METROLINX

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QUEEN STREET RAPID TRANSIT LRT OR BRT BENEFITS CASE

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TRANSPORTATION

Final Report

Brampton Queen Street Rapid Transit Benefits Case

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Executive Summary

In 2008, the Metrolinx Board of Directors approved a 25-year Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) entitled **The Big Move**. The top fifteen priority projects out of the 62 that were listed were carried forward for further analysis.

To support decision making regarding these rapid transit projects, a Benefits Case Analysis (BCA) is prepared for each study. The BCAs describe a range of feasible options for each project and evaluate their performance under five Evaluation Accounts: Transportation User Benefits, Financial, Environmental, Economic Development, and Social Community.

This report sets the foundation for the BCA for rapid transit service on Queen Street in Brampton. It includes the following sections:

- **Part A - Project Rationale** – This chapter provides a project overview, describes the policy context, and considerations for the proposed project.
- **Part B – Project Options** - This section presents a summary of the options to be evaluated in the BCA, including the Base Case.
- **Part C – Project Assessment** - This section presents the evaluation methodology, assessment for each evaluation account and the summary results of the analysis.

The Brampton Queen Street Rapid Transit Benefits Case Analysis was initiated in 2011 and completed in early 2013. This report summarizes the findings of the analysis.

Project Rationale

The Brampton Queen Street Rapid Transit project would provide enhanced transit along the Queen Street and Highway 7 corridor from Downtown Brampton at Main Street to the Toronto-York Spadina Subway extension. This 23.7-kilometre corridor serves a number of major destinations and land uses, including the Downtown Brampton Urban Growth Centre and Bramalea City Centre. The corridor would be developed as bus rapid transit, light rail transit, or a mix of both. Segregation of transit operations from other traffic will be a key consideration to enhance travel speeds and service reliability.

Rapid transit in the corridor would support Metrolinx's Regional Transportation Plan ("**The Big Move**") as well as regional and local Official Plans and Transportation Master Plans. The project would build upon the recently introduced Züm bus service, which is seen as an initial stage toward higher-order rapid transit in the Queen Street corridor.

Rapid transit would also provide a competitive travel choice in Brampton, supporting population and employment growth, improving connectivity, and influencing land use and urban form.

Project Options

Rapid transit would serve as a higher-order 'backbone' to the transit network in Brampton. Four project options will be evaluated incremental to the base case as part of this BCA for rapid transit on Queen Street. This approach allows for a consistent comparison between the two technologies most appropriate and under consideration for the corridor – bus rapid transit or light rail transit. The cases to be analyzed are briefly summarized below and in Exhibit 3.2.

- **Base Case:** The existing/committed transit network including Bus Rapid Transit (BRT) "light" that operates in mixed traffic known as Brampton Transit's Züm service.

Bus Rapid Transit (BRT) Options

- **Option 1A:** BRT service in exclusive right-of-way between Downtown Brampton and the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations;

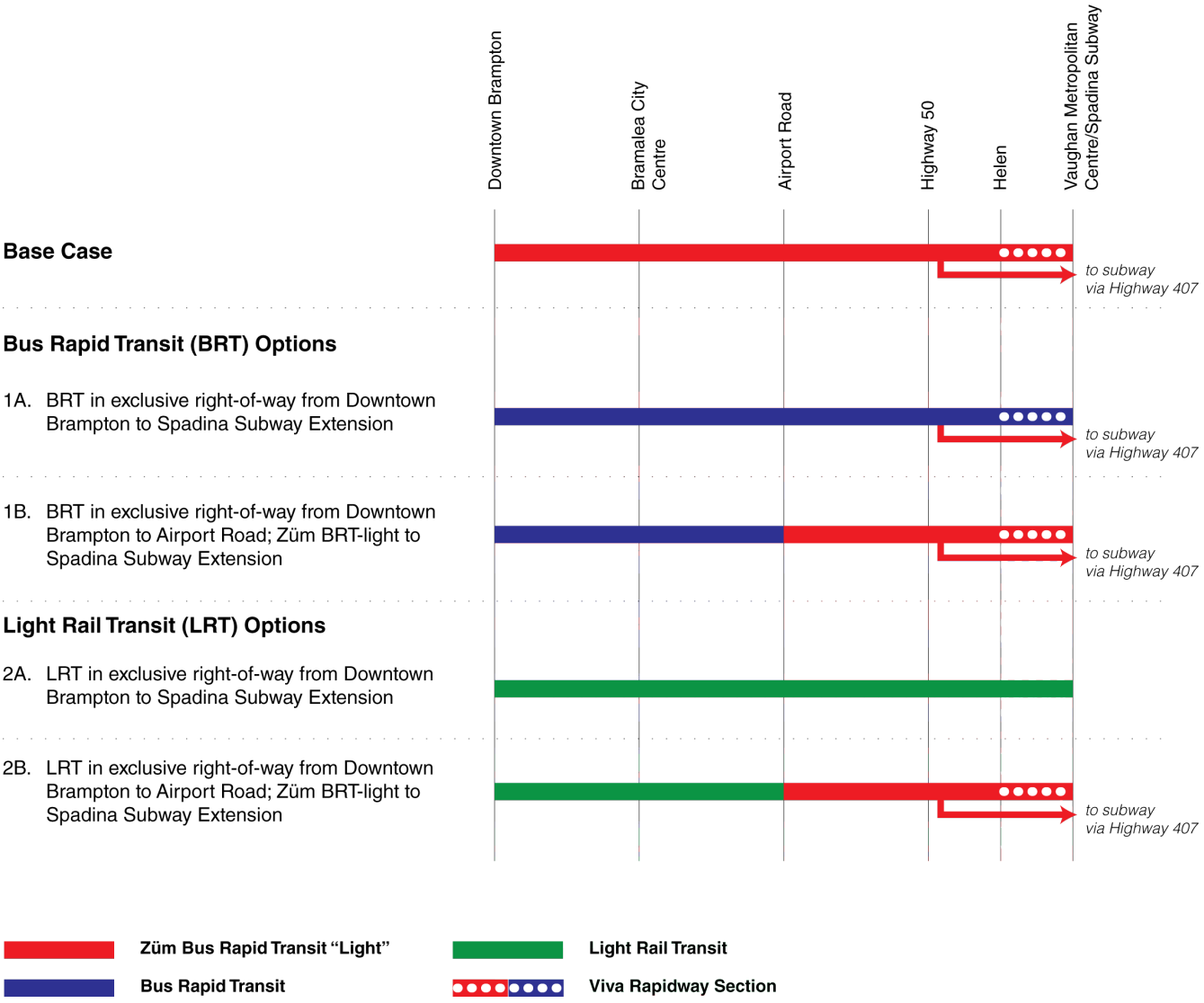
- **Option 1B:** BRT service in exclusive right-of-way between Downtown Brampton and Airport Road and Züm-BRT light service continuing on to the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations.

Light Rail Transit (LRT) Options

- **Option 2A**: LRT service in exclusive right-of-way between Downtown Brampton and Vaughan Metropolitan Centre Subway Station.

- **Option 2B:** LRT service in exclusive right-of-way between Downtown Brampton and Airport Road, and connection to Züm-BRT light service to the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations.

Exhibit 0.1: Options Summary



Summary

Exhibit 0.2 provides a summary of the benefits case for rapid transit in the Queen Street corridor in the City of Brampton. Of the four options, Option 1A, bus rapid transit in an exclusive right-of-way between Downtown Brampton and Vaughan Metropolitan Centre, results in the most favourable cost-benefit ratio. The full light rail transit option (Option 2A) also provides significant benefits such as higher transit ridership, greater GHG emissions reductions, and more significant land value increases. The bus rapid transit options (Options 1A and 1B) provide strongest benefits from the transportation user benefits perspective. Given the small range in the benefit cost ratio (0.6 to 0.8), the evaluation of the project options should be based on the full range of criteria across the different accounts.

Four options result in similar cost-benefit ratios; however, capital costs vary significantly

Although the four project options perform similarly in terms of a benefits case ratio, the capital costs vary significantly. Given the range of costs and the ability of all options to accommodate projected ridership to 2031, it would be prudent to invest in the corridor on an incremental basis. Focusing transit investment into the western section of the corridor, including the areas of downtown Brampton and Bramalea where congestion and redevelopment potential is greatest, would provide the greatest return in benefits, while keeping capital expenditures at a more affordable level.

LRT options require greater capital expenditure, but do not provide proportional increases in benefits

The applicability of BRT or LRT technology is also a major consideration in this corridor. For options between Downtown Brampton and Airport Road, the estimated capital cost for LRT is approximately 52% higher than for BRT, without a proportional increase in transportation user benefits. Option 2B provides an advantage in ongoing operating cost savings of approximately $1.7-million annually over Option 1B; however, these savings are predominantly reflective of the lower ridership projected for this option.

Qualitative comparison between LRT and BRT show both modes provide substantial opportunities for the corridor.

As BRT and LRT offer competing operational advantages, the qualitative aspects of the two modes should also be taken into consideration. Rail-based transport is generally perceived to be superior with a more comfortable ride, larger vehicles, and a sense of permanence in the urban environment. In addition, LRT is seen to have better environmental qualities through reduced noise, no local emissions, and reduced energy consumption. LRT is also perceived to play a greater role in land use shaping by attracting more intensified development. However, bus rapid transit design and technology is rapidly evolving. Many urban applications, including York Region's Viva Rapidways, are adopting LRT design characteristics in runningway, stations, and facilities. Bus technology and design is also improving with modern-styled vehicles, more comfortable seating, improved propulsion, and clean fuel technology.

Higher-order rapid transit in Queen Street corridor is desirable; decision on technology requires further study.

From a purely cost-benefit perspective, bus rapid transit from Downtown Brampton to Vaughan Metropolitan Centre (Option 1A), with the highest benefit-cost ratio (BCR), demonstrates the greatest benefits per taxpayer dollar invested. Option 2B, providing LRT from Downtown Brampton to Airport Road, also provides a comparable BCR, but with lower projected ridership. The marginal difference in the BCR between these options indicates decision-making will need to also strongly consider qualitative criteria, including meeting regional and municipal objectives, providing network connectivity, and shaping land use and urban form. Such an evaluation could be undertaken through the environmental assessment and preliminary design process that could be a next step for corridor planning.

Exhibit 0.2: Summary of Benefits Case

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Transportation User Benefits (in Millions, NPV 2011$)				
Total Transportation User Benefits	$563.6	$385.2	$757.7	$480.0
Financial Account (in Millions, NPV 2011$)				
Total Incremental Costs	$744.1	$616.2	$1,319.2	$687.9
Net Benefits (NPV 2011$) (net of passenger revenues)	($180.4)	($231.0)	($561.5)	($207.9)
Benefit-Cost Ratio (net of passenger revenues)	**0.8**	**0.6**	**0.6**	**0.7**
Environmental Account				
Reduction in GHG Emissions (metric tonnes)	78,400	49,200	92,800	56,600
Value of GHG reduction (NPV 2011$)	$1.5M	$1.0M	$1.8M	$1.1M
Economic Development Account				
Short-Term Person-Years of Employment	4,000	2,600	9,300	3,900
Long-Term Person-Years of Employment	220	230	220	200
Short-Term GDP (over construction period)	$331.9	$208.3	$764.5	$323.9
Long-Term GDP (annual)	$9.9	$10.2	$10.0	$9.0
Land Value Increase	4% to 8%	1% to 5%	8% to 15%	4% to 6%
Social and Community				
Increase in 2031 Population and Employment within 800 m of rapid transit stations (compared to base case)	126,700	87,300	126,700	87,300

1. Introduction

1.1 Background

In 2008, the Metrolinx Board of Directors approved a 25-year Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) entitled **The Big Move**. The top fifteen priority projects out of the 62 that were listed were carried forward for further analysis.

To support decision making regarding these rapid transit projects, a Benefits Case Analysis (BCA) is prepared for each study. The BCAs describe a range of feasible options for each project and evaluate their performance under five Evaluation Accounts: Transportation User Benefits, Financial, Environmental, Economic Development, and Social Community.

The BCAs provide the basis for robust and consistent decision making, taking into account both quantifiable results and qualitative aspects of each project. BCAs represent high-level analyses to help identify the preferred project scope and options, and inform project funding recommendations by the Metrolinx Board.

1.2 Report Objectives and Structure

This report sets the foundation for the BCA for rapid transit service on Queen Street in Brampton. It includes the following sections:

- **Part A - Project Rationale** – This chapter provides a project overview, describes the policy context, and considerations for the proposed project.
- **Part B – Project Options** - This section presents a summary of the options to be evaluated in the BCA, including the Base Case.
- **Part C – Project Assessment** - This section presents the evaluation methodology, assessment for each evaluation account and the summary results of the analysis.

The Brampton Queen Street Rapid Transit Benefits Case Analysis was initiated in 2011 and completed in early 2013. This report summarizes the findings of the analysis.

2. Part A: Project Rationale

2.1 Project Overview

The Brampton Queen Street Rapid Transit project would provide enhanced transit along the Queen Street and Highway 7 corridor from Downtown Brampton at Main Street to the Toronto-York Spadina Subway extension. This 23.7-kilometre corridor serves a number of major destinations and land uses, including the Downtown Brampton Urban Growth Centre and Bramalea City Centre. The corridor would be developed as bus rapid transit, light rail transit, or a mix of both. Segregation of transit operations from other traffic will be a key consideration to enhance travel speeds and service reliability. Details of the options to be analyzed as part of the BCA are provided in Section 3.

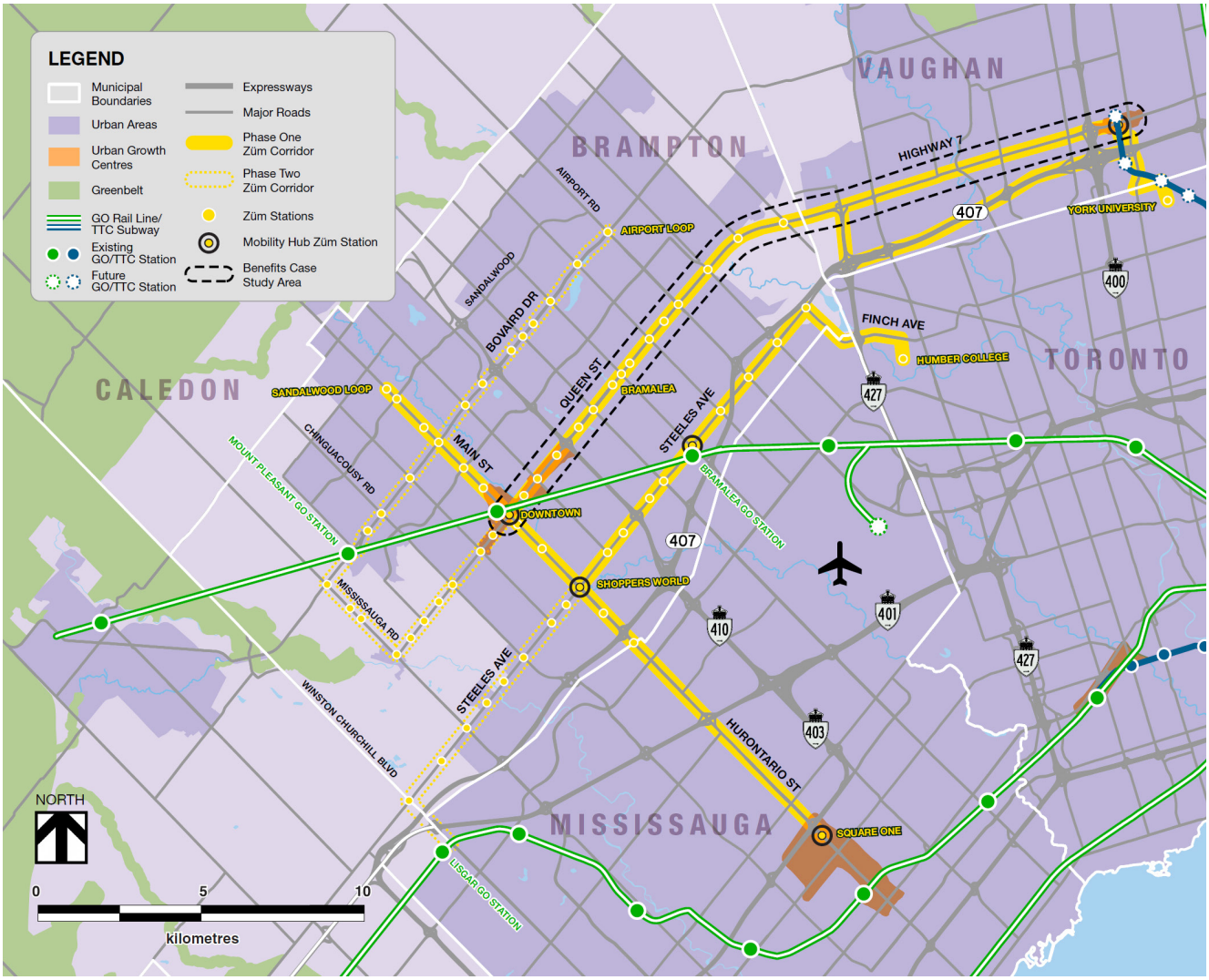
Züm

In September 2010, Brampton Transit launched **Züm**, a ”quick-start” implementation of bus rapid transit (BRT) on Queen Street from downtown Brampton to York University. The 501 Queen Street route provides limited stop service and includes features such as a dedicated and branded fleet of BRT-style buses and enhanced stations that provide fully enclosed and heated shelters and other customer amenities such as real-time service information. Buses operate in mixed traffic, but operations are improved with transit priority measures at key intersections. The new service has demonstrated significant success, with ridership on the Queen Street corridor increasing by over 20% over the past year to approximately 16,000 weekday boardings.

By 2014, Züm will have been expanded onto other corridors, including Main Street (2011), Steeles Avenue (2012), and Bovaird Drive (2014). Together, these routes will form a network of high quality transit services throughout the City of Brampton. The planned network and context are shown in Exhibit 2.1.

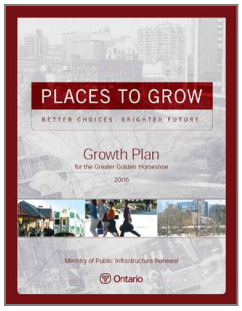
photo credit: Sean Marshall

Exhibit 2.1: Overview Map



Map source data: NAVTEQ, Ontario Growth Secretariat, City of Brampton

2.2 Planning Context



Provincial Planning

At the provincial level, a three-part approach was taken to prepare the Greater Toronto and Hamilton Area (GTHA) for growth and sustainability. The three parts are:

1. The Greenbelt Plan, that protects 1.8 million acres of environmentally sensitive and agricultural land in the region;
2. The Growth Plan, entitled **Places to Grow**;
3. The Metrolinx Regional Transportation plan, entitled **The Big Move**;

The second and third plans are important context pieces for this BCA and are outlined in more detail below.

Places to Grow

In 2006, the Province of Ontario adopted **Places to Grow: Growth Plan for the Greater Golden Horseshoe** to guide growth in the region to 2031. Places to Grow sets out growth and intensification targets for municipalities within the GGH to reduce suburban sprawl, protect the greenbelt and agricultural lands, and encourage the intensification of urban areas. The Plan also identifies Urban Growth Centres, where higher density targets are set to create vibrant urban cores throughout the region, linked by a high quality regional transit network.

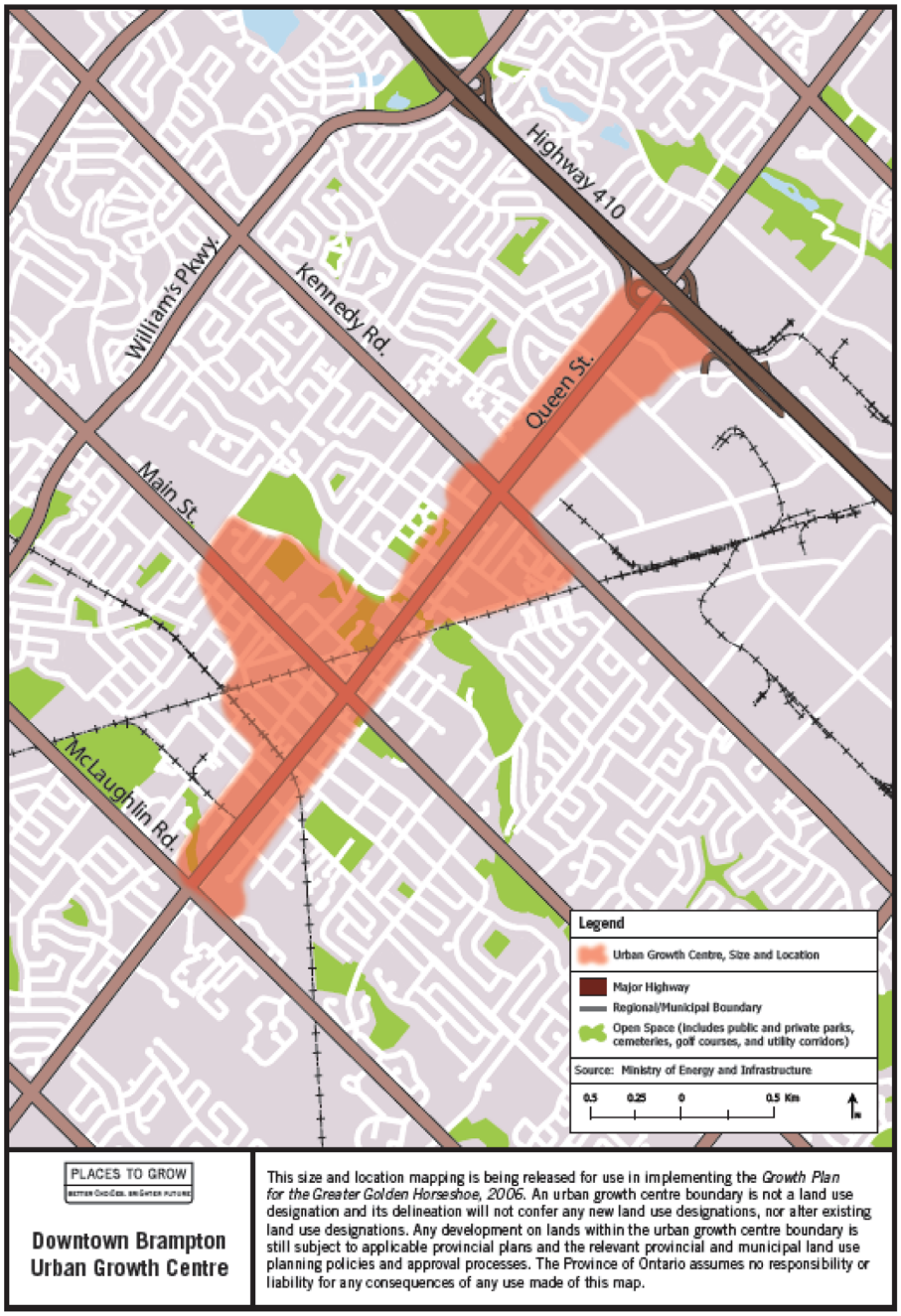
Downtown Brampton is identified in Places to Grow as an urban growth centre (UGC) with a density target of 200 persons and jobs per hectare by 2031. The boundary of the Downtown Brampton UGC, as shown in Exhibit 2.2, includes the historic downtown area and the Queen Street corridor between McLaughlin Road and Highway 410. Brampton's "Central Area" designation in the Official Plan corresponds closely with this boundary of the UGC.

Metrolinx Regional Transportation Plan – The Big Move

Metrolinx was established in 2006 by the Province of Ontario to coordinate, plan, finance and implement a fully integrated multi-modal transportation network across the Greater Toronto and Hamilton Area (GTHA). As part of this mandate, in 2009, operating authority of GO Transit was transferred to Metrolinx. The Union-Pearson Express and PRESTO have followed shortly after GO Transit and have been transferred to Metrolinx in 2010 and 2011, respectively.

One of Metrolinx's first initiatives was to lead the development of a regional transportation plan, which was released in 2008 and entitled **'The Big Move'**. The Big Move includes significant investments in a vastly expanded rapid transit network connecting all areas of the GTHA by 2031. A key objective in the development of the rapid transit network was to support the goals of the Places to Grow plan and as such, includes connections to regional urban growth centres and also introduces the concept of Mobility Hubs to create intensified mixed-use transit nodes around major transit stations.

Exhibit 2.2: Downtown Brampton Urban Growth Centre



Source: Ontario Growth Secretariat

Implementation of rapid transit on Queen Street in Brampton from Downtown easterly is identified within the 15-year Regional Transportation Plan. In addition, Downtown Brampton is designated as an anchor mobility hub in The Big Move, reflecting its key role in the regional transit network as both an urban growth centre and the linkage between the Hurontario-Main RT, Queen Street RT, and the Kitchener Regional Express lines. Vaughan Metropolitan Centre at the eastern terminus of the line is also designated as an anchor mobility hub, The Queen Street Rapid Transit project will provide a quality transit connection linking the two hubs.

2.3 Municipal & Regional Plans

City of Brampton Official Plan

The City of Brampton's Official Plan was adopted by City Council in 2006 and subsequently approved in part by the Ontario Municipal Board in 2008 to guide the development of the City over the next 25 years. Building upon the City's strategic plan, known as "The Six Pillars", the Plan provides guidance to achieve the City's vision:

> a vibrant, safe and attractive city of opportunity where efficient services make it possible for families, individuals including persons with disabilities and the business community to grow, prosper and enjoy a high quality of life.

The first key pillar in the City's strategic plan is to develop "Modern Transportation Systems", with an official plan objective to:

> Expand public transit service for Brampton's residents including persons with disabilities and employers and to provide seamless connections to popular destinations within the GTA (pp. 2-7).

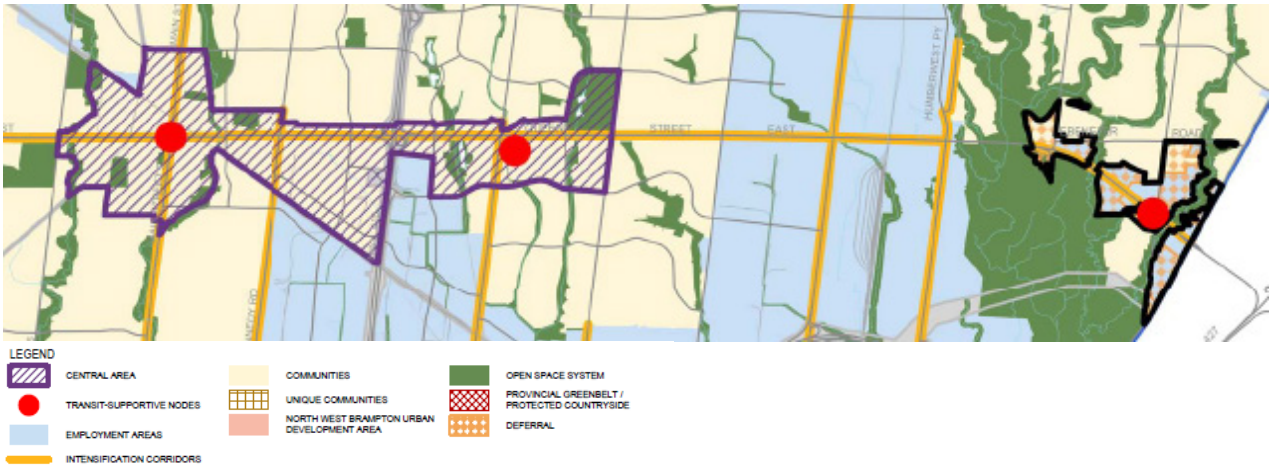
Rapid transit on Queen Street is one of the key initiatives seen to provide seamless regional transit connections. It is also recognized to be important to support other official plan goals including:

- the reinforcement of Downtown Brampton and Central Area as the City's cultural and economic core; and,
- the intensification and development of the Central Area and mixed-use corridors.

The Official Plan for the City of Brampton identifies a "Central Area", generally encompassing lands along Queen Street from McLaughlin Road to Bramalea Road and including the historic Downtown core that functions as the "heart" of the City and having significant GTA-wide significance. The Central Area contains Brampton's Urban Growth Centre as set out in the Growth Plan and a Mobility Hub as found in The Big Move. Other important transportation linkages include Züm bus service, the planned Hurontario LRT, a further transit hub (Bramalea City Centre), as well as GO and VIA rail service. This confluence of existing and planned transportation links provide the basis for the planned intensification sought by the policies of the Official Plan.

The Plan seeks to enhance and expand on the Central Area's role within the City, being the location for major cultural, civic, institutional, entertainment, commercial, employment and residential functions. The Central Area is identified for ongoing intensification and transformation that is transit-supportive and pedestrian friendly in its development forms, urban districts and street environments. It contains significant potential for intensification and redevelopment. Achievement of these goals is dependent on the implementation of higher order transit. Realization of these goals is important to achieve the broader sustainable structure sought by the City's Official Plan. From a land use planning perspective, higher order transit that is of a fixed variety is seen as establishing certainty in development investment as well as consumer choices when residents make buying decisions. These factors should play an important role in the decision on higher order transit options.

Exhibit 2.3: Official Plan Schedule 1 - City Concept



Source: City of Brampton Official Plan

City of Brampton Transportation and Transit Master Plan (2004)

In 2004, the City of Brampton adopted a Transportation and Transit Master Plan (TTMP), which charted the course for transportation policy and infrastructure in Brampton to 2031. The three key objectives of the TTMP are:

- Coping with Growth;
- Sustainability, Efficiency, and Equity; and
- Containing Urban Sprawl and Promoting Quality of Life.

These objectives resulted in a plan that balances the need to expand road capacity to accommodate growth while improving transportation alternatives to improve the sustainability of the overall transportation network and influence land use. One of the main components in the TTMP is targets relating to "future" transit mode share (Section 3.2.2.1), where by 2031, targets for transit mode share include 15% for internal trips, 15% to key rapid transit corridors, such as Queen Street, and 70% to 80% from GO Rail corridor nodes. The report does not clearly define the target year for future mode share; however, it is assumed for ultimate plan build out by 2031.

The resulting concept plan for the transportation network in 2031 shows a bus rapid transit corridor on Queen Street from Chinguacousy Road to the eastern city limit. This corridor, in addition to a north-south bus rapid transit on Hurontario/Main Street, is included in the TTMP's **Horizon 2011** plan, while BRT on Steeles Avenue and Bovaird Drive are included in the subsequent **Horizon 2021** plan.

Transportation and Transit Master Plan Sustainable Update (2009)

In 2009, Brampton updated its 2004 Transportation and Transit Master Plan, calling it the **Sustainable Update**. The purpose of the update was to ensure the plan reflected many changes since the original plan was adopted such as the new Official Plan, the creation of Metrolinx and its regional transportation plan, the Province's Growth Plan for the Greater Golden Horseshoe, and changes in forecasts and travel patterns.

The update maintained the designation of Queen Street as a rapid transit corridor, reinforced by The Big Move, Metrolinx's Regional Transportation Plan. The recommended BRT network in this plan was adopted into the committed Züm network.

City of Brampton Rapid Transit Initiative Business Case (2007)

To implement the vision of rapid transit in Brampton, as set out in the TTMP, the City undertook a business case for the rapid transit initiative, then known as AcceleRide. The report recommended that a bus rapid transit network be implemented in two phases:

- **Phase 1 (to 2012):** Queen Street (2010); Main Street (2011), Steeles Avenue (2012); and,
- **Phase 2 (to 2021):** Introduction of service on Bovaird Drive, extension of Queen Street to Mount Pleasant GO Station via Mississauga Road, and extension of Steeles Avenue to Lisgar GO Station.

Ultimately, in a time horizon beyond 2021, the business case recommends service be upgraded to run in an exclusive median right-of-way using LRT or BRT technology. Three types of infrastructure improvements were defined to implement the rapid transit network:

- **Intersection improvements** to provide transit priority at congested locations through transit priority signals and bypass lanes;
- **Major stations** will be equipped with larger, completely enclosed and heated permanent structures; and
- **Minor stations**, which will be equipped with conventional transit shelters but with enhanced appearance and customer service features.

The infrastructure requirements in both phases are summarized in Exhibit 2.4. The estimated capital cost for Phase 1 is $159-million and Phase 2 is $126-million and funded by all three levels of government. Estimates for operating costs are presented in Exhibit 2.5.

Exhibit 2.4: Infrastructure Requirements for Phase 1 and Phase 2 AcceleRide

Rapid Transit Line	Intersection Improvements	Major Stations	Minor Stations	Cost
Phase 1 -Queen Street (Downtown Brampton-York U) -Main Street (Sandalwood-Square One) -Steeles Avenue (Shoppers World-Humber College)	14	20	14	$159M
Phase 2 -Bovaird Drive (Mount Pleasant-Airport Rd) -Queen Street (Mount Pleasant-Downtown Brampton) -Steeles Avenue (Lisgar GO Station-Shoppers World)	+21	+11	+12	$126M
Total Phase 1 + Phase 2	**35**	**31**	**26**	**$285M**

Source: City of Brampton (2007). Rapid Transit Initiative Business Case

Exhibit 2.5: Estimated Operating Costs – Phase 1 AcceleRide

Cost Item	Phase One			
	2010	2011	2012	2013
Operating Costs (annualized)				
AcceleRide Corridors	$7,798,000	$13,714,000	$18,017,000	$18,017,000
Support/Local Routes (net)	$807,000	$2,151,000	$0	$0
TOTAL Operating Costs	$8,605,000	$15,865,000	$18,017,000	$18,017,000
Potential Revenues				
Fare Revenue	$6,369,000	$12,127,000	$14,287,000	$16,446,000
Total				
Net Operating Cost	**$2,236,000**	**$3,738,000**	**$3,730,000**	**$1,571,000**
Fare Recovery*	**74%**	**76%**	**79%**	**91%**
* Original projections for Phase 1 Business Case, subject to ongoing analysis and change, may not be reflective of actual results				

Source: City of Brampton (2007). Rapid Transit Initiative Business Case

Hurontario/Main Street Corridor Master Plan

In 2010, the Cities of Mississauga and Brampton completed a joint study to develop a Master Plan for the Hurontario/Main Street Corridor, which runs north-south through the two cities. The main objective of the Plan is to establish a rapid transit line from Lake Ontario to Downtown Brampton.

The study looked at four alternatives: BRT, LRT, LRT/BRT hybrid, and do-nothing. The evaluation of these alternatives led to the recommendation of implementing light rail transit in the Hurontario-Main corridor from Downtown Brampton to Port Credit. The line would be approximately 20 kilometres in length with 28 stations. The estimated cost of the project is between $755 million and $1.4 billion.

The northern terminus of the Hurontario-Main LRT line would be in Downtown Brampton, where connections would be made to the Kitchener GO Transit line at Brampton Station. The conceptual routing through Downtown Brampton is shown in Exhibit 2.6.

The Hurontario-Main LRT project is currently unfunded; however, the project is undergoing preliminary design and Transit Project Assessment. If the funding status changes, the case for rapid transit on Queen Street and related efficiencies with this Hurontario-Main LRT project could warrant re-assessment in the future.

Exhibit 2.6: Proposed Route of Hurontario-Main LRT through Downtown Brampton

Source: Adapted from Hurontario/Main Street Corridor Master Plan

Queen Street Environmental Assessment (Centre Street to Highway 410)

In 2008, an Environmental Assessment was completed for Queen Street between Centre Street and Highway 410 by the City of Brampton. The purpose of the study was to address operational deficiencies in the corridor, the need for additional east-west road capacity, and to accommodate increased transit service, including AcceleRide (Züm). The recommended solution included the following:

- Maintaining the existing 5-lane cross-section between Centre Street and Kennedy Road, but providing a minor widening within this entire section for a total widening of approximately 3 m;
- Widening from Kennedy Road to Rutherford Road to 7 lanes (three through lanes per direction with a centre left turn lane that transitions to left turn lanes at intersections). The curb lanes could be designated HOV lanes;
- Maintaining the existing 7-lane cross section between Rutherford Road and Highway 410;
- Modifications at intersections to improve turning movements at Kennedy Road;
- Provide transit queue-jump lanes at Centre Street, Kennedy Road, and Rutherford Road; and
- Streetscape and pedestrian improvements.

Some elements of the recommended solution have been implemented, such as the widening of the road and the integration of transit priority measures including queue-jump lanes and far-side bus bays. In 2012, the Region of Peel completed a Regional Road Characterization Study, which recognized Queen Street as a higher order transit corridor. The Study provides context-sensitive planning, design, and engineering guidelines for various regional roadway types.

Queen Street Environmental Assessment (West Drive to Highway 50)

In 2001, the Region of Peel completed an environmental assessment for its portion of Queen Street east of Highway 410 to Highway 50. At that time, Queen Street had an inconsistent cross-section with varying sections of 4-lane and 6-lane configurations. The environmental study report recommended for a consistent, six through-lane configuration between West Drive and Highway 50. This was accomplished through the widening of Queen Street along much of its length over the past several years.

The EA recommended that the curb lanes of Queen Street between Highway 410 and Highway 50 be designated as high-occupancy vehicle/reserved bus lanes. Although these lanes have not yet been designated, other Züm-specific intersection and roadway improvements were integrated into the construction projects.

2.4 Project Context and Considerations

Area Context

The City of Brampton is located northwest of the City of Toronto and is situated within the Regional Municipality of Peel. It is bordered to the north by the Town of Caledon, to the south by the City of Mississauga, to the east by the City of Vaughan, and to the west by Halton Region. In 2006, the City had a population of just over 450,000 people and was home to approximately 155,000 jobs.

Brampton is projected to continue to grow significantly over the next 20 years, mainly in secondary plan areas in its western and eastern fringes. By 2031, the population will increase by approximately 285,000 to 738,000 persons, accompanied by a doubling of employment within the city. Exhibit 2.7 summarises Growth Plan population and employment forecasts for Brampton through 2031. The secondary plan areas referenced in this table are shown in Exhibit 2.8.

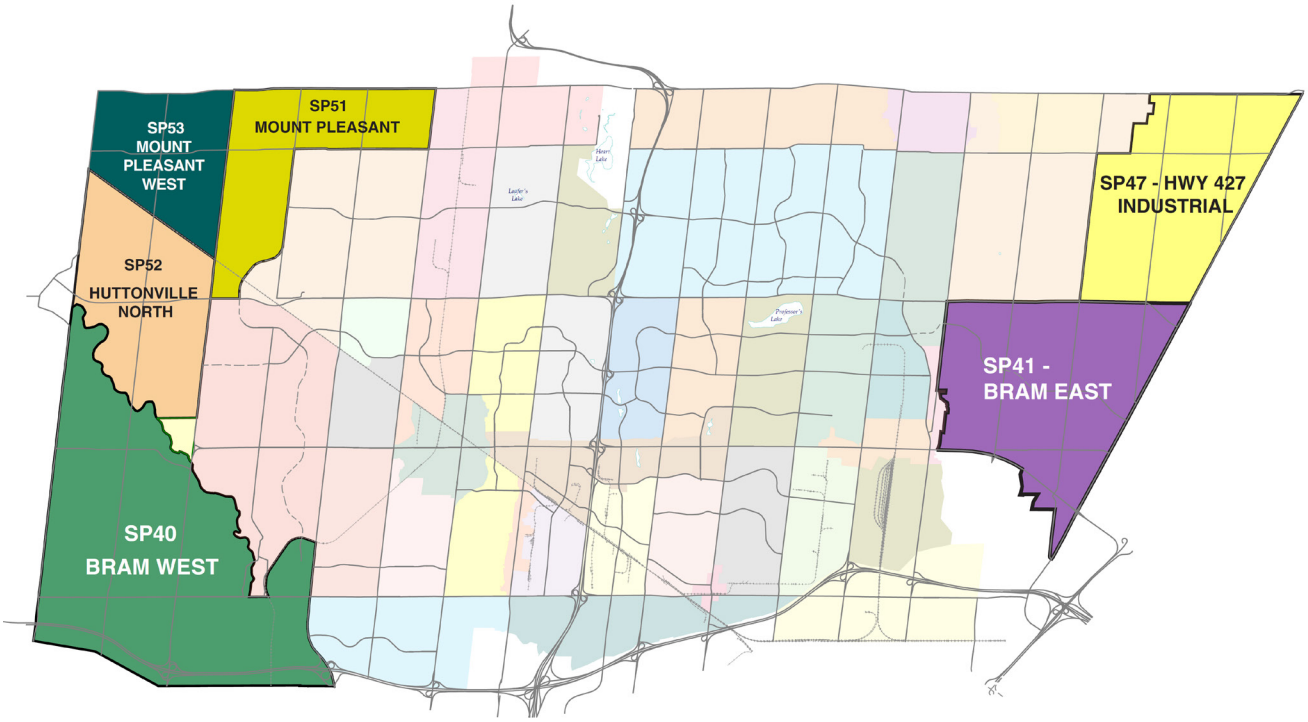
The secondary plan growth areas in the west and northwest sections of Brampton will have an impact on ridership potential on the west end of the Queen Street corridor. Forecasted growth in the Bram East area will increase travel demand in this section of the corridor when currently vacant lands are developed.

Exhibit 2.7: Population and Employment Forecasts for Secondary Plan (SP) Areas and City of Brampton 2006-2031

Brampton Sub-Area	2006		2031	
	Population	Employment	Population	Employment
SP41 - BramEast	6,470	5,460	39,610	31,650
SP40 - BramWest	15,360	3,750	50,960	13,200
SP47 - Highway 427 Industrial	0	270	17,590	17,810
SP51 - Mount Pleasant	520	10	36,710	4,480
SP52 - Huttonville North	110	60	10,350	13,890
SP53 - Mount Pleasant West	120	20	9,840	13,870
Rest of Brampton	430,190	146,290	573,360	223,800
Total City of Brampton	**452,770**	**155,860**	**738,420**	**318,700**

Source: Update to the forecasts prepared in 2009 for the City of Brampton by Hemson Consulting Ltd.

Exhibit 2.8: Brampton Secondary Plan Areas



Source: Adapted from City of Brampton 2008 Official Plan, Schedule G

Corridor Considerations

Queen Street is a major east-west arterial corridor through the City of Brampton, connecting in the east to Highway 7 in York Region. Prior to the completion of Highway 407, it was the main east-west travel corridor in Brampton. Jurisdiction of the roadway is split between the City of Brampton and the Regional Municipality of Peel. The City is responsible for the roadway section between McMurchy Avenue and Highway 410, while the Region is responsible for all other sections.

The roadway was recently expanded to accommodate increased traffic, provide the potential for high-occupancy vehicle (HOV) lanes, and introduce intersection improvements to accommodate turning movements and transit priority. Within Downtown Brampton, right-of-way width is restricted due to a more compact urban form and the road is limited to four lanes. East of Highway 410, Queen Street provides three lanes of travel in each direction and in most sections includes a centre left-turning lane. HOV lanes could be introduced between Kennedy Road and Highway 410.

Land Uses

It is the vision of the City that the land uses abutting the proposed Queen Street RT line complement the transit route through density and placemaking, and animate the street while supporting Complete Streets concepts. Exhibit 2.9 illustrates the land uses along the Queen Street corridor, which from west to east demonstrate a wide range of land use contexts, including:

- The **historic core of downtown Brampton**, centred on the intersection of Queen and Main Streets, is a pedestrian-oriented mixed-use area with a high concentration of commercial, institutional and cultural uses;
- The **former site of the Peel Memorial Hospital**, located southeast of the intersection of Queen and Centre Streets, which is currently under redevelopment;
- **Queen Street East corridor**, east of downtown to Highway 410, is an area in transition with higher density residential uses replacing previously auto-oriented retail. There is continued interest expressed through development applications for high rise mixed use developments following the completion of "The Rhythm", a high rise residential project;
- **Bramalea City Centre**, which was one of the region's first master-planned urban centres with high density residential surrounding a large and recently expanded regional shopping centre;
- **Airport Industrial Area**, which includes one of the region's largest employers, Chrysler Canada, in addition to a major CN intermodal facility; and,
- The **Claireville Conservation Area**, which follows the West Humber River and was created to serve as a flood control dam and reservoir.

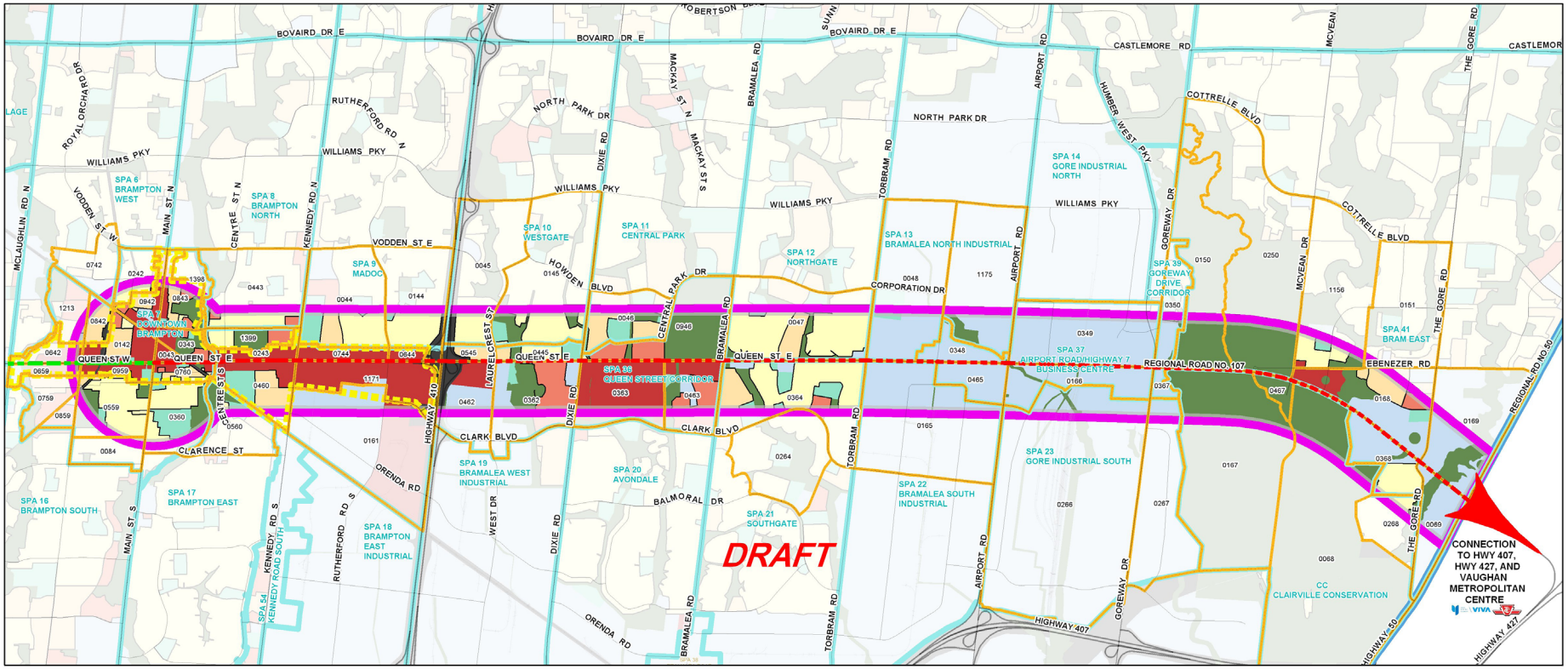
Adjacent Land Use Considerations

West of the study area, there are two major land use initiatives that may support extension of the rapid transit corridor west of Downtown Brampton. The **Flower City Community Campus (FCCC)**, located in the southwest corner of Queen Street West and McLaughlin Road, is planned to be a major recreational and community services district. There is potential for an expansion of seniors housing on the site and designated development blocks have been established along McLaughlin Road.

Development potential also exists along the section of Queen Street West connecting the FCCC to Downtown Brampton, between McLaughlin and George Streets. This area represents the western portion of the Downtown Brampton Urban Growth Centre. The **Queen Street West Land Use Planning Report** was completed for this area in 2009 in response to growing development pressure. A subsequent study to develop a policy and design framework for the district is not yet complete.

The Queen Street West Land Use Study was initiated in 2009 to review and make recommendations on changes to the planning and urban design policy framework for Queen Street West to guide the form and type of redevelopment in the area. The second phase of the study, which focuses on identifying the preferred form of redevelopment in the area, is currently being completed. A key recommendation from the first two phases is the establishment of a Development Permit System for the lands along Queen Street West to stimulate the redevelopment envisioned there. Work is expected to begin on the Development Permit System and implementing the other recommendations from the first two phases of the study in the summer of 2013.

Exhibit 2.9: Land Uses in Queen Street Corridor



Network Considerations

GO Transit

The Queen Street corridor intersects with the Kitchener GO Rail corridor at Brampton GO Station, located in Downtown Brampton just northwest of the intersection of Queen Street and Main Street. Service on this corridor is expected to increase dramatically over the next 10 years, with all-day, two-way rail service identified within GO Transit's GO 2020 Strategic Plan and full-fledged regional express rail service in the 25-year Regional Transportation Plan. The Kitchener Corridor was recommended for electrification in Metrolinx's Electrification Study, beginning with the Air Rail Link between Pearson Airport and Union Station.

The corridor also intersects with the planned Bolton GO Rail corridor in York Region on Highway 7, just east of Kipling Avenue. A station is not currently planned at this location; a connection could be warranted in the future once the timing of rail services has been confirmed. Peak period regional rail service is planned for the Bolton corridor in The Big Move, however a feasibility study complete in 2011 suggests this to be a longer-term proposition than originally proposed.

In addition to rail services, GO Transit also provides regional bus service in Brampton. These routes include:

- Brampton Trinity Common GO Bus, which provides service from north Brampton to Toronto Union Station via Bramalea, Thornhill, and North York Centre (Route 32);
- Brampton Local, Highway 27 & 427 GO Bus, which provides service from Downtown Brampton and Bramalea to various points including Pearson Airport, Humber College, Yorkdale, and York Mills (Route 34);
- Orangeville GO Bus, running from Brampton GO Station as an extension of Kitchener GO Train service (Route 37); and
- Kitchener GO Bus service which provides service on the corridor when train service is not operating, on four routes, including Route 30 (Kitchener – Bramalea), Route 31 (Guelph – Georgetown – Brampton – Toronto), Route 33 (Guelph – Georgetown – Brampton – Yorkdale – York Mills), and Route 39 (Guelph – Aberfoyle – Bramalea).

Brampton Transit

Brampton Transit is a division within the City of Brampton that provides local transit services throughout the city. It also operates the Züm service. Since 2001, annual ridership on Brampton Transit has nearly doubled, from 7.1 million to 13.8 million in 2010.

Queen Street operates as a key trunk for transit services in the city, providing a frequent service on a number of routes that also connect with north-south services. The Züm Queen Street service, Route 501, is a rapid, limited-stop express service every 7.5 minutes during peak periods, alternating between two branches terminating at York University. This service is augmented by Route 1, which is the main local route on Queen Street and provides service as frequent as 10 minutes during peak periods.

Two major transit terminals in the Brampton Transit network lie on Queen Street. The largest, at Bramalea City Centre, is a major transfer point between 14 routes, in addition to GO Transit bus services. A second terminal, in Downtown Brampton, provides connections between 5 routes and GO Bus services. The Downtown Terminal also provides a connection to GO Transit's Kitchener Rail Line.

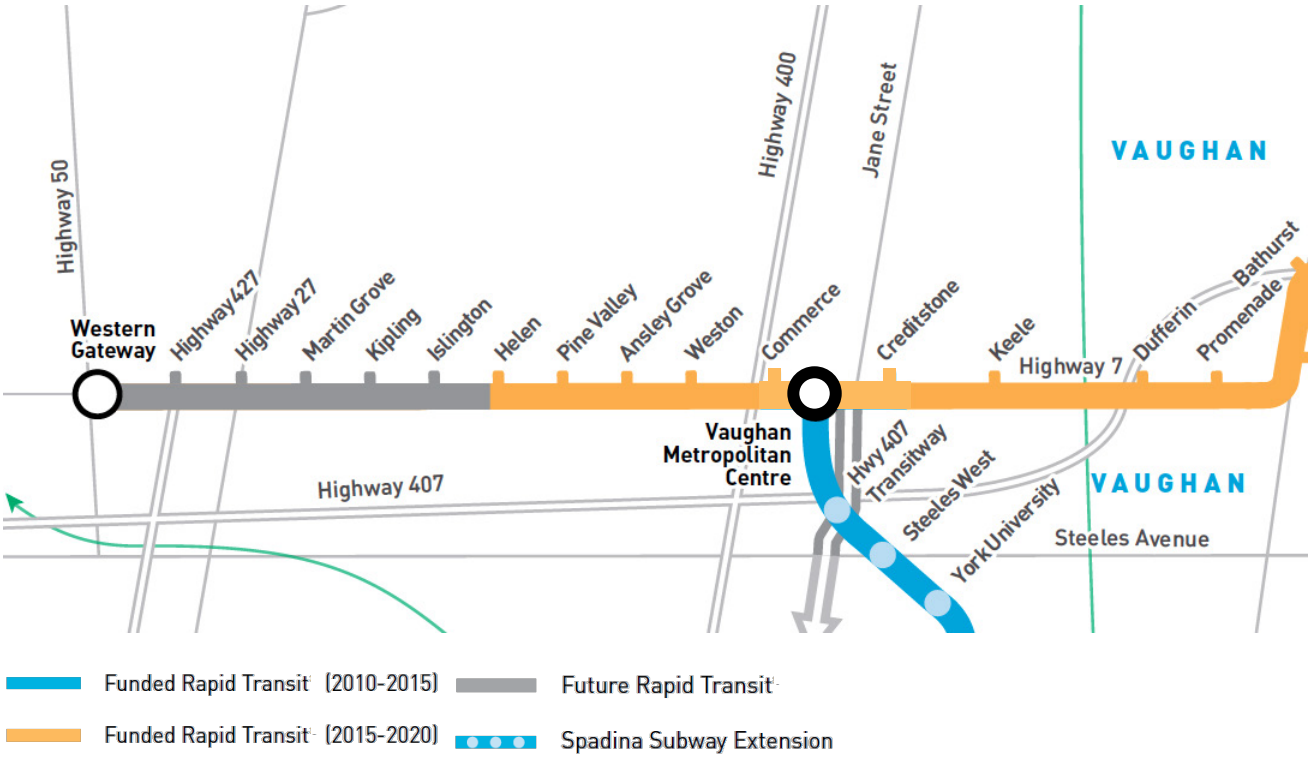
York Region Transit/Viva

York Region Transit (YRT) provides local bus services throughout the Regional Municipality of York, including the City of Vaughan on Brampton's eastern border. YRT also operates Viva, a bus rapid transit network similar to the current implementation of Züm.

Viva provides BRT service on the Highway 7 and Yonge Street corridors in York Region. Currently, the Viva Orange service runs between York University and Martin Grove Road, overlapping with Züm 501 service. A service integration agreement is in place between York Region and Brampton Transit to allow customers of both systems to use either service within the Queen Street/Highway 7 corridor.

York Region is currently working to expand and enhance the Viva system, a project known as vivaNext, shown in Exhibit 2.10. The first phase would create dedicated busways in segments throughout the region, including on Highway 7 through Vaughan Metropolitan Centre by 2015. The second phase that extends the busway between Yonge Street and Helen Street, just west of Pine Valley Drive, will be delivered by 2020. Ultimately, the exclusive transit lanes will be extended to the border between Vaughan and Brampton.

Exhibit 2.10: York Region Rapid Transit Expansion Plan



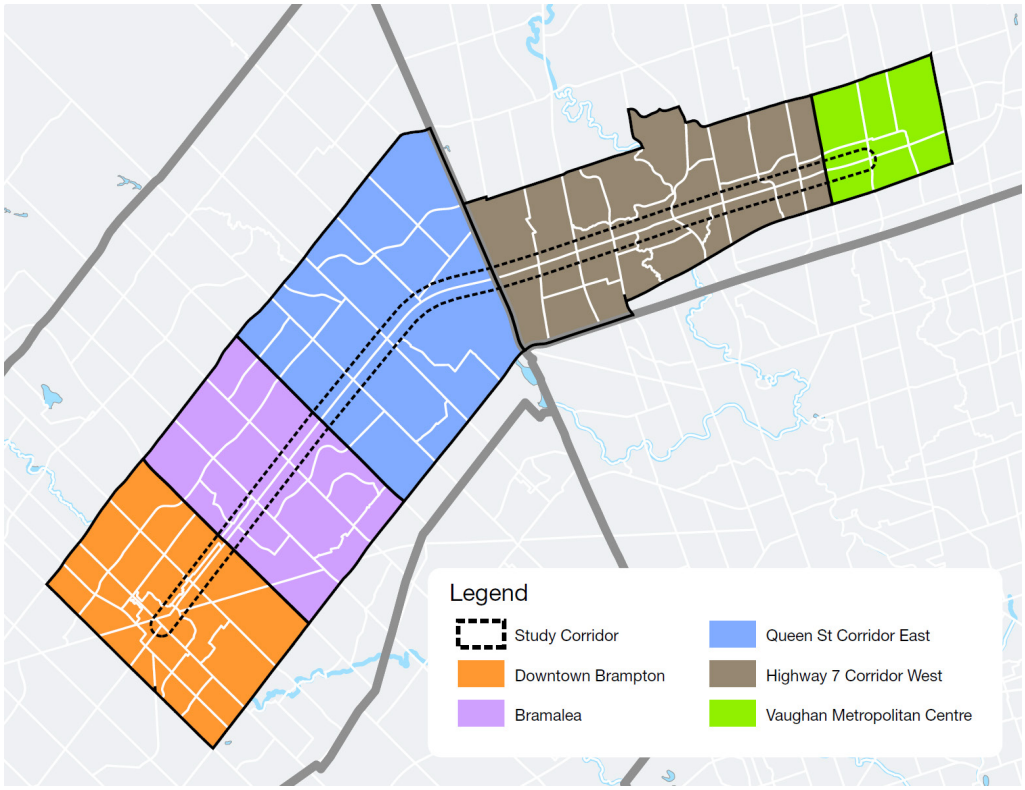
Toronto Transit Commission

The Toronto-York Spadina Subway extension from Downsview Station to Vaughan Metropolitan Centre is currently under construction and is expected to commence service by the end of 2016. This extension of subway service into York Region provides a natural eastern terminus for rapid transit on the Queen Street corridor. The connection from Brampton could be made at Vaughan Metropolitan Centre, where a direct transfer between the planned Viva Rapidway and the TTC subway is planned, or at Highway 407 Station, where a major interregional transit terminal is planned. While TTC will be operating subway service in the extension, York Region will own and operate the surface bus terminals and associated facilities for stations north of Steeles Avenue. No buses will be permitted onto York University campus following completion of the subway extension.

Current Corridor Travel Flows

The Queen Street corridor was divided into five functional areas to assess travel patterns to, from, and within the corridor. These areas are illustrated in Exhibit 2.11. Current morning peak travel flows by all travel modes between these locations and in the surrounding region are summarized in Exhibit 2.12.

Exhibit 2.11: Functional Groupings of TTS Zones for Travel Flow Analysis



Approximately 62,700 trips are made in the morning peak period within the Queen Street corridor between Downtown Brampton and Vaughan Metropolitan Centre. The majority of these trips take place within and between Downtown Brampton and Bramalea (38,300, or 61%). Travel demand is heavier in the eastbound direction, toward Vaughan Metropolitan Centre.

Exhibit 2.12: Travel Flows To and From Queen Street Corridor, AM Peak Period (2006 TTS)

ORIGIN \ DESTINATION	Downtown Brampton	Bramalea	Queen Street Corridor East	Highway 7 Corridor West	Vaughan Metropolitan Centre	Outbound Total	Rest of Brampton	Mississauga	Downtown Toronto	Rest of Toronto	Rest of York Region	Rest of Peel Region	Total
Downtown Brampton	16,300	3,800	2,400	200	200	**22,900**	9,600	9,600	2,300	5,000	1,200	500	**51,100**
Bramalea	3,900	14,300	5,700	300	400	**24,600**	6,200	9,900	2,200	5,900	900	500	**50,200**
Queen Street Corridor East	700	1,800	1,700	400	200	**4,800**	1,900	2,300	500	3,300	1,000	100	**13,900**
Highway 7 Corridor West	100	300	300	8,300	1,100	**10,100**	300	1,600	2,100	7,900	4,500	100	**26,600**
Vaughan Metropolitan Centre	-	-	100	100	100	**300**	100	200	100	700	200	-	**1,600**
Inbound Total	21,000	20,200	10,200	9,300	1,200								
Rest of Brampton	12,700	8,400	5,900	1,200	700								
Mississauga	3,400	3,500	3,400	1,600	1,200								
Downtown Toronto	200	100	-	100	200								
Rest of Toronto	2,300	2,200	3,600	7,400	6,500								
Rest of York Region	600	700	1,500	7,300	4,300								
Rest of Peel Region	1,000	1,000	900	800	300								
Total	**41,200**	**36,100**	**25,500**	**27,700**	**15,200**								

Corridor Zones →
- Internal Trip
- Eastbound
- Westbound

Rapid Transit Technology Considerations

The two transit modes considered for the benefits case analysis will be bus rapid transit (BRT) and light rail transit (LRT). These two modes were chosen as they are the predominant technology choices for medium-sized cities and are most appropriate for anticipated levels of demand. Exhibit 2.13 summarizes the advantages and disadvantages of each mode.

Exhibit 2.13: Technologies Considered for Queen Street Rapid Transit

Option	Advantages	Disadvantages
Bus Rapid Transit	-Lower capital cost -Operational and routing flexibility -Fewer infrastructure requirements	-Smaller vehicle capacity and shorter lifespan -Increased operating cost from fuel costs and additional vehicles to meet demand -Limited influence on development potential
Light Rail Transit	-Larger vehicle capacity -Lower operating costs -Greater impact on land values and development potential -Reduced local emissions	-Higher initial capital cost -Reduced routing flexibility -Requires additional fleet storage and maintenance capability

3. Part B: Project Options

3.1 Introduction

Rapid transit would serve as a higher-order 'backbone' to the transit network in Brampton. Four project options will be evaluated incremental to the base case as part of this BCA for rapid transit on Queen Street. This approach allows for a consistent comparison between the two technologies most appropriate and under consideration for the corridor – bus rapid transit or light rail transit. The cases to be analyzed are briefly summarized below and in Exhibit 3.2.

- **Base Case:** The existing/committed transit network including Bus Rapid Transit (BRT) "light" that operates in mixed traffic known as Brampton Transit's Züm service.

Bus Rapid Transit (BRT) Options

- **Option 1A:** BRT service in exclusive right-of-way between Downtown Brampton and the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations;

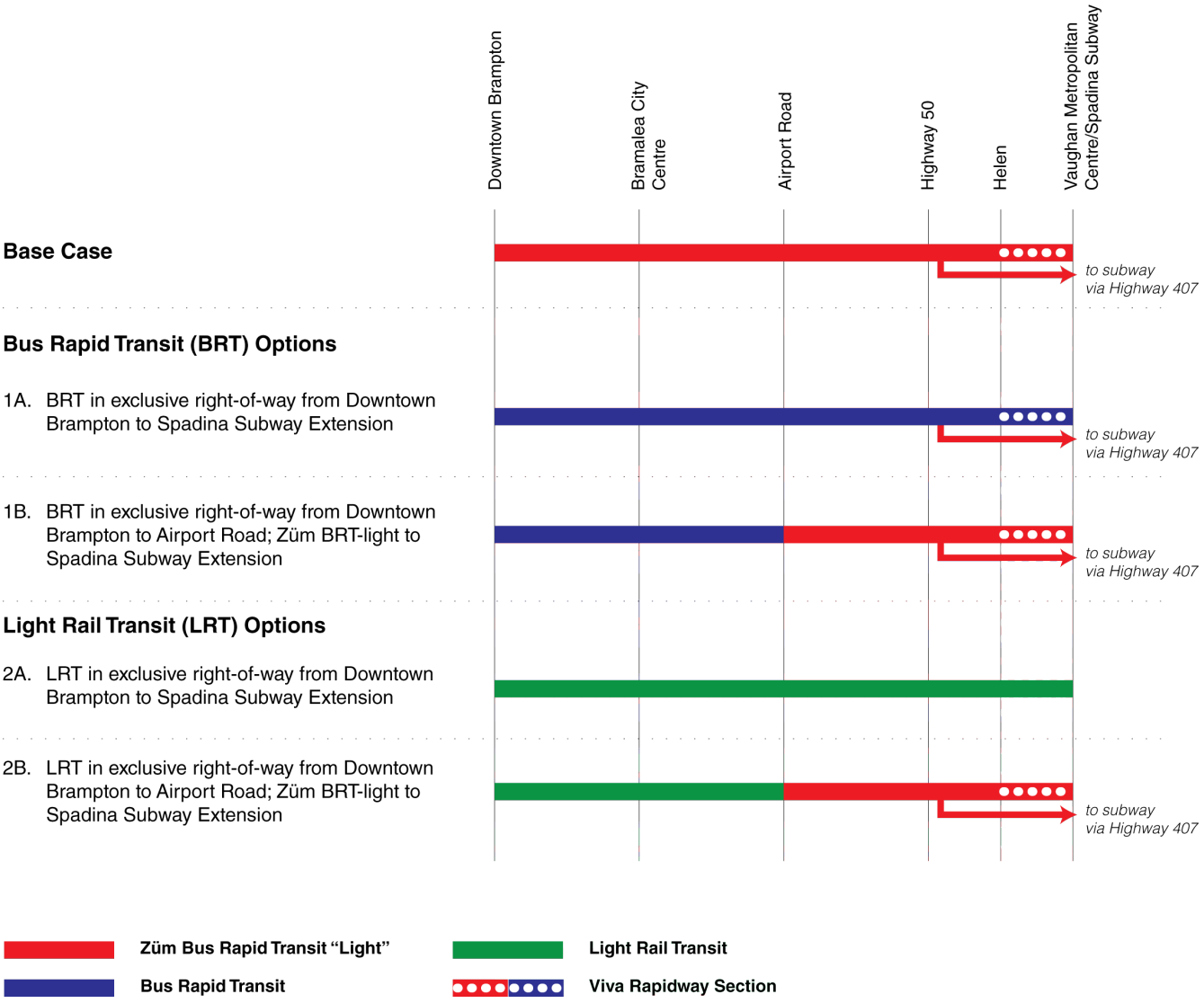
- **Option 1B:** BRT service in exclusive right-of-way between Downtown Brampton and Airport Road and Züm-BRT light service continuing on to the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations.

Light Rail Transit (LRT) Options

- **Option 2A**: LRT service in exclusive right-of-way between Downtown Brampton and Vaughan Metropolitan Centre Subway Station.

- **Option 2B:** LRT service in exclusive right-of-way between Downtown Brampton and Airport Road, and connection to Züm-BRT light service to the Spadina Subway extension. Branch service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations.

Exhibit 3.1 Options Summary



3.2 Common Elements

The following assumptions apply to all project options:

- **Stations on island platforms between transit and general vehicular lanes** will be assumed for infrastructure in exclusive transit right-of-way sections.
- **All door boarding and PRESTO fare payment** consistent with other Benefits Case Analyses.
- **Peak period rapid transit headways of 5 minutes**, with vehicle capacity of 1.5 times the number of seats in a vehicle.
- **Downtown Brampton as the western terminus of the proposed rapid transit line.**
- **Vaughan Metropolitan Centre Station on the Spadina Subway extension as the eastern terminus of the proposed rapid transit line.** Highway 407/Jane Station for branch service along Highway 407.
- **Existing Züm-BRT light stations** are the assumed stations for this service in Brampton and Viva Highway 7 stops within York Region.
- **Average speeds during peak periods** over various segments of the corridor as shown in the table below. It is assumed that LRT and BRT operations would show similar operating speeds given the same level of protection from mixed traffic. However, a 5 km/h speed benefit is provided to the LRT mode for ridership forecasting purposes to reflect its intangible benefits (e.g. comfort, permanence) over bus-based modes.

Segment	Distance (km)	Average Speed (km/h during Peak Periods)	
		Options 1A/2A Dedicated Right-of-way	Options 1B/2B Dedicated/ Mixed-Traffic
Downtown Terminal to Centre Street	0.7	18-23 *	18-23 *
Centre Street to Bramalea Terminal	4.6	28	28
Bramalea Terminal to Airport Road	3.5	28	28
Airport Road to Highway 50	4.8	32	20-25 *
Highway 50 to Vaughan Metropolitan Centre	10.1	28	20-25 *
Total Corridor	**23.7**	**28**	**24**
Hwy 50 to Hwy 407 Station (via Hwy 407)	11.5	**55**	**55**

* Transit operations in mixed traffic.

Exhibit 3.2: Summary of Project Options

	Base Case: Committed Züm Network	**Option 1A:** Bus Rapid Transit	**Option 1B:** BRT/Züm-BRT light	**Option 2A:** Light Rail Transit	**Option 2B:** LRT/Züm-BRT light
Transit Service Description	BRT-light in mixed traffic with moderate Transit Priority measures. Includes branch service along Highway 407, Committed Züm network expansion to other corridors and existing local routes.	BRT in exclusive right-of-way. Includes branch service along Highway 407 Parallel local route maintained but at lower frequency	BRT in exclusive right-of-way to Airport Road. Mixed traffic operation east of Airport Road Includes branch service along Highway 407 Parallel local route maintained but at lower frequency	LRT in exclusive right-of-way. No branch service along Highway 407 Parallel local route maintained but at lower frequency	LRT in exclusive right-of-way to Airport Road. Transfer to Zum-BRT light in mixed traffic east of Airport Road. Includes branch service along Highway 407. Parallel local route maintained but at lower frequency
Network Integration	Connections to local routes at intersections and bus terminals, service integration with Viva Orange on Highway 7. Connection with Subway at Vaughan Metropolitan Centre Station and 407/Jane Station.	Integration with YRT/Viva* BRT services; Connections to local Brampton Transit routes. Connection with Subway at Vaughan Metropolitan Centre Station and 407/Jane Station.	Integration with YRT/Viva* BRT services; Connections to local Brampton Transit routes. Connection with Subway at Vaughan Metropolitan Centre Station and 407/Jane Station	Integration with YRT/Viva* BRT services; Connections to local routes at LRT stations Connection with Subway at Vaughan Metropolitan Centre Station	Integration with YRT/Viva* BRT services; Connections to local Brampton Transit routes Connection with Subway at Vaughan Metropolitan Centre Station and 407/Jane Station.
Vehicles	60-foot articulated buses	60-foot articulated buses	60-foot articulated buses	Low-floor Light rail vehicles (LRV)	Low-floor Light rail vehicles (LRV) and 60-foot articulated buses
Storage and Maintenance Facilities	Utilizes existing Brampton Transit storage and maintenance facilities	Expanded BRT fleet will require expanded storage and maintenance capacity, which may require either a new facility or expanding existing Brampton Transit facilities	Expanded BRT fleet will require expanded storage and maintenance capacity, which may require either a new facility or expanding existing Brampton Transit facilities	New storage and maintenance facility required for light rail vehicles in Airport Road vicinity	New storage and maintenance facility required for light rail vehicles in Airport Road vicinity; bus storage in existing facilities

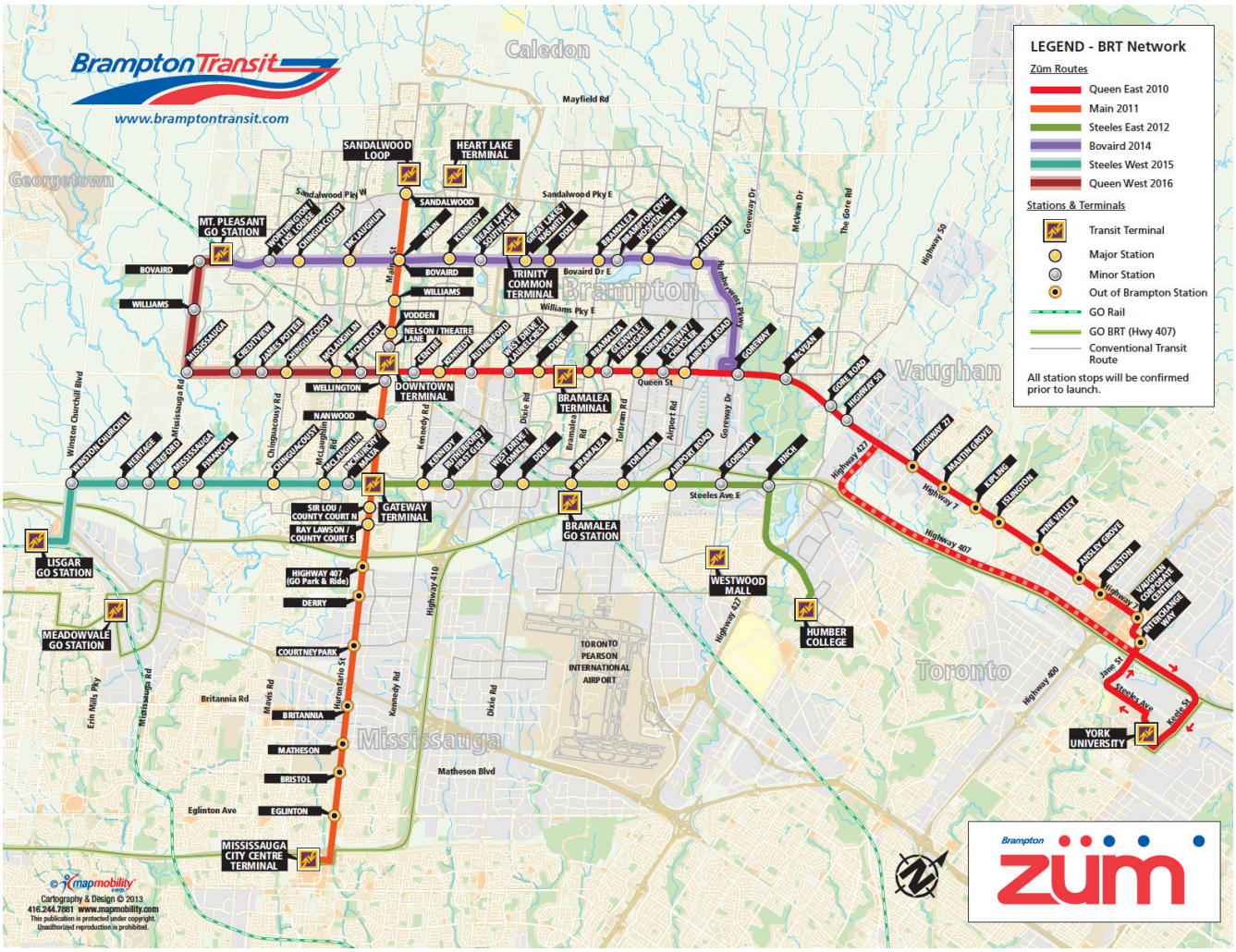
* Would require negotiations with Metrolinx for use of Highway 7 Rapidway and service coordination with YRT

3.3 Base Case

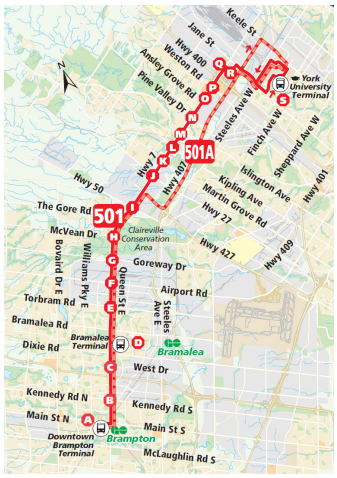
The Base Case reflects business-as-usual along Queen Street rapid transit corridor in the City of Brampton. While slightly different from the network currently operating, the base case is defined as the existing Züm service on Queen Street and includes the funded expansions of the Züm network to Main Street, Steeles Avenue, and Bovaird Drive over the next few years, as shown in Exhibit 3.3 as well as any committed operational changes. This includes the planned reconfiguration of the eastern terminus of the route, which will be either Vaughan Metropolitan Centre or Highway 407 Subway Stations on the Toronto-York Spadina Subway Extension.

Züm service is a "BRT light" (Züm-BRT light) service that operates in mixed traffic. However, its characteristic of wider stop spacing and Intelligent Transportation Systems (ITS), such as Transit Signal Priority (TSP) and queue jump lanes, allow the route to provide faster transit service than the conventional local bus service.

Exhibit 3.3: Committed Züm Network



Queen Street Züm Service



The base case Queen Street Züm Service is defined by the branched service operated as the 501 Züm-BRT light route:

- **Route 501**, which travels from Downtown Brampton to York University via Highway 7 in York Region. The average travel time during the morning peak period is approximately 62 minutes; and,
- **Route 501A**, which also travels from Downtown Brampton to York University, but bypasses Highway 7 stops in York Region via Highway 407. The average travel time during the morning peak period is approximately 46 minutes.

Headways for the Züm 501/501A service are as follows:

- Combined weekday peak period headway every 7.5 minute
- Combined weekday off-peak period headway every 10 minutes
- Combined all day weekend period headway every 15 minutes

Brampton Transit is currently operating 60-foot articulated buses along its 501 Züm corridor. As such, 60-foot buses are included as part of the base case. These buses will provide a seating capacity of 57 passengers with a Brampton Transit loading standard of 76 and maximum capacity of 90 passengers per vehicle.

Service Integration and Other Network Assumptions

Currently, Züm buses operating in York Region on Highway 7 between Highway 50 and York University accept YRT/Viva fares, and vice versa. YRT/Viva customers are required to pay an additional Brampton Transit fare if travelling west of Highway 50.

As construction is underway on the fully funded Toronto-York Spadina Subway Extension, this project is included in the Base Case. Once completed, buses will no longer be permitted to enter York University. The 501 Züm-BRT light service will be routed to terminate at subway stations at Vaughan Metropolitan Centre Station and 501A at Highway 407/Jane Station.

3.4 Project Options

Option 1A: Bus Rapid Transit on Queen Street in Dedicated Right-of-way

Option 1A would separate bus rapid transit operations from mixed traffic through the provision of a dedicated right-of-way between intersections. These lanes are typically centre-running bus-only lanes, physically separated from other traffic, supplemented by transit priority at intersections through physical treatments, such as queue-jump lanes, or signal priority.

Routing

The bus rapid transit line would travel along Queen Street and Highway 7 from Downtown Brampton in the west to Vaughan Metropolitan Centre (VMC) Subway Station in the east. A branch service, similar to the existing 501A service, would operate on Highway 407 to terminate at Highway 407 Subway Station. Stations served correspond to the existing Züm station locations (see Exhibit 3.4).

Exhibit 3.4: Station Locations (West to East)

Züm Stations (Major stations in bold)	York Region Highway 7 Stations (committed Viva Rapidway stations in italics)
Downtown Terminal Centre Street **Kennedy Road** Rutherford Road West Drive/Laurelcrest **Dixie Road** **Bramalea Terminal** **Bramalea Road** Glenvale/Finchgate **Torbram Road** Gateway/Chrysler **Airport Road** Goreway McVean Gore Road Highway 50	**Highway 27** **Martin Grove** **Kipling** **Islington** *Helen* **Pine Valley** **Ansley Grove** **Weston** *Commerce* **Vaughan Metropolitan Centre Subway Station** **Highway 407 Subway Station**

Service integration with Viva Orange is assumed to continue in the section of Highway 7 between Highway 50 and VMC[1] as currently negotiated between York Region Transit and Brampton Transit. Connections to local service are provided at intersecting locations and at bus terminals at Downtown Brampton and Bramalea City Centre.

[1] Access rights to the rapidways along Highway 7, east of Highway 50, are subject to negotiation with Metrolinx. Access to the direct connection platforms at Vaughan Metropolitan Centre (VMC)Station and bus terminals at Highway 407 Station are also subject to negotiations with York Region and Toronto Transit Commission (TTC).

Operational Considerations

A dedicated right-of-way is difficult to accommodate through Downtown Brampton and mixed-traffic operation may be necessary to preserve the existing built urban form and reduce property acquisition requirements. It is assumed that operation along this short segment would be supplemented by transit signal priority and/or physical intersection improvements.

The use of 60-foot articulated buses at 5-minute headways would provide increased service capacity. An additional storage and maintenance facility may be required with the expansion of the bus rapid transit fleet.

The parallel local bus service, Route 1, is assumed to continue to provide transit service along Queen Street to local stops. Route 1 is assumed to operate on Queen Street at a 20-minute headway during peak periods.

Exhibit 3.5: Summary of Operating Characteristics, Option 1A

Operating Segment	Distance (km)	Exclusive Right-of-way Section	Stations	Average Speed (km/h)	Travel Time (min)
Downtown Terminal to Centre Street	**0.7**	**No**	**2**	20	2
Centre Street to Bramalea Terminal	**4.6**	**Yes**	**5**	28	10
Bramalea Terminal to Airport Road	**3.5**	**Yes**	**5**	28	8
Airport Road to Highway 50	**4.8**	**Yes**	**4**	32	9
Highway 50 to Helen	**5.8**	**Yes**	**5**	28	12
Helen to Vaughan Metropolitan Centre	**4.3**	**Yes**	**5**	28	9
Total	**23.7**		**26**		**50**
Highway 50 to Spadina Subway via Highway 407	**11.5**	**No**	**1**	55	13
Downtown-Subway via Hwy 407 Total	**25.1**		**17**		**42**

Option 1B: BRT from Downtown Brampton to Airport Road, Mixed Traffic Züm-BRT Light East of Airport Road

Option 1B will evaluate a shorter segment of bus rapid transit in dedicated lanes between Downtown Brampton and Airport Road. East of Airport road, this service would transition into mixed traffic and resume Züm-BRT light service to provide the connection to the Spadina Subway.

Routing

The bus rapid transit line would run in dedicated lanes on Queen Street from Downtown Brampton to Airport Road. East of Airport Road, the service would transition into Züm-BRT light service to the Spadina Subway, thus reducing the need to transfer for through passengers. Stations served correspond to the existing Züm station locations (see Exhibit 3.4).

Branched Züm-BRT light service between Airport Road and the Spadina Subway would be operated similar to existing operations.

Service integration with Viva Orange is assumed to continue in the section of Highway 7 between Highway 50 and VMC[2] as currently negotiated between York Region Transit and Brampton Transit.

Connections to local service are provided at intersecting locations and at bus terminals at Downtown Brampton and Bramalea City Centre.

Operational Considerations

A dedicated right-of-way is difficult to accommodate through Downtown Brampton and mixed-traffic operation may be necessary to preserve the existing built urban form and reduce property acquisition requirements. It is assumed that operation along this short segment would be supplemented by transit signal priority and/or physical intersection improvements.

The ability for this option through service east of Airport Road from the BRT section west of Highway 50 is a benefit. However, there may be impacts on service reliability, as the Züm section would run in mixed traffic that would need to be taken into account should this option be further studied.

The use of 60-foot articulated buses at 5-minute headways would provide increased service capacity. An additional storage and maintenance facility may be required with the expansion of the bus rapid transit fleet. Brampton Transit has indicated that existing facilities could be expanded to accommodate a larger fleet of BRT vehicles.

The parallel local bus service, Route 1, is assumed to continue to provide transit service to stops along Queen Street. Route 1 is assumed to operate on Queen Street on a 20-minute headway during peak periods.

[2] See footnote 1

Exhibit 3.6: Summary of Operating Characteristics, Option 1B

Operating Segment	Distance (km)	Exclusive Right-of-way Section	Stations	Average Speed (km/h)	Travel Time (min)
Downtown Terminal to Centre Street	**0.7**	**No**	**2**	20	2
Centre Street to Bramalea Terminal	**4.6**	**Yes**	**5**	28	10
Bramalea Terminal to Airport Road	**3.5**	**Yes**	**5**	28	8
Additional 5 minute transfer time if no through service provided					
Airport Road to Highway 50	**4.8**	**No**	**4**	22.5	13
Highway 50 to Helen	**5.8**	**No**	**5**	22.5	15
Helen to Vaughan Metropolitan Centre	**4.3**	**Yes**	**5**	28	9
Total	**23.7**		**26**		**57 (+5)**
Highway 50 to Spadina Subway via Highway 407	**11.5**	**No**	**1**	55	13
Downtown-Subway via Hwy 407 Total	**25.1**		**17**		**46 (+5)**

Option 2A: Light Rail Transit on Queen Street in Dedicated Right-of-way

Option 2A would convert bus operations to light rail transit (LRT) along the corridor. Similar to BRT, LRT trains would run in physically separated, dedicated centre lanes with stations on island platforms in between transit and vehicular lanes.

Routing

A light rail transit route would run from Downtown Brampton to Vaughan Metropolitan Centre Station on the Spadina Subway Extension via Queen Street and Highway 7. The light rail transit line will run in a dedicated right-of-way, except in Downtown Brampton, where the limited right-of-way will require mixed-traffic operation. Stations served correspond to the existing Züm station locations (see Exhibit 3.4)

Implementing LRT on Highway 7 would likely result in the removal of Viva bus service in York Region between Highway 50 and Vaughan Metropolitan Centre. The integration of LRT and York Region Transit services will need to be clarified with YRT in the future should this option be carried forward for further study.

This option assumes no Queen Street Rapid transit branch service along Highway 407.

Operational Considerations

A light rail option would require a dedicated maintenance and storage facility. This facility would need a fair sized parcel of land, which is generally in short supply within the corridor. It is assumed that the available land for this facility is located in the Airport Road vicinity. Should the Hurontario/Main LRT be constructed, a shared facility is possible, but this will not be considered for this BCA.

Light rail vehicles (LRVs) similar to those on order to serve Toronto's new Eglinton Crosstown LRT line will be assumed for the BCA. These LRVs are 28-metres in length and can accommodate up to 280 passengers per vehicle.

The parallel local bus service, Route 1, is assumed to continue to provide transit service along stops on Queen Street. Route 1 is assumed to operate on Queen Street on a 20-minute headway during peak periods.

Exhibit 3.7: Summary of Operating Characteristics, Option 2A

Operating Segment	Distance (km)	Exclusive Right-of-way Section	Stations	Average Speed (km/h)	Travel Time (min)
Downtown Terminal to Centre Street	**0.7**	**No**	**2**	20	2
Centre Street to Bramalea Terminal	**4.6**	**Yes**	**5**	28	10
Bramalea Terminal to Airport Road	**3.5**	**Yes**	**5**	28	8
Airport Road to Highway 50	**4.8**	**Yes**	**4**	32	9
Highway 50 to Helen	**5.8**	**Yes**	**5**	28	12
Helen to Vaughan Metropolitan Centre	**4.3**	**Yes**	**5**	28	9
Total	**23.7**		**26**		**50**

Option 2B: LRT from Downtown Brampton to Airport Road

Option 2B would provide light rail transit (LRT) between Downtown Brampton and Airport Road. Züm – BRT light service would connect Airport Road to the Spadina Subway extension. This option provides LRT along the more densely populated section of the corridor; however, forces a transfer for passengers traveling east of Airport Road.

Routing

The light rail transit line will run on Queen Street between Downtown Brampton and Airport Road in a dedicated right-of-way, except in Downtown Brampton, where the limited right-of-way will require mixed-traffic operation. The eastern terminus of the line at Airport Road will allow access to storage and maintenance facilities which at this time is deemed the most feasible. Stations served correspond to the existing Züm station locations (see Exhibit 3.4).

Züm-BRT light service, connecting to the LRT at Airport Road, continues east to the Spadina Subway extension. Branch service would alternate between Vaughan Metropolitan Centre Station (via Highway 7) and Highway 407 Station (via Highway 407).

Operational Considerations

The design of the transfer between LRT and Züm service at Airport Road will be essential to ensure convenient travel through the corridor.

Similar to the Option 1 scenarios, Züm-BRT light service is assumed to continue to interline with Viva Orange services[3] as currently negotiated between York Region Transit and Brampton Transit

Light rail vehicles (LRVs) similar to those on order to serve Toronto's LRT projects will be assumed to operate over the light rail section of Option 2B. These LRVs are 28-metres in length and can accommodate up to 280 passengers per vehicle. 60-foot articulated buses will be assumed for connecting Züm-BRT light service.

The parallel local bus service, Route 1, is assumed to continue to provide transit service to stops along Queen Street. Route 1 is assumed to operate on Queen Street at a 20-minute headway during peak periods.

[3] See footnote 1

Exhibit 3.8: Summary of Operating Characteristics, Option 2B

Operating Segment	Distance (km)	Exclusive Right-of-way Section	Stations	Average Speed (km/h)	Travel Time (min)
Downtown Terminal to Centre Street	**0.7**	**No**	**2**	20	2
Centre Street to Bramalea Terminal	**4.6**	**Yes**	**5**	28	10
Bramalea Terminal to Airport Road	**3.5**	**Yes**	**5**	28	8
Add 5 minute transfer time between LRT and bus					
Airport Road to Highway 50	**4.8**	**No**	**4**	22.5	13
Highway 50 to Helen	**5.8**	**No**	**5**	22.5	15
Helen to Vaughan Metropolitan Centre	**4.3**	**Yes**	**5**	28	9
Total	**23.7**		**26**		**62**
Highway 50 to Spadina Subway via Highway 407	**11.5**	**No**	**1**	55	13
Downtown-Subway via Hwy 407 Total	**25.1**		**17**		**51**

3.5 Summary of Project Options

Rapid transit along Queen Street would serve as a higher-order 'backbone' to the transit network in Brampton. Four project options are evaluated incremental to the base case as part of this BCA for rapid transit on Queen Street. This approach allows for a consistent comparison between the two technologies under consideration for the corridor – Bus Rapid Transit (BRT) or Light Rail Transit (LRT). The options to be analyzed are briefly summarized below and in Exhibit 3.9.

- **Base Case:** The existing/committed transit network including Bus Rapid Transit (BRT) "light" that operates in mixed traffic known as Brampton Transit's Züm service.

Bus Rapid Transit (BRT) Options

- **Option 1A:** BRT service in an exclusive right-of-way between Downtown Brampton and Vaughan Metropolitan Centre. Branch express service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations on the Toronto-York Spadina Subway Extension. First year of operation would be 2016;

- **Option 1B:** BRT service in exclusive right-of-way between Downtown Brampton and Airport Road and Züm-BRT light service continuing on to the Toronto-York Spadina Subway Extension. Branch express service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations. First year of operation would be 2016;

Light Rail Transit (LRT) Options

- **Option 2A**: LRT service in exclusive right-of-way between Downtown Brampton and Vaughan Metropolitan Centre Subway Station. First year of operation would be 2018. This option does not offer the branch express service to Highway 407 Subway Station;

- **Option 2B:** LRT service in exclusive right-of-way between Downtown Brampton and Airport Road, and connection to Züm-BRT light service to the Spadina Subway extension. Branch express service would be provided for service to either Vaughan Metropolitan Centre or Highway 407 Subway Stations. First year of operation would be 2017.

Service levels for all four options will provide a peak period headway of five minutes.

Exhibit 3.9: Options Summary

3.6 Cost Estimates

Preliminary cost estimates were developed for the four options presented for higher-order rapid transit in the Queen Street corridor in Brampton. These cost estimates are in 2011 dollars:

- **Option 1A (estimated capital cost: $536M)** assumes a dedicated runningway for BRT would be constructed along the entire length of the corridor and that service would share the committed Viva rapidway between Helen Street and Vaughan Metropolitan Centre. As a result, the runningway capital cost estimate does not include this section.

- **Option 1B (estimated capital cost: $345M)** assumes a dedicated runningway for BRT would be constructed along a section of the corridor between Downtown Brampton and Airport Road. Capital expenditures will be isolated to this section west of Airport Road, with the exception of additional vehicles. Committed Züm service will continue between Airport Road and Vaughan Metropolitan Centre.

- **Option 2A (estimated capital cost: $1.2B)** assumes that LRT would be constructed along the entire length of the corridor and the committed Viva rapidway between Helen Street and Vaughan Metropolitan Centre would be replaced. Cost estimates do not take into account potential savings or costs related to the presence of the planned rapidway[4].

- **Option 2B (estimated capital cost: $525M)** assumes LRT would be constructed along a section of the corridor between Downtown Brampton and Airport Road. Capital expenditures will be isolated to this section west of Airport Road, with the exception of additional vehicles. Committed Züm service will continue between Airport Road and Vaughan Metropolitan Centre.

The above costs for the 23.7 km corridor from Downtown Brampton to Vaughan Metropolitan Centre include runningway, stations, maintenance and storage facilities, professional services, vehicles, and contingency.

Exhibit 3.11 provides a breakdown of the capital costs and estimated gross annual operating cost for each project option. Capital costs in subsequent sections are discounted cash flow values over the evaluation period.

[4] Costed on a replacement basis due to the high degree of uncertainty in the assumptions for BRT-to-LRT conversion. In addition, the York Rapid Transit Transition Plan assumed a 20% lower per-kilometre cost for LRT when converting existing BRT. Given the relatively small section of BRT being replaced with LRT, the savings would be minimal on a project basis.

Service Level/Operating Cost

Incremental operating and maintenance costs were also developed for each option. Annual estimated revenue service hours (RSH) and kilometres (RSK) were calculated based on service levels required to accommodate modelled demand. The service levels for each option are shown in Exhibit 3.10.

Exhibit 3.10: Service Levels by Option and Time of Day (Weekday headway in minutes)

Route	AM Peak	Midday	PM Peak	Early Evening	Late Evening
Option 1: BRT					
501 BRT	4	10	4	10	20
501A BRT	4	10	4	10	20
Combined	2	5	2	5	10
Option 2: BRT/Züm					
501	4	10	4	10	20
501A	4	10	4	10	20
Combined	2	5	2	5	10
Option 3: LRT					
LRT	3	10	3	10	10
Option 4: LRT/Züm					
LRT	5	10	5	10	10
West of Airport Road	5	10	5	10	10
501	5	10	5	10	20
501A	5	10	5	10	20
East of Airport Road	2.5	5	2.5	5	10

The resulting RSH and RSK for each service option was input into developing estimated operating and maintenance costs based on per RSH/RSK measures derived from a review of similar LRT and BRT operations. These costs were then calculated on an incremental basis over the cost of existing/base service in the Queen Street corridor. The estimated annual cost of existing Züm service in the corridor, based upon approximate hours of service and Brampton Transit's 2010 reported marginal cost per revenue service hour is $5.7-million (2011 $).

Fleet Requirements

The service levels, combined with estimated round trip time, allowed for the estimation of the required fleet for each option:

- **Option 1A:** 50 buses + 15 spare buses = 65 buses total
- **Option 1B:** 60 buses + 18 spare buses = 78 buses total
- **Option 2A:** 33 light rail vehicles (LRVs) + 10 spare LRVs = 43 LRVs total
- **Option 2B:** 8 LRVs + 3 spare LRVs = 11 LRVs total
  32 buses + 10 spare buses = 42 buses total

Exhibit 3.11: Capital Cost Summary by Option (2011 $, in Millions)

	Option 1A: BRT	Option 1B: BRT/Züm	Option 2A: LRT	Option 2B: LRT/Züm
CAPITAL COSTS				
A. Runningway and Stations				
Guideway & track elements	$117.3	$52.6	$204.7	$75.0
Stations, stops, terminals, intermodal	$40.8	$24.7	$72.1	$35.6
Sitework & special conditions	$25.5	$14.3	$42.7	$17.9
Systems	$10.6	$5.5	$96.5	$38.9
ROW, land, existing improvements	$69.0	$26.0	$79.0	$36.0
B. Maintenance and Storage Facilities				
Support facilities: yards, shops, admin. buildings	$26.0	$27.2	$98.9	$42.1
Subtotal (A+B): Runningway, Stations, and Facilities	$289.2	$150.4	$593.9	$245.6
C. Rolling Stock				
Vehicles	$65.0	$78.0	$232.2	$101.4
D. Professional Services				
Professional Services	$92.1	$59.4	$214.8	$90.2
TOTAL CAPITAL COSTS (without contingency)	$446.3	$287.8	$1,040.8	$437.2
Contingency (20%)	$89.3	$57.6	$208.2	$87.4
TOTAL CAPITAL COSTS (including contingency)	**$535.5**	**$345.3**	**$1,249.0**	**$524.6**
INCREMENTAL OPERATIONAL & MAINTENANCE COSTS (Annual) - Including bus savings	$13.8	$14.2	$13.9	$12.5

4. Part C: Project Assessment

4.1 Transportation Modelling Approach

The approach to transport modelling and appraisal makes use of the Greater Golden Horseshoe Transportation Model (GGHM) Version 2, which provides ridership projections and outputs required for the calculation of transportation user benefits. The model produces estimates of trip making, distance, and travel time differences by transit and auto. These results are used to evaluate the transportation user benefits for the benefits case analysis. Details of input variables and assumptions for the various accounts can be found at the back of the document.

4.2 Summary of Findings

Exhibit 4.1 provides a detailed summary of the findings of the Multiple Account Evaluation. Taking into account only transportation user benefits against the capital and operating cost, Option 1A provides the greatest benefit per dollar invested. However, there are other important findings in the MAE as well, including:

- In 2031, the full-corridor LRT option attracts the most ridership, with an estimated daily ridership of 43,800, while BRT options attract similar ridership of around 30,000 per day;
- Implementing rapid transit on the full corridor (either LRT or BRT) would have a greater positive impact on land value increase and have greater land-use shaping qualities; and,
- Accessibility to rapid transit would be dramatically improved by Queen Street rapid transit to between 90,000 and 120,000 people and jobs over the base case in 2031.

It should be understood that the base case for this benefits case includes Züm bus service committed throughout Brampton, including the Queen Street corridor. The Züm service is a high quality service providing competitive travel speeds, shorter than average wait times, and direct connections to other rapid transit in the GTHA. As a result, the incremental nature of the Queen Street benefits case improvements yield less dramatic ridership and transportation user benefits typically seen in other studies where no comparable service exists – the benefit cost ratios presented in the study findings should be interpreted with this in mind.

Exhibit 4.1: Summary of Multiple Account Evaluation

Measure/Criteria	Option 1A: BRT		Option 1B: BRT/Züm		Option 2A: LRT		Option 2B: LRT/Züm	
Option Description	Bus rapid transit in dedicated lane from Downtown Brampton to Vaughan Metropolitan Centre; Branch express service to Highway 407 Subway Station		Bus rapid transit in dedicated lane from Downtown Brampton to Airport Road/Queen Street; Existing Züm service from Airport Road to Vaughan Metropolitan Centre; Branch service to Hwy 407 Station		Light rail transit in dedicated lane from Downtown Brampton to Vaughan Metropolitan Centre		Light rail transit in dedicated lane from Downtown Brampton to Airport Road/Queen Street; Existing Züm service from Airport Road to Vaughan Metropolitan Centre; Branch service to Hwy 407 Station	
Transportation User Benefits								
Total Quantitative Benefits	▲	$563.6M	△	$385.2M	▲	$757.7M		$480.0M
Trip Quality (Qualitative)	▲	Provides more reliable, faster service and one-seat ride from Downtown Brampton to Vaughan Metropolitan Centre	▲	Dedicated transit lanes in area where congestion occurs to improve reliability and provides through routing at Airport Road. Targets investment where needed most to achieve maximum return on investment	▲	Provides rail-based rapid transit, which is often perceived as more preferable than bus. One-seat ride. Dedicated runningway increases reliability and operating speed.		Provides rail-based rapid transit within the most built-up area of the corridor within Brampton. Forces transfer to bus service for trips east of Airport Road.
Financial Account								
Total Incremental Costs		$744.1M		$616.2M		$1,319.2M		$687.9M
Net Benefit	▽	($180.4M)	▽	($231.0M)	▼	($561.5M)		($207.9M)
Benefit-Cost Ratio		**0.8**		**0.6**		**0.6**		**0.7**
Environmental Account								
Reduction in GHG emissions	-	$1.5M / 78,400 metric tonnes of GHG	-	$1.0M / 49,200 metric tonnes of GHG	-	$1.8M / 92,800 metric tonnes of GHG	-	$1.1M / 56,600 metric tonnes of GHG
Broader Environmental Benefits (Qualitative)	△	Encourages increased transit use, may lead to intensification of the corridor	△	Encourages increased transit use, may lead to intensification of the corridor	▲	Reduced energy consumption and emissions (electric LRT vs. buses)		Reduced energy consumption and emissions (electric LRT vs. buses)
Economic Development Account								
Short-Term Impacts Construction (direct and indirect)	△	$335.1M in wages; $331.9M in GDP	△	$218.9M in wages; $208.3M in GDP	▲	$784.6M in wages; $764.5M in GDP		$328.0M in wages; $323.9M in GDP
Long-Term Impacts (Annual) Operations (direct and indirect)	△	$13.3M in wages; $9.9M in GDP	△	$13.3M in wages; $10.2M in GDP	△	$13.4M in wages; $10.0M in GDP		$12.0M in wages; $9.0M in GDP
Long-Term Impacts Business/Industry Growth	△	Minimal to Moderate	-	Minimal	▲	Moderate to Strong	-	Minimal
Land Value Increase	△	Moderate (i.e. 4% - 8%)	-	Minimal (i.e. 1% - 5%)	▲	Moderate (i.e. 8% - 15%)	-	Minimal (i.e. 4% - 6%)
Social Community Account								
Accessibility	▲	Increased access to rapid transit across entire corridor	△	Improved access to rapid transit between Downtown Brampton and Airport Road	▲	Increased access to rapid transit across entire corridor		Improved access to rapid transit between Downtown Brampton and Airport Road
Safety	△	Improved corridor and roadway design to improve pedestrian, motorist, cyclist safety ; eyes on street	△	Improved corridor and roadway design to improve pedestrian, motorist, cyclist safety ; eyes on street	△	Improved corridor and roadway design to improve pedestrian, motorist, cyclist safety ; eyes on street		Improved corridor and roadway design to improve pedestrian, motorist, cyclist safety ; eyes on street
Liveability	▲	Provides rapid transit across corridor and link between Urban Growth Centres.	△	Allows transit to bypass congested areas of corridor, increasing attractiveness of transit	▲	Light rail transit seen as greatest catalyst for new development. Provides rapid transit link between Urban Growth Centres.		Light rail transit seen as greatest catalyst for new development. Focuses light rail in area with greatest development potential

Legend:

Impact Scale (comparing across benefit case options)	Strong Negative	Moderate Negative	Neutral	Moderate Positive	Strong Positive
	▼	▽	-	△	▲

NOTE: All figures, excluding economic development impacts, are net present values (2011$) over a period of 2012 to 2041, discounted at a rate of 5%.

4.3 Ridership

Implementing rapid transit in the Queen Street corridor in Brampton will induce varying degrees of ridership increase. Options with the most frequent, reliable, and fast services will attract a greater number of riders. Currently, approximately 9,500 daily boardings are observed on the 501/501A Züm route on Queen Street. Projections for daily ridership in 2031 for each of the four benefits case options range from 28,800 to 43,800 boardings. This represents a large increase in ridership, ranging from 28% to double over the base case, reflective of anticipated growth in population, employment, and travel patterns in the Queen Street corridor. Exhibit 4.2 provides a ridership summary for each benefits case option.

Exhibit 4.2: Summary of Ridership

Criteria	Base Case	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Ridership (2021)					
AM Peak Point Ridership	1,300	2,100	1,900	3,200	1,800
Total Daily Boardings (BRT/LRT/Züm)	17,400	24,000	22,800	33,900	20,700
Total Corridor Daily Boardings (BRT/LRT/Züm + Viva/Local)	32,600	38,200	37,100	45,400	36,300

Criteria	Base Case	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Ridership (2031)					
AM Peak Point Ridership	2,000	2,900	2,800	4,200	2,600
Total Daily Boardings (BRT/LRT/Züm)	22,500	31,500	30,300	43,800	28,800
Total Corridor Daily Boardings (BRT/LRT/Züm + Viva/Local)	40,700	48,400	47,300	56,900	47,200

Daily boardings in 2031 are anticipated to be highest for Option 2A (LRT) with approximately 43,800 daily boardings, followed by Option 1A (BRT) with approximately 31,500 daily boardings[5]. Option 2B (LRT/Züm) attracted the fewest daily riders, with only 28,800.

[5] Although the operational speed between the two options is expected to be similar, the greater comfort and quality of rail-based transit in the form of LRT was quantified in the modelling through an operational speed increase. Therefore, the faster modelled speed of LRT simulated its qualitative attractiveness and is reflected in the projected ridership results.

The incremental ridership differences between Options 1A, 1B, and 2B show a modest preference for options that provide a seamless trip, which attracted higher ridership than the LRT/Züm option. This is largely a result from reduced travel times offered by the BRT options, which provide through service from Downtown Brampton to the Toronto-York Spadina Subway Extension without the need to transfer. In addition, the branched BRT/Züm service east of Highway 27, with express service on Highway 407 to the Spadina Subway, is a high-speed, attractive service. In addition, while LRT is more attractive than BRT, it does not offset the inconvenience of a forced transfer between LRT and Züm services in Option 2B[6]. As a result, it attracts fewer riders than the through services offered by the BRT-based options.

Peak point ridership (at the peak hour and peak period direction) is an indicator of the maximum demand and by extension, the type of higher-order transit warranted based on capacity. Generally, peak point ridership above 2,500 passengers in the peak hour in the peak direction (PPHPD) warrants some degree of separation for transit from mixed traffic.

For projected ridership levels in 2031, all four benefits case options meet the 2,500 passengers in the peak hour and direction threshold to warrant the provision of transit exclusivity. The LRT option attracts the highest peak point ridership, at 4,200 PPHPD, while the BRT options attract between 2,800 (Option 1B) and 2,900 (Option 1A) PPHPD. Truncating the LRT line in Option 2B has a significant negative impact on ridership, dropping peak point ridership to approximately 2,600 PPHPD. This is a result of the forced transfer at Airport Road for through trips between Brampton and York Region, which is the prevailing trip pattern in the corridor. Peak point ridership for Options 1A, 1B, and 2A occurs between Airport Road and Highway 50.

[6] For Option 2B, a five-minute transfer penalty was included in travel times for LRT/Züm service to model the impact of the forced transfer between LRT and buses at Airport Road. While the design of the station at this location could minimize the walking distance and coordinated schedules could reduce waiting time, there is a strong negative perception of transfers between services for transit customers. The five-minute penalty is seen as a realistic measure to model the impact on ridership, which may be a conservative estimate of the impact. The TTC, for example, uses a 10-minute penalty for transfers between its surface routes despite high frequency service and short walking distances between routes (TTC Service Improvements Report).

4.4 Transportation Network Impacts

Rapid transit alternatives in the Queen Street corridor in Brampton would produce varying degrees of travel time and reduction in vehicle kilometres travelled. These reductions occur in response to the availability of faster transit in comparison to the base case. Exhibit 4.3 summarizes these network impacts, which include:

- Annual travel time savings for transit and auto trips in 2031 ranging between 1.8-million and 3.6-million hours;
- Annual reduction in vehicle kilometres traveled in 2031 ranging from 9.6-million to 19.1-million kilometres.

Exhibit 4.3: Summary of Transportation Network Impacts

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Transportation Network Impacts (2031)				
Annual Travel Time Hours Saved – Transit + Auto Trips (in millions of Hours)	2.3	1.8	3.6	2.2
Reduction in Annual Vehicle Kilometres Travelled (in millions of Kilometres)	15.3	9.6	19.1	11.2

All four rapid transit options are expected to produce significant reductions in travel time and vehicle kilometres travelled. These reductions are greatest for Option 2A (full LRT). The travel time saving and VKT reduction for full BRT (Option 1A) is also significant, providing greater reductions than a hybrid LRT/Züm option (Option 2B). The incremental increase in travel time savings/VKT reduction is greater between Option 1A and 2A than Option 1B and 2B, which is reflective of the attractiveness and convenience of LRT across the entire corridor compared to truncated line. Additional travel time savings are also present in Options 1A, 1B, and 2B, which provide branched express service on Highway 407 between Highway 427 and the Spadina Subway.

4.5 Transportation Account

The transportation account includes an estimation of transportation user benefits. Transportation user benefits are comprised of travel time savings to transit and road users, automobile operating cost savings, and safety benefits on the road network. The inputs to these measures are based on projections from the GGHM and the results are based on a comparison between the project options and the base case. The summary of the transportation account is shown in Exhibit 4.4, which includes benefits over the analysis period.

Exhibit 4.4: Summary of Transportation Account

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Transportation Account (in Millions, 2011$)				
Travel Time Savings (transit + auto):	$442.7	$309.2	$617.9	$392.8
Automobile Operating Cost Savings:	$110.1	$69.2	$127.5	$79.5
Safety Benefits:	$10.8	$6.8	$12.3	$7.7
Total Quantitative Transportation User Benefits:	**$563.6**	**$385.2**	**$757.7**	**$480.0**

NOTE: All figures are net present values (2011 $) over a period of 2012 to 2041, discounted at a rate of 5%.

The results show that the full light rail transit option (Option 2A) provides the greatest transportation user benefit, with a total discounted value of $757.7-million over the evaluation period. This reflects the higher quality service provided through LRT compared to bus-based options. This difference is quantified in the difference in benefits between Option 1A (BRT) and Option 2A (LRT), with a 35% increase in benefits in the rail-based option.

The impact of a forced transfer is observed in the difference in benefits between the hybrid Züm-BRT/LRT options (Options 1B and 2B). Comparison of these two options shows a decrease in benefits for the LRT hybrid option (Option 2B). Option 2B is negatively impacted by a forced transfer between LRT and Züm services, which is quantified by the five-minute transfer travel time penalty at Airport Road. The BRT/Züm hybrid option, in contrast, benefits from the ability to provide a one-ride through service at Airport Road, as buses can transition from separated right-of-way to mixed-traffic operation.

The BRT options provide demonstrable transportation user benefits and coupled with the lower capital costs can provide a greater overall benefit per dollar invested. LRT continues to be perceived as a more attractive transit mode; however, BRT technology continues to evolve and improved vehicle design and customer amenities can provide a comparable level of service.

4.6 Financial Account

The financial account includes the net present value of the capital and incremental operating costs and incremental passenger revenue over the evaluation period. Direct capital costs are detailed in Section 2.1. The difference between fare revenues in each option and the base case scenario represents the daily incremental passenger revenue, which is expanded to provide an annual figure.

Operating cost estimates were also developed for each option, which are incremental to the cost of operation of existing Züm service in the corridor. It is assumed that Züm service would be absorbed into operations of Options 1A and 2A and truncated in Options 1B and 2B. As a result, existing Züm operating costs are considered as operational savings.

The summary of the financial account for each option is provided in Exhibit 4.5.

Exhibit 4.5: Summary of Financial Account

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Financial Account (in Millions, 2011 $)				
Costs				
Direct Capital Costs	$522.8	$388.9	$1,120.5	$499.0
Incremental Operating Costs	$221.3	$227.3	$198.6	$189.0
Total Incremental Costs	**$744.1**	**$616.2**	**$1,319.2**	**$687.9**
Revenues				
Incremental Passenger Revenue	$69.4	$58.2	$138.0	$53.0

NOTE: All figures are net present values (2011 $) over a period of 2012 to 2041, discounted at a rate of 5%.

The total incremental costs for the benefits case options range from $616-million to $1.3-billion, with LRT-based options costing more than BRT-based options of the same length. Light rail transit capital costs are higher than that of bus rapid transit due to two main factors:

- **Higher vehicle cost:** Taking into account the longer service life of light rail vehicles, they are still more expensive than the equivalent number of buses. Some of this increased cost is offset by the need for fewer light rail vehicles to accommodate modelled demand, compared to buses; and

- **Higher cost of runningway:** Unlike bus rapid transit, light rail transit requires significant additional infrastructure related to the installation of track and switches, electrification of the runningway (catenary and substations), signalization, and communications and train control.

As a result of the higher capital costs, LRT requires a much greater return in the form of transportation user benefits in order to achieve a positive benefit-cost ratio. The estimated costs for the LRT options, approximately $40.9M per kilometre in Option 2A, are consistent with other light rail projects across Ontario. This compares to approximately $23.6M per kilometre estimated for bus rapid transit in Option 1A.

Over the evaluation period, the estimated incremental costs for the LRT options are lower than that of the BRT options, although all four options cost approximately the same to operate on an annual basis. However, Option 2A carries more passengers than the BRT options and has a lower operating cost largely due to the larger capacity of light rail vehicles. This reduces the number of vehicles required to accommodate projected demand. Option 2B (LRT/Züm) results in the lowest incremental operating cost over the evaluation period; however, most of this lower cost is a result of projected lower demand.

Combined with the estimated incremental increase in passenger revenue, the incremental revenue-cost ratio ranges for the four options between 26% (Option 1B) and 69% (Option 2A). However, a more useful measure would be to calculate the fare recovery ratio for the rapid transit route based on annual boardings and average fare per boarding, compared to estimated annual operating cost. Exhibit 4.6 shows the fare-recovery ratio for each option in 2021 and 2031. Average fare is based on a reported figure of $2.11 in 2010, escalated to modelled year at a rate of 2% per annum.

Exhibit 4.6: Fare Recovery Ratio

Year	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
2021	79%	74%	112%	73%
2031	104%	98%	144%	102%

All four options provide a high cost-recovery ratio, with revenue for Option 2A exceeding operating cost in both 2021 and 2031. Ridership growth by 2031 brings all options to a break-even scenario. High revenue-cost ratios are typical for “trunk” rapid transit services in urban areas that are fed by the local route network. As a result, the above fare recovery ratios should be interpreted as typical results for the type of rapid transit service proposed.

4.7 Environmental Account

Environmental benefits are mainly in the form of reduced greenhouse gas (GHG) emissions from automobile use. The reduction in GHG for the benefits case options over the evaluation period is expected to be moderate, ranging from 49,200 (Option 1B) to 92,800 (Option 2A) metric tonnes. Monetized, the savings equal to a value of approximately $1.0M to $1.8M over the evaluation period. The summary of the environmental account is presented in Exhibit 4.7.

Exhibit 4.7: Environmental Account

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Environmental Account				
Reduction in GHG Emissions (metric tonnes)	78,400	49,200	92,800	56,600
Value of GHG reduction	$1.5M	$1.0M	$1.8M	$1.1M
Broader Environmental Benefits (Qualitative)	Lower emissions from reduced vehicle use; promotes intensification, reduced sprawl; bus technology could reduce fuel consumption and emissions		Lower emissions from reduced vehicle use; LRT has no local emissions and is electrically powered; promotes intensification, reduced sprawl	

NOTE: All figures are net present values (2011 $) over a period of 2012 to 2041, discounted at a rate of 5%.

Light rail transit provides significant environmental benefits through reduced energy consumption and emissions. All modern, urban light-rail systems are electrically powered and as a result, there are no local emissions. Cities such as Calgary have taken the additional step and have invested significantly in wind energy to provide electricity for their LRT system. The result is a 100% emissions free transit operation. Reducing emissions and energy consumption is also possible in the BRT options. The most likely avenue is through the procurement of hybrid diesel-electric buses, which reduce fuel consumption and are currently used in the Züm fleet. Brampton Transit is procuring additional hybrid buses. Clean diesel and electric buses are actively being developed and could offer additional environmental benefits in the future. Electric trolley buses, popularized in North America from the 1940s to 1980s, are also an option. However, trolley buses would require the additional capital costs related to electrification, including catenary and substation infrastructure.

Finally, there is also an indirect environmental impact through the land use influences resulting from investment in rapid transit. Dedicated runningway transit provides a greater incentive to intensify land uses on a corridor, which reduces the need to expand subdivisions on valuable farmland and green space. These communities, in turn, have the potential to further reduce auto use as transit, walking, and cycling become more attractive and convenient. Further detail on potential land value uplift and land use shaping are documented in Sections 4.8 and 4.9.

4.8 Economic Development Account

Definition of Direct and Indirect Impacts: Transportation Infrastructure Projects

Direct Impacts: jobs and wages of workers and businesses involved in manufacturing of the vehicles and equipment, construction of rail or bus infrastructure and facilities, and the on-going operations and maintenance of transit.

Indirect Impacts: jobs and wages of workers and industries that supply goods and services required to construct and maintain transit (e.g. engines, steel, plastic, gas, electricity, uniforms, etc.).

The Economic Development Account provides estimates of the impacts the construction and operation of the four different Queen Street Rapid Transit options may have on the economy in terms of direct and indirect employment, income/wages and gross domestic product (GDP). These impacts will be both temporary in nature, occurring over the short-term during construction, as well as long-term during the ongoing operations of the transit service. In addition, the Economic Development Account considers, and compares, how the four different service options may stimulate business/industry growth and result in uplift in land value[7].

The summary of the economic development account for the various options of service is provided in Exhibit 4.8.

Short-Term Impacts (Construction)

The economic benefits associated with the construction activities required to implement the four transit options can be quantified in terms of the estimated number of direct and indirect person-years of employment, wages and additional GDP.

As shown in Exhibit 4.8, the analysis suggests that depending on the project option, the construction of the running way, stations, maintenance and storage facilities and other infrastructure/facilities could generate a range of approximately 1,500 to 5,300 direct person-years of employment and direct wages totalling approximately $124.3 to $449.7-million. Between approximately 1,100 to 3,900 indirect person-years of employment, with between $94.7 and $334.9-million in indirect wages, is also expected to result from the construction of the transit system. Combined, the direct and indirect wages associated with construction is estimated to total between $218.9 and $784.6-million, with a total impact on GDP estimated to be approximately $208.3 and $764.5-million, depending on the option.

The magnitude of short-term impacts would be directly based on the capital cost of the project, although the types of industries that would benefit from the construction (directly or indirectly) will depend on the transit mode. For example, both rail and bus-based options would have similar impacts on industries for the construction of the runningway and stations. For bus based options (Option1A and 1B), a greater proportion of the short-term impacts would be on the manufacturing of transit vehicles, as a large number of buses would be required to accommodate demand. Options utilizing light rail would create short-term impacts in different industries, including rail manufacturing and specialized manufacturing segments that produce advanced technology required for rail transit such as transit signals and other systems.

[7] The inputs to the economic analysis were generated using a variety of secondary data sources, such as, but not limited to, Statistics Canada (i.e. 2011 Expenditure Price Statistics, 2011 Employment, Earnings and Hours Statistics and 2005 Input-Output Multipliers, 2006 census), land inventories and property value assessments for the Queen Street Corridor prepared by the City of Brampton, reports produced as part of the City of Brampton's Growth Planning exercise (e.g. Inventory & Assessment of Intensification Opportunities and Employment Lands Inventory and Analysis), population and employment projections prepared for the City of Brampton, the City of Brampton Official Plan and various Secondary Plans (e.g. Downtown Brampton, Queen Street Corridor and Airport Road and Highway 7 Business Centre), annual economic reports and market updates, and various City of Vaughan planning and development policies and reports. Primary research was also collected through windshield surveys, analysis of air photos and reviews of real estate listings and historic transactions.

Option 1B (i.e. BRT/Züm) will cost the least to construct and generate the lowest level of short-term economic impacts. Option 2A (i.e. LRT) will cost the most to construct and will generate the greatest economic impacts during the construction phase.

Long-Term Impacts (Operations)

The economic benefits associated with the ongoing operations of the Brampton BRT, LRT or combination service can also be quantified in terms of the estimated number of direct and indirect person-years of employment, income (i.e. wages/salaries) and additional GDP. It should be noted that GDP, by definition, does include wages and salaries as a sub component and therefore the estimates of GDP and income cannot be added together.

These long-term economic benefits are directly tied to the annual operations costs and could be impacted by changes in ridership, operational subsidy, and service standards. The operating costs estimated for the four project options, and consequently the long-term economic impacts, reflect a minimum level of service to accommodate projected ridership demand.

Brampton Transit data (2010) was used to generate estimates of direct person-years of employment and wages over the operating period of 2012 to 2041. Operation of rapid transit service on the Queen Street corridor could generate between 130 and 150 direct person-years of employment and between $7.9 and $9.0 million in direct wage income (2011$), depending on the option. Bus-based options, which require more vehicles due to lower vehicle capacity, would generate more long-term economic impacts due to higher operating costs (including more operators), compared to the light rail-based options.

Statistics Canada's 2005 Input-Output Multipliers were applied to generate estimates of indirect employment (between 70 and 80 person-years of employment) and indirect wages (between $4.1 and $4.7 million). The multipliers were also used to establish potential growth in direct and indirect GDP (total growth estimated to range between $12.0 and $13.7 million, depending on the option).

Option 2B (i.e. BRT/Züm) has the lowest estimated incremental operating costs and therefore will generate the lowest long-term economic impacts – in terms of the number of direct and indirect jobs and associated wages. The higher maintenance costs associated with the full fleet of LRT vehicles in Option 2A will result in slightly higher economic impacts than LRT/Züm hybrid. Option 1B (i.e. BRT/Züm) will cost the most to operate and will generate the greatest ongoing economic impacts.

Exhibit 4.8: Summary of Economic Development Account

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Economic Development Account				
Short-Term Impacts Construction-related Impacts				
Person-Years of Employment	2,300 direct 1,700 indirect 4,000 total	1,500 direct 1,100 indirect 2,600 total	5,300 direct 3,900 indirect 9,200 total	2,200 direct 1,600 indirect 3,900 total
Income: (in millions, $2011)	$192.8 direct $142.3 indirect $335.1 total	$124.3 direct $94.7 indirect $218.9 total	$449.7 direct $334.9 indirect $784.6 total	$188.8 direct $139.1 indirect $327.9 total
GDP: (in millions, $2011)	$194.7 direct $137.2 indirect $331.9 total	$120.8 direct $87.5 indirect $208.3 total	$445.4 direct $319.1 indirect $764.5 total	$189.4 direct $134.5 indirect $323.9 total
Long-Term Impacts Operations				
Person-Years of Employment	140 direct 80 indirect 220 Total	150 Direct 80 indirect 230 total	150 direct 80 indirect 230 total	130 direct 70 indirect 200 total
Income: (in millions, annual, $2011)	$8.7 direct $4.6 indirect $13.3 total	$9.0 direct $4.7 indirect $13.7 total	$8.8 direct $4.6 indirect $13.4 total	$7.9 direct $4.1 indirect $12.0 total
GDP: (in millions, annual, $2011)	$6.2 direct $3.7 indirect $9.9 total	$6.4 direct $3.8 indirect $10.2 total	$6.3 direct $3.8 indirect $10.1 total	$5.6 direct $3.4 indirect $9.0 total
Land Value Increase	4% to 8%	1% to 5%	8% to 15%	4% to 6%

Long-Term Impacts – Business/Industry Development and Increased Land Values

Investment in transit often results in changes in lands value. Case study research has shown for the most part these changes are positive (i.e. increased property values) as lands become more desirable in their existing form and/or redevelop into higher density and higher order uses. Over the past few decades, construction of transit systems in North American has been seen to result in property value increases ranging from 2% to over 60%. Larger increases in property values are generally tied to heavy rail and subway systems, but in many cases LRT and BRT also leads to increased interest and demand for land and uplift in land value.

A number of other factors play an important role in the impact transit investment can have on property values, intensification and economic development. For example, studies have found that transit investment tends to have a larger impact on land values in lower and middle-income areas, or neighbourhoods with high proportions of students, seniors and young adults. A number of recent developments within Downtown Brampton are geared to such groups, including Chapelview Apartments, Greenway Retirement Village, and Rhythm Condos & Lofts.

The City of Brampton is well-positioned to accommodate transit-oriented development on vacant or underutilized lands, subject of course to market conditions/demand. The *Inventory & Assessment of Intensification Opportunities Discussion Paper for Public Review,* prepared in 2008, identified more than 1,350 parcels with intensification potential within Brampton totalling almost 700 hectares). The Municipal mapping and data illustrates that the vast majority of these lands are within 500 m of the Queen Street corridor. In addition to vacant/ undeveloped lands, almost 1.7 hectares of land within 500 m of the Queen Street corridor are currently being used as parking lots.

Steady population growth along with improved access to public transit often results in the redevelopment of surface parking lots. Population forecasts prepared by Hemson Consulting Ltd. anticipate that between 2011 and 2031 the population of the Queen Street Corridor BCA Area (i.e. lands within approximately 500 m of Queen Street) will grow by 31,600 people and that more than 21,500 new jobs will be created.

Population and Employment Projections: Queen Street Corridor BCA Area

	2011		2031	
	Population	**Employment**	**Population**	**Employment**
Downtown Brampton	17,043	13,852	37,644	30,140
Queen Street East	1,528	7,390	6,123	11,507
Bramalea	32,060	10,682	38,461	11,774
Total BCA Area	**50,631**	**31,924**	**82,228**	**53,421**

Source: Updates to the forecasts prepared in 2009 for the City of Brampton by Hemson Consulting Ltd.

Note: The projections are for small geographical units (SGUs) and TSS traffic zones within approximately 500 m of the Queen Street Corridor. The projections are updates to the Hemson 2009 findings and are meant to reflect the increased development opportunities that are likely to occur within the access to rapid transit. The forecasts are intended primarily to be an input to the Queen Corridor BCA, and do not replace the 2009 forecasts or ROPA 24.

The formation of industry and/or service clusters often results from transit investment. Over the past decade the City of Brampton has seen moderate growth in the professional, managerial and institutional sectors but according to 2011 reports, vacancy rates remain high for office space within the Downtown and Central Area (i.e. 12.1% to 14.1%). However, the City of Brampton anticipates that as it matures and continues to grow, its supply of major office space will more than triple between 2006 and 2031.

Over the past few years Downtown Brampton has strengthened its role as a regional service provider and institutional centre, with projects such as the Peel Memorial Hospital redevelopment, Peel Heritage Complex. Other areas along the Queen Street Corridor have also seen considerable private sector investment, such as the recent $200-million expansion of Bramalea City Centre.

Based on a review of City of Brampton employment data, five of Brampton's largest companies which employ approximately 5,400 people are located within 500 m of Queen Street and Airport Road, which are both potential future station locations. The City anticipates the creation of over 21,500 jobs within the area to be served by the proposed transit line. Much of Brampton's future job growth (estimated at 137,000 new jobs between 2011 and 2031) is expected to be accommodated on other, traditional 'employment lands' not within close proximity to the future BRT or LRT line.

Vaughan Metropolitan Centre (VMC) is comprised of approximately 179 hectares of largely undeveloped land and this area is intended to accommodate a target population of 25,000 residents and a minimum of 11,500 jobs, including 5,000 new office jobs and 1,500 new retail and service jobs. Much of the market demand and continued increase in land value will be driven by the extension of the Yonge-University-Spadina subway line and the opening of the VMC station in late 2015. The proposed BRT or LRT will allow for improved connections from the VMC to the Highway 7 Corridor West Area; however, this area will likely remain a largely auto-oriented employment area in the near- and mid-term and experience minimal uplift in property value as a result of the new transit service.

Option-Specific Land Value Assessment

All four transit options will help connect people to jobs (where they exist now), with the goal of eventually bringing employment opportunities and people closer together as clusters of residential and non-residential uses develop within proximity to the transit stations. Businesses within close proximity to the transit corridor will benefit from improved access to skilled workers and customers. Businesses throughout the Cities of Brampton and Vaughan will benefit from increased productivity and competitiveness resulting from a reduction in travel times and transportation costs. Those transit options which offer the highest level of service (e.g. travel time and frequency) will be the most likely to encourage transit usage and facilitate connections. However, consumer preference and perceptions will also play a strong role in the likelihood transit usage and a reduction in traffic and/or travel time. For many, rail and LRT is preferred to bus travel. This is reflected in the ridership levels estimated for each of the transit options, with the highest level of ridership expected for Option 2A (LRT). While the travel time differences for Option 2B, which requires a change in vehicle/service, is minimal, the perception of delay and hassle may be a barrier to enticing people to switch their mode of travel.

With the provincial, regional and municipal policies in place that require and support intensification and transit-oriented development, current land use and market conditions and development opportunities, the City of Brampton is well positioned to see an increase in land values near the Queen Street corridor. These increases may range from 1% to 15% for residential and non-residential land values (particularly for commercial and retail properties), depending on the transit option implemented.

Examples of Changes in Land Values Associated with Transit Investment (i.e. BRT and LRT)

Martin Luther King, Jr. East Busway (Pittsburgh) – The busway serves approximately 25,000 riders daily. Properties located 1,000 ft from a BRT station were found to be valued approximately $9,745 less than properties located 100 feet away (Source: Federal Transit Administration, 2009). Based on median housing values within neighbourhoods served by the Busway, this roughly translates into a 3% to 5% increase in property value (Source: IBI Group on based Trulia, Inc. 2011 data).

Bogotá BRT (Colombia) - Middle-income households, who tend to use BRT the most, are willing to pay 2.3% to 14.4% more for housing located close to stations. Lower-income households (relying more on walking and mini-buses) and upper-class households (relying more on cars) were not as willing to pay a premium for housing near a station (Source: Ramon Munoz-Raskin 2007).

Brisbane South East Busway (Australia) – The busway serves approximately 60,000 riders daily. In the first year of the BRT operation, properties along the busway experienced a 20% gain in value (Source: Institute of Transportation Engineers, 2008).

Calgary LRT – The 56 km line serves approximately 285,000 riders daily. When a Ring Road and new LRT stations are completed, communities within an 800-metre radius can anticipate a 10% to 20% increase in property values. The largest effect will be felt in older/more established neighbourhoods (Real Estate Investment Network, 2010).

Dallas Area Rapid Transit (DART) - The four light rail lines serve approximately 103,000 people daily. Near LRT stations, property value increases of 12% and more were seen compared to properties outside of a one quarter mile from LRT stations (Source: Weinstein & Cloward).

RTD Light Rail (Denver) –According to analysis done by a local real estate firm that specializes in transit-oriented-development, historically Denver has seen a 15% to 20% premium for properties located near transit (Source: Citiventure Associates, 2008).

Durham-Scarborough BRT (Ontario) - The introduction of the planned BRT is expected to provide only a modest lift in land value for residential and commercial properties within proximity to station areas (i.e. 1% to 3% for residential and 2% to 3% for commercial) (Source: Steer Davies Gleave, 2010).

Some BRT and LRT lines have had substantial impacts on land value, triggering increases of more than 20%. Research suggests that the greatest uplift in land value has been realized in areas where transit service is being introduced (opposed to an upgrade to existing service) or in situations where the rapid transit line is serving either a very dense urban area or a large geographic area and has particularly high daily ridership levels. Given that Queen Street is currently served by Züm and the 23.7 km rapid transit line is anticipated to have less than 44,000 daily riders, a conservative approach was taken when estimating potential impact on land value.

Option 1B is expected to result in minimal impact on regional competitiveness and uplift in property values (e.g. 1% to 5%). A continuous BRT line (i.e. Option 1A) will result in more competitive travel times, but still is expected to have a moderate impact on land values (i.e. 4% to 8%).

Option 2A is expected to result in the most significant uplift in property value, with increases ranging from 8% to 15% as a result of the new LRT line. Option 2A is anticipated to generate the largest number of passengers, which in turn will provide the largest consumer base for retail and services which may cluster around the station. Option 2B would likely result in a more moderate increase in land value (i.e. estimated to range between 4% and 6%), given lower projected ridership demand and the perceived inconvenience of transferring between transit lines.

4.9 Social and Community Account

Rapid transit in the Queen Street corridor will also provide significant social and community benefits. These benefits include:

- improved access to rapid transit for residents, workers, and persons with greater mobility needs, such as senior citizens; and
- land use influences to encourage the intensification and redevelopment of the transit corridor, leading to more vibrant and safer urban environments.

Increased Access to Rapid Transit

The project options are projected to significantly improve access to rapid transit for residents, workers, and seniors along the Queen Street and Highway 7 corridor. Access is measured by the number of people, jobs, and seniors within 800 metres (10-minute walk) of transit stations, which is presented in Exhibit 4.9[8].

In 2031, the project options will improve the availability of direct rapid transit access in Brampton. It will increase the number of people and jobs within 800 metres of rapid transit stations in the corridor from a base case of 76,700 people and jobs to 164,000 for the hybrid BRT/LRT and Züm options to 203,400 for full BRT/LRT options. The number of seniors within 800 metres of rapid transit stations will also increase from 5,800 to 19,700 in the full BRT/LRT option.

Exhibit 4.9: Population and Employment within 800 metres of Rapid Transit Stations (2031)

Criteria	**Base** Brampton GO + Committed Viva	**Option 1A/2A** Downtown Brampton to VMC	**Option 1B/2B** Downtown Brampton to Airport Rd + Committed Viva
2031 Population within 800 m of rapid transit stations	40,500	121,300	96,300
2031 Employment within 800 m of rapid transit stations	36,200	82,100	67,700
2031 Seniors within 800 m of rapid transit stations	5,800	19,700	16,600

[8] Population and employment projections are based upon the Greater Golden Horseshoe Model and Provincial Growth Plan estimates which were developed to the traffic zone level. Estimates of population within 800 metres of planned transit stations utilize a proportional sum approach of buffers overlapping with traffic zones, consistent with the approach utilized for other Metrolinx studies and projects.

In addition, rapid transit on the Queen Street corridor will also improve transit access for lower income households, which are more dependent on public transit access. According to Statistics Canada 2006 census data, most census tracts within the Queen Street corridor had lower median household incomes than the rest of Brampton. Improving transit access in the corridor will increase travel options for these households and by extension, increased access to housing, employment, and other opportunities. In general, all four project options will have a positive impact for low-income communities along the corridor by improving transportation access.

Queen Street rapid transit will also link two Urban Growth Centres identified in **Places to Grow** in Downtown Brampton and Vaughan Metropolitan Centre. Combined with the Toronto-York Spadina Subway Extension, rapid transit on Queen Street will significantly improve rapid transit access to urban centres across the region. More importantly, it provides higher-order transit in two directions, which could encourage ridership to and growth in employment centres in Brampton and York Region. These centres are currently underserved by rapid transit in a predominantly downtown Toronto-focused transit network. The result would be improved access to employment for residents across the regions.

Land Use Shaping

Rapid transit will also play a pivotal role in the reshaping of the Queen Street corridor into a more vibrant urban environment. Higher-order transit is a catalyst for redevelopment and intensification and as identified in Section 3.8, there are many opportunities for residential, office, and retail development in the corridor. Coupled with progressive land use and growth planning, increased development in the Queen Street corridor could help accommodate more of the population and employment growth projected for Brampton, reducing the need for continued greenfield expansion.

In addition, increased street activity and changes to the street environment resulting from rapid transit and its impact on adjacent land uses could increase the safety for all road users. As streets become more “urban”, traffic speeds would be reduced, making walking and cycling safer and more attractive while reducing the severity of auto collisions. In addition, more pedestrians and street-level activity would increase the overall safety and security of the street through more “eyes on the street” and passive surveillance from adjacent uses.

In addition to being identified as an Urban Growth Centres, Downtown Brampton and Vaughan Metropolitan Centres are also designated as mobility hubs in **The Big Move**. Mobility Hubs are envisioned to be active urban spaces that facilitate efficient and seamless transfers between modes.

5. Summary

Exhibit 5.1 provides a summary of the benefits case for rapid transit in the Queen Street corridor in the City of Brampton. The full light rail transit option (Option 2A) also provides significant benefits such as higher transit ridership, greater GHG emissions reductions, and more significant land value increases, however the bus rapid transit options (Options 1A and 1B) provide strong benefits from the transportation user benefits perspective. Given the small range in the benefit cost ratio (0.6 to 0.8), the evaluation of the project options should be based on the full range of criteria across the different accounts.

The analysis of the four project options indicates that there is high potential transit ridership in the Queen Street corridor between downtown Brampton and Vaughan Metropolitan Centre. As two of the fastest growing areas in the Greater Toronto and Hamilton Area, travel demand is increasing and congestion will lead to greater demand for travel options. Since 2010, Züm has begun to meet these demands with its BRT-like express bus service with competitive travel times, comfortable vehicles, short wait times, and high quality “station” facilities. Additional committed investments into the Züm service will continue to enhance service and attract ridership growth, creating a strong foundation for evolution toward rapid transit in the corridor.

It is largely because of Züm’s success and its capacity to accommodate future growth that additional investment into the Queen Street corridor through dedicated runningway BRT or LRT service could be phased in over the long term. Although the four project options perform similarly in terms of a benefits case ratio, the capital costs vary significantly. Given the range of costs and the ability of all options to accommodate projected ridership to 2031, it would be prudent to invest in the corridor on an incremental basis. Focusing transit investment into the western section of the corridor, including the areas of downtown Brampton and Bramalea where congestion and redevelopment potential is greatest, would provide the greatest return in benefits, while keeping capital expenditures at a more affordable level.

The applicability of BRT or LRT technology is also a major consideration in this corridor. For options between Downtown Brampton and Airport Road, the estimated capital cost for LRT is approximately 52% higher than for BRT, without a proportional increase in transportation user benefits. Option 2B provides an advantage in ongoing operating cost savings of approximately $1.7-million annually over Option 1B; however, these savings are predominantly reflective of the lower ridership projected for this option.

As BRT and LRT offer competing operational advantages, the qualitative aspects of the two modes should also be taken into consideration. Rail-based transport is generally perceived to be superior with a more comfortable ride, larger vehicles, and a sense of permanence in the urban environment. In addition, LRT is seen to have better environmental qualities through reduced noise, no local emissions, and reduced energy consumption. LRT is also perceived to play a greater role in land use shaping by attracting more intensified development. However, bus rapid transit design and technology is rapidly evolving. Many urban applications, including York Region's Viva Rapidways, are adopting LRT design characteristics in runningway, stations, and facilities. Bus technology and design is also improving with modern-styled vehicles, more comfortable seating, improved propulsion, and clean fuel technology.

From a purely cost-benefit perspective, bus rapid transit from Downtown Brampton to Vaughan Metropolitan Centre (Option 1A), with the highest benefit-cost ratio (BCR), demonstrates the greatest benefits per taxpayer dollar invested. Option 2B, providing LRT from Downtown Brampton to Airport Road, also provides a comparable BCR, but with lower projected ridership. The marginal difference in the BCR between these options indicates decision-making will need to also strongly consider qualitative criteria, including meeting regional and municipal objectives, providing network connectivity, and shaping land use and urban form. Such an evaluation could be undertaken through the environmental assessment and preliminary design process that could be a next step for corridor planning.

Exhibit 5.1: Summary of Benefits Case

Criteria	Option 1A BRT	Option 1B BRT/Züm	Option 2A LRT	Option 2B LRT/Züm
Transportation User Benefits (in Millions, NPV 2011$)				
Total Transportation User Benefits	$563.6	$385.2	$757.7	$480.0
Financial Account (in Millions, NPV 2011$)				
Total Incremental Costs	$744.1	$616.2	$1,319.2	$687.9
Net Benefits (NPV 2011$) (net of passenger revenues)	($180.4)	($231.0)	($561.5)	($207.9)
Benefit-Cost Ratio (net of passenger revenues)	**0.8**	**0.6**	**0.6**	**0.7**
Environmental Account				
Reduction in GHG Emissions (metric tonnes)	78,400	49,200	92,800	56,600
Value of GHG reduction (NPV 2011$)	$1.5M	$1.0M	$1.8M	$1.1M
Economic Development Account				
Short-Term Person-Years of Employment	4,000	2,600	9,300	3,900
Long-Term Person-Years of Employment	220	230	220	200
Short-Term GDP (over construction period)	$331.9	$208.3	$764.5	$323.9
Long-Term GDP (annual)	$9.9	$10.2	$10.0	$9.0
Land Value Increase	4% to 8%	1% to 5%	8% to 15%	4% to 6%
Social and Community				
Increase in 2031 Population and Employment within 800 m of rapid transit stations (compared to base case)	126,700	87,300	126,700	87,300

Input Variables and Assumptions

Parameter	Standard Value	Source
Assessment Period	2012 to 2041	
Discount Rate:	5% real	Province of Ontario
Value-of-time (in 2008$)	Business: $35.16/h Other: $10.82/h Weighted Average: $13.02 /h	GGHM
Value of Time Growth:	1.6% per annum	Based on GDP per capita increases, population estimates form www.greatertoronto.org
Accident cost	$0.07 per km	Collision Statistics: 2004 Canadian Motor Vehicle Collision Statistics, TP3322. Vehicle Kilometres: Statistics Canada, Catalogue No. 53-223-XIE, "Canadian Vehicle Survey"
Greenhouse Gas Emissions	2006 – 2.39 kg/L or 0.23 kg/km 2021 – 2.35 kg/L or 0.21 kg/km 2031 – 2.35 kg/L or 0.20 kg/km	Urban Transportation Emissions Calculator, Transport Canada, GGHM
Average Cost of CO_2	$0.01 /km $40/tonne (median cost)	Several literature sources, Transport and Environment Canada, GGHM and http://envirovalution.org/index.php/2007/09/06/university_of_hamburg_forschungsstelle_n_1
Automobile operating costs per km	In 2008$ + 2.0 % p.a. increase 2007 - $0.50 / km 2021 - $0.65 / km 2031 - $0.79 / km	Based on 2007 CAA calculations of average driving costs and includes operating cost and ownership (long-term costs) Increase based on GGHM
Annualization factors:	Peak to Daily / Daily to Annual 3/300 - Variable based on transit mode 10/300 - Road Users	GGHM