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HURONTARIO/ MAIN STREET RAPID TRANSIT BENEFITS CASE

June 2010

Hurontario/Main Street

Rapid Transit Benefits Case

Final Report

June 2010

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In 2006 the Province of Ontario created the Greater Toronto Transportation Authority, renamed Metrolinx in December 2007. The primary responsibilities of the new organisation are to provide leadership in the planning, financing and development of the Greater Toronto and Hamilton Area's (GTHA) multi-modal transportation network and to conform to the objectives and vision set out in the Places to Grow Act, 2005.

Part of Metrolinx' mandate and one of its first deliverables was the development of *The Big Move*, the Regional Transportation Plan, a 25-year plan that presents the road map for the implementation of the Province's MoveOntario 2020 vision.

As the rapid transit projects contemplated in *The Big Move* progress closer to implementation, a Benefits Case will be prepared for each project. The purpose of the Benefits Case is to undertake a comparative analysis of feasible options for a specific rapid transit project and present the results in such a way that it will assist decision makers to select a preferred option for implementation. The Benefits Cases help to identify the preferred project scope and inform project funding recommendations by the Metrolinx Board.

The Hurontario/Main Street Rapid Transit project is one of the projects contemplated in MoveOntario 2020, and was identified as a Top 15 project in *The Big Move*. The project involves the provision of BRT and/or LRT from Port Credit to Brampton along the Hurontario/Main Street corridor.

Three options have been identified for this corridor. They are:

- **Option 1:** LRT: Port Credit to Downtown Brampton, via Mississauga City Centre
- **Option 2**: BRT: Port Credit to Downtown Brampton, via Mississauga City Centre
- **Option 3**: LRT: Port Credit to Mississauga City Centre,
  BRT: Mississauga City Centre to Downtown Brampton

Note that Option 3 was developed to provide an indication on how BRT and LRT would interact and the effect of a transfer on the corridor. Potential implementation phasing will need to be examined through more detailed design work.

Each of the options is compared to the Base Case, which is defined as the committed municipal bus network and GO Transit services (namely existing, planned and committed services) that serve the Hurontario/Main Street corridor. The table below summarizes the key characteristics of the options.

SUMMARY OF OPTIONS

Assumptions	Option 1 - LRT	Option 2 - BRT	Option 3 – LRT/BRT
Opening Year	2015	2015	2015
Headway	3 min	3 min	3 min
Capacity (per hour per peak direction)	2,600 / 5,200	1,800	2,600 / 5,200 (LRT) & 1,800 (BRT)
LRT Vehicles	36 / 72	-	12 / 24
BRT Vehicles	-	42	32
Travel time (end-to-end)	38 min	51 min	12 min & 35 min
Bus Circulator Mississauga City Centre	Yes	Yes	Yes
Depot facility	LRT depot located vicinity of Hwy 407	BRT depot costed but no specific site selected	LRT depot costed but no specific site selected BRT depot costed but no specific site selected

NOTE: LRT Fleet Capacity and Requirements: To 2021/After 2021

The assessment of the options is done using a Multiple Account Evaluation (MAE) methodology. The MAE is a framework that provides a systematic identification and analysis of broader public policy implications and criteria of an option, not only costs and user benefits. The MAE framework is based on a number of evaluation "accounts" that together address the most significant project performance and policy considerations for a specific project:

- Transportation User Benefits;
- Financial Impacts;
- Environmental Impacts;
- Economic Development Impacts; and
- Socio-Community Impacts.

The assessment is done by comparing each option to the Base Case and identifying any incremental impacts, costs or benefits that are generated by each option. The analysis is done over a 30-year period (2009-2038). In order to compare the options on a "like-to-like" basis the monetized values are discounted to today's value. The values are discounted at a real discount rate of 5% and expressed in net present value in 2008 dollars.

The analysis of the Hurontario/Main Street rapid transit options reveals that the highest cost option (Option 1, the full LRT along the Main Street corridor), with estimated capital and operating costs of $1,206 million in net present value terms, also generates the highest transportation user benefits. These are estimated at $1,779 million resulting in a benefit-cost ratio of 1.5:1. By comparison, Option 2 (the full BRT option), generates an estimated $538 million in Transportation User Benefits. However demand levels for this option are considerably higher than bus-based systems can accommodate suggesting that that long-term capacity needs are unmet.

By combining the LRT and BRT technologies in Option 3, the transportation user benefits, at $692 million in present value terms are higher than the BRT only Option, but with considerable costs due to the LRT element the benefit-cost ratio reduces to 1.0:1. This suggests that mixing the two technologies does not optimize the economic performance of rapid transit along this corridor.

For Option 1 the majority of benefits are derived from the travel time savings due to the faster journey times offered by LRT, highlighting the importance of the operating speed of the rapid transit system to the success of the project. Options 2 and 3 deliver less travel time savings and the auto time savings become the largest element of transportation user benefits. Given the supportive transit signal priority measures proposed under each of the options, there is an opportunity to establish a high performance standard for the region to fully realize the benefits from the rapid transit investment with LRT.

All of the options are somewhat effective in attracting people out of their cars and reducing automobile usage. Option 1, which has the largest effect, will result in a reduction of greenhouse gas emissions by approximately 13,000 tonnes annually by 2021 increasing to 22,000 tonnes by 2031. In net present value terms, this equates to $8.0 million for Option 1 compared to $4.7 million and $5.9 million for Options 2 and 3 respectively.

As expected the options with the highest capital costs generated the most significant economic development effects. Option 1, which has the highest capital cost will have the largest impact on employment, income and GDP during construction and is estimated to generate approximately 7,000 person-years of employment[1]. By contrast, the lower cost BRT option produces the lowest overall economic development and employment benefits during construction as well as during the on-going operations.

[1] Includes both direct and indirect impacts.

All of the options support the GTHA land use and economic development objectives to revitalize the corridor by enhancing and supporting complementary planning and densification initiatives. LRT demonstrates a greater ability to attract investment and redevelopment than the BRT alternative and consequently provides higher property value uplift. At the upper end of the range of estimated uplift, LRT Option 1 produces more than double the uplift of the BRT Option 2 at $417 million versus $157 million, with the LRT/BRT Option 3 estimated at $317m. At the lower end of the range, the difference is less dramatic with Option 1 producing an estimated $208 million in property value uplift versus $98 million for Option 2 and $158 million for Option 3.

Overall, the results indicate that an investment in LRT in the Hurontario/Main corridor will generate significant benefits and support Mississauga and Brampton's broader objectives to revitalize, redevelop and reshape its most significant north-south corridor. The lowest cost option, Option 2, produces a high benefit-cost ratio but the analysis has shown demand exceeds capacity for this option by 2021 (note that the forecasting model is not capacity constrained), suggesting it may not provide a long term solution. While only BRT sections show capacity constraints, another advantage of a LRT system is it allows for increased capacity by increasing vehicle size (from 30 to 40m vehicles) or adding new vehicles.

The highest cost option, Option 1, also produced the greatest benefits in all accounts, all of which make an important contribution towards achieving the objectives and goals of the municipalities and the Province.

The table below summarizes the results from the MAE.

MULTIPLE ACCOUNT EVALUATION SUMMARY

	Option 1	Option 2	Option 3
Transportation User Account			
Transportation User Benefits (PV $m)	**1,779**	538	692
Qualitative User Benefits	✓✓✓	✓	✓✓
Financial Account			
Costs (PV $m)	1,206	**330**	679
Benefits Less Costs (PV $m)	**572**	208	13
Benefit-Cost Ratio	1.5	-[2]	1.0
Environmental Account			
GHG Emissions (PV $m)	**8.0**	4.7	5.9
Economic Development Account			
Economic Impacts During Construction			
Employment (person-years)	7,000	1,309	3,671
GDP ($m)	$270	$51	$142
Income ($m)	$596	$111	$312
Long-term Economic Impacts (2031)			
Employment (person-years)	575	16	260
GDP ($m)	$22	$1	$10
Income ($m)	$49	$1	$22
Development Potential ($m)	208-417	98-157	158-317
Social Community Account			
Land Use Shaping	✓✓✓	✓	✓✓
Road Network	✓	✓	✓
Construction Implications	✓	✓✓✓	✓✓

[2] Benefit-Cost ratio is not provided as the disbenefits of un-serviced demand have not been included

Part A Project Rationale

Introduction

Purpose of Report

In 2006 the Province of Ontario created the Greater Toronto Transportation Authority, renamed to Metrolinx in December 2007. The primary responsibilities of the new organisation are to provide leadership in the planning, financing and development of the Greater Toronto and Hamilton Area's (GTHA) multi-modal transportation network and to conform to the objectives and vision set out in the *Places to Grow Act*, 2005.

Part of Metrolinx' mandate and one of its first deliverables was the development of *The Big Move*, the Regional Transportation Plan, a 25-year plan that presents the road map for the implementation of the Province's *MoveOntario 2020* vision.

As the rapid transit projects contemplated in *The Big Move* get closer to implementation, a Benefits Case will be prepared for each project. The Benefits Case will describe a range of feasible options for each project, be it different technology, capacity, routing or length of alignment, and demonstrate the benefits and costs associated with each of the options.

The Hurontario/Main Street project was one of the projects contemplated in *MoveOntario 2020* and was identified as a Top 15 project in *The Big Move*. The project involves the provision of a higher order rapid transit service from Brampton to Port Credit along the Hurontario/Main Street corridor.

Three different options were identified for this corridor and this document presents the comparison of these options against the Base Case (namely existing, planned, and committed services). The assessment of the options includes the relative strengths and weaknesses of each option on people, the economy and the environment compared to the cost of implementing the option. The objective of the assessment is to clearly outline the trade-offs among the criteria to enable decision makers to make an informed decision.

Report Structure

This report is structured as follows:

- **Part A - Project Rationale**: This section describes the policy context, the broader regional and project objectives, the characteristics of the corridor and the issues and opportunities to be addressed by the proposed project;
- **Part B – Project Options**: This section describes the options that are evaluated; and
- **Part C – Project Assessment:** This section will describe the evaluation methodology, the analysis and the summary results.

Project Rationale

Context and Need

The City of Mississauga and the City of Brampton are the 6th and 11th largest municipalities in Canada, respectively. The two cities initiated the Hurontario/Main Street Study to develop a Corridor Master Plan that integrates rapid transit, land use and urban design for the corridor from Port Credit to downtown Brampton. Working in partnership, they completed the first step in the overall study, the Directions Report, and presented it to both city councils in March 2009. The Directions Report outlines a conceptual vision for the corridor and outlines the case for action. The corridor currently has frequent local and express bus service operated by Brampton Transit and Mississauga Transit. The bus service, however, is limited in that it *does not have* signal priority and therefore is subject to the congestion along the route.

Land use along the corridor varies to a considerable degree from stable low-density developments to high-density residential and car oriented retail and commercial developments and there is currently healthy ridership along the corridor. High quality transit is seen as a catalyst to support growth and intensification in these areas and elsewhere along the corridor and result in development uptake and enhanced urban design.

Looking forward, the Directions Report cites transit investment as a key element for city building with significant opportunities for redevelopment and intensification that will help to create a more transit oriented environment and connect Downtown Mississauga (the area between Queen Elizabeth Way and Highway 403) and Downtown Brampton, which are both designated as Urban Growth Centres (UGC). Furthermore, the City of Mississauga is currently developing the Downtown 21 Master Plan to help nurture a vibrant, walkable and compact City Centre with the key objectives of improving access to transit, biking and walking. Similarly, the Hurontario/Main Street Corridor is within the City of Brampton's Intensification Corridor and Transit Supportive Nodes area as defined in the 2006 Official Plan, and several studies are being conducted, including a review of built and planned densities, a Downtown Built Form Study, and a Downtown Heritage Strategy.

Between Highway 403 and Matheson Boulevard there is currently a mix of high and medium density housing, retail, office and institutional uses, and greenfield sites slated for similar uses. Future development, based on current applications, is likely to be predominantly high density residential units. By 2041 the area's population is projected to grow by 33% and employment by 54%. Early plans for a 1.46 million square foot office development at Bristol Road and Hurontario Street have also been received. Given the planned and forecast development it is anticipated that the Hurontario/Main Street Corridor and City Centre will have the highest concentration of office space in the City of Mississauga.

Project Objectives

As outlined in the Hurontario/Main Street Study the project goals are:

- To integrate transit, land use and urban design features which serve the area residents as well as the interests of a range of stakeholders;
- To establish the required and necessary parts of the vision and the opportunities and constraints which will arise from the vision;
- Select the technology to use along the Hurontario/Main Street corridor and devise a strategy for its implementation;
- Establish the design principles, routing, alternatives and opportunities as well as cycle and pedestrian links which all support a conceptual character plan; and
- Adhere to and fulfill the requirements of Phase 1 and Phase 2 of the Municipal Class Environmental Assessment process.

Specific goals and objectives include:

- Increase public transit ridership and offer an alternative to the private car;
- Put pedestrians and transit first in planning the corridor;
- Allow transit vehicles to bypass traffic congestion;
- Provide effective connections to regional and neighbouring transit systems; and
- Encourage transit-supportive land uses in the corridor consistent with Growth Plan policies.

Project Overview

Context

As identified above Mississauga and Brampton have undertaken significant initial work on the corridor to date. This document draws upon information contained in the Hurontario/Main Street Study and builds further upon data provided by both cities:

- Transit service operations details;
- Transit line passenger count data;
- Transit investment proposals; and
- Land use proposals.

Within the Hurontario/Main Street Study various options for the technology to be used along the corridor have been considered and narrowed down to BRT and/or LRT. A large component of the selection process came from conducting case studies from around the world looking at BRT and LRT and their physical aspects. Land use, urban design and the factors that made for successful systems were all considered. From this a shortlist of feasible technologies was developed and potential land use capacities (people plus jobs per hectare) were then defined. From this point

five community workshops were held as well as the Connect 10 Symposium, a consultation forum with stakeholder agencies, developers and the public. Each of these sessions resulted in strong support for an integrated transit solution for the corridor. The policy context in which the corridor and plan sits has also been analyzed and a consultation strategy developed.

Within the corridor there is the potential for enhanced transit services to provide and improve connections between major activity centres and urban growth centres, further enhancing transit ridership. With growing transit use there is also significant opportunity to increase the area's land-use concentration and for infill development with an eye towards creating a more pedestrian and transit friendly environment. Within this context the rapid transit project will be able to improve urban design and unlock the area's significant potential. The case studies which have been conducted support this analysis through the provision of BRT or LRT.

Transit Corridor Considerations

On the Port Credit to Downtown Brampton corridor along Hurontario Street, Mississauga Transit operates bus routes 19, 19A and 202 between Port Credit and Shoppers World Terminal. Brampton Transit operates routes 2 and 52 northwards from Shoppers World Terminal to Downtown Brampton. The daily ridership for the services is around:

- 19: 16,500 daily riders
- 19A: 8,000 daily riders
- 202: 2,000 daily riders
- 2: 4,500 daily riders
- 52: 3,500 daily riders

The boarding and alighting pattern for the corridor is shown in Figures 1 and 2.

FIGURE 1 BOARDINGS AND ALIGHTINGS – NORTHBOUND AM PEAK (2008)

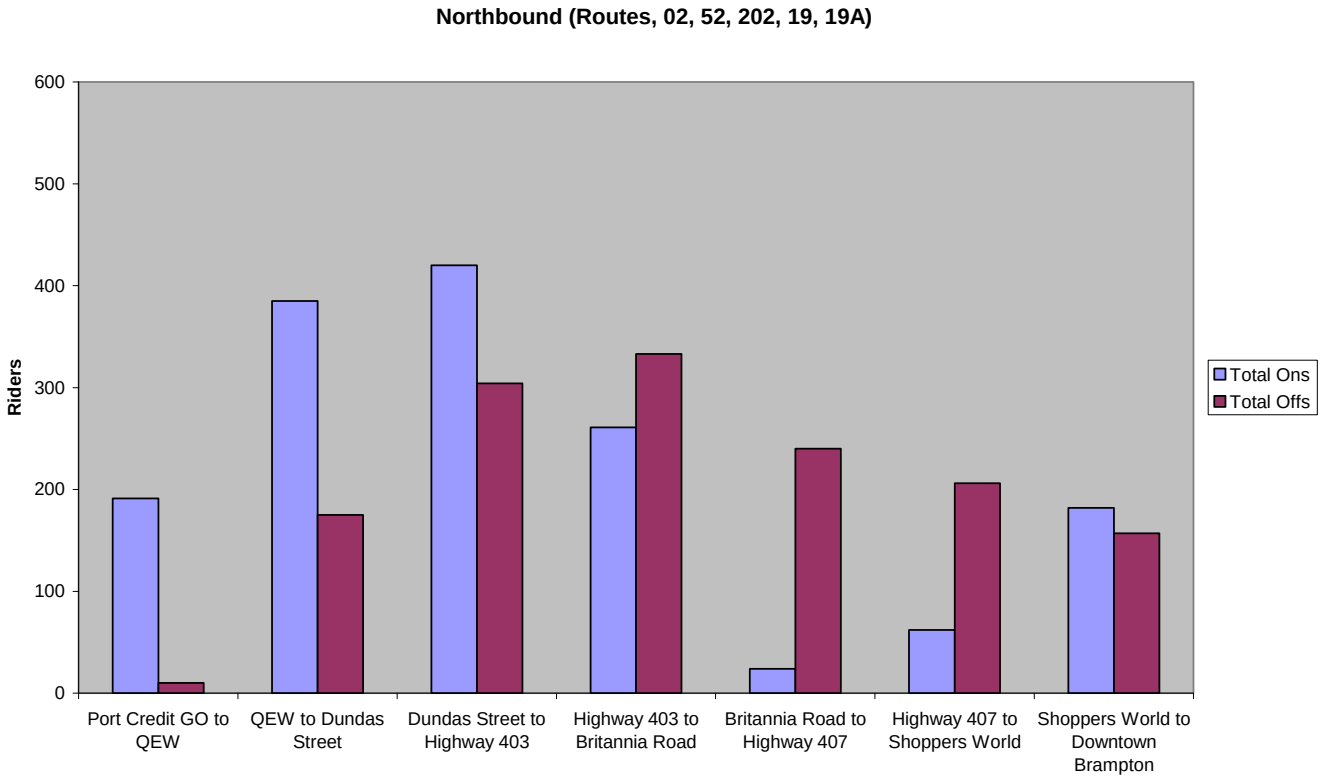

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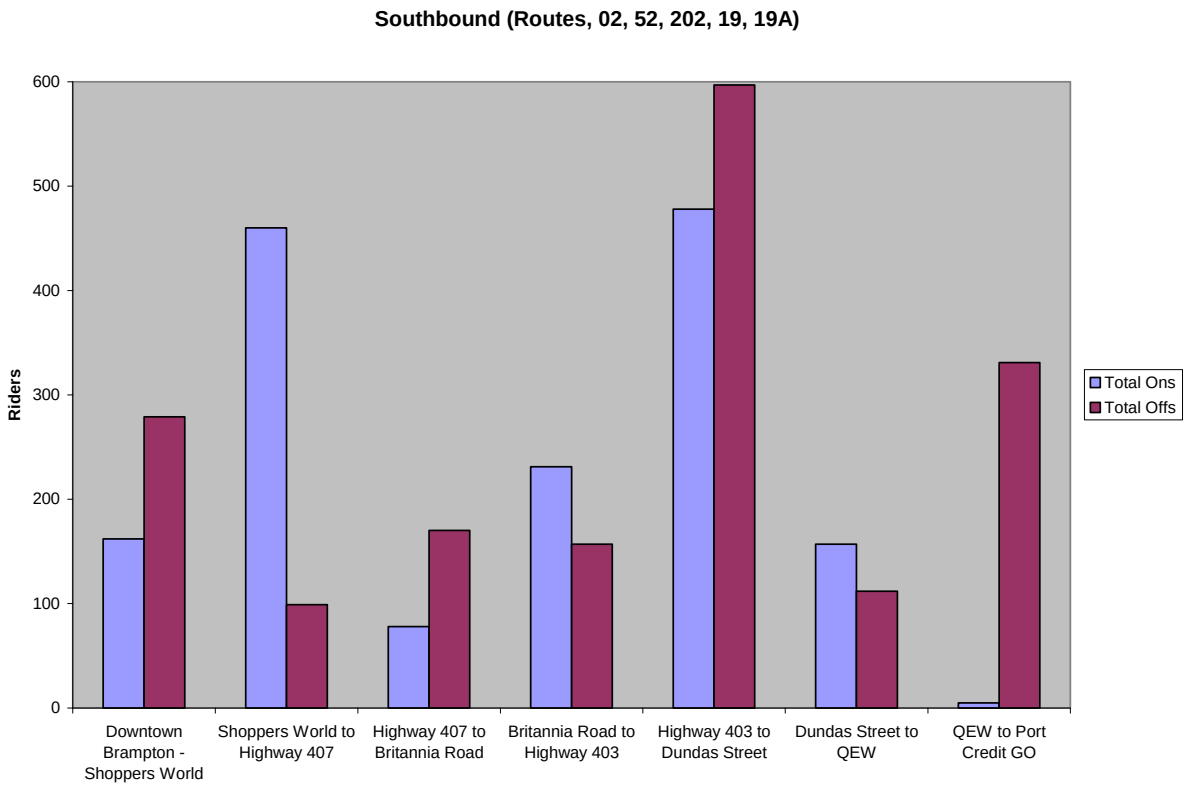
FIGURE 2 BOARDINGS AND ALIGHTINGS – SOUTHBOUND AM PEAK (2008)



An additional service introduced in May 2009, Route 102, operates with four peak buses and an 18 minute headway from Mississauga City Centre to Shoppers World in Brampton.

In total, there are 35 peak buses in the corridor, with an approximate combined headway of 3-4 minutes in the peak on core segments, representing a capacity of around 1,600 passengers per hour per peak direction of travel, assuming buses are full.

Regional Transportation Plan (RTP) assumptions show continued and growing population and employment forecasts along the corridor to 2031. Furthermore the RTP transit forecasts show a significant number of trips between Port Credit and Downtown Mississauga, as well as from Downtown Mississauga to Downtown Brampton.

Network Considerations

The Hurontario/Main Street corridor will connect with important existing transit infrastructure serving the Greater Toronto area. As envisaged and shown in Figure 3 the corridor will provide direct connections with various GO services as well as other bus and BRT services in the area.

Brampton is served by both VIA rail and GO services; the current Georgetown South corridor improvements will see improved GO services between Brampton and Downtown Toronto. In Mississauga, the GO Milton line has a stop at Cooksville and GO has local and express trains serving Port Credit.

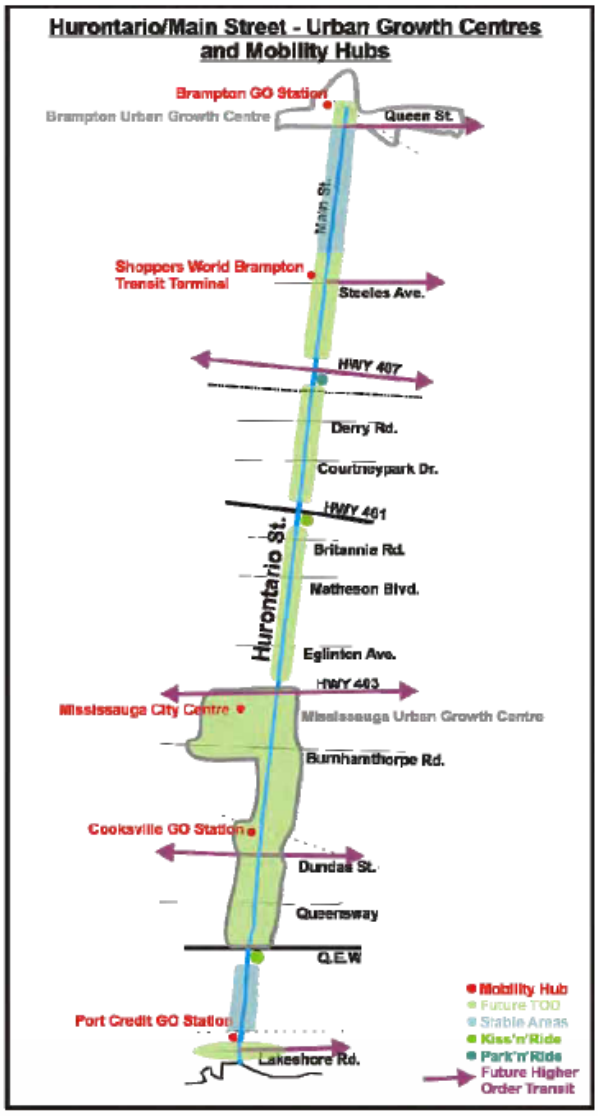
Mississauga Transit operates express bus transit routes on Dundas and Eglinton with a limited stop service utilizing segments of Highway 403. In addition to the existing municipal transit services, Mississauga and GO Transit are planning to begin construction of an east-west express transitway very shortly; this transitway will operate along and adjacent to Highway 403, improving the connectivity between Downtown Mississauga, the Airport Corporate Centre area, Toronto's Pearson International Airport, and Kipling Subway Station within the Etobicoke Centre UGC.

In addition to the current municipal transit services, Brampton will be introducing Züm, a bus rapid transit service, for the City's key north-south and east-west corridors. These corridors include Queen Street, Steeles Avenue and Main Street North. A GO Transit transitway similar to that of Highway 403 is also being planned for Highway 407; however, it is not in the 25-year Metrolinx plan, and should only be considered a long term possibility.

According to the Hurontario/Main Street Study, transit along the corridor will be reliable, frequent, comfortable and convenient, offering an alternative to the private single occupant car. "The transit service will provide 'stress free' service along Hurontario/Main Street from Port Credit to downtown Brampton, supported by transit priority signals, rapid fare collection systems and transit stops balancing system access and travel speed".

To this end various transit options have been considered and at-grade Bus Rapid Transit and/or Light Rail have been designated as the preferred technologies. The selection of BRT and/or LRT is consistent with the Metrolinx RTP and meets the various requirements for cost, urban integration and ridership capacity.

FIGURE 3 NETWORK CONSIDERATIONS



GO Transit operates rail services from three stations along the corridor which all serve the Hurontario/Main corridor, points west, and points east to downtown Toronto. The services run from Port Credit (Lakeshore West Line), Cooksville (Milton Line) and Brampton (Georgetown Line). Note that electrification of all these lines is being considered as part of the GO network electrification study.

From Port Credit services are operated on an hourly basis to downtown Toronto all day with 4 trains per hour in the peak period. The scheduled journey time in the morning peak from Port Credit to Toronto Union Station ranges from 20 to 28 minutes, depending on whether the service is express or local, respectively.

A third track on the Lakeshore line is currently under construction and would allow for more peak-hour trains and an all-day service with 30-minute headways. A Benefits Case for electrification of the line has been completed. Port Credit has been identified as a Metrolinx Gateway Mobility Hub and Mississauga and Metrolinx are currently working together on a Port Credit Mobility Hub study to ensure Port Credit station will be an attractive and functional station integrated with mixed-use development.

The Milton line, which serves Cooksville station, operates a peak period direction service of four trains per hour and GO buses in the off peak hours. An Environmental Assessment is currently being conducted to move towards an all-day service and a Benefits Case is currently being conducted to identify the costs and benefits of implementing two-way, all-day services. Additionally, a smart card ticketing system is being trialled from Cooksville station. The journey time from Cooksville GO station to Toronto Union station is just under 30 minutes. Cooksville has also been identified as a Metrolinx Gateway Mobility Hub and like at Port Credit, Mississauga and Metrolinx are currently working together on a Cooksville Mobility Hub study.

Service from Brampton on the Georgetown line follows a similar pattern to that of the current Milton line. The journey time to Toronto Union station is approximately 45 minutes.

The highway 403 bus-only Transitway is being introduced in 2012. The Transitway will provide for improved GO Bus and Mississauga Transit services and greater access into Toronto and links to other modes at Toronto Pearson International Airport.

The City of Brampton is also on the verge of launching its first phase of Bus Rapid Transit, Züm, which will provide improved transit service along and intersecting the corridor. This service will provide for an enhanced and uniquely branded bus rapid transit service along the key east-west and north-south corridors. It is intended to significantly improve the reliability, speed, frequency, and quality of transit service with better connections within and beyond Brampton's boundaries. The Queen Street line will launch services in 2010 and run from Downtown Brampton into the York region connecting to York University. The Main Street line will launch in 2011 and run between Sandalwood Pkwy and Mississauga City Centre. The Steeles Avenue line will launch in 2012 and run from the Shoppers World Transit Terminal at the northwest corner of Steeles Avenue and Hurontario Street to Humber College in the City of Toronto.

Several highways and major streets also cross the corridor. These include:

- Queen Street;
- Steeles Avenue East;
- Highway 407;
- Derry Road;
- Highway 401;
- Eglinton Avenue;
- Highway 403;

- Burnhamthorpe Road;
- Dundas Street;
- Queensway;
- QEW; and
- Lakeshore Road.

Both local and express transit services operate on a number of these streets and Mississauga has developed proposals for limited stop express routes that would intersect with the Hurontario/ Main Street corridor, in addition to the Transitway.

There are currently no transit priority measures along the corridor, although they will be included as part of Brampton's launch of BRT service on Main Street in 2011.

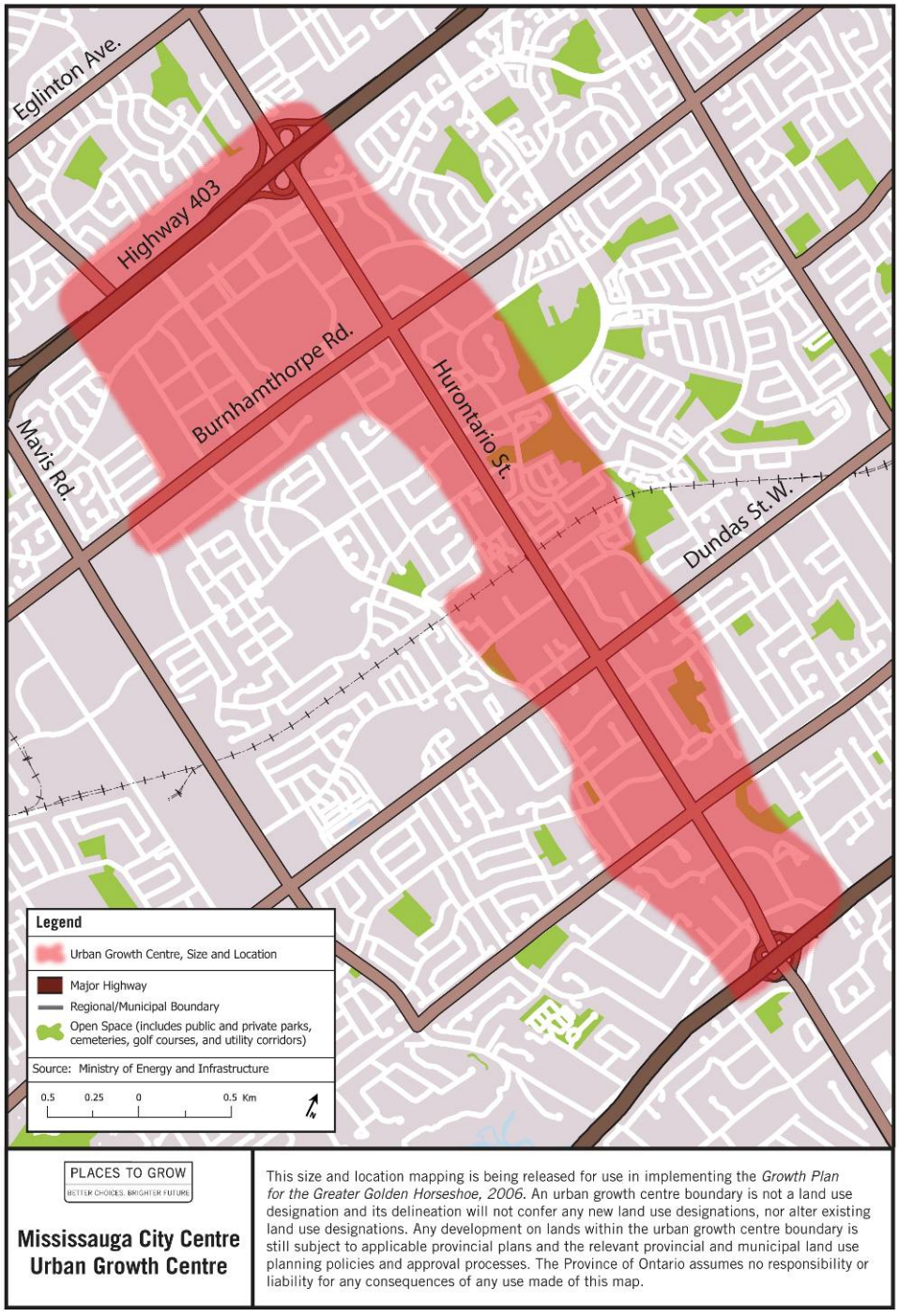
The Mississauga City Centre Transit Terminal is a main transfer station for local transit services that is utilized by over 20 routes and accommodates 40,000 daily transit users. In addition, GO Transit operates a bus terminal on Station Gate Road. The City Centre has also been identified as a Metrolinx Anchor Mobility Hub.

Two points along the corridor within the City of Brampton also have mobility hub designations in *The Big Move*. The Downtown Terminal is both an Urban Growth Centre and an anchor hub, while the Shoppers World Terminal is designated a gateway hub.

The Big Move plans for rapid transit in Brampton on Queen Street in the 15 year plan and Steeles Avenue in the 25 year plan.

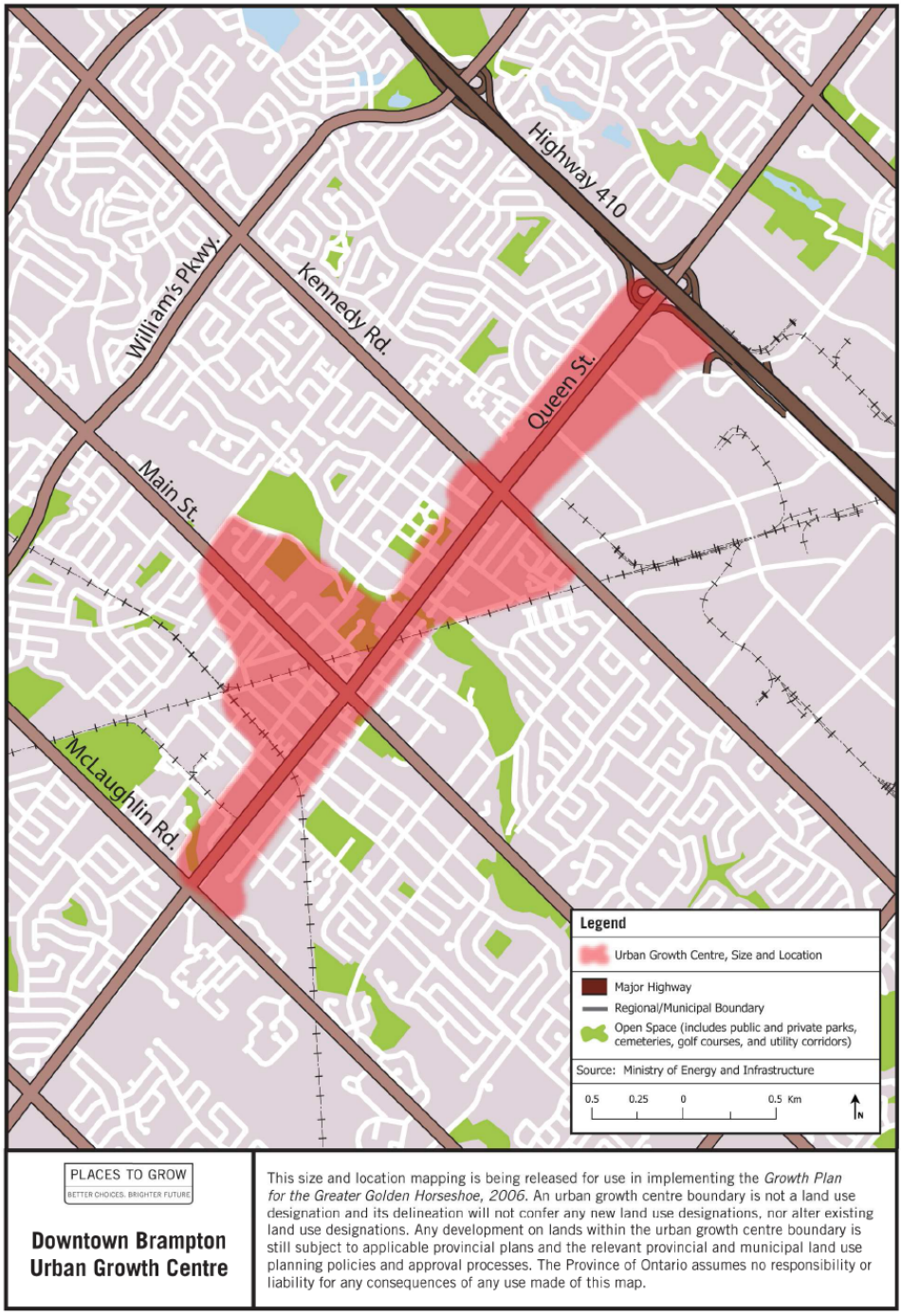
Figure 4 shows the extent of Mississauga City Centre UGC and Figure 5 shows the extent of the Brampton City Centre UGC.

FIGURE 4 MISSISSAUGA CITY CENTRE URBAN GROWTH CENTRE



SOURCE: 'Size and Location of Urban Growth Centres in the Greater Golden Horseshoe' (2008), Ministry of Public Infrastructure Renewal

FIGURE 5 BRAMPTON CITY CENTRE URBAN GROWTH CENTRE



SOURCE: 'Size and Location of Urban Growth Centres in the Greater Golden Horseshoe' (2008), Ministry of Public Infrastructure Renewal

Part B Options

Introduction

Three options have been identified for the Hurontario/Main Street project and a summary description of each option is provided below. Each of the options will be compared to the Base Case.

The options for testing are:

- **Base Case:** Business as usual;
- **Option 1:** LRT: Port Credit to Downtown Brampton, via Mississauga City Centre Drive;
- **Option 2**: BRT: Port Credit to Downtown Brampton, via Mississauga City Centre Drive;
- **Option 3**: LRT: Port Credit to Mississauga City Centre Drive,
  BRT: Mississauga City Centre Drive to Downtown Brampton

Note that Option 3 was developed to provide an indication on how BRT and LRT would interact and the effect of a transfer on the corridor. Potential implementation phasing will need to be examined through more detailed design work.

Base Case

Over and above the existing transit services there are a number of committed "Quick Wins" and a relevant Top 15 project which will be a part of the base case. For this project the Base Case is defined as a network consisting of:

- Assumes Phase 1 of Lakeshore GO electrification in place by 2021;
- Implementation of the Züm program – 5 minute frequency service between Brampton and Mississauga (and removal of the section between downtown Brampton and Shopper's World for bus routes 2 and 52);
- Mississauga Bus Transit proposals; and

The transit improvements will focus upon providing improved services with branded vehicles and stations, some intersection priority measures and real time information for passengers. In Brampton the Shoppers World transit terminal will be relocated to front Main Street.

Project Options

Three options have been identified for the Hurontario/Main Street project and a summary description of each option is provided below. Each of the options will be compared to the Base Case. For each option it is assumed that a circulator transit service is in operation in Mississauga

City Centre providing connections within the central area and to and from the Hurontario/Main transit service. The characteristics of the circulator service will be:

- Clockwise service of Square One running on City Centre Drive, Burnamthorpe Road, Living Arts Drive, and Rathburn Road;
- 9.5 minute journey time;
- 3 minute frequency;
- Stations at:
    - Rapid Transit stop at City Centre Drive / Robert Speck Parkway;
    - Burnhamthorpe Rd. between Kariya Gate and Duke of York Boulevard (future Main Street);
    - Civic Centre at Princess Royal Drive and Living Arts Drive; and
    - Transit Centre Terminal on Rathburn Road.

The combination of high order transit service and circulator service is intended to provide an appropriate public transit offer. The final identification of phasing and scheme design will result from further detailed assessment and planning work.

Finally, in order to deal with congestion on Highway 403 and capacity constraints at that location, it has been suggested that a 2 lane transit-only structure be built across Highway 403. Note that if any additional features are required (e.g. general traffic lanes) these would not be funded as part of this project. The cost of the transit-only structure has been included in the development of this report.

Option 1 – Corridor LRT

This option will provide a primarily on-street segregated LRT system running within the existing road right of way of Hurontario Street from Port Credit in the south to Brampton in the north. It is assumed that the local bus service will be discontinued and replaced with the LRT service. The LRT will run at grade with signal priority at intersections. The characteristics of the route are:

- Port Credit to Cooksville GO - The route is assumed to operate with traffic within the existing 4 lane road corridor from Port Credit to the six-lane road corridor north of QEW using physical and signal priority at each of the signalled intersections. The LRT would also be given priority over traffic under the GO Line to mitigate the need to widen the existing bridge. Segregated alignment would be provided at proposed stations. The remainder of the route would operate in a segregated LRT alignment taking over existing road space as necessary through to Cooksville;
- Cooksville GO to Mississauga (Mississauga City Centre Drive) – The route is assumed to run within the existing roadway from Cooksville through to Mississauga where the route would divert through an unopened road allowance on to City Centre Drive to provide better

connectivity to Square One with a stop at Robert Speck Parkway. The route would then turn up a widened Square One Drive, crossing the 403 using the new, transit-only structure, and then rejoining Hurontario Street; and

- Mississauga to Brampton - From Brunel Road through to Elgin Drive the route would be segregated within the existing roadway. Through Brampton priority gates and dedicated stop infrastructure would be used, as road widening would be difficult to achieve.

An alternative to road widening, in order to achieve segregation would be tunnelling. However, for the purposes of this Benefits Case this has not been considered due to its anticipated negative impact on the performance of the option due to the substantial cost implications. Within Downtown Brampton, as for Mississauga City Centre, the eventual transit service configuration will reflect the findings of a detailed design assessment.

There are a total of 28 stations proposed and Table 1 lists them. The stop positions have been identified on the basis of serving key origins and destinations along the route. A potential maximum stop distance of 1,000 metres was used as a guide.

TABLE 1 OPTION 1 STOPS (LRT)

Route Section	Station Locations (South to North)	
Port Credit to Cooksville GO	1. Lakeshore Road 2. Port Credit (GO) 3. Mineola Road 4. Pinetree/QEW 5. Harborn Road	6. Trillium Health Centre 7. Paisley Blvd 8. Dundas Street 9. Cooksville GO
Cooksville GO to Mississauga City Centre	10. Central Parkway 11. Burnhamthorpe/Matthews Gate	12. City Centre Drive / Robert Speck Parkway
Mississauga City Centre to HW 407	13. 403 Transit Terminal/Rathburn 14. Eglinton Avenue 15. Ceremonial Drive 16. Bristol Drive 17. Matheson Boulevard	18. Britannia Road 19. Courtneypark Drive 20. Derry Road 21. Highway 407
HW 407 to Downtown Brampton	22. County Court South (Ray Lawson Boulevard) 23. County Court North (Sir Lou Drive) 24. Shoppers World	25. Elgin Drive/Charolais Blvd. 26. Nanwood Drive 27. Wellington Street 28. Brampton Station

The estimated travel time from end to end of the LRT line is 38 minutes. Despite signal priority at intersections, the travel time will vary to some degree dependent on traffic congestion. Table

1 below shows the estimated travel times based on assumed average speeds and station spacing. The average speed is based on the assumption that there are no major delays.

The operational reliability of the route will vary along its length depending on the level of segregation provided. Where completely segregated, the run times will be consistent whereas, where the route is at-grade crossing road intersections services will be delayed even with significant signal priority. Experience from similar LRT systems shows that this delay is in the order of 10%, which on the proposed route could provide a variation in run time of about 4 minutes. This potential variability in journey time can result in differential headways which at peak times can increase the dwell times of vehicles at busy stops potentially increasing the travel time further.

TABLE 2 OPTION 1 TRAVEL TIMES AND SPEEDS

Route Section	Distance	Average Speed	Travel Time
Port Credit to Cooksville GO	4.6 km	31 kph	9 min
Cooksville GO to Mississauga City Centre	1.9 km	33 kph	3 min
Mississauga City Centre to HW 407	9.1 km	34 kph	16 min
HW 407 to Downtown Brampton	5.2 km	33 kph	10 min
TOTAL ROUTE	**20.8 km**		**38 min**

The average speed for the section of the alignment between Highway 407 and Downtown Brampton takes account of the reduced operating speed for the last 1.5 km through Brampton where the average speed of the LRT vehicle would be between 20 and 25 kph.

For the purposes of the Benefits Case, it is assumed that LRT vehicles have a capacity of 130 passengers per vehicle. This is consistent with the relatively conservative Toronto Transit Commission service planning guidelines used in previous Benefits Cases and would provide a high-level service to the passengers. RTP forecasts suggest demand on the corridor will reach 5,500 passengers per peak hour per peak direction (north and south Mississauga) by 2031[3].

This suggests service frequency will have to be increased over the life of the project and we suggest running a 3 minute frequency until 2021 (for capacity of 2,600 passengers) and introducing 2 car trains at the same frequency in 2021 (capacity of 5,200 passengers based on TTC capacity loadings).

[3] This information is in the RTP Modelling Backgrounder, available on the Metrolinx website.

For Option 1 a total of 36 LRT vehicles would be required including spares to provide the required 3 minute service with a single 30 metre vehicle. The fleet requirements would double after 2021 to 72. This is summarized in Table 3.

To provide additional passenger capacity depending upon the demand identified when modelled the following vehicle scenarios are possible.

TABLE 3 OPTION 1 VEHICLE REQUIREMENTS AND CAPACITY

Vehicle Scenario	Number of Vehicles	Capacity
30 metre at 3 minute HW	36	2,600
Coupled 2 x 30 metre at 3 minute Headway	72	5,200

A dedicated maintenance facility would be required. At this stage its location has not been determined, however initial findings from work undertaken for the Hurontario/Main Street Study has identified the vicinity of Highway 407 as offering the most suitable area.

Option 2 – Corridor BRT

This option includes the same alignment and stations as Option 1 except it assumes BRT technology for the corridor. The average speed of the BRT in the at-grade sections is assumed to be 25 kph. It is assumed that the express bus services will be discontinued and replaced with the BRT service.

The estimated travel time from end to end of the BRT line is 51 minutes. Despite signal priority at intersections, the travel time will vary to some degree dependent on traffic congestion. Table 4 below shows the estimated travel times based on assumed average speeds and station spacing. The average speed is based on the assumption that there are no major delays.

The operational reliability of the route will vary along its length depending on the level of segregation provided. Where completely segregated the run times will be consistent whereas, where the route is at-grade crossing road intersections service will be delayed even with significant signal priority. Experience from similar BRT systems shows that this delay is in the order of 10%, which on the proposed route could provide a variation in runtime of about 5 minutes. This potential variability in journey time can result in differential headways which at peak times can increase the dwell times of vehicles at busy stops, potentially increasing the travel time further.

TABLE 4 OPTION 2 TRAVEL TIMES AND SPEEDS

Route Section	Distance	Average Speed	Travel Time
Port Credit to Cooksville GO	4.6 km	23 kph	12 min
Cooksville GO to Mississauga City Centre	1.9 km	25 kph	5 min
Mississauga City Centre to HW 407	9.1 km	25 kph	22 min
HW 407 to Downtown Brampton	5.2 km	24 kph	13 min
TOTAL ROUTE	**20.8 km**		**51 min**

NOTE: Totals may not sum due to rounding

For the purposes of the Benefits Case, it is assumed that articulated buses have a capacity of 90 passengers per vehicle. This is consistent with service planning guidelines elsewhere in the region and would provide a high-level service to the passengers. The service has been assumed to provide a 3 minute peak frequency, which would provide a peak design load of 1,800 passengers per hour per direction. The minimum operable frequency would be approximately 2 minutes based upon the priority and effect on intersection capacity. This would provide a peak capacity of 2,700 passengers per hour per direction. Operation of a route at this high frequency is achievable, but would require significant levels of priority at intersections and could result in an increased journey time with greater BRT delays at intersections.

A total of 42 BRT vehicles would be required including spares to provide the required 3 minute service with a single 18 metre articulated vehicle. A dedicated maintenance and storage facility would be required and was included in the analysis for costing work, although no specific site has been selected.

To provide additional passenger capacity, depending upon the demand identified when modelled, the following vehicle scenarios are possible.

TABLE 5 OPTION 2 VEHICLE REQUIREMENTS AND CAPACITY

Headway	Number Vehicles	Capacity
5 minutes	26	1,100
4 minutes	33	1,350
3 minutes	**42**	**1,800**
2 minutes	64	2,700

Option 3 – Corridor LRT & BRT

Note that Option 3 was developed to provide an indication on how BRT and LRT would interact and the effect of a transfer on the corridor, therefore this option splits the route between modes, with the section from Port Credit through to Mississauga operating as LRT and a BRT route running from Mississauga through to Brampton. Potential implementation phasing will need to be examined through more detailed design work.

The provision of LRT on the southern section rather than the northern section reflects the existing and proposed land use development along the corridor. While significant growth is forecast for north of Mississauga City Centre, it is starting from a lower base compared to Mississauga City Centre and south Hurontario/Main Street corridor (collectively making up the Downtown Mississauga Urban Growth Centre) where intensification is proposed. Additionally, the southern end of the corridor is anchored by two higher-order transit corridors which are targeted for short term implementation: the GO Lakeshore Line (the first rail corridor targeted for significant upgrades in the RTP) and the 403 Transitway, which is very close to construction phase.

The stop locations are also assumed to be in the same locations as the BRT/ LRT options described previously. The same average speeds for each mode are also assumed. The estimated journey time for the LRT between Port Credit and City Centre Drive is 12 minutes. The estimated journey time for the BRT section to Brampton is 35 minutes.

Again, as for the previous two options, the operational reliability of the route will vary along its length depending on the level of segregation provided. Where completely segregated the runtimes will be consistent whereas, where the route is at-grade crossing road intersections service will be delayed even with significant signal priority. Experience from similar LRT/ BRT systems shows that this delay is in the order of 10%, which on the proposed route could provide a variation in runtime of about 1 minute for the LRT and 4 minutes for the BRT. This potential variability in journey time can result in differential headways which at peak times can increase the dwell times of vehicles at busy stops potentially increasing the travel time further.

TABLE 6 OPTION 3 TRAVEL TIMES AND SPEEDS

Route Section	Distance	Average Speed	Travel Time
LRT ROUTE			
Port Credit to Cooksville GO	4.6 km	31 kph	9 min
Cooksville GO to Mississauga City Centre	1.9 km	33 kph	3 min
TOTAL LRT	**6.5 km**		**12 min**
BRT ROUTE			
Mississauga City Centre to HW 407	9.1 km	25 kph	22 min
HW 407 to Downtown Brampton	5.2 km	24 kph	13 min
TOTAL BRT	**14.3 km**		**35 min**

The assumptions on vehicle capacity are as previously detailed, namely 130 passengers for a 30 metre LRT vehicle and 90 passengers for an articulated bus. A total of 12 LRT vehicles is required until 2021 and 24 afterwards. 32 BRT vehicles would be required. These numbers include spares to provide the required 3 minute service frequencies.

As for Options 1 and 2 maintenance facilities will be required. For LRT the proposed depot area assumed for Option 1 is inappropriate for this option due to it being significantly north of Mississauga City Centre. Therefore an alternative location for Option 3 would be required to service this segment within close proximity of the corridor and the current established land uses will make this a challenge that would need to be addressed. A dedicated BRT maintenance and storage facility would also be required and was included in the analysis for costing work, although no specific site has been selected.

Summary of Options

The summary of key option statistics is set out in Table 7.

TABLE 7 SUMMARY OF OPTIONS

Assumptions	Option 1 - LRT	Option 2 - BRT	Option 3 – LRT/BRT
Opening Year	2015	2015	2015
Headway	3 min	3 min	3 min
Capacity (per hour per peak direction)	2,600 / 5,200	1,800	2,600 / 5,200 (LRT) & 1,800 (BRT)
LRT Vehicles	36 / 72	-	12 /24
BRT Vehicles	-	42	32
Travel time (end-to-end)	38 min	51 min	12 min & 35 min
Bus Circulator Mississauga City Centre	Yes	Yes	Yes
Depot facility	LRT depot located vicinity of Hwy 407	BRT depot costed but no specific site selected	LRT depot costed but no specific site selected BRT depot costed but no specific site selected

NOTE: LRT Fleet Capacity and Requirements: To 2021/After 2021

Part C Assessment

Evaluation Framework

The comparative analysis uses a Multiple Account Evaluation (MAE) methodology. The MAE is a framework that provides a systematic identification and analysis of broader implications and criteria of an option. It systematically compares the impacts on costs, users, environment, economy and community and shows the trade-offs among the often conflicting criteria.

The MAE framework includes a number of evaluation accounts that together address the most significant project performance and policy considerations for a specific project. The criteria and the accounts can be tailored for a project. The relevant accounts for the analysis of the Hurontario/Main Street project are:

- Transportation User Benefits;
- Financial Impacts;
- Environmental Impacts;
- Economic Impacts; and
- Socio-Community Impacts.

It is important to note that the options defined in this report have only been developed to a level of technical detail sufficient to enable a comparative analysis for the purpose of selecting a preferred option. Project scope, costs and service plans need to be developed in more detail for funding and implementation.

The assessment is done by comparing each option to the Base Case and identifying any incremental costs or benefits that are generated by each option. Hence, the results should not be interpreted as "total" values, but as the incremental impact compared to the Base Case.

The analysis is done over a 30-year period (2009-2038). Where possible the impacts are monetized and quantified. In order to compare the options on a "like-to-like" basis and to reflect time value of money the monetized values are discounted to today's value at a real discount rate of 5%. These values, and other input variables used in this analysis are shown in Appendix A.

Transportation User Benefits

This account considers the incremental benefits to the transportation users as a result of the investment in the Hurontario/Main Street project. The monetized benefits are measured in travel time savings for both transit users and road users; automobile operating cost savings achieved by

individuals as their trip times or overall automobile usage declines; and reduction in accidents as a result of declining automobile usage.

In addition to the monetized benefits, there are qualitative user impacts which may include passenger comfort, accessibility and reliability. In most instances they are captured in the ridership and travel time savings, but in some instances they can be isolated and identified separately if significantly different among the options.

All transportation user benefits described below are incremental to the Base Case.

Travel Time Savings

Travel time savings are included for both transit and non-transit users. With the improvement of transit services along the Main Street in Hurontario between Port Credit and Downtown Brampton, the analysis shows that the investment will generate significant time savings for existing transit users (those who currently travel on buses), new transit users and auto users. The value of time is estimated at an average of $13 per hour[4] and is expected to grow, in real terms, by 1.6% per year over the period.

Option 1 delivers the highest transit incremental benefits, followed by Option 3 while Option 2 provides the lowest level of travel time savings. This is because the journey time savings offered by the LRT option delivers significant additional benefits to transit users, which in turn attracts significantly more new users. As a comparison Option 2 is considerably slower and Option 3 requires a transfer between BRT and LRT. However overcapacity issues have been identified for the BRT (Option 2) suggesting that medium/long-term capacity needs are unmet. **Comparative tables throughout this report have Option 2 results in grey to indicate that long-term capacity needs are unmet.** See 'Ridership and Revenues' section for further background on forecast estimates.

The present value of travel time savings for both transit and auto users over the evaluation period (2009-2038) is largest for Option 1, the Full LRT option, estimated at $1,154 million in present value terms and significantly greater than the travel time savings generated by Option 3 at $238 million. Option 2, the Full BRT option, generated the lowest travel time savings of the three options resulting in a present value savings of $174 million.

Automobile Operating Cost Savings

Automobile operating costs savings are derived from a reduction in auto kilometres as a result of the transit investment. The analysis shows that the Hurontario/Main Street project will result in reduced auto usage and that the degree of the decline is related to the rapid transit technology. It is estimated that the reduction in auto kilometres by 2031 ranges from 67 million vehicle kilometres for Option 2 to more than 111 million kilometres for Option 1.

[4] See Appendix A for details.

Translating these savings into monetary terms, the present value of the automobile operating cost savings over the period are $569 million, $331 million and $412 million for Options 1, 2 and 3 respectively. The estimates for all options are shown in Table 8.

The automobile operating cost savings are greatest for the LRT options reflecting the ability for LRT to draw a greater number of auto users to transit than BRT for at least a portion of their journey or an occasional trip.

Safety Benefits

The reduction in collisions is based on fewer vehicle kilometres driven. The monetary savings resulting from a reduction in collisions is calculated based on an assumed value of 7 cents per kilometre in reduced road travel (see Appendix A). The present value of safety benefits over the period ranges between $56 million for Option 1 to $33 million for Option 2. The estimates for all options are shown in Table 8.

Qualitative Transportation Benefits

The major differences among the Hurontario/Main Street options from a user's perspective are travel time, reliability, need for transfer and passenger comfort. Travel time and transfer requirements are largely captured in the travel time savings estimates. Therefore, from a user's perspective, the options are differentiated by the degree to which service and schedule reliability are achieved and by passenger comfort.

Under all three of the Hurontario/Main Street options, the operating assumptions include significant signal priority at intersections along the corridor. Despite these priority measures, the at-grade alignments proposed for both BRT and LRT will create challenges for both technologies. While transit only lanes will enhance the reliability of the LRT option, both technologies will likely experience some variability in travel time depending on traffic congestion and cross-traffic at intersections as well as accidents.

The comparatively strong benefits generated by LRT are in large part driven by the higher average travel speeds, and consequently lower travel times, relative to BRT. For the purpose of this comparative assessment, average speeds for LRT were assumed to be between 31 and 34 kph as compared to 25 kph for BRT. While these average speeds are achievable, as demonstrated in other jurisdictions, the LRT will likely require signal priority along much of the corridor to ensure that these average speeds can be maintained. As indicated earlier, the majority of the benefits are related to travel time savings which in turn is related to the operating speeds and travel time.

Summary

Table 8 summarizes the incremental transportation user benefits associated with the Hurontario/Main Street project.

TABLE 8 INCREMENTAL TRANSPORTATION USER BENEFITS

All Values in NPV $m in 2008 prices	Option 1	Option 2	Option 3
Travel Time Savings	$1,154	$174	$238
Automobile Cost Savings	$569	$331	$412
Accident / Collision Reductions	$56	$33	$42
Transportation User Benefits	**$1,779**	**$538**	**$692**

Financial Account

This account includes the assessment of the direct incremental "cash" items, primarily costs and revenues from the owner's perspective, for each option over the assessment period. Costs include the incremental capital and operating costs incurred by each option compared to the Base Case. Incremental revenues may also include fare revenues, advertising, and proceeds from disposal of assets. Any savings resulting from the implementation of the options are also included in this account.

Ridership and Revenues

Table 9 shows the maximum passenger link flows by direction for the various options, with Option 3 split between the LRT and the BRT sections.

TABLE 9 PASSENGER FORECASTS (AM PEAK HOUR LOAD BY DIRECTION, MAXIMUM)

	Option 1		Option 2		Option 3 (LRT)		Option3 (BRT)	
	NB	SB	NB	SB	NB	SB	NB	SB
2021 AM Peak								
Passengers	2,500	4,600	1,200	2,900	1,800	2,600	900	2,300
Capacity Assumptions	5,200	5,200	1,800	1,800	5,200	5,200	1,800	1,800
Over-Capacity?	No	No	No	Yes	No	No	No	Yes
2031 AM Peak								
Passengers	2,800	5,400	1,300	3,200	1,900	3,200	950	3,100
Capacity Assumptions	5,200	5,200	1,800	1,800	5,200	5,200	1,800	1,800
Over-Capacity?	No	Yes	No	Yes	No	No	No	Yes

The ridership estimates show Option 1 attracts the highest demand. This is primarily because of the journey times offered by Option 1 are significantly faster than Option 2 or do not require a transfer compared to Option 3 and therefore has the ability to attract a greater mode shift from auto to transit.

As indicated previously, and shown in the table, maximum model forecasts indicate demand exceeds capacity (note that the model is not capacity constrained) for the BRT sections in the southbound direction as a result of their relatively low capacity compared to forecast flows.

Further review of the southbound flows show heavy forecast flows on the local bus network (bus route #19) on certain sections of the route south of Dundas, at levels well beyond the capacity of BRT or BRT plus the local transit system would be able to accommodate. As an example, the section at Queensway shows southbound corridor demands in 2021 between 3,700 and 4,000 peak hour passengers per direction for all options. This demand is considerably higher than bus-based systems can accommodate and comparative tables throughout this report have the Option 2 column in grey to indicate that long-term capacity needs are unmet.

Based on these ridership estimates, the analysis shows that in 2031 (from a system-wide perspective) Option 1 would generate incremental annual fare revenues of close to $10,600 versus $840 and $1,200 for Options 2 and 3 respectively. In net present value terms over the

period of the analysis, incremental revenues are $105 million, $8 million and $12 million for Options 1, 2 and 3 respectively.

Capital and Operating Costs

The capital costs include all costs associated with the construction and acquisition of the infrastructure, revenue collection, vehicles, and maintenance centre. The estimates also include, design, management & administration, insurance, environmental permitting, property, and contingencies.

The construction period is assumed to be the same for all three options with start in 2011 and completion by 2014 for opening of service in 2015. Predictably, Option 1 has the highest capital cost of the three options with an estimated cost of $1,346 million in 2008 prices. The full BRT proposed under Option 2 is estimated to cost $359 million while the estimated capital cost for the LRT/BRT Option 3 is $755 million (all costs excluding interest during construction). For Options 1 and 3 the LRT vehicle costs have been split to reflect opening and 2021 capacity assumptions while BRT vehicle costs for Options 2 and 3 include vehicle replacement costs in 2026-27.

Table 10 shows the capital costs and operating costs for each option. All values are expressed in 2008 dollars.

TABLE 10 CAPITAL AND OPERATING COSTS[5] ($ MILLIONS)

All Values in 2008 $m	Option 1	Option 2	Option 3
Capital Costs	$1,345m	$359m	$755m
Annual incremental operating costs (2021)	$15.8m	$6.7m	$9.7m
Annual incremental operating costs (2031)	$19.2m	$6.7m	$10.8m

The incremental operating costs assume the operating patterns identified previously (including the operation of the bus shuttle around Mississauga Centre) continue but assume Express service 202 and Züm are not operated, resulting in costs savings. The LRT operating costs are based on TTC operating estimates and assume a doubling of capacity in 2021. Bus costs are derived from Mississauga Transit ($110/hour for standard buses and $132/hour for articulated buses). For BRT,

[5] Operating costs are based on providing the different capacity assumptions identified for each alternative, not on a per passenger basis.

the bus operating cost estimate has been increased by 15% to account for additional infrastructure maintenance requirements likely to be required.

Summary

Table 11 shows the capital costs, operating costs and incremental fare revenues expressed in present value for the period 2009-2038.

TABLE 11 INCREMENTAL COSTS AND REVENUES

All Values in NPV $m	Option 1	Option 2	Option 3
Capital Costs	$1,022	$261	$572
Operating Costs	$185	$69	$107
Total Incremental Costs	**$1,206**	**$330**	**$679**
Incremental Fare Revenues	$105	$8	$12

Comparing Benefits and Costs

Table 12 compares the results from the Transportation User Benefits and Financial accounts. As illustrated in the table, all of the proposed rapid transit options generate positive net benefits resulting in a benefit cost-ratio that is greater than 1. Option 2 is the lowest cost option and generates the highest benefit-cost ratio of 1.6:1 while the full LRT option is the most costly but also generates the greatest benefits and results in a positive benefit cost-ratio. Option 3 shows a positive net benefit but this is close to the costs incurred resulting in a BCR of 1.0. It should be noted that the BCR only captures part of the benefits that contribute to the Multiple Account Evaluation. Since the BRT does not provide sufficient capacity to meet the demand in the corridor (even by 2021), the potentially very high benefit-cost ratio may be misleading as the dis-benefits of un-serviced demand have not been included.

TABLE 12 COMPARISON BENEFITS AND COSTS

All Values in NPV $m	Option 1	Option 2	Option 3
Transportation User Benefits	$1,779	$538	$692
Incremental Costs	$1,206	$330	$679
Net Benefit (Cost)	**$572**	**$208**	**$13**
Benefit-Cost Ratio	**1.5**	**n/a[6]**	**1.0**

Environmental Impacts

This account examines the environmental impacts of the Hurontario/Main Street Transit options. The major environmental impact with respect to urban transit projects is the ability of the project to reduce greenhouse gas emissions from reduced automobile usage.

Greenhouse Gas Emissions

As mentioned in the Transportation User Benefits section, all three options lead to an annual decline in automobile usage. By 2021, it is estimated that the number of kilometres travelled by automobile will decline by almost 65 million kilometres annually under Option 1. The annual reduction anticipated under Options 2 and 3 are approximately 36 million and 54 million kilometres respectively in 2021. By 2031 the annual reduction in vehicle kilometres increases significantly to 111 million kilometres for Option 1 whereas Option 2 and 3 increase to around 67 million and 68 million kilometres respectively.

As shown in Table 13, this translates into an annual reduction of CO_2 emissions ranging from 7,300 tonnes for Option 2 to 13,000 for Option 1. These annual reductions increase by 2031 to more than 22,000 tonnes for Option 1 and 13,000 tonnes for Options 2 and 3.

The present value of the reduction in CO_2 emissions over the period 2009-2038, based on an average value of $0.01 per kilometre (see Appendix A), is estimated at $8.0 million for Option 1, $4.7 million for Option 2 and $5.9 million for Option 3. The value of a tonne of CO_2 is currently a subject of debate. These figures, regardless of the value assigned per tonne of CO_2, are still very useful for comparison purposes among the options.

[6] Benefit-Cost ratio is not provided as the disbenefits of un-serviced demand have not been included

TABLE 13 REDUCTION IN CO_2 EMISSIONS

	Option 1	Option 2	Option 3
2021 Reduction in CO_2 tonnes	13,000	7,300	10,900
2031 Reduction in CO_2 tonnes	22,000	13,300	13,400
NPV Value ($ m)	8.0	4.7	5.9

Economic Development Impacts

This account measures the economic impacts for each scenario relative to the Base Case, including impacts from construction and economic impacts incurred from implementation of project options. These impacts are reported in terms of GDP. The change in jobs and the change in the associated labour income are stated in 2008 dollars. Results reflect how the implementation of the Hurontario/Main Street Rapid Transit Project will directly affect both households and businesses in the regional economy, and total provincial economic impacts that are derived by applying Ontario specific multipliers to derive indirect affect of employment, wages and GDP generated by the direct impacts of construction and improvements to the transportation network.

This account also includes an assessment of the incremental impacts the options will have on land values and development in the corridor.

Temporary Economic Impacts During Construction

The implementation of the Hurontario/Main Street Rapid Transit Project will generate both direct and indirect economic benefits that are temporary in nature and span the schedule of construction. As shown in Table 14, the construction is estimated to create between 843 and 4,506 person-years of employment and between 466 and 2,494 person-years of employment indirectly as a result of increased economic activity for suppliers. The impact on employment, wages and GDP is driven by the capital cost required to build each option. Option 1, which has the highest capital cost of the three options, also has the largest employment and income impacts.

TABLE 14 EMPLOYMENT AND INCOME IMPACTS DURING CONSTRUCTION

Option	Direct Impacts			Regional (Indirect) Impacts		
	Employment (person years)	Wages ($m)	GDP ($m)	Employment (person years)	Wages ($m)	GDP ($m)
Option 1	4,506	$174.0	$383	2,494	$96.3	$213
Option 2	843	$32.5	$72	466	$18.0	$40
Option 3	2,363	$91.3	$201	1,308	$50.5	$111

Long-term Economic Impacts

In the long-term there will be ongoing economic benefits as a result of the Hurontario/Main Street Rapid Transit Project. These benefits reflect both households' freed up vehicle operating expenditures and transportation cost savings to area businesses. The former effect is simply a redirected consumption demand by households away from purchases of gas, parking, automotive parts and services and into other consumer goods/services.

The latter reflects improved regional competitiveness for local businesses that now have lower costs of doing business, including access to a larger labour market and encountering less congestion on roadways because people are choosing to use the transit system instead of driving. The impact of the Hurontario/Main Street Rapid Transit project will be different for each business.

Implementation of the Hurontario/Main Street Rapid Transit project will also generate social benefits that can be monetized, including valuing time savings and emission benefits. These have already been captured above under transportation user benefits.

As shown in Table 15, the Hurontario/Main Street Rapid Transit project is also expected to have an on-going and positive impact on jobs, wages and the GDP once it is in operation. The impacts for each option are driven by transit and auto travel time savings provided by each option. Option 1 has the greatest employment and income impact with an estimated 406 direct jobs and 169 indirect jobs created in 2031. The long term economic impacts of Option 2 are limited.

TABLE 15 EMPLOYMENT AND INCOME IMPACTS

Scenario	Direct Annual Impacts			Indirect Annual Impacts		
	Employm. (Jobs)	Wages ($m)	GDP ($m)	Employm. (Jobs)	Wages ($m)	GDP ($m)
2031						
Option 1	406	$15.1	$34.6	169	$7.0	$14.4
Option 2	10	$0.4	$0.8	6	$0.2	$0.5
Option 3	183	$7.0	$15.6	77	$3.0	$6.5

Land Value Changes

There is evidence from a number of different jurisdictions around the world that investment in rapid transit can have a positive impact on property values in the general area of a new rapid transit line and particularly within close proximity to station areas. This evidence also suggests that the specific rapid transit technology is also a determining factor in the degree to which property values may be influenced. For example, a more permanent, rail-based, higher capacity technology such as LRT will typically capture a larger area of property within their area of influence than lower capacity bus-based transit facilities. As shown in Table 16, the catchment area around at-grade LRT is typically 500 metres as compared to the slightly smaller catchment area around a BRT station estimated to be 400 metres.

As indicated in the table, the introduction of rapid transit will provide a modest lift in percentage terms to land values within the applicable area of station impact. Based upon the ranges shown, BRT has up to 2% and 4% property uplift for residential and commercial respectively while LRT 4% for both residential and commercial, in addition to the greater impact area as mentioned above.

TABLE 16 PROPERTY VALUE UPLIFT FACTORS

Technology		BRT	LRT
Station Impact Area		**400m**	**500m**
Residential	Low	1%	2%
	High	2%	4%
Commercial	Low	2%	2%
	High	4%	4%

Based on the ranges of value uplift found in research studies reviewed for this analysis, land uses along the proposed Hurontario/Main RT route and the current property value data obtained from the cities of Mississauga and Brampton, the potential land/property value uplift is estimated for the three implementation options currently under consideration. The following summarizes the assessment for each of the options.

Option 1 – Corridor LRT

Option 1 contemplates LRT technology being introduced along the entire route. Under this option, land value uplift is estimated to impact all 28 station areas. The impact of the LRT technology can be expected to result in station impact areas to be approximately 500m around each station.

Land value uplift is calculated by multiplying the percentage of value uplift typical for each land use by the total assessment of lands within station areas in each land use category. Within the land area impacted by Option 1, the average uplift is between 1.5% and 3.1%. It is estimated that the potential uplift in assessment value as a result of this Option could result in approximately $208 million to $417 million.

Option 2 – Corridor BRT

Option 2 contemplates a BRT service to be introduced using a route that follows the same route as in Option 1. Research undertaken indicates that the station area impacts for BRT are generally within 400m of the station. Therefore, for the purpose of this analysis, the impact on the Hurontario/Main RT is estimated at 400m impact area for each of the 28 station areas.

The station spacing is the same as Option 1. As a result, Option 2 is estimated to create a lower overall impact area and imply lower land value uplift benefits accrued to the project.

Within the area impacted in Option 2, the average uplift is between 1.2% and 2%. It is estimated that the potential uplift in assessment value as a result of this Option may result in nearly $98

million to $157 million. Under this Option, two factors, namely a lower area for uplift and BRT technology, are considered the primary factors resulting in the lands/properties being subject to lower uplift as compared to using the LRT technology in Option 1.

Option 3 – Corridor LRT & BRT

Option 3 considers a mix of technologies serving the corridor. LRT technology will operate along 12 of the 28 stations. This results in a decrease in the total number of stations served by LRT technology as compared to Option 1. The remainder 16 stations will be served by BRT technology. Since 12 of the station impact areas are served by LRT technology, having a larger impact area of 500m will increase the overall impact area in this Option as compared to Option 2.

Within the area impacted in Option 3, the average uplift is estimated in the range of 1.4% to 2.8%. It is estimated that the potential uplift in assessment value as a result of this Option may result in almost $158 million to $317 million. The impact area for LRT is expected to be larger than that for BRT hence offering an increased uplift as compared to Option 2. However when comparing with Option 1, the smaller number of stations under LRT results in lower impact area as compared to Option 1 and is estimated to result in a less amount of land/property being subject to uplift effect.

Summary

Table 17 summarizes the economic development impacts including direct and indirect impacts along with the land value uplift for each option.

TABLE 17 ECONOMIC DEVELOPMENT IMPACTS

	Option 1	Option 2	Option 3
Total Impacts During Construction Period:			
Employment (Person-years)	7,000	1,309	3,671
GDP ($m)	$270m	$51m	$142m
Income ($m)	$596m	$111m	$312m
Impacts in 2031:			
Employment (jobs)	575	16	260
GDP ($m)	$22m	$1m	$10m
Income ($m)	$49m	$1m	$22m
Land Value Increase			
Low Estimate ($m)	$208m	$98m	$158m
High Estimate($m)	$417m	$157m	$317m

Social Community Impacts

This account examines each option from the community perspective with specific consideration given to the ability of each option to enhance the quality of life within a local community. This may result from land use changes or developments that can occur in response to the introduction of a new rapid transit line, as well as the improvements brought about by the enhanced accessibility, both locally and regionally, offered by the new transit alternative. This account also considers the ability of each option to positively affect the overall health of the local community and its residents through reduced auto congestion on local streets as well as the ability of transit to support a more balanced lifestyle for local residents along with enhanced personal safety. Visual impacts and noise are also assessed as part of this account.

Land Use Shaping

Experience in other jurisdictions demonstrates that, when combined with complementary local planning initiatives, the implementation of transit can positively support and influence development, particularly around rapid transit stations, and promotes more compact, mixed use

communities. The type and magnitude of the development is dependent upon a number of factors including the general nature of the transit corridor and the surrounding neighbourhoods.

As shown in the land value uplift section above, the Hurontario/Main Street corridor is a well establish corridor within the city consisting of a mix of residential, commercial, retail, industrial, recreational (parks) and institutional uses. Densities also vary along the corridor with more concentrated development occurring closer to the city centre and within the downtown section of the proposed rapid transit alignment.

For the purpose of this analysis, it is assumed that, consistent with the land value uplift estimates presented earlier in this report, all three transit options are capable of promoting land use changes to support the local planning initiatives and changes to the local zoning. While it is difficult to quantify, it is generally accepted that investments in rail rapid transit initiatives are more likely to attract complementary land development investments compared to bus-based transit initiatives, provided that the transit investment is undertaken in concert with other complementary planning initiatives. With this in mind, the investment associated with the fixed rail infrastructure proposed under Options 1 is more likely to result in the redevelopment of the corridor and therefore achieve the city's objective to revitalize the city's core and create a more densely developed, less car-dependent urban environment.

Road Network

As proposed, the new rapid transit line will impact the local road network in two significant ways. Firstly, based on the average transit speeds proposed for the corridor, particularly LRT which is proposed to operate at an average speed of between 31 and 34 kph, a significant level of signal priority will be required to support the transit operation. Depending on the extent of signal priority required, there is the potential to negatively impact traffic at intersections where there are likely to be longer delays while priority is given to the LRT/BRT.

Construction

All three options will involve a certain degree of disruption to traffic, neighbouring commercial, retail and residential properties during construction. While the specific construction impacts associated with the implementation of each option cannot be determined until the project is defined in more detail, it is assumed that the LRT construction will be more disruptive than the BRT options.

Sensitivity Analysis

Discount Rate

Since the analysis is based on discounted cash flow and subject to changes as the discount rate changes, the robustness of the ranking of the options with respect to the benefit-cost ratio was tested under two alternative discount rates – 3% and 7%. As shown in Table 18, under all discount

rate tests Option 1 shows the highest BCR. The NPV changes considerably with the 3% test showing between $350 and $1,140m benefits while at 7% Option 3 shows a negative NPV.

TABLE 18 DISCOUNT RATE SENSITIVITY ANALYSIS

Discount Rate	3%		5%		7%	
Option	**NPV ($m)**	**BCR**	**NPV ($m)**	**BCR**	**NPV ($m)**	**BCR**
Option 1	1,141	1.8	572	1.5	220	1.2
Option 3	352	1.4	13	1.0	-98	0.8

Summary of Results

The analysis of the Hurontario/Main Street rapid transit options reveals that the highest cost option (Option 1, the full LRT along the Main Street corridor), with estimated capital and operating costs of $1,206 million in net present value terms, also generates the highest transportation user benefits. These are estimated at $1,779 million resulting in a benefit-cost ratio of 1.5:1. By comparison, Option 2 (the full BRT option), generates an estimated $538 million in Transportation User Benefits. However demand levels for this option are considerably higher than bus-based systems can accommodate suggesting that that long-term capacity needs are unmet.

By combining the LRT and BRT technologies in Option 3, the transportation user benefits, at $692 million in present value terms are higher than the BRT only Option, but with considerable costs due to the LRT element the benefit-cost ratio reduces to 1.0:1. This suggests that mixing the two technologies does not optimize the economic performance of rapid transit along this corridor.

For Option 1 the majority of benefits are derived from the travel time savings due to the faster journey times offered by LRT, highlighting the importance of the operating speed of the rapid transit system to the success of the project. Options 2 and 3 deliver less travel time savings and the auto time savings become the largest element of transportation user benefits. Given the supportive transit signal priority measures proposed under each of the options, there is an opportunity to establish a new performance standard for the region to fully realize the benefits from the rapid transit investment with LRT.

None of the options generate sufficient incremental fare revenues to cover the incremental operating cost associated with the introduction of the new rapid transit line. The greatest incremental fare revenues are generated by Option 1 which is also the most costly to operate on an annual basis. The relatively low incremental fare revenues however indicate that much of the travel time savings are associated with improved travel times for existing riders, which does not

contribute to additional fare revenue for the operator. However incremental revenue for Option 1 covers a higher proportion of the operating costs (57%) than Options 2 and 3 (11%).

All of the options are somewhat effective in attracting people out of their cars and reducing automobile usage. Option 1, which has the largest effect, will result in a reduction of greenhouse gas emissions by approximately 13,000 tonnes annually by 2021 increasing to 22,000 tonnes by 2031. In net present value terms, this equates to $8.0 million for Option 1 compared to $4.7 million and $5.9 million for Options 2 and 3 respectively.

As expected the options with the highest capital costs generated the most significant economic development effects. Option 1, which has the highest capital cost will have the largest impact on employment, income and GDP during construction and is estimated to generate approximately 7,000 person-years of employment[7]. By contrast, the lower cost BRT option produces the lowest overall economic development and employment benefits during construction as well as during the on-going operations.

All of the options support the GTHA land use and economic development objectives to revitalize the corridor by enhancing and supporting complementary planning and densification initiatives. LRT demonstrates a greater ability to attract investment and redevelopment than the BRT alternative and consequently provides higher property value uplift. At the upper end of the range of estimated uplift, LRT Option 1 produces more than double the uplift of the BRT Option 2 at $417 million versus $157 million, with the LRT/BRT Option 3 estimated at $317m. At the lower end of the range, the difference is less dramatic with Option 1 producing an estimated $208 million in property value uplift versus $98 million for Option 2 and $158 million for Option 3.

Overall, the results indicate that an investment in LRT in the Hurontario/Main corridor will generate significant benefits and support the Mississauga and Brampton's broader objectives to revitalize, redevelop and reshape its most significant north-south corridor. The lowest cost option, Option 2, produces a high benefit-cost ratio but the analysis has shown demand exceeds capacity for this option by 2021 (note that the forecasting model is not capacity constrained) and suggesting it may not provide a long term solution. While only BRT sections show capacity constraints, another advantage of a LRT system is it allows for increased capacity by increasing vehicle size (from 30 to 40m vehicles) or adding new vehicles.

The highest cost option, Option 1, also produced the greatest benefits in all accounts, all of which make an important contribution towards achieving the objectives and goals of the municipalities and the Province.

Table 19 below summarizes the results from the MAE.

[7] Includes both direct and indirect impacts.

TABLE 19 MAE SUMMARY

Impact	Option 1	Option 2	Option 3
Transportation User Account			
Transportation User Benefits (PV $m)	**1,779**	538	692
Qualitative User Benefits	✓✓✓	✓	✓✓
Financial Account			
Costs (PV $m)	1,206	**330**	679
Benefits Less Costs (PV $m)	**572**	208	13
Benefit-Cost Ratio	1.5	**n/a**[8]	1.0
Environmental Account			
GHG Emissions (PV $m)	**8.0**	4.7	5.9
Economic Development Account			
Economic Impacts During Construction			
Employment (person-years)	7,000	1,309	3,671
GDP ($m)	$270	$51	$142
Income ($m)	$596	$111	$312
Long-term Economic Impacts (2031)			
Employment (person-years)	575	16	260
GDP ($m)	$22	$1	$10
Income ($m)	$49	$1	$22
Development Potential ($m)	208-417	98-157	158-317
Social Community Account			
Land Use Shaping	✓✓✓	✓	✓✓
Road Network	✓	✓	✓
Construction Implications	✓	✓✓✓	✓✓

[8] Benefit-Cost ratio is not provided as the disbenefits of un-serviced demand have not been included

APPENDIX

A

INPUT VARIABLES AND ASSUMPTIONS

Factor	Value	Source
Discount Rate Sensitivity Analysis	5% (real terms) 3% and 7%	Province of Ontario
Value of Time Business Other Weighted Average	 $35.16 (2008$) $10.82 $13.02	Transport Canada, Greater Golden Horseshoe Model
Value of Time Growth	1.6% per annum	Based on GDP per capita increases, GDP/ Population estimates from www.greatertoronto.org
Average Accident Cost	$0.07 per km	Collision Statistics: 2004 Canadian Motor Vehicle Traffic Collision Statistics, TP3322. Vehicle Kilometers: Statistics Canada, Catalogue No. 53–223–XIE, "Canadian Vehicle Survey"
Greenhouse Gas Emissions 2006 2021 2031	 2.39 kg /l or 0.23 kg per km 2.35 kg /l or 0.21 kg per km 2.35 kg /l or 0.20 kg per km	Urban Transportation Emissions Calculator, Transport Canada, Greater Golden Horseshoe Model
Average Cost of CO_2	$0.01 per km $40/tonne (median cost)	Several literature sources, Transport and Environment Canada, Greater Golden Horseshoe Model and http://envirovaluation.org/index.php/2007/09/06/university_of_hamburg_forschungsstelle_n_1
Auto Operating Costs	In 2008$ + 2.0% p.a. increase 2007 - $0.50/km 2021 - $0.65/km 2031 - $0.79/km	Data in 2007 based on CAA calculation of average driving costs and includes operating and ownership costs (long-term costs). Increase based on Greater Golden Horseshoe Model
Annualisation Factors: Metro / LRT Road	Peak-daily/Daily-Annual 3 / 300 10 / 300	Greater Golden Horseshoe Model