Gardiner Expressway East Planning Study
Innovative Planning Techniques

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Abstract

The Gardiner Expressway in downtown Toronto is 60 years old and facing the need for significant and expensive reconstruction. The City of Toronto, partnered with Waterfront Toronto, initiated a planning study to identify the preferred infrastructure solution for the eastern section of the Gardiner Expressway. The technical work to assess infrastructure alternatives features a number of innovative analysis techniques, including:

- The scope of the planning study integrates an Individual Environmental Assessment for the Gardiner Expressway with an Urban Design study for the neighbourhoods adjacent to the Gardiner Expressway corridor;

- The transportation demand data collection program featured a survey of existing traffic patterns and speeds using Bluetooth signals from electronic devices in passing vehicles; and

- The transportation modeling approach features a marriage of the existing City of Toronto EMME/2 macroscopic model and a microsimulation model of the primary study area in Paramics software.

This paper will present some of the creative planning techniques adopted in the Gardiner Expressway East Planning Study.

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Introduction

The City of Toronto stands at a crossroads, facing a difficult decision. The Gardiner Expressway, an elevated highway originally constructed in the 1960s as a key piece of the emerging freeway system, requires major reconstruction of the expressway deck. The eastern section of the Gardiner Expressway, where it connects to Lake Shore Boulevard west of the Don Valley Parkway, carries 120,000 vehicles per day to/from the north and east of downtown. Clearly, this segment of the Gardiner Expressway/ Lake Shore Boulevard combination plays an important role in the city's transportation network.

At the same time, many public and private land owners are starting to come together to transform the Toronto Waterfront, changing it from a legacy industrial and transportation hub to a premier residential and commercial address at the heart of one of North America's largest urban centres; one that connects to and integrates its Lake Ontario waterfront. The design and location of the Gardiner Expressway/ Lake Shore Boulevard corridor will significantly influence the design of the waterfront – it defines, among other things, size and shape of land parcels, local road access, urban design characteristics of multiple neighbourhoods, and connectivity and environment for pedestrians and cyclists. Just as clearly, the design of the Gardiner Expressway/Lake Shore Boulevard combination will be an important factor in the efforts to transform the Toronto Waterfront.

The response from the City of Toronto in this position in the past would be to repair the existing structure, possibly making minor modifications to the cross-section if required; essentially maintaining the status quo. Reconstruction would be expensive and impactful to local residents and commuters, but the City would no choice. Or would it? On this occasion, mindful of its city-building objectives, and the significant cost of repairs, the City of Toronto chose to ask a bolder, more insightful question: "What is the best design for the Gardiner Expressway/ Lake Shore Boulevard corridor to meet the many stakeholder objectives?"

This paper looks at a few of the innovations in planning process, data collection, and transportation modeling that were adopted by the project team to consider this question.

Project Description

The Gardiner Expressway and Lake Shore Boulevard East Reconfiguration Environmental Assessment (EA) and Integrated Urban Design Study addresses the preferred approach and design to the reconstruction of the Gardiner Expressway between Jarvis Street and the Don Valley Parkway – a stretch of approximately 3.2 km. **Figure 1** shows the primary Study Area.

The existing Gardiner Expressway in this area has portions of six and eight lane cross-section, with interchanges at Lake Shore Boulevard, Sherbourne Street, Parliament Street, and Jarvis Street. **Figure 2** shows a schematic of the Gardiner Expressway configuration.

Lake Shore Boulevard has a six lane dual carriageway cross-section in the Study Area. Lake Shore Boulevard is south of the Gardiner Expressway in places and underneath the Gardiner Expressway in others. This segment of Lake Shore Boulevard carries an arterial road designation, with five signalized intersections, namely: Don Roadway, Cherry Street (split intersection), Parliament Street, Sherbourne Street, and Jarvis Street.

Planning Approach

The Challenge / Opportunity

The Gardiner Expressway/ Lake Shore Boulevard combination is a major transportation corridor passing through a district of the City of Toronto that has substantial objectives for regeneration and redevelopment. There are currently five new neighbourhoods within the Study Area that are being planned to serve growth to 2031, along with some older well-established neighbourhoods in the study area that have a long history contributing to Toronto's character. The decisions about the design and location of the Gardiner Expressway/ Lake Shore Boulevard corridor will meaningfully influence not only the design of the Waterfront and these new neighbourhoods, but the relationship between the established neighbourhoods and Lake Ontario.

The study also needed a planning process that allowed for the consideration of alternatives with substantially different economic conditions. The potential solutions ranged from an elevated expressway to an expressway tunnel to a grand boulevard. Capital costs for these options range significantly, but so do the potential benefits to redeveloping neighbourhoods.

The Solution

The key to the study process is the underlying philosophy that this is a city building study, not a transportation corridor study. The Gardiner Expressway study – formally called both an EA and an Urban Design Study – is based on the framework for an individual EA for a transportation corridor, but it includes an urban design study for the combined Gardiner Expressway and Lake Shore Boulevard lands as well. It recognizes that the road corridors are themselves a *place* that has a relationship with the adjacent neighbourhoods and Waterfront. The design of the road corridors is just one element of the overall design of the City-owned rights-of-way.

Urban design is very much a driver in the project in the development of alternative solutions and designs and in the evaluation of environmental effects. An open Urban Design competition was held early in the process to allow wide-ranging input into the generation of potential solutions. **Figure 3** shows an urban design concept for the Boulevard Alternative.

Economics has also played a key role in the generation and assessment of solutions. Capital and operating costs for all alternatives have been considered, as is typical through the EA process. In addition to this, the potential for uplift in public and private real estate values adjacent to the corridor has been quantified and considered as a potential benefit of any reconstruction scenario. The potential for the creation of new development blocks with their own inherent value was also closely examined, given the larger than normal transportation right-of-way and additional miscellaneous City of Toronto land holdings.

Transportation Data Collection

The Challenge

As with all projects, the data collection program was shaped by the questions that needed to be answered, namely:

1. What is the existing role of the Gardiner in the transportation system? and
2. What is the impact on transportation system operations of modifications to the Gardiner Expressway/ Lake Shore Boulevard corridor?

Understanding the role of the Gardiner Expressway would allow for the proper definition of solution options. Prior to project commencement there were many perceptions about the role of the Gardiner (e.g., the Gardiner Expressway plays a significant role in regional travel), but little data existed to allow for the true determination of the Gardiner's function. It was critical to measure existing travel patterns to understand how the facility is being used so that solution options could be generated.

Impact assessment was an obvious requirement of the EA process, and the methodology proposed the development of a microsimulation model in Paramics software to measure systems operations to complement the existing strategic travel demand forecasting model. We needed to develop a detailed profile of existing operations to properly calibrate the microsimulation/ traffic operations model, including peak hour demands on the Expressway and Expressway ramps and to measure travel speed to calibrate traffic operations model. We could not use conventional origin-destination survey methods due to the traffic and roadway context, including high traffic volumes and speeds; the lack of shoulders on the central elevated section; and limited vantage points for visual observations.

The Solution

Following a review of data collection options, the project team selected a survey methodology based on tracking Bluetooth signals in vehicles driving on the Gardiner Expressway/ Lake Shore Boulevard combination. This approach permitted surveys to be undertaken continuously over a full week, capturing a variety of traffic demand scenarios, including traditional peak hour commuting; mid-day, evening and weekend travel patterns with a greater mix of trip types; and special events (e.g., a Saturday evening hockey game; the Santa Claus parade on Sunday afternoon). This approach also yielded additional data on travel times and delays on different sections of the corridor, including the duration and magnitude of periods of congestion entering and exiting downtown.

The survey was undertaken over a one-week period in November 2009, by Traffic and Parking Automation (TPA) under direction from the consulting team and the City of Toronto. Bluetooth detection units were installed at 11 locations on the Gardiner Expressway, Lake Shore Boulevard and Don Valley Parkway, as shown in **Figure 4**. Locations were selected within the Gardiner EA study area itself, on the outskirts of the downtown area, and farther upstream. This permitted the survey to differentiate "local" trips (destined to or from the downtown area), shorter-distance "through" trips (non-downtown trips destined to areas within the former City of Toronto, East York and south Etobicoke), and longer-distance "through" trips (trips bound for the QEW/Highway 427 and/or Highway 401). **Figures 5 and 6** show sample output from the Bluetooth survey.

By cross-referencing the detection results against permanent count station data, it was determined that Bluetooth devices were detected in approximately 10–15% of all vehicles (depending on location and time of day). This sample size was high enough to obtain representative results.

The survey found that the majority of traffic entering the downtown area via the Gardiner Expressway, Don Valley Parkway and Lake Shore Boulevard has a destination within the downtown area. During the AM peak period, less than 25% of traffic on these roads is "through" traffic (not bound for downtown). This includes both shorter-distance "through" trips (non-downtown trips destined to areas within the former City of Toronto, East York and south Etobicoke) and longer-distance "through" trips (trips bound for the QEW/Highway 427 and/or Highway 401). At other times, the percentage of through traffic is slightly higher, but still a minority of traffic.

However, although through traffic is a minority of the total Expressway traffic, it is still a significant amount in absolute terms. If all through traffic was to use Lake Shore Boulevard, it would use approximately a lane and a half of eastbound capacity, and nearly two lanes of westbound capacity. By comparison, through traffic can be accommodated in less than one lane on the Gardiner Expressway, since an expressway lane has a significantly higher capacity than a surface arterial lane.

Transportation Modelling

The Challenge

The most significant challenge from a transportation modelling and analysis perspective was how to best forecast the impacts of local changes to a regionally significant facility out to that region. There was a clear need from the outset of the project to assess not only the operational constraints of a congested road and transit network locally within the study area, but also to gauge the regional influence that changes to the Gardiner Expressway would precipitate in demographics, travel choices, and demand for transportation infrastructure in the region. This required some new thinking on the applicable transportation modelling methodology and the measures that could be used to compare and contrast various scenarios at a local and regional level.

The Solution

The solution to transportation modelling for the project was a marriage of the City of Toronto's regional travel demand model with a detailed transportation microsimulation model of a smaller study area. The larger model was used to judge changes in movement and settlement patterns and their impacts on demand at a regional level, whereas the smaller model was used to assess the roadway operations resulting from these regional changes to travel behaviour. **Figure 7** shows a portion of the microsimulation model in operation.

The Project team adopted a 4-step modelling process for the study, as described below.

1. The City of Toronto's EMME model was used to forecast the peak hour auto trip table for the project Study Area (essentially southeastern portion of City of Toronto). The City's Strategic Demand model judges changes in movement and settlement patterns and their impacts on demand at a regional level;

2. Manual reductions to the peak hour auto trip table were applied outside of the EMME model to account for anticipated changes in future travel behaviour for Study Area and Greater Toronto Area residents. This step is discussed in greater length below;

3. Paramics microsimulation software was used to predict route choice for drivers within the Study Area under anticipated future conditions and determine travel times within the Study Area; and

4. Synchro intersection analysis software was used to optimize the traffic signal settings within the Lake Shore Boulevard corridor and allow for refined estimates of future travel times.

Forecasting Changes in Travel Behaviour in the Future

It was necessary to provide a significant amount of critical thinking outside of the modelling tools to ensure that the best forecast of future transportation behaviour was applied. Typical modelling processes rely on observation of existing conditions, prior trends, and plans for the future. As such, they are typically restricted to predicting the future by observing past behaviour, which is no longer a valid approach in this era of changing attitudes towards auto-centric transportation. The study team took the regional forecasts and adjusted the demands based on research into the ways in which auto use is being observed to change: downward trends in vehicle ownership, increasing urbanization, e-commuting, increasing use of active and transit modes – elements to which a traditional four-step regional travel demand model is not necessarily sensitive.

Research into the various facets of changes in transportation demand over time included a number of data sources:

- City of Toronto EMME Model – Examination of future settlement patterns and resulting travel needs
- Transportation Tomorrow Survey – Long-term survey of transportation behaviour for GTA residents conducted every five years
- Bluetooth Origin/Destination Survey – Current breakdowns of through vs. local traffic on major facilities
- City of Toronto Cordon Counts – Trends in auto occupancy and vehicle counts over the longer term
- Census Data – Trends in demographics
- City of Toronto Permanent Counting Station Data – Trends in vehicle counts over time
- Research and Case Studies – Examination of the current body of research, guidance documents, and case studies for changes in transportation behaviour over time and with removal of large elements of infrastructure

The research and analysis effort produced **Table 1**, which shows the reduction potential across the range of potential changes in transportation demand.

Guided by the results shown in Table 1, two demand reduction programs were applied to the future year models. The first program, nominally the "15% adjustment", was applied to the Maintain, Improve, and Replace options as a representation of changing attitudes and priorities with respect to transportation over time. A reduction of 10% was applied to general trip making to and from the western and northern borders of the study area (those most concerned with travel to and from the study area via the Gardiner Expressway and Don Valley Parkway) with an additional 5% credit being taken for trips less than 5km within the study area to represent increased active mode participation.

The second program was applied to the Remove option, which would remove the easternmost portion of the Gardiner Expressway between Jarvis Street and the Don Valley Parkway. This option represented the type of paradigm shift and capacity reduction that would result in more significant behaviour change over time; as the City signals its desire to shift priority away from auto users, there would need to be a commensurate adjustment in travel behaviour to accommodate the changes. This program was nominally the "25% adjustment", which included a 20% reduction for trips to and from the outer areas and the same 5% credit for increased active mode participation.

Table 1 – Recommended Post-EMME Modelling Adjustments to Auto Demand Forecasts

Areas for Adjustment to Forecasted Peak Hour Auto Trip Generation	Magnitude of Adjustment*	Trip Forecasts Requiring Adjustment
Trip Reassignment Trip shifts to alternate route, but not within the FGE/LSB corridor	0%	Handled by EMME model, no additional change
Mode Shift Trip occurs, but not as auto driver • Transit Mode Share increase • Cycling and Walking Mode Share increase	 5 - 7% 5 - 7%	 Global reduction to Study Area Demand Primarily applied to shorter, internal trips (under 5 km)
Auto Occupancy	0%	No substantive change expected
Peak Spreading Trip occurs, but not in peak commuter hour/period	3 - 7%	Global reduction
Trip Redistribution Origin and/or destination of trip is changed	0%	Handled by EMME model, no additional change
Trip Reduction Trips are reduced due to telework, teleconferencing, compressed work week, etc.	2 - 4%	Global reduction
Trip Elimination Trip is completely eliminated	1 - 2%	Global reduction
Overall	**16 - 27%**	

** Note the term "adjustment" in this case refers to reductions to peak hour auto trip generation rate*

Performance of the transportation network was assessed via the microsimulation model, as it was able to consider the operations of all travel modes in relation to the realities of movement through a modern urban environment. To quantify the performance of an already saturated system in a future year, it was deemed most useful to use various forms of travel time observations as the major points of comparison between alternatives. Travel time provides a concrete and immediately understandable measure that is useful to technical analysts and non-technical stakeholders alike. It was possible to observe differences in travel times through specific neighbourhoods, along key routes, between important destinations, and as an overall system.

In addition to the operational assessment, a qualitative assessment of safety was undertaken in order to differentiate the various alternatives. Elements such as posted speed limit, number of left turns, number of pedestrian crossings, and provision of separated left turning pockets and protected signal phases were used to compare and contrast the potential safety tradeoffs between alternatives. This provided a template for the study team and stakeholders to examine the potential impacts to safety in the area provided by each of the alternatives.

Summary

As the needs of the public for transportation and their attitudes towards it change over time, it is necessary also that our approach to forecasting, analysing, and prioritising elements of transportation planning, land use planning, and urban design take these changes into account. As befits such a significant opportunity for a city-building in the heart of Canada's largest and most complex urban environment, the approaches taken on this project took the opportunity to challenge the approaches to each and every element of the study to provide solutions, analysis, and insight into the outcomes that better reflect the needs of a changing populace.

Figure 1 - Study Area

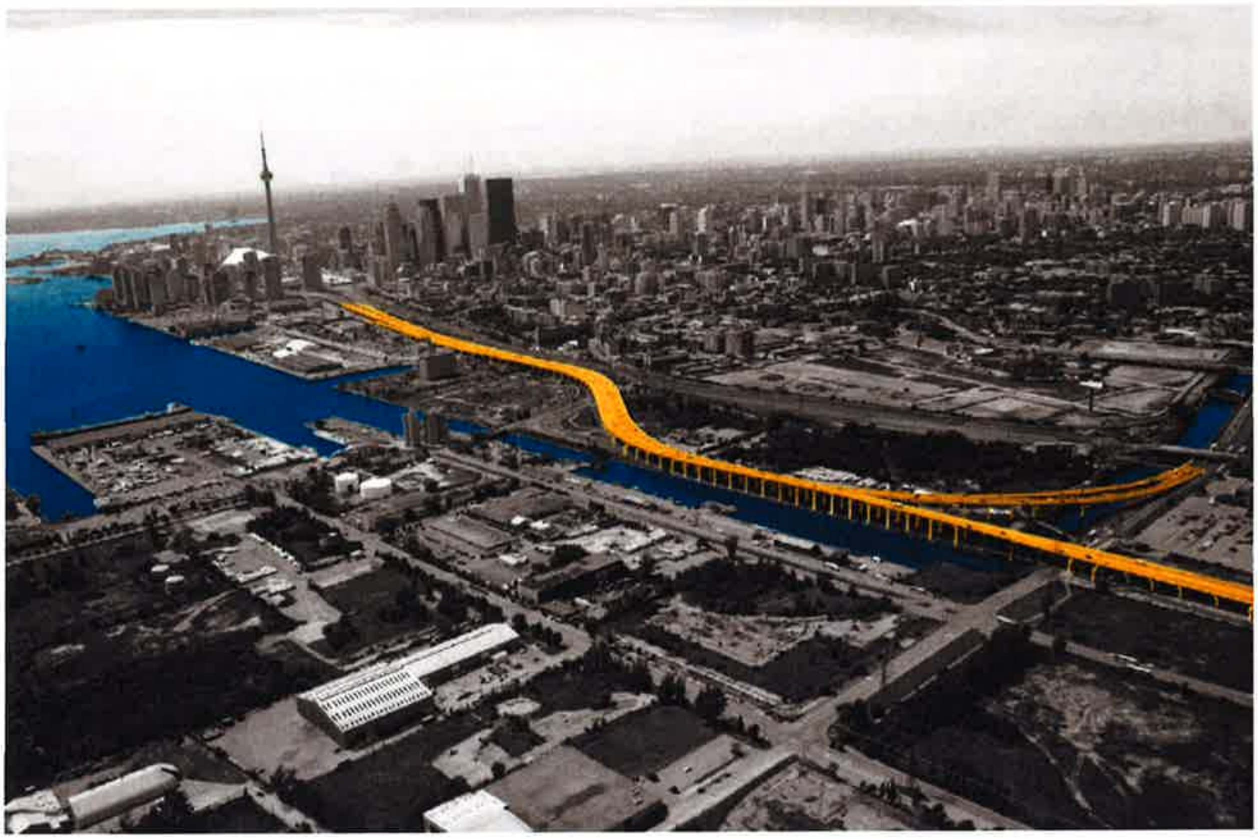

Figure 2 – Gardiner Expressway Schematic with Interchanges Indicated

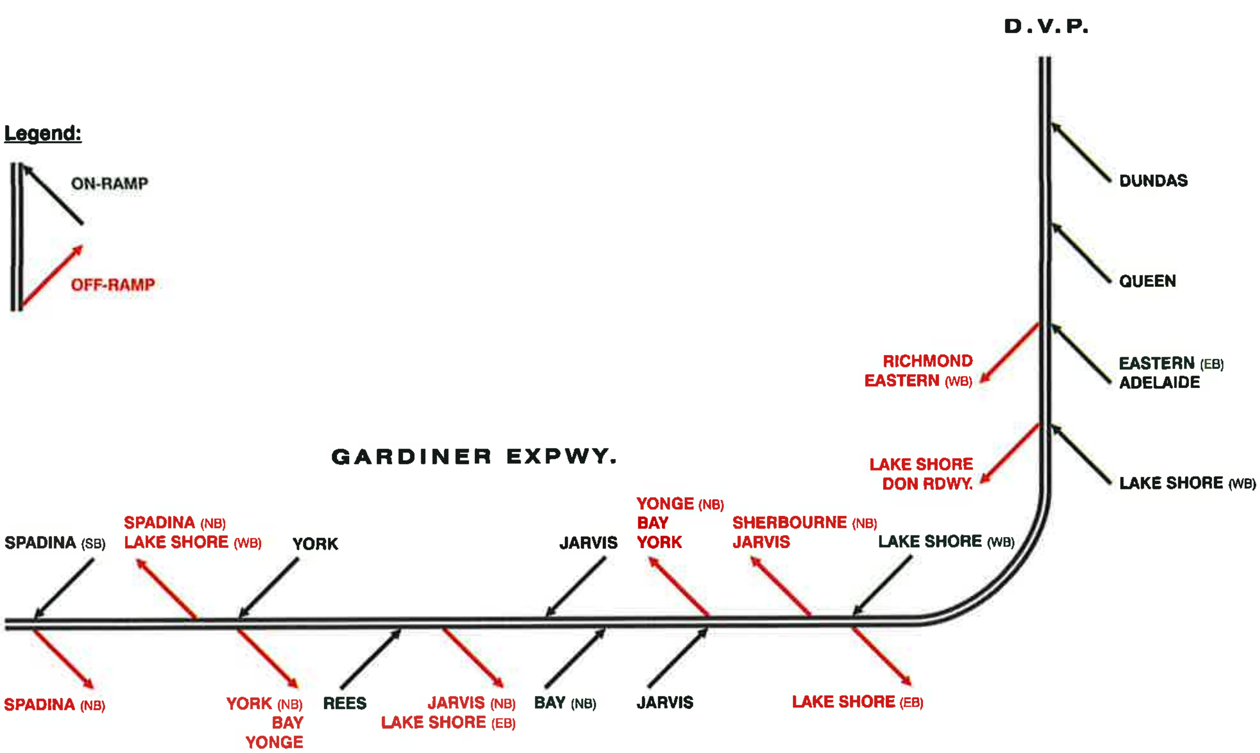

Figure 3 – Urban Design Concept for the Boulevard Alternative

Figure 4 – Bluetooth Detector Locations

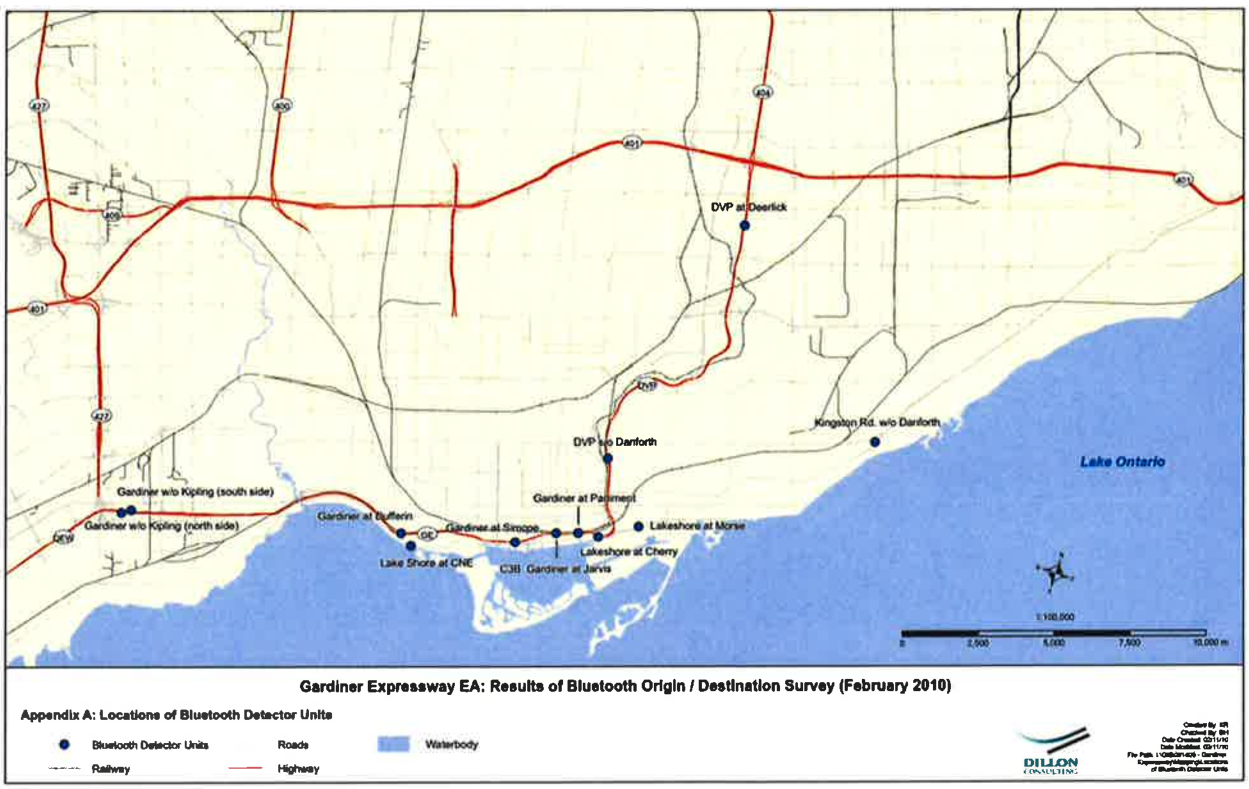

Figure 5 – Bluetooth Origin/Destination Results for Westbound Gardiner Expressway Vehicles

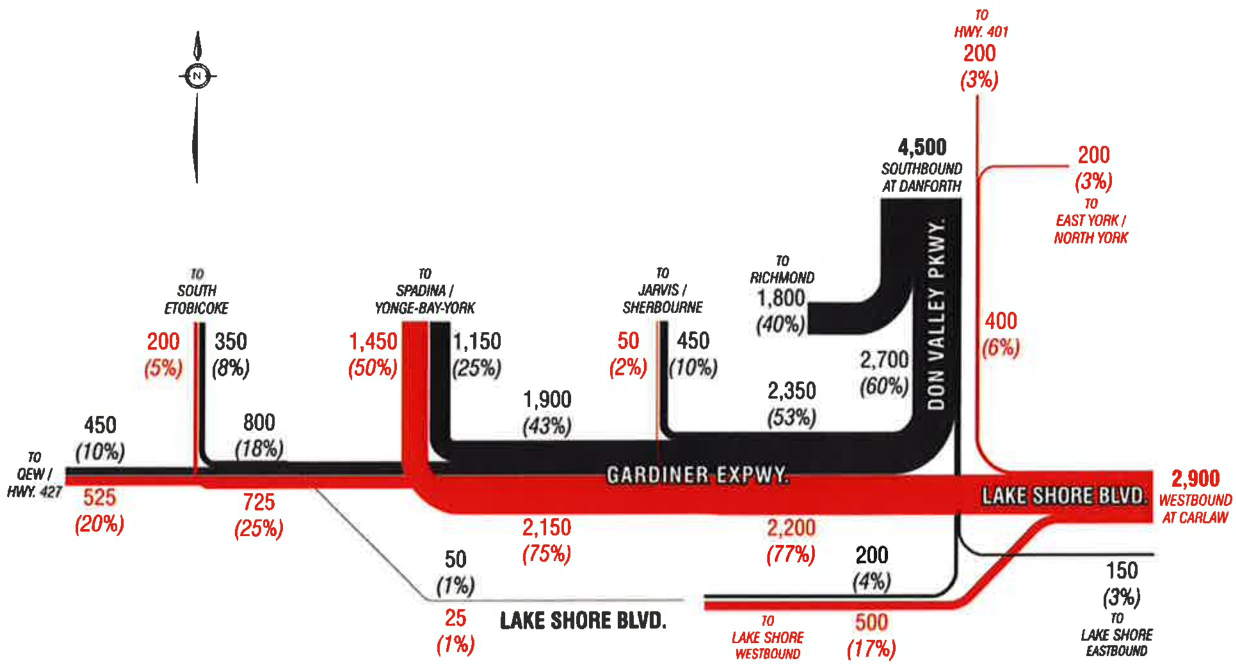

Figure 6 – Bluetooth Travel Time, Travel Speed, and Detection Rate for Westbound Gardiner Expressway Between Parliament Street and Danforth Avenue

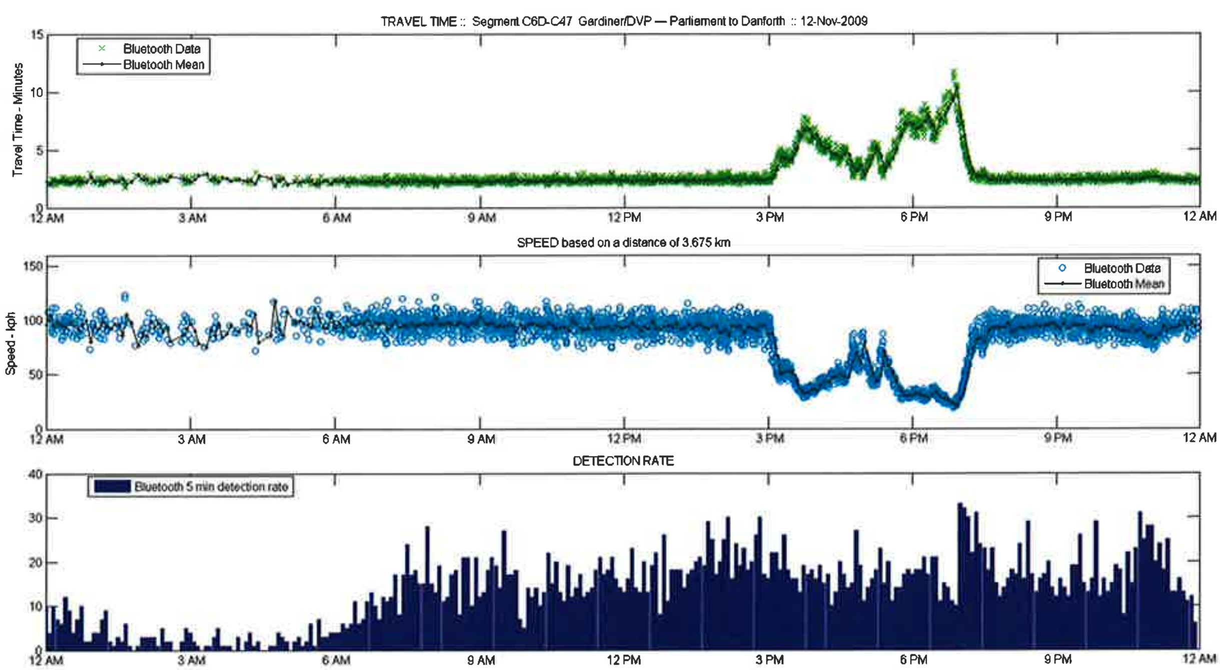

Figure 7 – Gardiner Expressway Microsimulation Model

Figure 8 – Boulevard Alternative – Conceptual Landscape and Block Layout