

			AM Peak Hour Average Approach Delay (s)					
TCS #	Street 1	Street 2	Base	FB	Alt1	Alt2	Alt3	Alt4
34	Yonge St	Queen St	18	18	23	23	16	26
36	Yonge St	Dundas St	26	26	24	29	30	25
37	Yonge St	Gerrard St	19	20	25	21	29	20
38	Yonge St	College St	21	22	22	25	27	25
64	Bay St	Queen St	22	22	23	24	26	23
66	Bay St	Dundas St	23	23	29	31	33	28
67	Bay St	Gerrard St	22	23	25	25	26	24
68	Bay St	College St	23	23	23	24	25	24
19	Church St	Queen St	24	26	25	25	25	26
21	Church St	Dundas St	28	28	28	31	30	24
22	Church St	Gerrard St	24	24	22	26	37	22
23	Church St	College St	23	30	29	28	33	27

8.6.3 SAT Peak

Table 8.21: SAT intersection delay comparison

			AM Peak Hour Average Approach Delay (s)					
TCS #	Street 1	Street 2	Base	FB	Alt1	Alt2	Alt3	Alt4
34	Yonge St	Queen St	19	18	21	22	11	23
36	Yonge St	Dundas St	26	27	27	29	29	29
37	Yonge St	Gerrard St	16	16	16	15	22	17
38	Yonge St	College St	18	16	17	18	17	18
64	Bay St	Queen St	21	23	22	26	27	25
66	Bay St	Dundas St	19	27	27	31	32	31
67	Bay St	Gerrard St	19	18	18	18	21	20
68	Bay St	College St	21	21	21	21	22	21
19	Church St	Queen St	18	26	27	27	27	27
21	Church St	Dundas St	23	24	23	24	22	21
22	Church St	Gerrard St	18	19	19	19	21	19
23	Church St	College St	18	20	20	20	19	19

Analysis of Results

Network Results

1. All of the alternatives generally result in a worsening of network performance compared to the future baseline, which is to be expected from a reduction in downtown vehicular traffic capacity.
2. Alternative 3 performs significantly worse at the network level when compared to the other options, in all three peak hours. This indicates significant congestion and gridlock in the model due to the full Yonge Street closure.
3. Results indicate that permitting a right turn southbound out of the Eaton Centre Shuter Street garage would be beneficial to network performance as it reduces strain on Shuter Street and better utilizes the open segments on Yonge Street in alternatives 1 and 4. Poor network performance in alternatives 2 and 3 is partially caused by this restriction due to the Yonge Street closure.

General Traffic

4. For general traffic, impacts to northbound and southbound travel times are generally greater, and more noticeable than impacts on eastbound and westbound travel times.
5. Impacts to northbound (NB) movement on Bay Street in the PM is particularly high, with increases of over a minute in all alternatives except Alternative 1. Other increases above one minute occur on Bay Street NB in the AM, and Bay Street SB in the AM. This indicates that Bay Street is particularly sensitive to changes on Yonge Street. Similar impacts can be seen on Bay St during the Saturday peak hour, albeit at a smaller magnitude of change, with Bay St seeing up to 60 seconds of increased travel time in both directions.
6. Impacts to Church Street are more moderate than Bay Street across all four alternatives, in the AM, PM and Saturday peak hours, though the street still sees substantial increases in travel times southbound in both AM and PM in alternatives 2 and 3. This indicates that vehicles are choosing Bay Street over Church Street as an alternative route to Yonge Street, and a more optimal solution that encourages more traffic to switch to Church Street would be beneficial.
7. Results on Yonge Street are limited to Alternative 1 as through-traffic is restricted in alternatives 2, 3 and 4. Alternative 1 sees a substantial increase in travel time (over a minute) in both directions, in the AM, PM and Saturday peak hours. This occurs due to the lane reduction on the street and turning vehicles that cause significant queues.
8. In the AM, travel times on Dundas Street decrease by up to 1 minute in alternatives 2, 3 and 4 in both directions, due to reduced cycle length at the Yonge & Dundas intersection. Alternative 1 sees no change as the cycle length remains unchanged. In the PM peak hour however, westbound traffic sees moderate to significant delays (except in Alternative 4) because of a backup of traffic turning northbound onto Chestnut Street. This backup is caused by congestion on Bay Street, which propagates onto side streets. In the Saturday peak hour, Dundas sees a small reduction of travel time (less than 30 seconds) in both directions in all four alternatives, except in Alternative 1 which sees a negligible increase in travel time in the eastbound direction.

9. Minimal impacts to travel times are observed on College Street in both directions, during the AM, PM and Saturday peak hours.

10. Moderate impacts to travel times on Queen Street are observed in both directions during both the AM and PM peak hours, most notably in alternatives 2 and 3. This is partially be attributed to relaxed turning restrictions at the Yonge & Queen intersection, as cars deviate around the Yonge Street closure. The impacts to Queen St during the Saturday peak hour are largely negligible.

Transit

11. Impacts to the 501/502 routes are not significant in the eastbound direction in the AM, PM and Saturday peak hours, except Alternative 3 in the PM, caused by general network congestion in the model. In the PM, impacts to the routes are not significant in the westbound direction either. However, in the AM, the streetcars face moderate increases in travel time (up to a minute) in alternatives 1 to 3, and a significant increase in Alternative 4 (over two minutes).

12. Minimal impacts are observed to the 505 streetcar in both directions during the AM peak hour. Significant impacts are observed in the PM due to a high volume of turning traffic at Dundas and Chestnut Street. The 505 sees a small reduction in travel time (30-45 seconds) in both directions in Alternatives 2, 3 and 4 in the Saturday peak hour; the route is not materially impacted in Alternative 1.

13. Minimal impacts are observed to the 506 streetcar in the westbound direction in both peak hour. Most substantial increases are eastbound in both AM and PM peak hours due to turning vehicles at College and Elizabeth. In the Saturday peak hour, the 506 sees over a minute of reduced travel time westbound and a small to negligible decrease in travel time westbound.

14. Bay Street routes (6A and 6B) do not feel the full effect of increased congestion on Bay Street due to the dedicated bus lane. However, since traffic can use the lane when turning, TTC bus travel times do increase on Bay Street, especially southbound in the AM peak hour and northbound in the PM peak hour. The impact is felt most in Alternative 3 due to the high level of congestion in that model.

The problems mentioned above are generally caused by turning vehicles that generate queues because they have difficulty finding the time gap to perform their maneuvers. This could be resolved by the implementation of mitigation measures such a turning restrictions or optimization of traffic signal.

9 Conclusions

Aimsun Next hybrid micro-meso traffic simulation models have been set up to enable a high-level comparison of various proposed concept designs for Phase 1 of the Yonge Street corridor between Queen Street in the south and College Street / Carlton Street in the north.

The 2018 base model for AM and PM weekday peak hours, and a Saturday peak hour has been calibrated and validated against turning counts and travel time information obtained from the City of Toronto. Subsequently, a Do-Nothing future conditions model and two proposed alternative solutions have been modelled and compared against outputs from the base case to inform decisions about potential changes to the layout of Yonge Street.

Traversal matrices developed based on the City of Toronto's (City) GTA V4.0 EMME demand model were used to obtain base origin destination matrices. Additional data sets used for calibration and validation include traffic counts, Streetlight location-based data, travel times and queues.

The overall study area forming the extent of the mesoscopic model area is formed by:

- Roxborough Street / Crescent Avenue in the north;
- Mount Pleasant Road / Jarvis Street in the east;
- King Street in the south; and
- University Avenue / Queens Park / Avenue Road in the west.

The more detailed focus area for the microscopic simulation is bound by:

- College Street / Carlton Street in the north;
- Church Street in the east;
- Queen Street in the south; and
- Bay Street in the west.

The results show that the 2018 base case models calibrate and validate to a high standard, particularly considering the large model area and that data inputs ranged from 2008 to 2018 and therefore needed a significant amount of processing.

The results of the Do-Nothing future conditions models and the initial high-level analysis of the two alternatives indicate that the traffic demand is expected to increase by roughly 5% during the AM and PM peak hours and about 7% during the Saturday peak hour.

The current modelling work of the four alternatives indicates that a closure of Yonge St would not have a significant impact on overall vehicular traffic in the study area, but would cause increased localized congestion along Bay St, and would have a material impact on certain TTC routes.

Further optimization is required to mitigate potential conflicts identified by this work, and to reflect the final proposed design.

For any further analysis, the following items may need further investigation to confirm details of the proposed alternative(s):

- Potential turning restrictions or provision of turning lanes into side roads along Yonge Street for Alternative 1 to avoid turning vehicles blocking traffic;
- Location and types of bus stops along Yonge Street for Alternative 1 or off-peak service in Alternatives 2, 3 and 4;
- Operation of bus route 97B which is currently travelling along Yonge Street, particularly for alternatives pedestrianizing Yonge Street;
- Development-specific considerations such as the Chelsea Hotel redevelopment and the linking of Bay Street to Yonge St via Walton St;
- Impact of the proposed Ontario Line on traffic for each mode within the study area;
- Final lane configuration and allowed turns in the final design, as well as allowed speed and access exceptions.

A Base Model: Turns with GEH > 5

A1 AM Peak

Table 9.1: AM turns with GEH > 5

TCS #	Intersection	Turn	Observed	Modelled	GEH
19	CHURCH ST AT QUEEN ST	EBL	59	0	10.8
19	CHURCH ST AT QUEEN ST	NBR	38	121	9.3
19	CHURCH ST AT QUEEN ST	SBL	24	5	5.0
19	CHURCH ST AT QUEEN ST	SBR	64	11	8.7
19	CHURCH ST AT QUEEN ST	WBR	28	0	7.5
20	CHURCH ST AT SHUTER ST	EBR	40	7	6.7
20	CHURCH ST AT SHUTER ST	NBL	48	12	6.6
20	CHURCH ST AT SHUTER ST	NBT	350	236	6.7
20	CHURCH ST AT SHUTER ST	SBT	353	265	5.0
20	CHURCH ST AT SHUTER ST	WBL	63	201	12.0
21	CHURCH ST AT DUNDAS ST	NBT	350	256	5.4
22	CHURCH ST AT GERRARD ST	SBT	405	296	5.8
22	CHURCH ST AT GERRARD ST	WBR	71	177	9.5
23	CARLTON ST AT CHURCH ST	EBL	45	4	8.4
23	CARLTON ST AT CHURCH ST	EBT	352	234	6.9
23	CARLTON ST AT CHURCH ST	NBR	47	12	6.5
23	CARLTON ST AT CHURCH ST	NBT	330	491	7.9
23	CARLTON ST AT CHURCH ST	SBR	68	0	11.6
35	SHUTER ST AT YONGE ST	EBT	18	98	10.5
35	SHUTER ST AT YONGE ST	WBR	68	19	7.5
37	GERRARD ST AT YONGE ST	NBL	2	34	7.6
37	GERRARD ST AT YONGE ST	NBR	32	69	5.2
37	GERRARD ST AT YONGE ST	WBR	25	3	5.7
38	CARLTON ST AT COLLEGE ST AND YONGE ST	EBT	392	298	5.1
38	CARLTON ST AT COLLEGE ST AND YONGE ST	SBR	51	9	7.8

TCS #	Intersection	Turn	Observed	Modelled	GEH
64	QUEEN ST AT BAY ST	WBR	87	6	11.8
66	BAY ST AT DUNDAS ST	EBR	103	170	5.7
66	BAY ST AT DUNDAS ST	SBR	84	7	11.5
67	BAY ST AT GERRARD ST	EBT	267	191	5.0
67	BAY ST AT GERRARD ST	NBR	130	59	7.3
67	BAY ST AT GERRARD ST	SBR	97	31	8.2
67	BAY ST AT GERRARD ST	WBR	83	8	11.2
68	BAY ST AT COLLEGE ST	EBT	399	288	6.0
68	BAY ST AT COLLEGE ST	WBR	53	0	10.3
909	GOULD ST AT YONGE ST	NBR	7	43	7.2
909	GOULD ST AT YONGE ST	WBL	6	75	10.9
909	GOULD ST AT YONGE ST	WBR	12	53	7.2
913	BAY ST AT ELM ST	EBR	32	8	5.3
913	BAY ST AT ELM ST	EBT	91	49	5.0
913	BAY ST AT ELM ST	SBT	666	512	6.3
913	BAY ST AT ELM ST	WBR	41	8	6.5
993	CHURCH ST AT GOULD ST	EBR	23	2	6.1
993	CHURCH ST AT GOULD ST	NBR	0	17	5.8
993	CHURCH ST AT GOULD ST	SBT	402	289	6.1
993	CHURCH ST AT GOULD ST	WBR	51	95	5.1
1478	BAY ST AT 12M N OF HAGERMAN	SBT	577	426	6.7
2035	CARLTON ST AT 108M W OF CHURCH ST AND MAPLE LEAF GDNS	EBT	398	301	5.2

Figure 9-1: AM turns with GEH > 5

Blue: modelled flow lower than observed

Red: modelled flow higher than observed

A2 PM Peak

Table 9.2: PM turns with GEH > 5

TCS #	Intersection	Turn	Observed	Modelled	GEH
19	CHURCH ST AT QUEEN ST	EBL	60	0	11.0
19	CHURCH ST AT QUEEN ST	SBL	60	6	9.4
19	CHURCH ST AT QUEEN ST	SBR	52	10	7.6
19	CHURCH ST AT QUEEN ST	WBL	31	0	7.9
19	CHURCH ST AT QUEEN ST	WBR	39	0	8.8
20	CHURCH ST AT SHUTER ST	EBR	32	2	7.4
20	CHURCH ST AT SHUTER ST	NBT	363	250	6.4
20	CHURCH ST AT SHUTER ST	WBL	30	152	12.8
21	CHURCH ST AT DUNDAS ST	EBR	66	20	7.1
21	CHURCH ST AT DUNDAS ST	SBT	534	350	8.7
22	CHURCH ST AT GERRARD ST	WBR	69	173	9.4
23	CARLTON ST AT CHURCH ST	EBT	641	415	9.8
23	CARLTON ST AT CHURCH ST	NBR	90	25	8.5
23	CARLTON ST AT CHURCH ST	NBT	373	582	9.5
23	CARLTON ST AT CHURCH ST	SBR	60	1	10.6
23	CARLTON ST AT CHURCH ST	WBR	59	108	5.4
34	QUEEN ST AT YONGE ST	SBT	174	282	7.1
35	SHUTER ST AT YONGE ST	WBL	53	19	5.7
35	SHUTER ST AT YONGE ST	WBT	43	84	5.2
37	GERRARD ST AT YONGE ST	NBL	0	20	6.4
37	GERRARD ST AT YONGE ST	WBR	42	1	8.8
38	CARLTON ST AT COLLEGE ST AND YONGE ST	EBR	64	7	9.6
38	CARLTON ST AT COLLEGE ST AND YONGE ST	EBT	650	480	7.1
38	CARLTON ST AT COLLEGE ST AND YONGE ST	NBR	46	4	8.5
38	CARLTON ST AT COLLEGE ST AND YONGE ST	WBT	402	267	7.4
64	QUEEN ST AT BAY ST	NBT	506	385	5.7
64	QUEEN ST AT BAY ST	WBR	48	17	5.5

TCS #	Intersection	Turn	Observed	Modelled	GEH
65	ALBERT ST AT BAY ST	WBL	37	90	6.6
66	BAY ST AT DUNDAS ST	EBR	42	140	10.3
66	BAY ST AT DUNDAS ST	SBR	86	7	11.6
67	BAY ST AT GERRARD ST	EBT	297	188	7.0
67	BAY ST AT GERRARD ST	NBR	208	104	8.3
67	BAY ST AT GERRARD ST	NBT	886	718	5.9
67	BAY ST AT GERRARD ST	SBR	105	29	9.2
67	BAY ST AT GERRARD ST	WBR	101	11	12.0
68	BAY ST AT COLLEGE ST	EBT	652	450	8.6
68	BAY ST AT COLLEGE ST	NBR	78	38	5.3
68	BAY ST AT COLLEGE ST	WBR	51	0	10.1
68	BAY ST AT COLLEGE ST	WBT	435	291	7.5
909	GOULD ST AT YONGE ST	NBR	6	30	5.6
909	GOULD ST AT YONGE ST	WBL	10	77	10.1
909	GOULD ST AT YONGE ST	WBR	15	52	6.4
913	BAY ST AT ELM ST	EBL	136	79	5.5
913	BAY ST AT ELM ST	EBR	38	6	6.7
913	BAY ST AT ELM ST	EBT	142	63	7.8
913	BAY ST AT ELM ST	WBR	50	16	6.0
993	CHURCH ST AT GOULD ST	EBR	20	2	5.5
993	CHURCH ST AT GOULD ST	NBR	0	17	5.8
1460	QUEEN ST AT 70 M W OF YONGE ST	WBT	454	567	5.0
1478	BAY ST AT 12M N OF HAGERMAN	SBT	600	464	5.9
1518	SHUTER ST AT VICTORIA ST	SBL	71	29	5.9
1518	SHUTER ST AT VICTORIA ST	SBR	44	7	7.4
1518	SHUTER ST AT VICTORIA ST	WBR	104	46	6.6
1802	YONGE ST AT 85M N OF SHUTER	NBT	465	308	8.0
1905	DUNDAS ST AT VICTORIA ST	SBL	42	10	6.3
2035	CARLTON ST AT 108M W OF CHURCH ST AND MAPLE LEAF GDNS	EBT	697	484	8.8

Figure 9-2: PM turns with GEH > 5

Blue: modelled flow lower than observed

Red: modelled flow higher than observed

A3 SAT Peak

Table 9.3: SAT turns with GEH > 5

TCS #	Intersection	Turn	Observed	Modelled	GEH
23	CARLTON ST AT CHURCH ST	EBL	55	0	10.5
23	CARLTON ST AT CHURCH ST	EBR	83	39	5.6
23	CARLTON ST AT CHURCH ST	EBT	386	241	8.2
23	CARLTON ST AT CHURCH ST	NBL	89	40	6.2
23	CARLTON ST AT CHURCH ST	SBR	105	1	14.2
23	CARLTON ST AT CHURCH ST	WBT	288	206	5.2
34	QUEEN ST AT YONGE ST	SBT	338	138	12.9
37	GERRARD ST AT YONGE ST	SBR	55	21	5.4
64	QUEEN ST AT BAY ST	SBL	0	17	5.8
909	GOULD ST AT YONGE ST	WBL	0	135	16.4
909	GOULD ST AT YONGE ST	WBR	0	25	7.1

Figure 9-3: SAT turns with GEH > 5

Blue: modelled flow lower than observed

Red: modelled flow higher than observed

Control Information

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