steer davies gleave

Hamilton Rapid Transit Preliminary Design and Feasibility Study

A-LINE

ECONOMIC POTENTIAL IMPACT REPORT

Version: 2.0

METROLINX
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February 2012

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Executive Summary

1. Rapid Transit (RT) is seen as a key economic stimulator and community rebuilding tool for Hamilton. In recognition of the full potential of RT, the City of Hamilton is planning the implementation of a comprehensive five line RT network throughout the city. These plans are in line with the Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) that was released in November 2008, entitled *The Big* Move. This identified the B-Line as a top 15 project and the first route in Hamilton to be developed. The A-Line, the subject of this report, was identified as the second line. Both lines have been identified for completion within 15 years.
2. The Hamilton Official Plan is based on a concept of nodes and corridors. The A-Line is defined as a Primary Urban Corridor, which are livable and vibrant pedestrian-oriented and transit-supportive streets, which incorporate a mix of street oriented commercial, employment and residential uses, while making efficient use of the City's public transit network and other infrastructure.
3. The purpose of the study reported here is to understand the potential economic impact that is likely to result from implementing RT on the A-Line. Economic potential impact of a project can be measured through direct economic uplift, such as GDP, jobs, land values and development potential, as well as potential social, environmental and transportation user effects. Although Light Rail Transit (LRT) has been selected as the preferred technology for the B-Line, both LRT and Bus Rapid Transit (BRT) are under consideration for the A-Line. The study therefore considers both options and will be one of the tools used to inform decisions around which RT technology is taken forward for further investigation.
4. The study takes the approach of Multiple Account Evaluation, which looks at a range of economic indicators that are used to assess the direct economic effects, as well as land use, environmental and social impacts of the different options.
5. The key headlines of the study are summarized below:

Providing for the future requires significant investment

6. Implementing LRT along the A-Line will require a capital investment of $706m and an on-going operating allowance of $13m per annum. BRT is a more economical upfront investment of $244m (35% of LRT), but costs around 25% more to operate ($16m per annum). Despite anticipated fare revenue, both options would require a yearly subsidy to operate.

RT will benefit people throughout Hamilton

7. Both LRT and BRT are expected to create advantages for transit users in the form of journey time benefits, reliability and improved service quality. These benefits are particularly marked when congestion continues to grow in the future. Both options will also improve accessibility throughout Hamilton, particularly to key destinations and other modes, such as existing local bus services and GO rail. This in itself is likely to encourage a large degree of mode shift from autos and provide improved

transportation options for Hamiltonians. Because of its perceived higher quality, the benefits for LRT exceed those of BRT by 40% when considering journey time savings, and vehicle operating, out of pocket, and collision costs.

LRT creates more potential for development than BRT

8. RT along the A-Line is expected to create benefits in the form of the land value uplift impact on property tax, development charges revenue, and development and intensification of current vacant land. Because BRT is known to create effects within a smaller radius from the route, LRT will have a 24% - 124% greater development impact across these criteria, based on assumptions drawn from similar studies, and current density and land use characteristics surrounding the routes. The results by criteria are shown in Table 1.

TABLE 1 SUMMARY LAND USE AND URBAN DEVELOPMENT IMPACTS

Item	LRT	BRT	Diff (L-B)	+ LRT%
Vacant population land within catchment areas (HA)	33	22	11	50.0%
Vacant employment land within catchment areas (HA)	56	45	11	24.4%
Actual development units estimate (#)	1,460	652	808	50.0%
Total residential development charges ($m)	12.3	5.5	6.8	123.8%
Total commercial development charges ($m)	86.0	69.3	16.7	24.0%
Component hypothecated to transit ($m)	*1.4*	*1.1*	*0.3*	*27.4%*
Land value uplift (Low) ($m)	43	24	18	72.0%
Land value uplift (High) ($m)	86	48	38	79.2%
Annual property tax impacts from new developments ($m per annum)	5.0	3.5	1.5	42.9%

RT will deliver jobs

9. The LRT option is expected to create $540 million in economic output and 4,000 full time equivalent (FTE) jobs during the construction period. This is followed by further impacts on GDP ($20m per annum) and employment (217 FTEs per annum) throughout the operating period. Due to lower investment costs, BRT would generate $187m in output and 1,380 FTEs during the construction period, but greater impacts throughout the project operation than LRT ($25m per annum in GDP and 273 FTEs per annum).

Auto displacement will create negative impacts, particularly for BRT

10. Transference of lanes from auto to transit results in a degree of auto displacement under both cases. This causes a disadvantage for highway users that is marginal for LRT (less than $1m per annum), but more significant for the BRT option, equating to

$4.3m per annum in auto operating and collision costs and a further negative effect of $0.1m per annum through increased emissions.

RT along the A-Line will transform the corridor and beyond

11. Both LRT and BRT will help support the development of the corridor as a more pedestrian-friendly environment, delivering social benefits in the form of reduced crime and health advantages through lower corridor-oriented emissions and local accident reduction, as evidenced in other RT examples. However, the social effects of RT can be greater than such direct effects. Increasing the use of transit is also known to increase the physical health of its users and both technologies have the potential to reduce household spending on transportation and increase accessibility to areas of high social need in Hamilton.
12. The implementation of urban realm improvements alongside the RT will be fundamental in maximising benefits in health, identity and quality of life.

Maximum benefits versus maximum returns on minimal investment

13. The findings of this study indicate that BRT or LRT could create a significant net economic potential impact in Hamilton and the province of $390m or $450m over 30 years respectively. When comparing the two options, the results show that BRT provides a greater impact relative to its costs; however, the overall potential benefits are $342m less than that of the LRT option.
14. Hamilton’s RT vision focusses on delivering increased development and economic benefits and in this respect, the LRT option would be preferred.

1 Introduction

Background

1.1 Hamilton has a resonant history as a prominent manufacturing city that sits in the centre of the Golden Horseshoe. More recently, globalization and overseas competition for manufactured goods have been detrimental to the North American manufacturing industries and consequently Hamilton is challenged with creating growth and improving quality of life for its residents.

Hamilton skyline

1.2 Rapid Transit (RT) is a mode of public transportation that is characterised by a high quality, fixed route service. When developed within appropriate policy frameworks and land use planning strategies, RT is recognised to enhance the economic vitality, jobs, and quality of life of a city. RT can create increased accessibility, higher land values, increased density and associated property tax income. In addition RT can help to shape the future development of a city, allowing smarter growth and Transit Oriented Development (TOD), which promotes intensification and development that better serves the needs of the community.

1.3 In recognition of the full potential of RT, the City of Hamilton is planning the implementation of a comprehensive five line RT network throughout the city. These plans are in line with the Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA) that was released in November 2008, entitled *The Big* Move. This identified the B-Line as a top 15 project and the first route in Hamilton to be developed. The A-Line, the subject of this report, was identified as the second line. Both lines have been identified for completion within 15 years.

1.4 Steer Davies Gleave has been commissioned by the City of Hamilton to carry out the Hamilton Rapid Transit Preliminary Design and Engineering (PDE) Study, which includes work on both the B-Line and A-Line. This report is a component of the PDE study.

Study Purpose

1.5 The development and implementation of a RT system in Hamilton is much more than a transit project. The Rapid Transit Vision developed and endorsed by the Council is expressed as follows:

“Rapid Transit is more than just moving people from place to place. It is about providing a catalyst for the development of high quality, safe, environmentally sustainable and affordable transportation options for our citizens, connecting key destination points, stimulating economic development and revitalizing Hamilton”.

1.6 RT is therefore seen as a key economic stimulator and community rebuilding tool for Hamilton. The purpose of this study is to understand the potential economic impact that is likely to result from implementing RT on the A-Line.

1.7 Although Light Rail Transit (LRT) has been selected as the preferred technology for the B-Line, both LRT and Bus Rapid Transit (BRT) are under consideration for the A-Line. This study therefore considers both options and will be one of the tools used to inform decisions around which RT technology is taken forward for further investigation.

1.8 LRT systems (shown in Figure 1.1) are electrically powered from overhead lines, and feature vehicles with steel wheels running on steel rails. The technology primarily runs on segregated alignments and modern low floor systems are integrated into urban areas to provide easy and direct connections for passengers and local communities.

1.9 BRT systems (shown in Figure 1.2) use buses and a series of priority and design measures to improve service quality and performance. This commonly involves infrastructure investments in the form of dedicated / segregated bus lanes that offer faster and more reliable journey times and improved facilities for passengers, as shown in Nantes, France.

FIGURE 1.1 LRT – LYON, FRANCE

FIGURE 1.2 BRT – NANTES, FRANCE

1.10 In order to fulfil the purpose of the study, the following study objectives have been identified:

- Provide qualitative and quantitative measures for the economic advantages and disadvantages for both LRT and BRT
- Identify economic improvements to the proposed RT corridor and surrounding area
- Identify economic disadvantages to the proposed RT corridor and surrounding area
- Identify estimated timing when economic advantages/disadvantages might occur with RT implementation on the A-Line
- Identify the estimated areas/sites for economic advantages/disadvantages related to RT on the A-Line
- Identify the potential land value uplift to the proposed RT corridor and surrounding area
- Identify the potential intensification/revitalisation/development opportunities along the proposed corridor

1.11 This study is carried out alongside the Opportunities and Challenges report for the A-Line, which presents the land use characteristics of the corridor, as well as the technical feasibility of the different alignment options. This report is also contemporaneous with the submission of the A-Line Benefits Case, which presents the initial business case of the project at this early stage in its development. There are many interfaces and overlaps between these three studies and associated reports, and overall they will provide a comprehensive assessment of the case and relative merits of the alternative technologies for the A-Line RT project.

1.12 This study will ultimately form a key component of the A-Line Environmental Report, which is to be completed as a separate exercise prior to implementation.

Report Overview

1.13 The structure of this report is as follows:

- Chapter 2 provides a project description, which includes the policy and RT context, as well as the description of the project options
- Chapter 3 presents the study approach, describing the 'accounts' and criteria that will form the assessment
- Chapters 4 to 9 examine each of the six 'accounts' in turn. These are ordered as follows:
  - Chapter 4 Financial Account
  - Chapter 5 Transportation User Account
  - Chapter 6 Land Use and Urban Development Account
  - Chapter 7 Economic Development Account
  - Chapter 8 Environmental Account
  - Chapter 9 Social and Community Account
- Chapter 10 provides a summary of the economic potential impact of the project
- Chapter 11 delivers a summary of the study's findings and conclusions on the potential economic impact which could result from implementing RT on the A-Line corridor.

1.14 In addition to the report chapters, there are also a number of appendices, which are listed below.

- Appendix A Traffic Area Zone (TAZ) Boundary Map
- Appendix B Bibliography
- Appendix C Land Use and Urban Development Account supporting information / analysis
- Appendix D Economic Development Account Methodology

2 Project Description

Introduction

2.1 This chapter provides a description of the Hamilton RT initiative and an overview of its policy context and linkages. The A-Line project, route and technology options to be assessed are then outlined along with other assumptions made.

Policy Context Overview

2.2 Over the past ten years Hamilton has made significant progress towards achieving its vision:

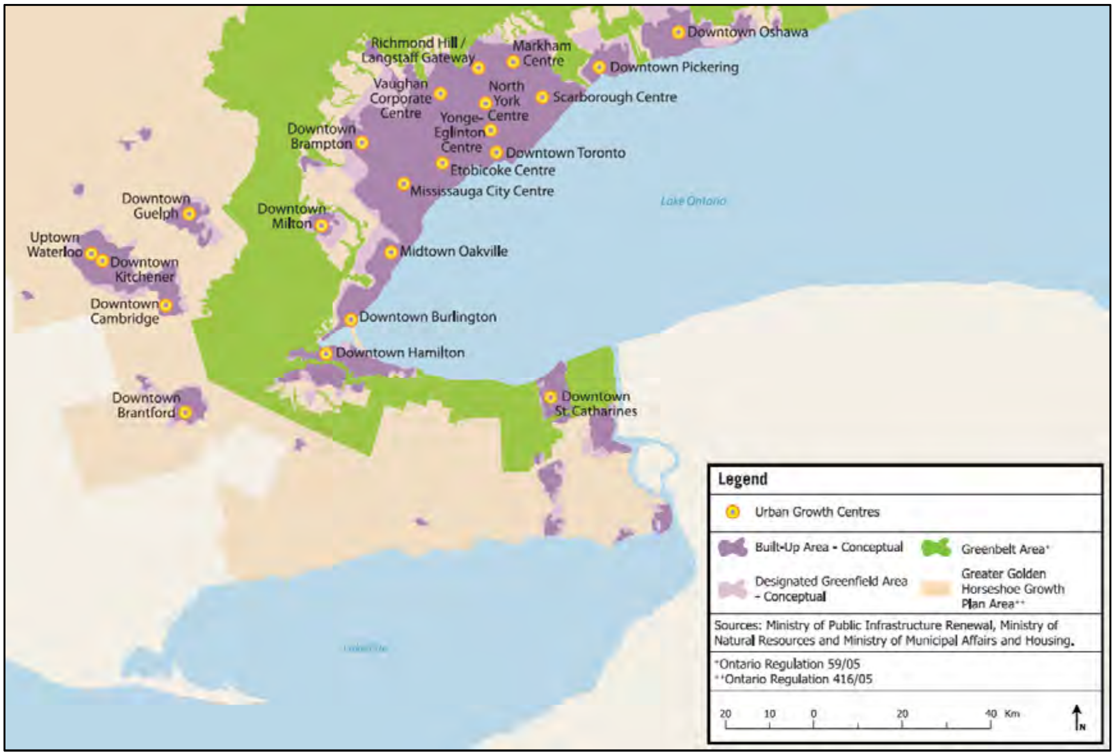
"To be the best place in Canada to raise a child, promote innovation, engage citizens and provide diverse economic opportunities."

2.3 The community-centered *Vision 2020* development process put sustainability firmly at the forefront of subsequent plans such as the *Growth Related Integrated Development Strategy (GRIDS)*, policy documents including the *Transportation Master Plan (TMP)* and the *Urban Hamilton Official Plan* as well as complementary secondary plans. This was enabled in part by the umbrella initiative *Building a Strong Foundation (BASF)*, which integrated the renewal of *Vision 2020* in 2003 with the City's growth and development work.

2.4 According to GRIDS, the current population of the City of Hamilton is estimated to be 531,000, with employment at 234,000. There are an estimated total of approximately 210,000 households in Hamilton at present.

2.5 As set out in the Province of Ontario's *Places to Grow: A Growth Plan for the Greater Golden Horseshoe*, Downtown Hamilton is a designated Urban Growth Centre for the GTHA Region, and as such, will be expected to accommodate much of the City's forecast growth (see Figure 2.1). By 2031 Hamilton is forecast to accommodate a population of 660,000 (24% increase from 2011) and 300,000 jobs (28% increase from 2011). This plan also directs that 40% of residential development (around 24,000-26,000 units) take place in built-up areas and that the areas around transit stations and corridors be intensified with a mix of uses to densities supportive of transit service.

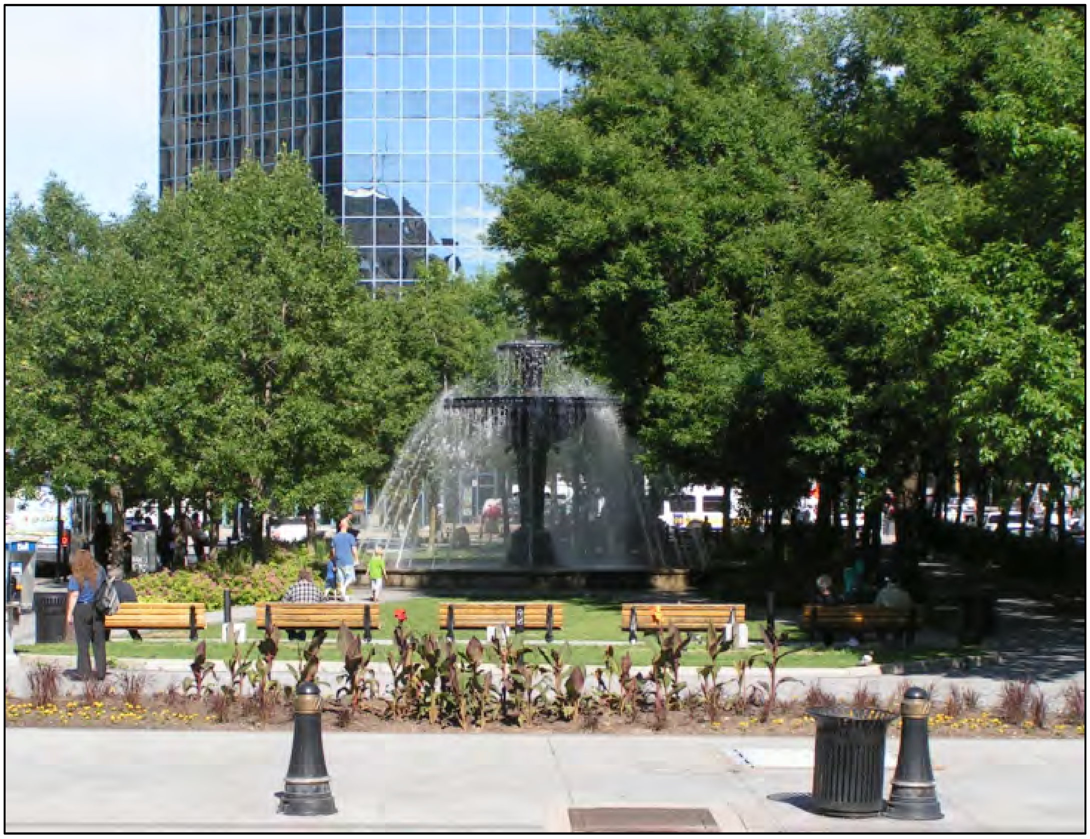
FIGURE 2.1 LOCATION OF URBAN GROWTH CENTRES IN AND AROUND HAMILTON



Source: Places to Grow (2006)

2.6 Key to supporting this forecast growth is the implementation of a compact urban structure set out in *GRIDS* and later formalized in the *Urban Structure Report* and *Urban Official Plan*. The system of transit-supportive nodes and corridors supported by these plans, with a vibrant downtown at the centre, provide the framework for intensification. The proposed RT corridors implement the Council approved *Urban Official Plan*, which identifies James Street as a High Order Transit Corridor.

2.7 Downtown revitalization is at the core of Hamilton's vision. *Putting People First: The New Land Use Plan for Downtown Hamilton* provides guidelines for public realm improvements, development and the diversification of uses to solidify downtown Hamilton's role as the government, cultural and institutional centre of the city. Planned to accommodate 20% of residential intensification amounting to 5,000-6,000 dwelling units, it is envisioned that the Downtown will develop as an attractive residential neighbourhood with a range of housing types, amenities and services to serve the local population and support public transit service.



Downtown Hamilton

2.8 In light of the growth challenges and ambitious sustainability targets Hamilton faces, *The Playbook: A Framework for Human Services*, was developed to align human services planning with land use planning. The *Human Services Planning Initiative (HSPI)* introduces the concept of human services infrastructure, defined as the "facilities, services, and networks required to maintain a high quality of life for all residents." This emphasis on complete communities where the needs of residents are met is also vital to the economic prosperity and well-being of the City.

2.9 The *Economic Development Strategy* outlines plans to increase the City's non-residential assessment base with targeted development of key market areas through increasing domestic and foreign investment. The core of the strategy is a range of measures to attract and retain businesses. Though the focus of the document is business development, it is acknowledged that the success of this outcome depends on the achievement of other deliverables such as quality of life, workforce development, and community redevelopment.

2.10 Employment growth is targeted at existing and planned employment nodes including Hamilton International Airport. Key industry groups targeted for potential investment include advanced manufacturing, agri-business and food processing, clean-tech, creative industries, goods movement and life sciences.

2.11 As only 16% of Hamilton residents currently use transit, walking or cycling to commute, the development of RT is a critical element in implementing the urban structure and achieving other planning visions and goals. Both *GRIDS* and the *Urban Official Plan* highlight the necessity of reducing auto dependent land uses and behaviours and improving transit accessibility and options.

2.12 The *Transportation Master Plan* sets out a vision for a RT network with three BRT corridors connecting with other priority routes. Metrolinx's transportation plan for the GTHA, *The Big Move*, expanded on this plan, introducing further improvements. These have been refined to form the 5-line B-L-A-S-T network with a 25+ year time horizon. When realized, this RT network will seamlessly connect Hamilton's current and future growth and employment nodes.

2.13 Metrolinx's *Green Paper 2 - Mobility Hubs – Development of a Regional Transportation Plan for the Greater Toronto and Hamilton Area* identifies locations targeted as 'Mobility Hubs', which are central to the concept of Transit Oriented Development. Four have been identified in Hamilton, of which three are situated on the A-Line (Downtown Hamilton, Mohawk College and Hamilton International Airport). Indeed, the airport has its own *Employment Growth District Project,* which responds to the employment targets set out in *GRIDS*.

2.14 In 2001, Metrolinx published the *Mobility Hub Guidelines*, which defines mobility hubs in the GTHA and provides comprehensive guidance in the form of objectives, themes and guidelines. The three key themes of the guidance are seamless mobility, placemaking, and successful implementation, with a strong emphasis on transit, active transportation and attractive streetscapes.

Rapid Transit Network

Long term overview

2.15 As a response to *The Big Move*, the City of Hamilton is proposing to develop the 5-line RT B-L-A-S-T network, as shown in Figure 2.2. Within the document the two corridors that are identified for implementation within 15 years are:

- The A-Line, extending from the waterfront to the Airport via the James Street/Upper James Street corridor
- The B-Line, extending from Eastgate Square/Centennial Parkway to McMaster University along the King/Main corridor

2.16 The B-Line was identified as a 'top 15 priority project' within *The Big Move*. As such, the City of Hamilton has been working with Metrolinx with a focus on the proposed B-Line. Although not a top 15 priority project for Metrolinx, the City is also interested in accelerating the planning of the proposed A-Line.

2.17 Hamilton's Rapid Transit Vision (see paragraph 1.5) reinforces that development and implementation of RT in Hamilton is much more than a transit project. RT in Hamilton is viewed as a development and regeneration tool as well as a means of travel and is therefore instrumental in the future growth and shaping of the city.

FIGURE 2.2 PROPOSED B-L-A-S-T NETWORK

Source: Adapted from *The Big Move*

A-Line Corridor

2.18 The A-Line broadly follows the James Street/Upper James Street corridor from the Waterfront, crossing the B-Line route at the heart of the Downtown, then ascending the Niagara Escarpment and terminating at Hamilton International Airport (see Figure 2.3).

2.19 The A-Line route serves the existing urban area between the Waterfront and Rymal Road, which has areas destined for intensification in the future. From Rymal Road to Hamilton International Airport the corridor is generally open land at present, but much of this is designated for development over the next 20 years.

2.20 The overall route length is approximately 16 km, of which 9 km is through the existing built up areas between the Waterfront and Rymal Road. The A-Line is currently assumed to have 21 stops.

FIGURE 2.3 THE A-LINE CORRIDOR

Source: Dialog

2.21 One of the key geographical features of the A-Line route is the Niagara Escarpment, which separates the older, lower part of the city from the more recent development on the higher ground ('the Mountain') to the south. The overall difference in level between the Downtown and the Escarpment crest is approximately 100m, with most of this occurring in the steep, heavily wooded Escarpment section.

2.22 The Escarpment is traversed by three roads within the A-Line corridor:

- James Mountain Road, which connects James Street South (below the Escarpment) to West Fifth Street (above), with a gradient of approximately 10.8%
- Claremont Access, connecting Wellington Street South and Victoria Avenue South to Upper James Street, with a separate south/westbound ramp connecting to West Fifth Street. The maximum gradient is approximately 6 %
- Arkledun Avenue/Jolley Cut, connecting John Street South to Concession Drive/Upper Wellington Street, with a gradient of 6-7%

2.23 Creation of a new surface RT route up the Escarpment face would be expensive and also unacceptable given the policies set out in the *Niagara Escarpment Plan*. Therefore, it is required that the route either uses one of the existing road routes, although a tunnel option beneath the Escarpment may also be possible.

2.24 The A-line Opportunities and Challenges study has identified preferred LRT and BRT options for the A-Line (see Figure 2.4) and these are the two options assessed in this study. Over the majority of the route these follow a common alignment with common stop locations, which enables a direct comparison of the different technologies. However, due to the differing gradient capabilities of buses and light rail vehicles (LRVs), different alignments have been adopted for these two technologies over the Niagara Escarpment.

2.25 The recommended BRT route commences at the Waterfront stop, located to the north of Guise Street East (with a turning loop to the east of the stop), and runs along James Street North to the Downtown, crossing the B-Line at King Street. The route continues along James Street South, James Mountain Road, West Fifth Street and Fennel Avenue to then follow the Upper James Street route.

2.26 The route is generally within the existing street from James Street North/Guise Street to south of Rymal Road. From here to the intersection of Upper James Street and Homestead Drive the route runs on a segregated alignment, on the west side of Upper James, then continues on street along Homestead Drive and Airport Road, with a terminal loop following the existing circulatory road at the Airport.

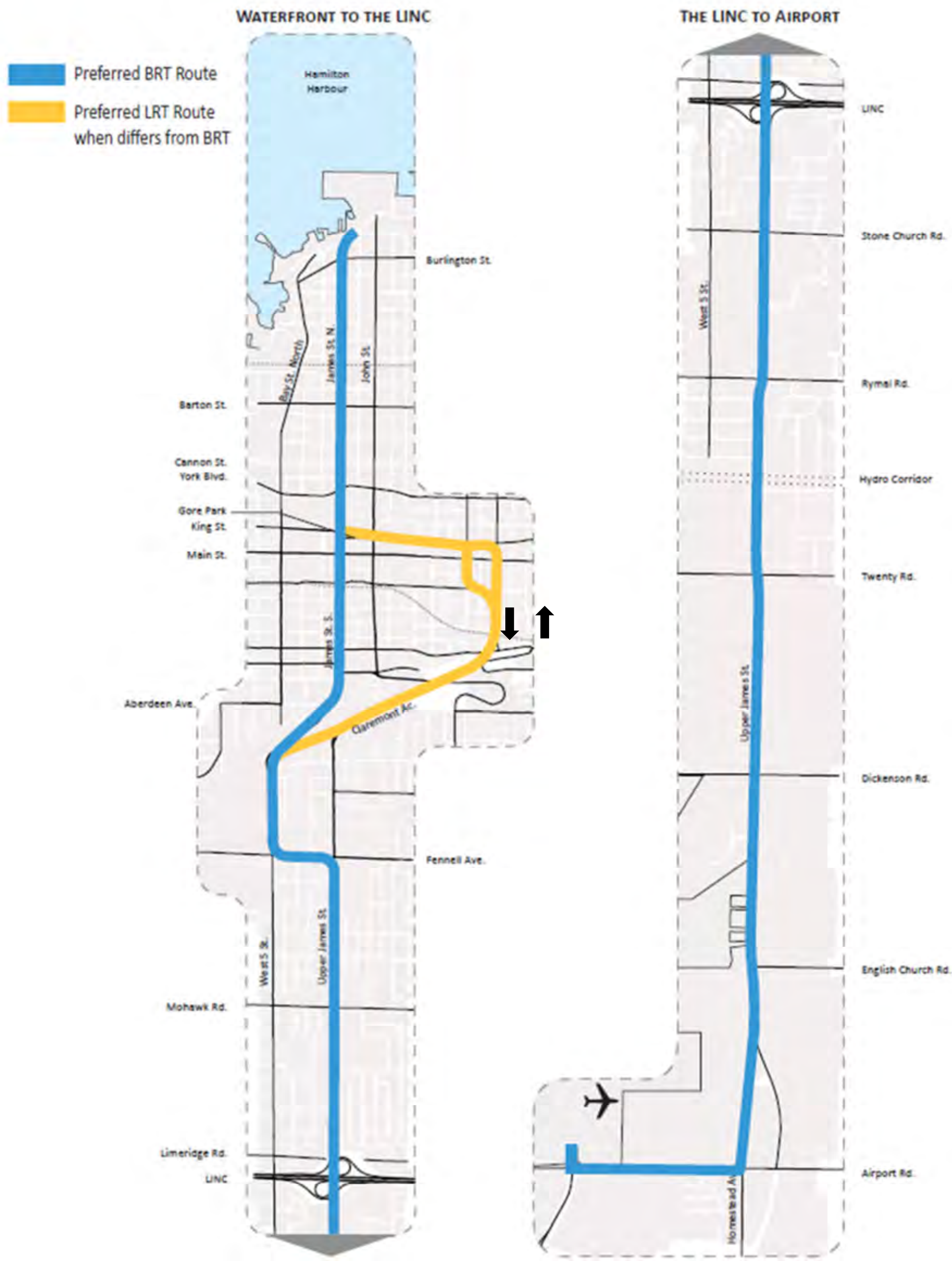
2.27 This route serves all the key locations along the James/Upper James corridor.

The Escarpment - James Mountain Road

2.28 LRT cannot operate on the almost 11% gradient on James Mountain Road, and so the recommended LRT route uses the 6% gradient Claremont Access. The route follows the same alignment as the BRT option on James Street North (except that the turning loop is not required), then runs along the B-Line tracks to Wellington Street/Victoria Street. This would run through the B-Line stops at Walnut (both directions) and First Place (westbound only). An additional stop on the B-Line is provided at Gore Park to allow for passenger transfer between bus services at the MacNab terminal, B-Line services west of the Downtown and the A-Line.

2.29 The LRT route then ascends the Escarpment via the Claremont Access and the ramp to West Fifth Street. From Fennel Avenue to the airport, the route is the same as for the BRT option, except that the terminal loop is not required. This route does not serve two key James Street locations – the GO Centre on Hunter Street and St Joseph's Healthcare Charlton Campus.

FIGURE 2.4 A-LINE LRT AND BRT OPTION ALIGNMENTS



Source: Dialog

Implementation Phasing

2.30 Two phasing options for the implementation of the A-Line RT are considered. These apply to both LRT and BRT options:

- Construction of the full route from the Waterfront to the Airport
- Construction in two phases:
  - Phase 1 – Waterfront to Mountain Transit Centre
  - Phase 2 – Mountain Transit Centre (MTC) to Airport

2.31 In the second option, construction of the first phase would serve the existing built up area, as well as proposed developments within this section. However, construction of the MTC to Airport section would be deferred until development of the Airport Employment Growth District had progressed to a point where potential ridership would be appropriate to warrant the full service. This option will also reduce the level of subsidy required from the City to assist towards the operation of the RT system for the initial phase; however, buses will still need to operate between MTC and the airport, so bus operating savings would be lower than the non-phased option.

Definition of Alternatives

Base Case

2.32 The Base Case, used as the comparator with the RT options, is essentially minor development of the existing transportation network with local transit service being provided exclusively using buses. Within the A-Line corridor, buses would continue to operate in mixed traffic similar to the existing A-Line express bus service. The section between Waterfront and downtown by Route 4 takes 8 minutes, while the section between downtown and the Airport by Route 20 takes a further 32 minutes (including looping around MacNab and Mohawk College), giving a total journey time of 45 minutes under current traffic conditions and assuming that the transfer between Route 4 and Route 20 takes 5 minutes. This journey time is also expected to increase in the future as the corridor develops and congestion worsens.

2.33 In order to accommodate growing ridership, services on Route 20 are assumed to increase, with the headway during peak periods reducing from every 30 minutes currently to 20 minutes by 2021. Peak period headways on Route 27 will be reduced from every 20 minutes currently to 12 minutes by 2021. Articulated 18 metre buses are assumed on the route 20 A-Line service and conventional rigid 12-metre buses are assumed in operation elsewhere. There are other enhancements to the bus network in the City to accommodate the forecast increase in transit ridership assumed in the Base Case[1].

2.34 The Base Case also includes planned improvements to GO Transit services, including establishing a second Downtown GO Train station at James Street, which is assumed to receive an all-day rail service to and from downtown Toronto.

[1] Documented in the Model Refinement Report (completed as part of Making the Case work)

LRT Option

2.35 The overall route length of the LRT option is 17.5km (including the length common with the B-Line), with 21 stops (3 of which are common with the B-Line) and an end-to-end journey time of 40 minutes and average speed of 26.3 km/hr. The proposed peak service headway is 5 minutes between the Waterfront and MTC and 15 minutes between MTC and the Airport. 17 LRVs are required, including spares, (additional to the B-Line fleet) to operate the service. While the LRT journey times are expected to be similar to current A-Line journey times, as the corridor develops and becomes more congested, the dedicated alignment and signal priority of LRT will offer faster and more reliable journey times compared to conventional bus in the Base Case.

2.36 With the implementation of the LRT option, the Route 20 service will be removed, while route 27 will be retained. Route 21 will be reduced to a 30 minute headway and a new Route 21A operated between Mountain Brow Loop and Mohawk College via Route 21, also at a 30 minute headway. Finally, Route 33 will be diverted via Fennel Avenue and Jolley Cut (as Route 27) between Mohawk College and Downtown.

2.37 The creation of a segregated LRT alignment on the Claremont Access to ascend the Escarpment would result in the loss of 2 traffic lanes from the existing, mostly 6-lane road.

BRT Option

2.38 The overall BRT route length is 15.9km, with 21 stops and an end-to-end journey time of 37 minutes and average speed of 25.8 km/hr. The proposed peak service headway is 3 minutes between Waterfront and MTC and 12 minutes between MTC and the Airport. 28 BRT vehicles are required, including 3 spares, to operate the service.

2.39 James Mountain Road is a two-lane road, with an existing gradient of approximately 10.8%. It is not considered feasible to widen the existing road, so this section of route would have to be closed to other traffic in order to attain the grade-separated preference for RT operations.

2.40 Changes to the bus network with the implementation of BRT are the same as those assumed for the LRT option.

Options Summary

2.41 The proposed headways and travel times for each option compared to the Base Case are shown in Table 2.1. As a result of the changes, the number of services running between downtown Hamilton and Mohawk College will increase from 16 to 24 per hour for LRT and 32 per hour for BRT, and with them improved connectivity to north of the downtown and the Waterfront will be provided.

TABLE 2.1 RT HEADWAY[2] AND TRAVEL TIMES[3]

	Base Case	BRT	LRT
Opening Year		2025	2025
Route Length (kilometres)		15.9	17.5
Number of stops		21	21
RT Headway: Waterfront to MTC (minutes)		3	5
RT Headway: MTC to airport (minutes)		12	15
HSR Routes 20, 21, 27 Headway (minutes)	3.75	5	5
Travel time (end-to-end) (minutes)	45[4]	37	40
Vehicles Required		28	17
Capacity per Vehicle		120	200
System Passenger Carrying Capacity (phpd): Waterfront to MTC		2,400	2,400
System Passenger Carrying Capacity (phpd): MTC to airport		600	800

2.42 Over the sections of route where the LRT and BRT options follow a common alignment (i.e. north of Downtown and south of the Escarpment), the journey times are assumed to be the same for both options. However, for the Escarpment section, the longer LRT route results in increased journey times. Clearly this additional journey time only affects those passengers whose journey includes this section of the route

[2] Headway measured for the section between Downtown and Mountain Transit Centre.

[3] Based on current journey times and does not reflect future congestion.

[4] The transfer between Route 4 and Route 20 is assumed to take 5 minutes.

3 Study Approach

Introduction

3.1 This chapter presents the approach taken to assess the Potential Economic Impact arising from implementation of RT on the A-Line, including the selection of economic indicators. The analysis and results of each are then presented in Chapters 1 to 10.

Approach

3.2 To ensure consistency between B-Line and A-Line reporting this study follows a similar methodology to the B-Line Economic Potential Report. A Multiple Account Evaluation framework, which builds on the accounts used for the Benefits Case, is employed.

3.3 The MAE approach is a widely applied process for evaluating major capital investments in the GTHA and considers both quantitative and qualitative criteria. In this study, the MAE assesses criteria beyond that of the Benefits Case, this includes in particular, an assessment of land value uplift and tax returns, as well as economic growth, social need and accessibility. The study primarily focuses on the economic potential of the A-Line proposals, but gives some consideration to social and environmental accounts also.

3.4 In order to determine the economic potential impact resulting from RT along the A-Line, both long-term and short-term effects are considered. These include the impact of construction as well as long-term RT operation and future city development.

3.5 The analysis not only examines the advantages and disadvantages of RT in general, but also assesses both LRT and BRT, using the corresponding preferred alignments for each case. In doing so, the study will provide insight into the most beneficial technology, beyond that shown in the traditional Benefits Case assessment.

3.6 The following categories or 'accounts' are used in order to structure the analysis:

- Financial
- Transportation User
- Land Use and Urban Development
- Economic Development
- Environmental
- Social and Community

3.7 The indicators that are used to assess the A-Line proposals within each account are outlined in the following section.

3.8 As mentioned previously, there is a strong tie between this study and the Benefits Case and both should be used to inform the final technology and route choice.

Selection of Economic Potential Indicators

3.9 For consistency, and as agreed with City of Hamilton, the economic indicators used to assess the RT proposals for the A-Line follow those that were used in the B-Line Economic Potential report.

3.10 Table 3.1 displays the economic potential indicators that are considered in this study and in doing so, sets out the general structure of the remainder of this report. As shown, the majority of the indicators are quantified, however, for others their nature dictates that they cannot be quantified and so are assessed in descriptive terms.

TABLE 3.1 ECONOMIC POTENTIAL INDICATORS

MAE Account	Category	Indicator	Assessment
Financial	Project costs	Capital costs Operating & maintenance costs Capital & operating savings Revenues	Quantitative
Transportation User Account	Passenger benefits	Journey time Reliability & Quality Wait time	Qualitative / quantitative
	Personal Costs	Vehicle operating costs Out-of-pocket costs Collision Costs	Quantitative
	Accessibility	Wheelchair accessibility Key destinations Transit capacity Neighbourhood connectivity Connections with other modes	Qualitative / quantitative
Urban Development	Property value	Land value Property tax	Quantitative
	Land Use	Vacant land and new development Incremental residential density Incremental commercial/retail density Development charges	Quantitative

MAE Account	Category	Indicator	Assessment
Economic Development	Economic growth	Employment GDP Output	Quantitative
	Construction impacts	Disruption Access Retail sales impacts	Qualitative
	Operational impacts	Disruption Access	Qualitative
	Tourism		Qualitative
Environmental	Emissions	GHG & CAC emissions	Quantitative
	Energy use	Energy use Potential for local energy	Quantitative Qualitative
Social & Community	Crime	Impact on crime	Qualitative
	Health	Accident reduction Air quality Physical impacts	Qualitative
	Social Need	Transport spend as % income Social need indicators	Quantitative

3.11 In order to comparatively assess the qualitative indicators, a seven point scale has been used in the MAE summary tables, where ticks (✓) represent a positive net effect and crosses (x) represent any adverse impact. These occur to a maximum of three, where the greater number of ticks / crosses represents a greater impact. A neutral effect is represented by a dash (-).

4 Financial Account

Introduction

4.1 The Financial Account looks at the direct costs, including capital, operating and maintenance costs, and revenues of each alternative, as well as the cost savings compared to the Base Case option. The relative cost:revenue ratio can then be used to indicate the financial performance of an option.

Capital Costs

4.2 The total capital cost of the LRT and BRT options, as reported in the A-Line Benefits Case, is $706.1m and $244.1m respectively (2010 prices). The BRT option therefore costs 35% of the LRT total capital cost to build.

4.3 BRT and LRT are very different technologies, and despite the intention that the BRT encompasses some of the benefits of LRT[5], there are inherent differences that result in disparate cost estimates between the two technologies; trackwork and power supply infrastructure for example. Aside from the technological differences, the BRT route is 1.7km shorter than the LRT route as it takes a more direct route up the escarpment. However, this cost saving is offset to a degree by the fact that some of the LRT infrastructure will already be provided by the B-Line.

4.4 As described in the Project Description chapter, the fleet size for the LRT and BRT are 17 LRVs and 28 buses respectively. This equates to a total capital vehicle cost of $92.7 million for the LRT option and $42.0 million for the BRT option.

4.5 The total capital costs for each alternative are shown in Table 4.1.

TABLE 4.1 TOTAL CAPITAL COSTS FOR BRT AND LRT (2010 PRICES)

Cost Component ($m)	LRT	BRT
Construction	366.9	109.4
Design & Management	111.5	37.7
Property	20.0	20.0
Vehicles	92.7	42.0
Contingency	115.0	35.0
Total[6]	**706.1**	**244.1**

Source: A-Line Benefits Case 2011, Steer Davies Gleave

[5] As described in the A-Line Technology Review, which forms an appendix of the A-Line Opportunities and Challenges Report.

[6] Excludes interest during construction at a 5% lending rate

4.6 The construction of both LRT and BRT is assumed to take up to 6 years, consistent with the on-going B-Line work. The operation of the project is assumed to begin in 2025, as agreed with the City of Hamilton, to reflect delivery within the 15 year timeframe envisaged in *The Big Move*.

4.7 Implementation of RT will also avoid bus capital expenditure on bus renewal as the existing A-Line buses become life-expired. These cost savings are estimated at $4m for both options, and assumed to be incurred in 2025.

Operating & Maintenance Costs

4.8 The operating costs of a RT system can vary greatly both between and within technologies. BRT typically has a lower annual operating cost to LRT when fleet sizes are equal because there is less equipment to maintain, such as the track and power supply systems. Conversely, BRT energy costs tend to be higher and for high demand corridors LRT will be cheaper on a per-seat basis because of the higher passenger capacities.

4.9 Based on the proposed service and employing the same operating cost unit rates to those used in the B-Line Benefits Case Update, the A-Line RT annual operating cost for the LRT option in 2025 is estimated at $12.9m (2010 prices). In comparison, the BRT option would cost $15.1m per annum to operate and maintain. The LRT option therefore costs 85% of the BRT operating costs in the start-up year.

4.10 Over time the BRT operating costs will increase as the cost of fossil fuels is expected to increase at a greater rate than inflation, reaching $16.0m per annum in 2031. The LRT option costs remain constant in real terms as it operates using electricity rather than fossil fuel sources.

Capital and Operating Savings

4.11 With the implementation of LRT or BRT, the Route 20 bus service would be removed. These changes would result in capital and operating cost savings. It is estimated that 10 buses would no longer be required and the overall bus operating costs would reduce by 3.5% compared to the Base Case. This equates to a saving of $1.2m per annum in 2010 prices by 2025. As with BRT, these savings will increase over time and are estimated to be $1.3m per annum by 2031.

4.12 The net yearly operating costs of the RT options in the start-up year are therefore $11.7m for LRT and $13.9m for BRT. In 2031 this will remain constant (in real terms) for LRT, but increase to $14.7m per annum for BRT, due to the growth in BRT operating costs.

Revenues

4.13 The level of revenue for each option is directly related to demand, which is a complex function of growth and service quality i.e. frequency, comfort, price, convenience, reliability etc.

4.14 The higher perceived quality of RT compared to conventional buses will result in new transit passengers who would otherwise use auto and hence increased transit revenues. Based on a literature review of numerous LRT and BRT studies around the world[7], LRT would typically be more attractive to users than BRT due to a better ride quality and lower levels of noise. In addition, LRT provides a higher capacity and is less crowded than BRT. This means that LRT is likely to generate higher levels of revenue. Conversely, the journey time for LRT exceeds that of BRT due to the longer route alignment, and this would offset the extra LRT revenue.

4.15 In 2009, the HSR network attracted 27.3 million boardings and collected $32.1 million in operating revenues; an average yield of $1.18 per boarder (or $1.54 per passenger after accounting for interchange trips).

4.16 At a constant fare of $1.18 per one-way trip for both technologies, total revenues in 2031, after the initial demand ramp-up period, are estimated at $2.4m for LRT, exceeding the BRT alternative of $1.9m by $0.5 million or 21%.

Revenue-Cost Ratio

4.17 The financial case of the project can be better understood by calculating the costs of each option relative to revenues from. Table 4.2 summarizes the per annum operating costs and revenues for each option in the start-up year and forecast year, as well as the revenue-cost ratio.

TABLE 4.2 REVENUE-COST RATIO FOR BRT AND LRT (2010 PRICES)

	LRT		BRT	
	2025	**2031**	**2025**	**2031**
Net operating costs ($m)	11.7	11.7	13.9	14.7
Revenue ($m)	1.5	2.4	1.4	1.9
Revenue-Cost Ratio	0.13	0.20	0.10	0.13

Source: A-Line Benefits Case 2011, Steer Davies Gleave

4.18 These results show that both technologies result in an annual operating deficit. However, the LRT has a slightly higher revenue-cost ratio, thus suggesting a better performing option financially. When considering capital costs however, the BRT costs 65% less than the LRT option and so would require a more conservative up-front investment.

[7] Hamilton Rapid Transit: Making the Case. Steer Davies Gleave 2011 – based on Steer Davies Gleave stated and revealed preference data in transportation models from Leeds New Generation Transit, Manchester Metrolink and Vancouver SkyTrain, and Demand Performance of Bus Rapid Transit, Graham Currie, Monash University, Journal of Public Transportation Volume 8 No.1 (2005).

5 Transportation User Account

Introduction

5.1 The Transportation User Account assesses the impact of the options on existing and new transit users. An important function of RT in Hamilton is to improve opportunities and accessibility for its residents. As well as looking at passenger benefits and personal costs, this section analyses each technology option against accessibility criteria.

Key inputs and assumptions

5.2 The evaluation of transportation impacts was undertaken by employing the City of Hamilton EMME Transportation Model developed for the Hamilton RT Projects. It is more detailed than the Greater Golden Horseshoe Model (GGHM) typically employed by Metrolinx for high level project evaluation.

5.3 In order to model the proposed LRT and BRT options, it employs the headway, run time and stop assumptions set out in Chapter 2 of this report.

5.4 The model provides forecasts on transportation benefits, ridership and revenue for 2021 and 2031 forecast years. These outputs of the model, including other statistics such as the change in vehicle kilometres travelled, are used for this account.

Passenger Benefits

Journey time

5.5 The existing bus Routes 20 and 4 provide service between the Airport and Waterfront and, including an assumed transfer time of 5 minutes, the end-to-end journey time is approximately 45 minutes. The proposed LRT option is expected to provide journey times comparable to existing buses, while the end-to-end journey time for BRT is lower at 37 minutes (the route alignment for BRT is 1.7km (or 10%) shorter than that of the LRT option).

5.6 As future congestion increases, the journey time of LRT is not expected to change significantly due to its dedicated alignment and signal priority, while conventional buses might experience a gradual increase in journey times into the future. Similarly, due to the majority of the BRT option being segregated from traffic, future congestion increases are unlikely to affect journey times except at sections where the BRT will operate at-grade with autos. However, this is expected to have minimal effect on journey times as these areas are at the ends of the alignments (south of English Church stop (towards the airport) and at the Waterfront), or downtown but in the northbound direction only (by the Hunter Street Go Station). The LRT also has an at-grade section south of English Church stop, but as it is a low density area journey times are unlikely to be effected.

5.7 The A-Line Benefits Case reports that the overall annual journey time benefits for all transit users as a result of LRT on the A-Line equates to $37.7m in 2010 prices by

2031. For BRT, the journey time benefits are $21.5m per annum. Compared to LRT, the BRT option generates around 57% of the benefits of LRT.

Reliability and Quality

5.8 One of the key benefits of RT is the quality and reliability. LRT is designed to provide good ride-quality and journey ambience, while the image of LRT is also a perceived benefit to users compared to bus.

5.9 The quality and reliability of BRT is known to be greater than that of conventional bus services, yet not equal to the benefits of LRT. The BRT image remains associated with that of buses and therefore the ambience is perceived as inferior to LRT. This difference should be small in the case of the A-Line, since the BRT option is anticipated to have many similarities to LRT, including low floor access and segregated running where possible. Further alignment development of both options would be required to determine any differences in the level of segregated running for BRT compared with LRT, but based on the current level of development, any differences should be minor.

5.10 The LRT and BRT options are proposed to operate at 5 minute and 3 minute headways respectively. Similar levels of traffic signal priority have been assumed for both options, giving similar journey times over the common sections of route. In practice however, the traffic signals may be less able to give this level of priority for the more frequent BRT service, particularly at peak times, and consequently journey times are likely to be more variable for BRT.

Wait time

5.11 The LRT and BRT options are proposed to operate at 5 minute and 3 minute headways respectively, with the local Route 27 operating at a 15 minute headway. This compares with the Base Case which includes the A-Line Route 20 at a 12 minute headway and the Route 27 at a 15 minute headway. Overall, the volume of transit services is significantly higher and wait times for passengers travelling from the Mountain to downtown will decrease significantly.

5.12 In addition, RT users can expect an improved waiting environment due to investment in higher quality stops and associated amenities. These could include shelters, real-time information, CCTV etc. Considering these benefits, the perceived cost of waiting for each transit user would be lower for the RT service, compared to conventional buses with existing stop amenities.

Personal Costs

Automobile operating costs

5.13 Passengers who shift from auto to transit would no longer need to pay for the operating costs of their auto – primarily fuel and wear and tear. However, an increase in diversion of autos to other roads as a result of RT on the A-Line will cause an increase in auto operating costs for those that do not shift modes. Overall this creates a net negative affect in both LRT and BRT cases.

5.14 The marginal vehicle operating costs, based on 2007 Canadian Automobile Association (CAA) calculations on average is $0.64/km in 2010 prices (increasing at 2% per annum in real terms). This is taken into account in the transportation model when trade-offs between transit and auto are being made. Applying this unit rate to the net number of auto vehicle kilometres that are increased by implementation of RT along the A-Line, the increase in vehicle operating costs are estimated at $0.5m per annum for LRT and $4.0m per annum for BRT (by 2031).

5.15 Some individuals may decide to reduce the number of vehicles owned because they feel that they could rely on the transit network. In those cases the individuals would also save on car ownership costs.

Auto use in Hamilton

Out-of-Pocket costs

5.16 Passengers who transfer from other bus services onto RT would continue to pay the transit fare they would otherwise pay. It is assumed that they would effectively pay the same cost for a better quality service and that the fare structure will remain the same for RT and other HSR buses. Under this scenario, existing transit users will not be unfairly penalised.

5.17 Passengers who are attracted by RT and shift from auto to transit would need to pay a fare. This fare is considered an out-of-pocket cost. These costs would be offset by the vehicle operating costs and parking charges they have avoided.

5.18 The evaluation assumption is that the fare structure will be similar to today and payment can be made by cash at $2.55 per journey or by PRESTO smart card at $2 per journey for adults. There are a number of products available to choose, such as single tickets, monthly and annual passes for adults and other concessionary groups. In addition, a single ticket allows users to interchange onto other services within 2 hours of validation. As a result the average fare was calculated at $1.18 per trip. The incremental fares collected attributed to RT is estimated at $2.4 million per annum for LRT and $1.9 million per annum for BRT in 2031.

Collision costs

5.19 One of the effects of reducing the levels of traffic in Hamilton is the corresponding decrease in auto collisions. These costs are not directly included in the transportation model and are largely related to human costs through fatality or injury, and infrastructure repairs incurred by the City.

5.20 As mentioned previously, in the case of RT on the A-Line both technologies would create additional traffic mileage in Hamilton, due to diversion of autos that have been diverted from the more direct routes. This is particularly the case for the BRT option, as its service along James Mountain Road is assumed to close the route to autos completely.

5.21 Based on the 2004 Canadian Motor Vehicle Traffic Collision Statistics the estimated collision cost is $0.07 per vehicle kilometre. Applying this unit rate to the number of auto vehicle kilometres that are increased by implementation of RT along the A-Line forecast by the transportation model, the increase in collision costs are estimated at a $33k per annum for LRT and $0.3m per annum for BRT.

Accessibility

Wheelchair accessibility

5.22 For both LRT and BRT options, all stops and vehicles would be fully accessible for wheelchair users and those with mobility scooters, strollers etc. Raised low floor platforms would be provided at stops to allow level boarding of the vehicles. LRT allows for a very small boarding gap between the stop platform and the vehicle, and so provides better accessibility than BRT where the boarding gap would be more variable.

5.23 The vast majority of HSR bus routes currently use low-floor accessible buses, and therefore for BRT, the incremental impact on vehicle and stop accessibility would be limited. The provision of raised low floor platforms will avoid the need for buses to kneel for wheelchair users etc, although the ramps may still need to be deployed to bridge the gap between the bus and the platform edge. For LRT there will be an improvement in vehicle accessibility arising from the smaller and more consistent boarding gap and from easier movement for wheelchairs, mobility scooters and strollers within the LRV.

5.24 In addition to wheelchair accessibility, the RT stops will include Urban Braille, which is a solution for wayfinding for the blind and visually impaired. The incorporation of Urban Braille into public realm improvements is Council adopted policy.

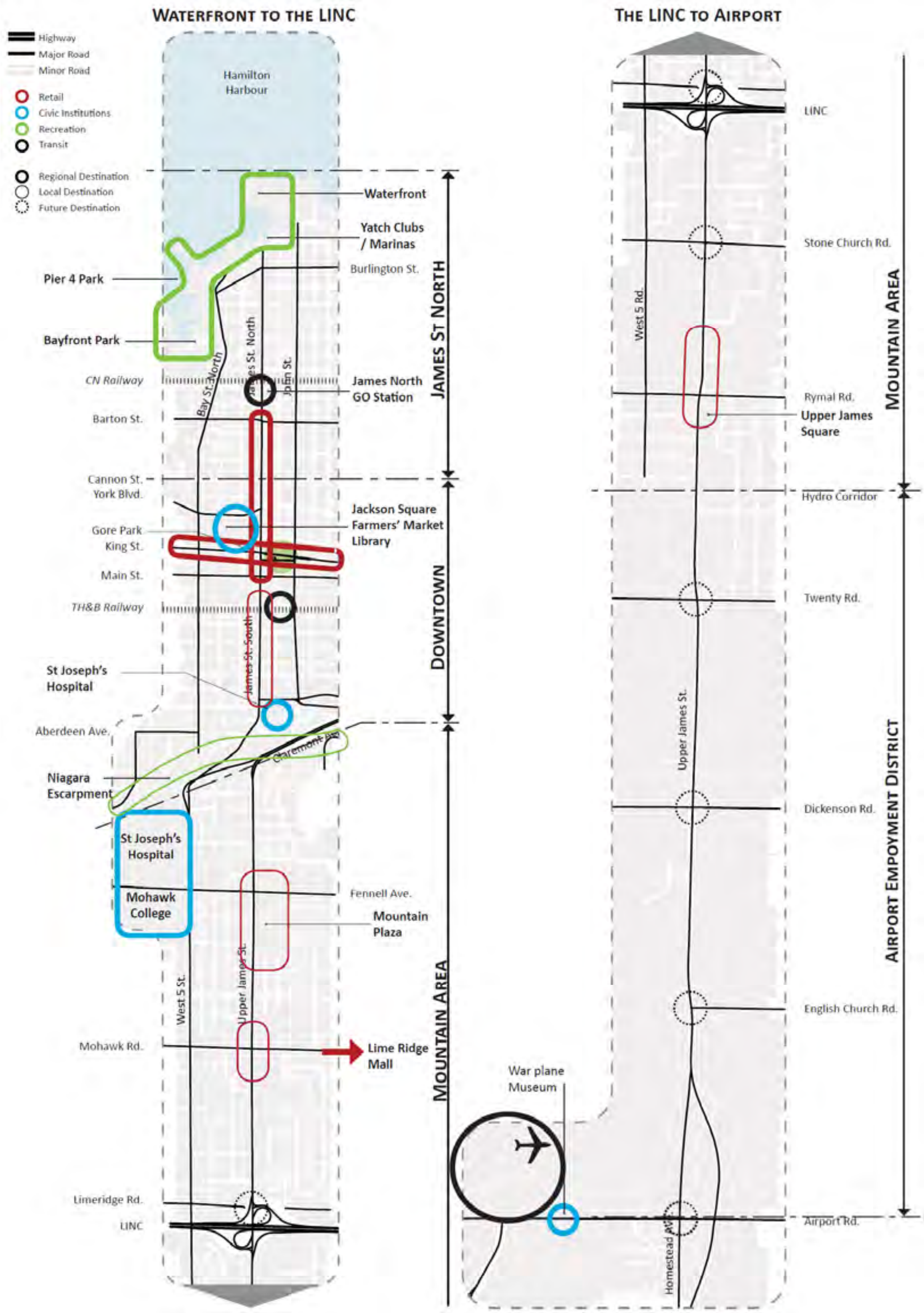
Key Destinations

5.25 A number of key destinations along the A-Line route have been identified and are shown in Figure 5.1. The BRT option would serve all of these destinations.

5.26 The higher frequency of service proposed, compared to existing HSR bus services, would provide increased accessibility in the corridor, particularly between the Downtown and the Waterfront and between Rymal Road and the Airport. This in itself has the potential to increase regeneration and revitalisation of key leisure/tourist destinations along the corridor, such as the waterfront.

5.27 The LRT route via Claremont Access would not serve destinations on and close to James Street South, including the GO Centre (Hunter Street) and St Joseph's Healthcare Charlton Campus. However, by sharing a section of route and 3 stops with the B-Line, the LRT option would offer easier transfer between the A-Line and B-Line services compared with the BRT option.

FIGURE 5.1 KEY DESTINATIONS ALONG THE A-LINE CORRIDOR



Source: Dialog

Transit capacity

5.28 For the LRT option it is proposed to operate a peak service of 12 vehicles per hour (vph) (5 minute headway) between the Waterfront and MTC, of which 4 vph (15 minute headway) would continue on to the Airport.

5.29 For BRT the proposed service is 20 vph (3 minute headway) between the Waterfront and MTC, of which 5 vph (12 minute headway) would continue on to the Airport.

5.30 Typical vehicle capacities are 200 passengers for LRT and 120 for BRT. For planning purposes Metrolinx recommends using an average capacity of 65% of these figures. The resulting route capacities using these figures are set out in Table 5.1.

TABLE 5.1 RT CAPACITIES

Route Capacity	LRT	BRT
Typical vehicle capacity (passengers)	200	120
Waterfront to MTC (passengers per hour per direction)	2400	2400
MTC to Airport (passengers per hour per direction)	800	600
Metrolinx Planning Capacity (passengers)	130	78
Waterfront to MTC (passengers per hour per direction)	1560	1560
MTC to Airport (passengers per hour per direction)	520	390

5.31 The BRT option matches LRT in terms of capacity between Waterfront and MTC. South of MTC, the capacity of the LRT service exceeds that of BRT by 33%.

5.32 The ridership forecasts estimate that by 2031, the highest loadings of the RT is 1,900 persons (in the northbound direction). In comparison with the theoretical capacity, this suggests a maximum load factor of 79%, exceeding Metrolinx Planning Capacity for both technologies.

Neighbourhood connectivity

5.33 Both options for the A-Line route run at-grade along existing streets through the developed areas, with the main off-street sections through currently undeveloped areas between Rymal Road and Mount Hope. Existing pedestrian and cycle crossing points will be maintained, with additional pedestrian access and road crossings being provided at some of the stops. In some areas it may be necessary to reduce the width available to pedestrians and/or cyclists, although such impacts will be minimised, in keeping with the City's hierarchy of modes. The requirement for RT priority will lead to changes in the traffic signal timing, which in some cases may adversely impact pedestrians - in other cases there may be improvements. Overall, the severance impacts of the route on pedestrians and cyclists will be small.

5.34 For the B-Line, the loss of traffic lanes to provide segregated RT lanes has a relatively minor impact as the grid road layout provides multiple alternative routes for displaced traffic. For much of the A-Line corridor the same is the case, however the loss of traffic capacity is proportionally higher at the Escarpment section. Here, the LRT option results in the loss of 2 of the 6 traffic lanes on the Claremont Approach, and the BRT option would result in the closure of the 2-lane James Mountain Road to other traffic. Although the number of lanes lost is the same in both cases, it is likely that the impacts on the distribution of traffic will be greater for the BRT option as this involves the complete closure of one of the Escarpment traffic routes.

Connections with other modes

5.35 The A-Line route has significant transfer opportunities to other modes at the following locations:

- Proposed James Street North GO Station
  - Planned all-day GO Train services to Toronto
- Downtown Hamilton (Metrolinx Mobility Hub)
  - B-Line RT
  - HSR bus services using the MacNab Terminal
- GO Centre (Hunter Street) – BRT Option only
  - GO Train services to Toronto (peak period only)
  - Long distance bus services
  - Local HSR bus services
- Mohawk College / Upper James (Metrolinx Mobility Hub)
- James Street North / Liuna Station (Metrolinx Mobility Hub)
- Hamilton International Airport

5.36 Along the route there are a number of locations where the RT service crosses other local HSR routes, allowing transfer to services to areas beyond the A-Line route.

HSR Bus Services

Summary

5.37 To the transit user, RT on the A-Line would bring a wealth of benefits in terms of journey time reliability, service quality and reduced wait time. In addition, RT would increase accessibility with other modes and to destinations along both the A- and B-lines. Although the closure of lanes to traffic would create some disbenefits, these are relatively minor for LRT ($0.5m per annum). In the case of BRT, the effects of displaced traffic could create an increase in collision costs and auto operating costs to the value of $4.3m per annum.

5.38 A summary of the Transportation User impact of both technologies is provided in Table 5.2

TABLE 5.2 TRANSPORTATION ACCOUNT IMPACTS – 2031

	LRT	BRT
Passenger Benefits		
Journey Time Savings ($m)	37.7	21.5
Reliability & Quality	✓✓✓	✓✓
Wait Time	✓✓	✓✓✓
Personal Costs		
Automobile Operating Costs ($m)	-0.5	-4.0
Out of Pocket Costs ($m)	-2.4	-1.9
Collision Costs	-0.1	-0.3
Accessibility		
Wheelchair Accessibility	✓✓	✓
Key Destinations	✓✓	✓✓✓
Transit Capacity	✓✓	✓✓
Neighbourhood Connectivity	✓	✓
Connection with Other Modes	✓✓	✓✓✓

6 Land Use and Urban Development Account

Introduction

6.1 The Land Use and Urban Development Account assesses current land use within the A-Line corridor and estimates the potential for development based on population and employment projections. This information is used to predict the uplift in land value as a result of each RT option, as well as the effect on public revenue through property tax and development charges. In so doing, the analysis identifies intensification areas along the A-Line in the form of existing vacant parcels and other potentially under-utilised land uses.

6.2 Supporting information in the form of research on the minimum densities required to support the development of a RT project, and analysis of the full development charge and property tax impacts of the LRT and BRT options can be found in Appendix C.

Transport and Urban Development

6.3 There is significant evidence that high quality public transportation can generate a positive impact on the urban development of a city or region. RT projects in particular have been used widely to promote economic development and Vancouver, Toronto, Calgary and Edmonton have all used transit projects as a sustainable regeneration policy tool.

6.4 Transit projects can promote regeneration in several ways, by improving accessibility, productivity, access to labour and employment opportunities, boosting land values and promoting sustainable land use patterns and development. These effects occur through several processes:

- **Increased Transport Accessibility** – lowering the cost of travel and making it easier and cheaper to get to and from work and to access services. This increases the availability of labour for local businesses and expands the available range of employment, education, health and leisure options for individuals. It can also open up new areas of land for development and increase the attractiveness of underused land parcels.

- **Increased Urban Density** – altering land use patterns by focussing transport accessibility around transit stops and stations. This increases the demand for residential and commercial land at stations, therefore increasing the density of development. This in turn reduces the demand for travel and energy consumption, and improves sustainability.

- **Increased Productivity** – improving transport links reduces business costs and directly boosts the productivity of firms. Transport can also reduce the ‘effective distance’ between businesses and individuals and for business sectors can generate ‘agglomeration effects’, improving access to shared inputs and outputs, creating a more competitive labour pool and creating positive network effects.

- **Improved Urban Fabric** – when combined with urban realm improvements, new stations or stops can improve the level of facilities and the quality of the urban fabric at a location. This can, in turn, have a positive impact on the environment and perceptions of an area, and can induce further private sector investment in some cases.
- **Increased Footfall** – a new station or stop may cause an increase in levels of pedestrian traffic. This enhances the value of a location as a retail or commercial site by bringing more customers and increasing its profile.
- **Improved City Image** – transport hubs are often the first point of call for visitors to city locations and major transport projects, particularly high quality transit projects, can have an important impact on the image of a city, encouraging new investment and migration.

6.5 The A-Line RT project has the potential to promote the regeneration of the city of Hamilton through each of these effects. The economic value of these impacts is largely captured within the traditional cost-benefit analysis framework[8], which measures the total theoretical economic value of a transport project largely based on generalised time savings. This impact is capitalised through various linkages including wider labour market and customer catchment areas, and increased employment. The rest of this section will examine the potential land use and development impacts of the project.

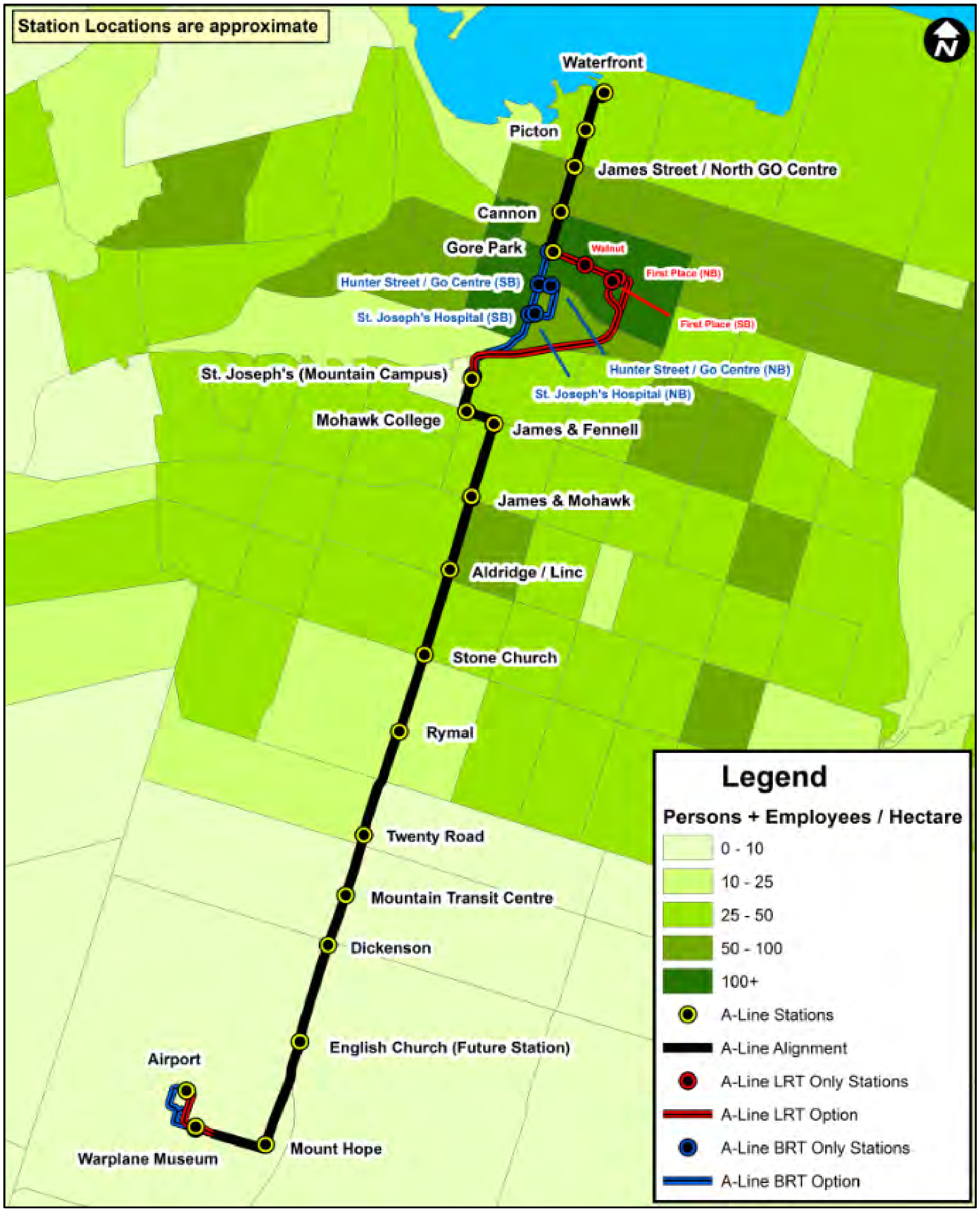
Socio Economic Context

6.6 The City of Hamilton currently has a total population of over 531,000 people and total employment of almost 234,000. The current combined population and employment densities in the A-Line corridor and surrounding area vary significantly, as shown in Figure 6.1. The map shows Traffic Area Zones (TAZ), which are statistical boundary areas encompassing several city blocks. A map of TAZs is provided in Appendix A. Within each TAZ, population densities range from 0 – 100+ persons per hectare on a general south to north basis from the airport to downtown. Employment densities follow a similar pattern, with the highest densities (over 50 persons per hectare) in the downtown and less than 3 persons per hectare towards the airport.

6.7 Both the LRT and BRT alignments intercept the areas of highest current combined population and employment densities, namely the downtown area. Where the LRT alignment differs from that of the BRT and follows the B-Line corridor along King Street, the route accesses areas with densities in excess of 100 persons per hectare.

[8] However standard cost-benefit analysis does not include wider economic impacts such as imperfect competition benefits, labour supply benefits and agglomeration productivity benefits.

FIGURE 6.1 2011 COMBINED POPULATION AND EMPLOYMENT DENSITIES

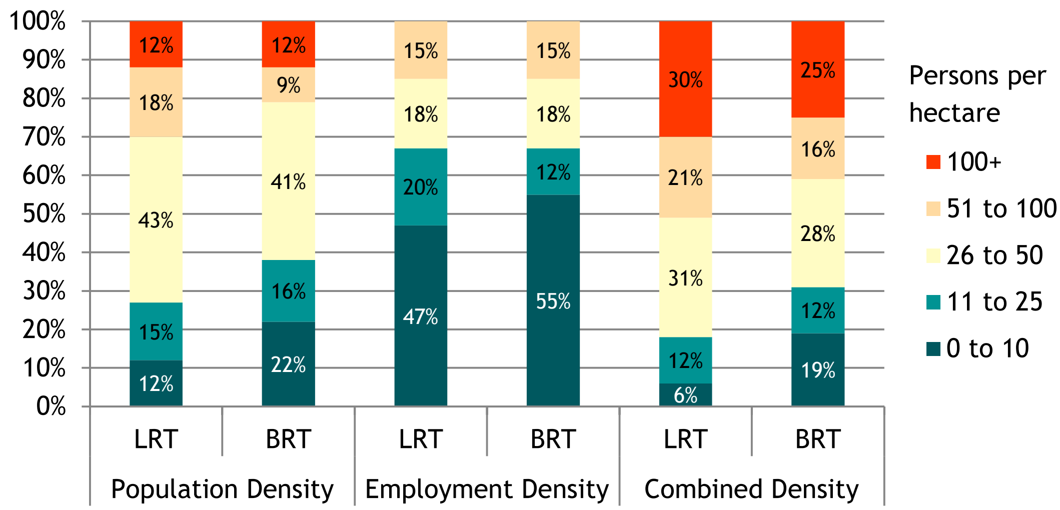


Source: Steer Davies Gleave – data from City of Hamilton

6.8 The impacts of the RT system are assumed to occur within a 500m catchment area of the LRT and a 400m Catchment area of the BRT alignment. Within the LRT catchment area, there is a population and employment count of 87,746 and 31,209 respectively. Within the BRT catchment area the population within the catchment drops to 83,449, with 29,090 employment.

6.9 Figure 6.2 shows the population, employment and combined density proportions within the LRT and BRT catchment areas. The charts show that 30% of the TAZs within the LRT catchment area have a combined population and employment density of 100+ persons per hectare and over 80% with a combined density exceeding 26 persons per hectare. This compares to the density proportions of the BRT catchment area, in which currently 25% of the TAZs within catchment area have a combined population and employment density of 100+ persons per hectare and 69% with a combined density exceeding 26 persons per hectare. This shows that, based on 2006 distributions of population and employment, the LRT option will serve more existing high density areas than the BRT option.

FIGURE 6.2 2011 DEMOGRAPHIC DENSITIES OF THE TAZ STATISTICAL BOUNDARY AREAS WITHIN THE LRT AND BRT CATCHMENT AREAS



Source: Steer Davies Gleave – data from City of Hamilton

Future growth

GRIDS

6.10 *GRIDS* (Growth Related Integrated Development Strategy) is the adopted development strategy for current transit projects that draws together land use planning and infrastructure investment planning for the next 30 years. Table 6.1 shows the *GRIDS* population, employment and household forecasts for the City of Hamilton up to 2031.

TABLE 6.1 GRIDS POPULATION & EMPLOYMENT FORECASTS

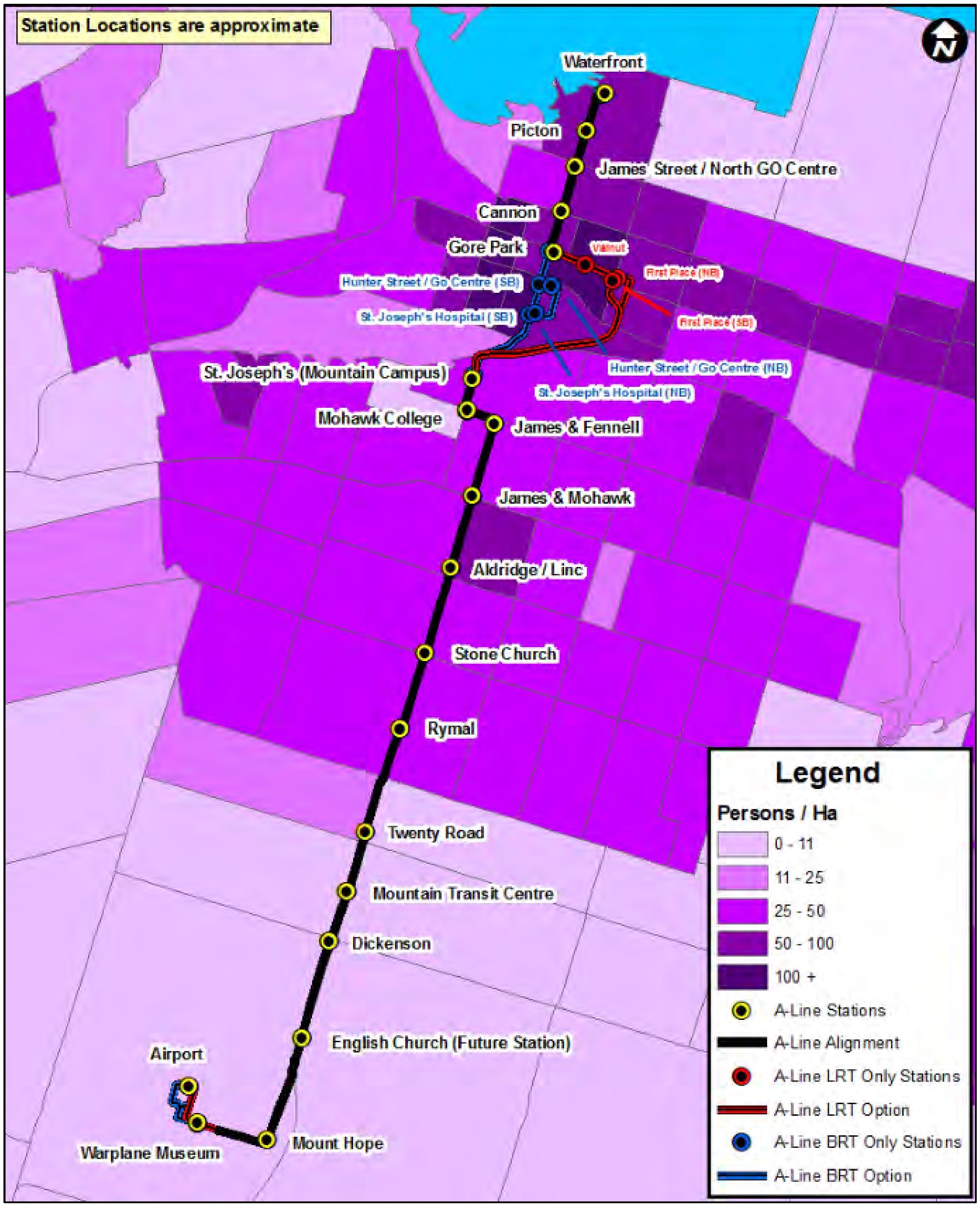
Year	Population	Households	Employment
2001	510,000	190,000	210,000
2006	497,400	194,455	258,755
2011	531,000	210,000	234,000
2021	590,000	240,000	270,000
2031	660,000	270,000	300,000
2011-2031	129,000	60,000	66,000

Source: (Hamilton 2006) (Canada 2007)

6.11 Within the TAZs surrounding the LRT and BRT alignments, total population and employment in 2011 is 97,000 and 31,000 respectively. The DCMI scenario forecasts that by 2031 population and employment will increase to 184,000 and 75,000 respectively. The areas of greatest overall increase are expected to be within the downtown area, which will require significant building and regeneration if this growth is to be accommodated.

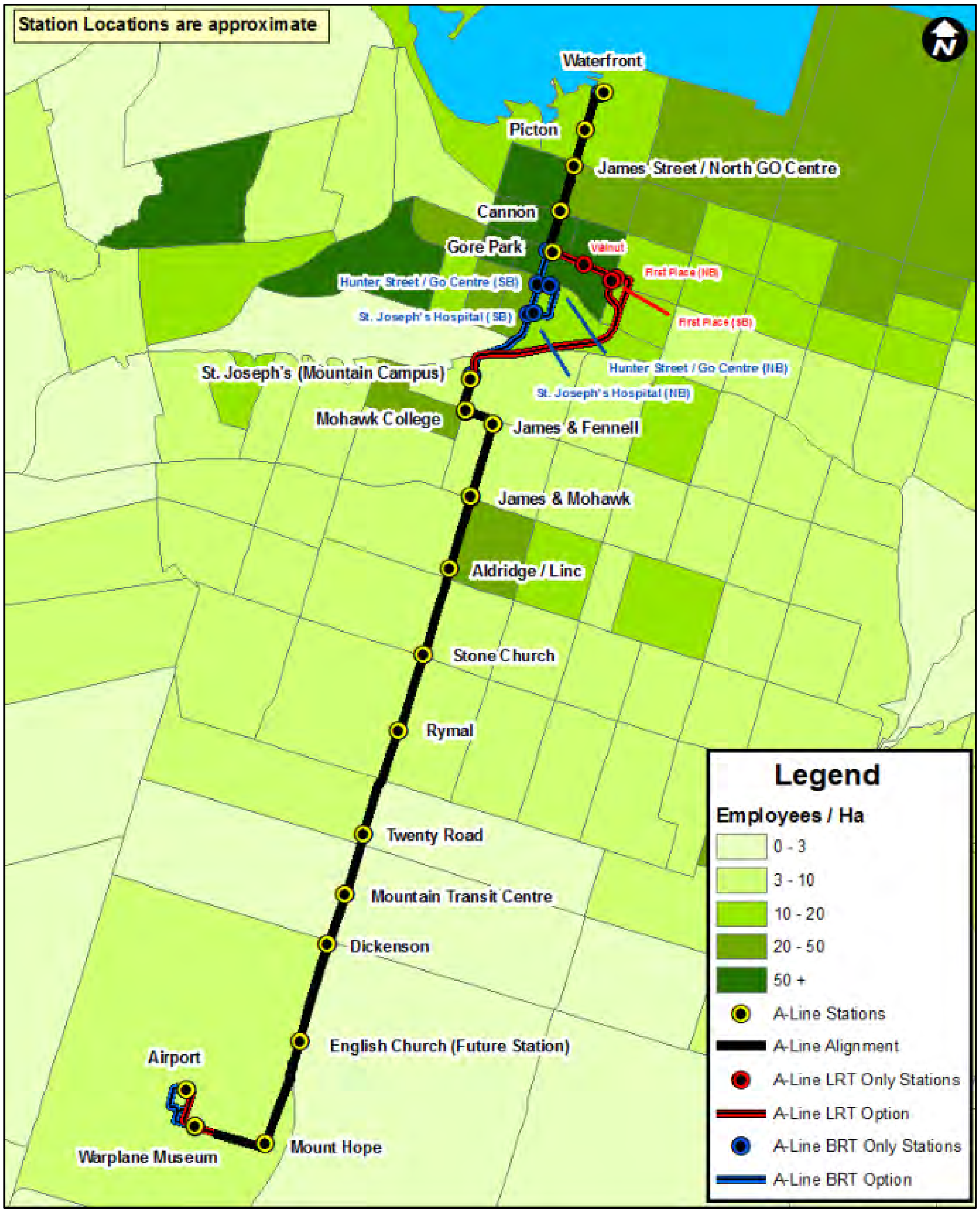
6.12 The projected 2031 population and employment densities in the A-Line corridor vary significantly, as shown in Figure 6.3 and Figure 6.4. These show that population densities within TAZs are expected to range from 0 to194 persons per hectare on a south to north axis from the airport to Downtown. Employment densities follow a similar pattern, with the highest densities of 80 employees per hectare in the downtown and fewer than 3 persons per hectare towards the airport.

FIGURE 6.3 2031 FORECAST POPULATION DENSITIES ALONG THE A-LINE CORRIDOR



Source: Steer Davies Gleave – data from *GRIDS*

FIGURE 6.4 2031 FORECAST EMPLOYMENT DENSITIES ALONG THE A-LINE CORRIDOR



Source: Steer Davies Gleave – data from *GRIDS*

Dual Corridor Medium Intensity (DCMI) Scenario

6.13 The DCMI scenario was developed by Steer Davies Gleave and the City of Hamilton to provide a set of development assumptions for use in the transport modelling and business case work. The scenario takes the overall GRIDS growth forecasts for the city and reallocates the projections to allow intensification of land around both the B and A-line corridors. The scenario makes the following assumptions:

- By 2031 the average density (population and employment) of each TAZ will increase from 22 to 44 persons per hectare
- The greatest increase in overall density will occur in TAZ 2571 (southwest Hamilton) and 2514 (Downtown Hamilton), which will increase from 4 to 141 persons per hectare and 73 to 190 persons per hectare respectively
- 80% of the city's total population growth will occur within the A- and B-Line RT corridors
- TAZ 2645, 2649 and 2650 that cover the airport and its surrounds (see Appendix A) are only intensified with employment growth
- The total population and employment within the TAZs that are in the RT catchment area and are being intensified is 310,000 and 132,000 respectively

6.14 The DCMI scenario and our economic forecasts in the subsequent text are based on several assumptions that reflect policy aspirations as well as the 'most likely' economic projection. The results and figures in the remainder of this Chapter should therefore be considered as a 'what if' scenario based upon these assumptions being realised.

6.15 As the project progresses, the DCMI scenario will be replaced by Secondary / Corridor Plans for the A-Line, which are being developed by the City.

Minimum Density

6.16 There is an extensive amount of research and guidance on the level of population density required to support the development of a RT service (see Appendix C). One such example is provided by (H. Chang 2005). Chang recommends minimum levels of at least 15 residential units per hectare (or 38 people per hectare) in residential areas and 62 employees per hectare in commercial centres, and twice that for premium quality transport.

6.17 City wide, 48 of the 195 TAZs in Hamilton meet the minimum employment density condition recommended by (Chang 2005) in 2011, 12 of which are along the A-Line RT alignment. By 2031, based upon the DCMI forecast scenario, 67 TAZs will meet minimum density in Hamilton, 27 of which are along the A-Line RT alignment. Given that there are 35 TAZs along the A-Line RT alignment in total, there may therefore be a need to increase the level of density around each stop to improve the economic and commercial case for the project, maximise the economic benefits of RT and deliver a more sustainable transport network and city in the longer term.

6.18 The higher attractiveness of land surrounding stop areas will make this process partially endogenous, which is reflected within the applied DCMI development assumptions; however there is significant scope for planning and policy intervention to encourage the development of land around each new stop. The City's Downtown and Community Renewal Division was established to promote the revitalisation and development of properties in Hamilton's Downtown Areas, Business Improvement Areas (BIAs), and other commercial corridors throughout the City. Financial Incentive Programs in the form of loans and grants are provided to assist with redevelopment in commercial areas and could also be used to promote development around stops (see Appendix C for a list of programs administered through this office).

Development Impacts

6.19 In addition to the impacts on the value of existing properties, the A-Line RT is likely to have a substantial effect on the level of new development within Hamilton. The A-Line RT will make many areas in the surrounds of the new stops more attractive to residential and property developers and is likely to change the overall number and distribution of new developments within the city.

6.20 This impact has been estimated based on the supply and demand for residential development within the city at a TAZ level, based on the following assumptions:

- Supply of vacant population and employment land surrounding each transit stop is calculated from the cities land use database.
- Demand for development based on the Dual Corridor Medium Intensity Scenario population and employment 2031 forecasts for each TAZ
- Demand and supply for development is constrained at the TAZ level.
- Development impacts will only occur within 500m of an LRT stop and 400m of a BRT stop (i.e. within the catchment areas)
- Development density assumptions of 2.5 persons per dwelling unit and between 30 and 100 dwelling units per hectare on vacant land

Vacant Land & New Development

6.21 Table 6.2 shows the total number and area of vacant properties within the LRT and BRT catchment areas, broken down by purpose[9]. Taking account of the forecast population growth and property market impacts, this land has significant potential for redevelopment.

[9] Existing land use categories have been assigned to the vacant land according to zoning areas.

TABLE 6.2 VACANT LAND WITHIN THE RT CATCHMENT AREAS

	LRT		BRT	
Vacant Land	**Properties**	**Land (HA)**	**Properties**	**Land (HA)**
Residential	95	30	79	19
Commercial	77	14	37	4
Institutional	1	0	1	0
Industrial	26	42	21	41
Mixed Use	49	8	31	6
Unknown	13	63	12	63
Agricultural	19	22	14	9
Parking	6	2	5	2
Open Space	2	1	2	1
Business District	5	6	8	1
Total	**293**	**189**	**210**	**145**

Vacant Residential Land

6.22 The vacant residential land within the LRT and BRT catchment areas have the potential to accommodate around 2,500 and 1,600 new residential development units respectively.

6.23 Considering other areas of vacant land, including parking spaces and a proportion of the mixed use land[10], there is also potential to develop up to 2,700 new development units throughout the city on 'population' land[11] within the LRT catchment area and 1,800 within the BRT catchment area. Over half of this vacant 'population' land is located in TAZ 2578 in Hamilton South. There is also a significant amount of vacant land in the downtown area.

6.24 This level of development implies a potential population of 6,300 new people on classified vacant residential land, and up to 6,800 if all available population land was developed for residential use in the LRT case. For the BRT option, the equivalent potential population is 4,100 and 4,500. These estimates imply that up to 7% of the total population growth forecast in the DCMI Scenario (for the study area) could accrue to the LRT catchment area. For BRT the equivalent figure is 5%.

[10]Assumed to be 10%.

[11]Vacant 'Population' includes vacant residential land plus all parking land and 10% of mixed use land.

6.25 Despite this potential, the actual demand for new development could be significantly less than the potential supply. In order to estimate the level of development which can be realistically achieved within the A-Line corridor the development potential estimates have been equalised to the total level of forecast population growth within the development scenario. This ensures that the level of new development is never greater than the level of forecast demand or available supply within any given TAZ.

6.26 This accounts for the fact that several TAZs have a significant amount of vacant residential land, but are likely to have relatively little development demand. An important simplifying assumption implicit in this approach is that in some cases the entire increase in TAZ population takes place within the alignment catchment area. This approach also takes into account the three TAZs where the total population is expected to decline.

6.27 Using this approach, it is estimated that the A-Line LRT catchment area is likely to generate around 1,500 new residential developments, which could accommodate around 3,600 people. The BRT alignment could generate around 650 new residential developments which could accommodate around 1,600 people. Table 6.3 summarises the potential residential property impact of the LRT & BRT alignments.

TABLE 6.3 POTENTIAL RESIDENTIAL DEVELOPMENT – CAPACITY AND ESTIMATES

	LRT			BRT		
Capacity / Estimate	**Land (HA)**	**Units**	**People**	**Land (HA)**	**Units**	**People**
Vacant Residential	31	2,524	6,311	20	1,635	4,087
Vacant "Population"	33	2,714	6,784	22	1,816	4,540
Actual Development Estimate	**20**	**1,460**	**3,650**	**10**	**652**	**1,631**

6.28 The table illustrates that there is a potential for higher density development in the TAZs within the RT catchment areas than envisaged in the growth assumptions. This may be due a potential mismatch between land supply and demand in many TAZs as, for example, zone 2647 and 2646 near Twenty Road (see Appendix A), both have an excess of development demand over supply of 5,000 units. If this demand is to be met it will require either a significant intensification of the vacant land within the catchment area or some development outside of the catchment area. Overall, there is a potential misallocation of demand and supply equating to around 33,000 units across all TAZs in both LRT and BRT options. There is therefore significant scope to intensify and refocus future development towards areas of vacant land supply within the catchment area and increase building density in areas of excess demand. Such an approach would further strengthen the case for RT.

Vacant Commercial Land

6.29 Table 6.2 shows the extent of vacant commercial properties within the LRT and BRT catchment areas, as well as industrial and institutional units.

6.30 Overall, vacant land within the LRT alignment catchment area could potentially accommodate around 3,200 new jobs, whereas the BRT alignment catchment area could accommodate a total of 1,800 new jobs. Table 6.4 summarises the potential employment development capacity for each alignment.

TABLE 6.4 POTENTIAL EMPLOYMENT LAND & JOBS – CAPACITY ESTIMATE

	LRT		BRT	
	Land (HA)	**Jobs**	**Land (HA)**	**Jobs**
Office	6	1,254	2	346
Retail	8	669	2	185
Industrial	42	1,249	41	1,222
Institutional	0.2	14	0.2	14
Total	**56**	**3,187**	**45**	**1,768**

6.31 The major difference between the LRT and BRT alignment is the greater availability of vacant commercial space located near to the Twenty Road stop in the LRT option. The greater radius of impact in the LRT option provides over 8 hectares of employment land over the BRT option.

6.32 By far the largest area of potential employment in both options is within TAZ 2649 which contains the airport (see Appendix A). This area contains over 37 hectares of employment land most of which is industrial space.

6.33 The DCMI Scenario for the entire study area assumes there is a 44,000 increase in employment between 2011 and 2031. This increase is likely to be dispersed throughout the study area.

6.34 In order to take account of the actual demand for employment land within the study area the employment land supply with the DCMI scenario employment forecasts have been equalised within each TAZ. This ensures that development only takes place where there is a suitable level of supply and demand.

6.35 Using this approach, every TAZ has a potential excess of employment demand over employment supply. As a result, it has been estimated that all vacant employment land will be utilised by 2031 based on existing forecasts for the study area. This implies that there could be significant scope for increasing the density of employment land and the estimates are therefore likely to be conservative. Zones 2524, 2646, 2577 and 3045 (see Appendix A) in particular have a large excess of employment demand over vacant employment land supply. Catering for this excess demand through revisions to the growth allocations / density would further strengthen the case for RT.

Development Charges

6.36 Hamilton levies a development charge which is used to "recover the growth related costs associated with the capital infrastructure needed to service new development" (City of Hamilton 2011). The charge is used to fund a variety of services within the city including transit projects.

6.37 Residential charges are made on a unit basis depending on the type of property. Commercial and Industrial space is charged per square foot. The level of charge applied to new developments is shown in Table 6.5. The table shows the Urban Area Charge and the Municipal Wide charge, including the portion of this which is specifically earmarked for Transit funding.

TABLE 6.5 HAMILTON DEVELOPMENT CHARGE RATES ($)

	Single-Detached Dwelling	Apartment (2+ bdrms)	Apartment (1-bdrm)	Townhouse	Residential Facility	Non-Residential
	Per Unit	Per Unit	Per Unit	Per Unit	Per Bdrm	Per Ft^2
Urban Area Charge	17,110	10,599	7,066	12,264	5,552	7.75
Municipal Wide Charge	9,817	6,027	4,028	7,036	2,897	7.44
hypothecated to Transit	*218*	*116*	*77*	*134*	*56*	*0.23*
Total Charges	**26,927**	**16,626**	**11,094**	**19,300**	**8,449**	**15**

Source: (City of Hamilton 2011)

6.38 The application of Development Charges to new developments is uniform across the city with the following exceptions:

- Additional fees are charged in three areas: Binbrook, Dundas & Waterdown
- The Urban Area charge is not applied in rural areas
- Charges are not applied in the Downtown area within the boundaries of Queen, Cannon, Victoria and Hunter. This broadly corresponds to TAZs 2513-2516, 2520 and 2521 (see Appendix A)

6.39 Overall the LRT project could generate a total of $86m in development charges by 2031. Only $1.4m of this could be hypothecated towards transit funding under current arrangements. The BRT project could generate a total of $69m in development charges by 2031. Only $1.1m of this could be hypothecated towards transit funding under current arrangements. Appendix C shows how these charges have been calculated.

6.40 In addition, the project is likely to refocus new development on high density brownfield sites within the core of the city. This will reduce the cost of providing new services and infrastructure to green field building. There is also significant evidence that denser, more urbanised developments are more sustainable in terms of transportation and energy demands and this will reduce the on-going infrastructure costs for the city (see Appendix C).

Tax Impacts

6.41 In addition to development charges, the redevelopment of vacant property could provide a significant source of additional revenue from annual property taxes. As part of this study it has been estimated that around 1,500 new residential developments could be created by 2031 with the LRT option and 650 with the BRT option. It has also been estimated that around 56 hectares of employment land would be redeveloped in the LRT option and 45 in the BRT option.

6.42 This newly developed property will become liable for property tax and generate a significant amount of revenue for the city, based on current tax rates and the assumption that the newly developed properties achieve the average property value in the rest of the study area.

6.43 The LRT option could generate $5.0m per year in additional property taxes. The BRT option could generate $3.5m per year. Over half of this revenue is from commercial property taxes in both options.

Land Value Uplift

6.44 Transportation projects affect land values through several mechanisms that cause properties located near to transit hubs to often enjoy a significant price premium. This effect can be principally attributed to the lower access costs of such locations, which enable large travel ‘catchment’ areas and make such locations valuable for many different uses. Similarly, transport projects can also increase the accessibility and availability of unused land, which can encourage new development.

6.45 Quantifying the actual link between transport and land values is difficult as the relationship is dependent upon numerous factors including market conditions, the demand and supply for individual properties, and institutional factors such as planning and tax regulations. Nevertheless, there are numerous studies which have sought to quantify the effect. The following provides a summary of some of this literature:

- In London, UK, the impact of the $5.4bn Jubilee line extension linking Canary Wharf to the Underground (subway) network was evaluated by (Geofutures & Atis Real 2005). The authors found that the project resulted in an aggregate increase in property values of more than $3bn, the vast majority of which is a result of new builds occurring in response to increased accessibility, primarily at Canary Wharf.
- (Debrezion, Pels and Rietveld 2007) carried out a meta-analysis of North American transit-land value literature. The results suggest that typically, moving 250 metres closer to a transit station increases residential property values by around 2.4%. The impact on commercial values is estimated to be lower, at 0.1%.
- A study by (Parsons Brinkerhoff 2001) carried out a literature review of transit property market studies finding that residential property impacts vary from $0.2 to

$32.0 per metre from the station, with an average impact of $6.75 per metre from the station. The study also notes that there is strong evidence of negative impacts in the short term as 'planning blight' and construction impacts affect residential and commercial activities.

- A study by (Cerveris 1995) estimated that residential properties located near to BART stations in San Francisco have a 10-15% rent premium in values per square foot.

6.46 The empirical evidence clearly supports the theory that transit projects can provide a positive land value impact for the areas immediately surrounding a transit station or stop. However, many of these studies do not account for the potential 'displacement' of such impacts from other areas. This effect is very difficult to analyse as property prices tend to be 'sticky'[12] in the short term. It is likely that positive land value impacts are at least partially offset by declines in property values elsewhere within a city as demand is redistributed toward transit locations[13]. This means that at a regional level the impact may be slightly less than estimated in this report.

The Distribution of Land Value Impacts

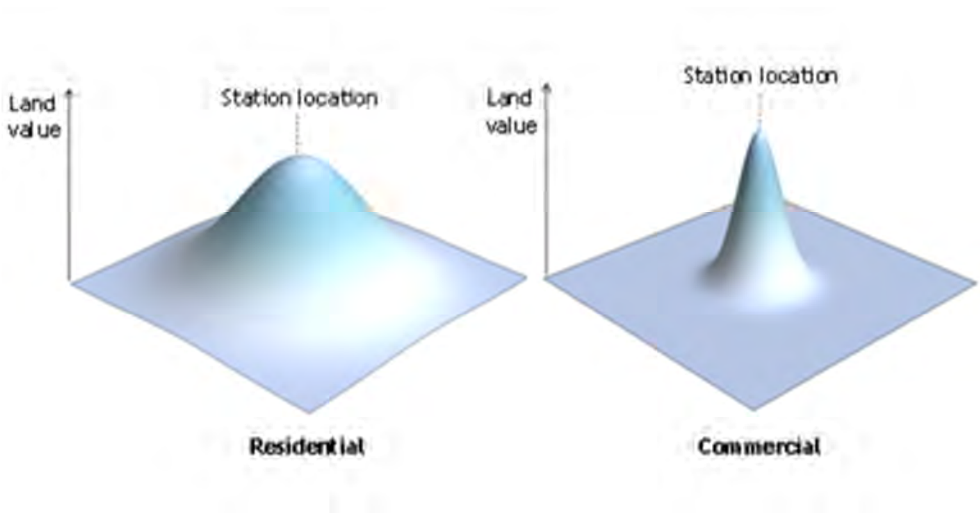
6.47 The distribution of land value impacts is variable across different types of land use. The uplift impact of transit for residential property occurs principally through increased accessibility and reduced commuting costs. This means that the impact tends to decline constantly with distance from the station.

6.48 For commercial properties, and retail premises in particular, the value of transit is related to the increased visibility, catchment and footfall that locations near to a transit stop or station enjoy. Because footfall declines exponentially with distance, the commercial property market impact also tends to decline in a more exponential way. The effect is illustrated in Figure 6.5.

[12] 'Sticky' prices adjust slowly to changes in demand or supply. In the property market prices tend to be slow to adjust downwards. This effect occurs for several reasons including the risk of negative equity for home owners and optimism bias about future prices. Commercial contracts also tend to last over several years meaning that an increase in value is often not immediately reflected in rental values. For reference see (Mankiw 1991) or (Carlton 1987).

[13] Based on a theoretical relationship between supply and demand

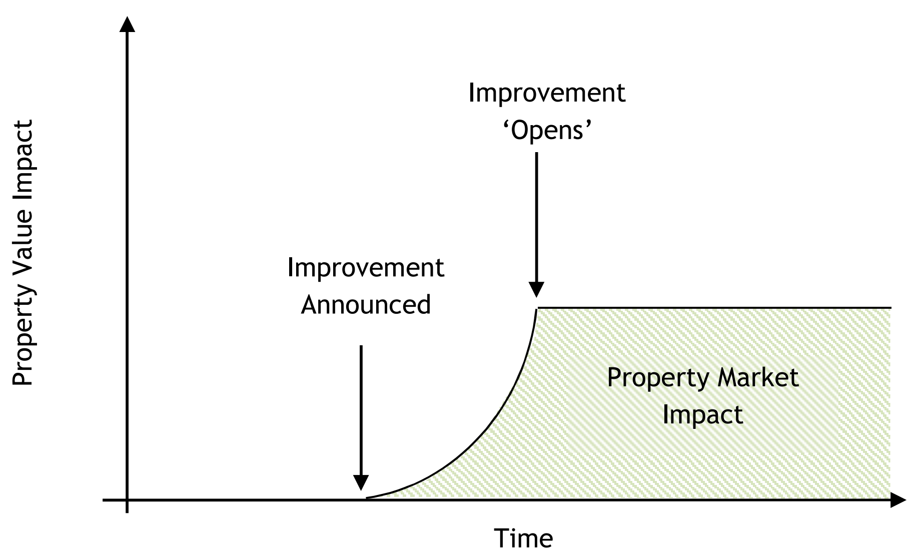
FIGURE 6.5 ILLUSTRATION OF PROPERTY MARKET IMPACTS



Source: Steer Davies Gleave

6.49 In theory, assuming the effects of a transport project is correctly anticipated, any uplift in property values is likely to begin following the announcement of the improvement and be fully realised upon opening. This means that the timing of the property impact is complex, potentially taking place over several years as the project nears completion. The fact that building leases are normally made across multiple years adds an additional complication. The effect is illustrated in Figure 6.6.

FIGURE 6.6 PROPERTY MARKET IMPACT TIMING



Source: Steer Davies Gleave

6.50 The structure of the commercial property market also makes the impacts more difficult to isolate. Unlike the residential market which is generally highly liquid, the commercial property market tends to be 'lumpy' with a few large buyers and sellers who often negotiate rent values over multi year periods. This means that the impact of a transport project may not become apparent in prices and rent levels for several years after the project.

A-Line Property Market Impacts

6.51 The City of Hamilton has a comprehensive land parcel inventory that contains information on every parcel of land in the city, including information on its use, total area, and rateable value. The inventory also provides a list of available vacant land within the city.

6.52 This data has been used to estimate the property value and development impact of the proposed A-Line using a bespoke Land Use and Development model. This model is based on GIS analysis of the parcel inventory and route alignments and uses a similar set of assumptions as used to estimate the impact for the B-Line RT (IBI Group 2009).

6.53 This approach ensures that a consistent and comparable estimate of the impact of A-Line RT is made based on a robust, traceable, and spatially detailed methodology. The assumptions used in the analysis are described in the following points:

- The impacts of the RT system are assumed to only occur within a 500m catchment area of the LRT and a 400m catchment area of the BRT alignment. This reflects the higher quality perceptions of the LRT. The proximity of stations means that this generates an almost continuous impact area. It has been assumed that there will be no impact outside of this area.
- The impacts will fall between a 'low' and 'high' impact scenario representing the minimum and maximum likely impact based on the available evidence from other studies.
- There are no displacement effects as a result of the project.
- The RT system has no impact on the total level of population and employment growth, only the distribution of that growth within each TAZ.
- Population, employment and development estimates are demand and supply constrained within each TAZ. This means that the level of development cannot exceed the demand for, or supply of, land in any area.

6.54 Based on the City of Hamilton Municipal Property Assessment data, there are 7,300 properties located within the LRT catchment area, which are worth a total $2.6Bn in rateable value. There are 5,000 properties within the BRT catchment area, which are worth a total $2.2Bn in rateable value. The property values are from the 2010 tax valuation and accordingly the price base for the analysis is 2010.

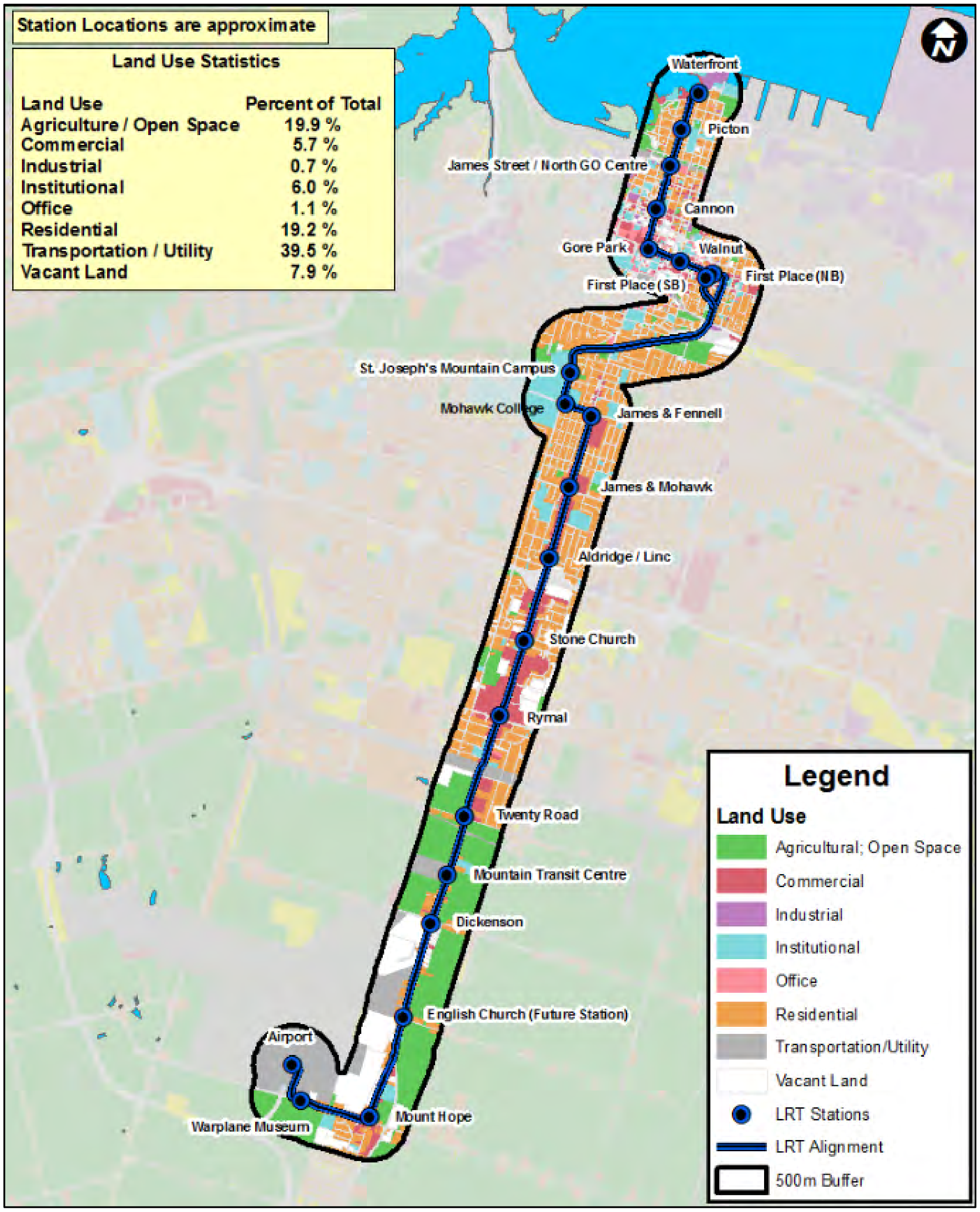
6.55 Table 6.6 provides a summary of the property supply and value within the LRT and BRT catchment areas.

TABLE 6.6 A-LINE PROPERTY WITHIN THE CATCHMENT AREA

	LRT			BRT		
	Properties	Land (HA)	Value ($m)	Properties	Land (HA)	Value ($m)
Residential	6,266	348	1,386	4,157	255	1,105
Commercial	655	141	696	494	121	619
Institutional	179	144	400	129	137	459
Industrial	37	18	20	27	12	15
Agricultural	17	241	6	16	238	5
Open Space	56	260	39	44	217	26
Vacant-Residential	95	30	18	79	19	13
Vacant-Commercial	77	14	13	37	4	9
Vacant-Other	0	0	0	0	0	0
Total	**7,382**	**1,196**	**2,578**	**4,983**	**1,004**	**2,249**

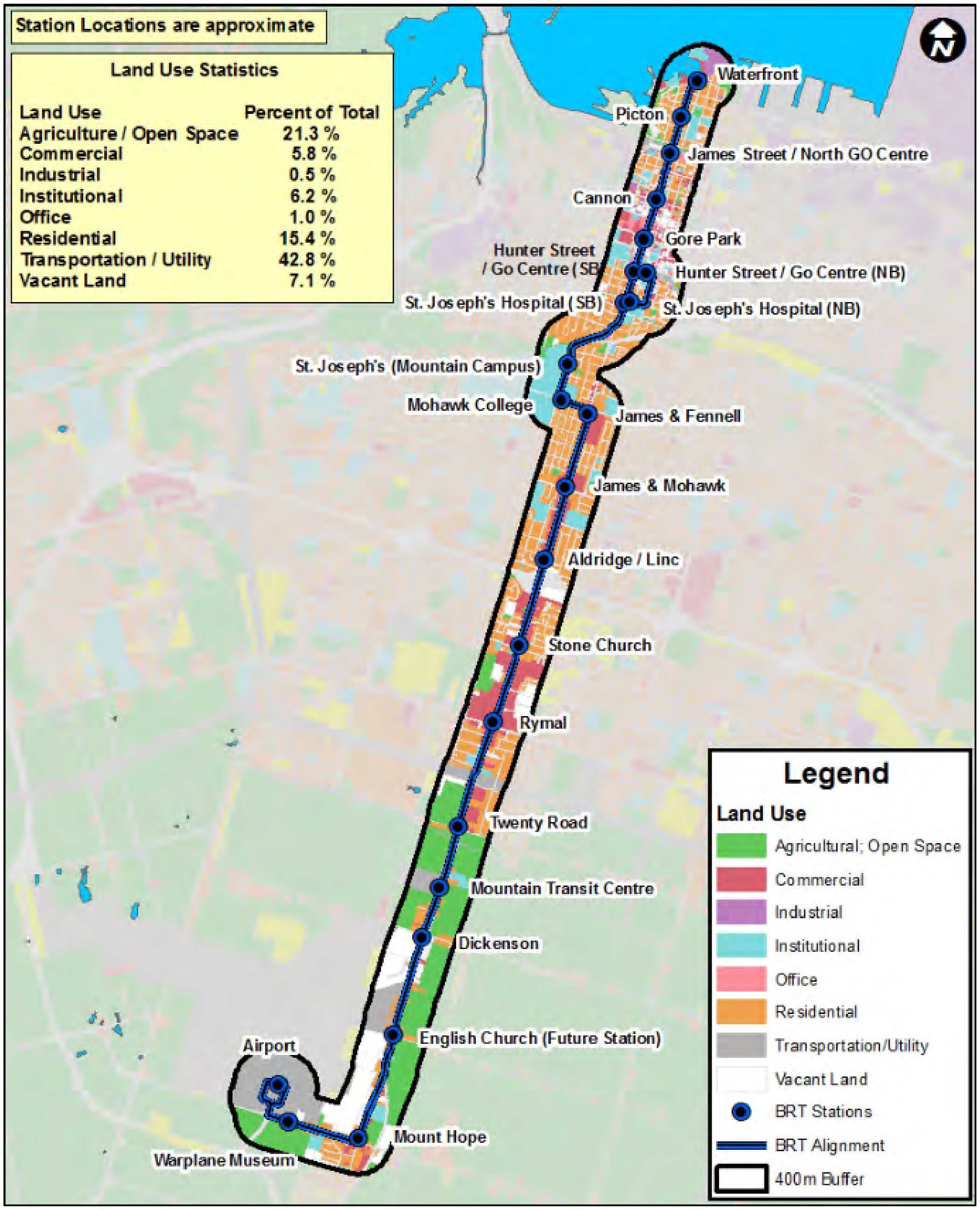
6.56 Dickenson, Mount Hope and English Church stops each have a significant supply of vacant land within a 500m radius (39, 36 and 23 hectares respectively). This pattern can be seen in Figure 6.7 and Figure 6.8, which show the land use patterns surrounding the station areas within each catchment area.

FIGURE 6.7 CURRENT LAND USE WITHIN THE LRT CATCHMENT AREA



Source: Steer Davies Gleave – data from City of Hamilton

FIGURE 6.8 CURRENT LAND USE WITHIN THE BRT CATCHMENT AREA



Source: Steer Davies Gleave – data from City of Hamilton

6.57 As discussed earlier, there is a significant amount of evidence that suggests that a RT project could generate an uplift impact on the overall values of the properties within the study area in the long term. A property market uplift has been applied to estimate this effect based on the assumptions used to estimate the property market impact for the B-Line (Metropolitan Knowledge International 2009). This report provides a range of upper and lower impacts across different types of property based on a literature review of 150 transit evaluationstudies. Table 6.7 summarises these impact assumptions.

TABLE 6.7 PROPERTY VALUE IMPACT ASSUMPTIONS

	LRT Value Uplift		BRT Value Uplift	
Land Use / Scenario	**Low**	**High**	**Low**	**High**
Commercial	2%	4%	2%	4%
Residential	2%	4%	1%	2%
Office	2%	4%	2%	4%
Vacant-Residential	4%	6%	1%	7%
Vacant-Commercial	8%	14%	2%	6%

Source: (IBI Group 2009)

6.58 Based on these assumptions it is estimated that the LRT option would generate a total property market uplift of between $43m and $86m on 2010 property values by 2031. The BRT option could generate a total property market impact of between $24m and $48m. These impacts are summarised in Table 6.8.

TABLE 6.8 PROPERTY MARKET UPLIFT($M)

	LRT		BRT	
Land Use / Scenario	**Low**	**High**	**Low**	**High**
Commercial	13.9	27.8	12.4	24.7
Residential	27.7	55.4	11.0	22.1
Vacant-Residential	0.7	1.1	0.1	0.9
Vacant-Commercial	1.1	1.9	0.2	0.5
Total	**43.4**	**86.2**	**23.7**	**48.2**

6.59 LRT has a much greater impact on property values than BRT, primarily because of its larger assumed catchment area, and also because the LRT uplift effect is significantly higher for vacant commercial properties. The most significant impact occurs around Gore Park stop which accounts for around 18% of the total impact in the LRT option and 24% in the BRT option due to the large amount of commercial and office space surrounding this location.

6.60 Changes in property prices are highly dependent on the wider economic environment, including interest rates, economic growth and inflation. These forecasts should therefore be considered as relative to the average rather than in absolute terms. Furthermore, the land use impact is dependent on numerous factors including the change in transport accessibility, quality of the station or stop and any urban fabric improvements, and therefore the level of impact is dependent on the design of the project.

6.61 This increase in property values could be realised through property taxes; however, this would require the city to explicitly choose to increase the overall tax take. At the current tax take, the higher property values around the stops would create greater returns from the corridor and decrease the tax burden on properties further from the alignment.

Summary

6.62 The following table summarises the land use and urban development impacts of the A-Line RT project, comparing the LRT and BRT options. The table shows that the impacts of the LRT alignment range from 24% to 124% above those of the BRT.

TABLE 6.9 SUMMARY LAND USE AND URBAN DEVELOPMENT IMPACTS

Item	LRT	BRT	Diff (L-B)	+ LRT%
Vacant population land within catchment areas (HA)	33	22	11	50.0%
Vacant employment land within catchment areas (HA)	56	45	11	24.4%
Actual development units estimate (#)	1,460	652	808	50.0%
Total residential development charges ($m)	12.3	5.5	6.8	123.8%
Total commercial development charges ($m)	86.0	69.3	16.7	24.0%
Component hypothecated to transit ($m)	*1.4*	*1.1*	*0.3*	*27.4%*
Land value uplift (Low) ($m)	43	24	18	72.0%
Land value uplift (High) ($m)	86	48	38	79.2%
Annual property tax impacts from new developments ($m pa)	5.0	3.5	1.5	42.9%

7 Economic Development Account

7.1 The Economic Development Account examines the potential impact that the construction and operation of LRT/BRT could have on economic activity within Ontario and the City of Hamilton. Spending on new track, construction, equipment and labour to build and operate the RT system will have a significant impact on economic activity on the demand side of the economy, whereas wider impacts, such as agglomeration, labour supply and imperfect competition benefits, impact the supply side.

Supply Side Impacts

7.2 On the supply side, the project could lead to significant impacts on business and labour productivity (agglomeration), increased labour supply, and imperfect competition benefits, which will directly increase employment, output and GDP throughout the province. These effects are known as 'wider economic impacts' and are typically estimated to generate productivity benefits proportional to between 5% and 56% of 'standard' economic benefits for major transport projects, such as RT. Table 7.1 provides a list of projects showing the level of agglomeration, labour supply and imperfect competition impacts for a range of public transportation projects evaluated by Steer Davies Gleave in the recent past.

7.3 Agglomeration, labour supply and imperfect competition impacts are not yet part of the established appraisal framework within Canada and the evidence does not currently exist to estimate the impacts reliably. However these effects are becoming widely recognised internationally, now forming part of official guidance in the UK, Australia and New Zealand. The theory remains valid for Canada and the effect is likely to be positive and significant in this case. These supply side impacts are described in detail below.

Agglomeration

7.4 There is a significant body of evidence to show that businesses that operate in denser economic environments tend to be more productive (Department for Transport (UK) 2009), (Graham 2006) (Baldwin 2008). This effect is apparent in the formation of business clusters, for example, which 'agglomerate' in an area to take advantage of co-location benefits in business parks and 'incubator units', and is the fundamental reason for the existence, success and growth of cities throughout the world. Transportation is a critical factor in the determination of the effective density of an area, and good transportation links can increase the productivity of firms by expanding their access to a range of shared inputs and outputs, including labour, suppliers and customers.

7.5 The location of the A-Line running directly through the downtown area of a major city means that it has the potential to significantly increase the economic density of the city and deliver productivity benefits for the businesses that operate there by reducing the effective distances between them.

7.6 Major city transportation projects typically produce the highest impact as they tend to have a significant effect on business accessibility. For example the London Crossrail project, which will provide an east-west rail link through the UK capital, is expected to generate a 44% productivity uplift (on conventionally measured benefits). The A-Line project provides a north-south RT link from the airport to the Downtown area of Hamilton and on to the waterfront, and on this basis it is expected that the project would provide at least the median average uplift of 22% on conventionally measured benefits.

Labour supply

7.7 By reducing the time and cost of commuting to work, transportation projects effectively increase the real wage of employees by reducing the fixed cost of commuting. This can result in a significant increase in labour supply, as for example, those at the margins of participation in the workforce decide to re-enter employment as a result of the improved access to employment opportunities or reduced access costs. This impact has numerous benefits for the individual and an important tax externality. Labour market impacts are not always positive and transportation projects are typically shown to generate labour supply impacts of between -2% to 22% of conventionally measured benefits.

7.8 Labour supply impacts are highest for projects which deliver significant time saving benefits to commuters, increasing the mobility of workers and potential workers. The median labour supply impact is worth 2% of conventionally measured benefits and the A-Line project could reasonably be expected to generate this level of impact.

Imperfect Competition

7.9 Standard cost benefit analysis is based on assumptions of perfect competition which are a simplification of the structure of the economy. It can be shown by adopting a more realistic monopolistic competition model that there are additional 'imperfect competition' benefits related to the undersupply of goods. This impact is directly related to the business cost saving impacts of a transportation project and typically generates an uplift of around 3% on conventionally measured benefits.

7.10 Assuming the project achieves the median uplift from the benchmark analysis, the total wider economic benefits of LRT could equal $215m in total over the 30 year appraisal period. For BRT the equivalent figure is $141m.

TABLE 7.1 WIDER ECONOMIC IMPACT PROJECT EXAMPLES

Type of Project	Location	Project	Agglomeration	Imperfect Competition	Labour Market	Total Additionality
Rail	Major City	Crossrail, London	24%	4%	28%	56%
HSR	Interurban	High Speed Line London Birmingham	44%	8%	0%	52%
Road	Conurbation	Leeds to Bradford Improved Highways Connections	30%	6%	5%	41%
Road	Conurbation	Leeds Urban Area Highway Improvements	31%	5%	3%	39%
Mixed	Major City	Melbourne East West Road and Rail Package (Australia)	22%	2%	6%	30%
Rail	Major City	Airtrack, London - Heathrow	26%	2%	1%	29%
Road	Interurban	Leeds to Sheffield Highways Improvements	24%	6%	-2%	28%
HSR	Interurban	HSL Lisbon Porto (Portugal)	18%	8%	0%	26%
HSR	Interurban	HSL Y-Line London - Manchester and Leeds	18%	7%	0%	25%
Bus	Conurbation	Leeds to Bradford PT Improvements	18%	3%	2%	23%
HSR	Interurban	HSL London - Scotland (West Coast)	14%	8%	0%	22%
Rail	Major City	Cross River Rail, Brisbane (Australia)	16%	0%	5%	21%
Road	Interurban	A46 Interurban Road, East Midlands Region	13%	6%	1%	20%
Mixed	Conurbation	Victoria Transportation Plan Package (Australia)	17%	1%	1%	19%
Bus	Urban	Intra Leeds Bus Fare Reduction and Frequency	13%	2%	2%	18%
Road	Interurban	M6 Shoulder, West Midlands Region	11%	5%	0%	17%
Rail	Major City	Melbourne East West Rail Package (Australia)	14%	1%	2%	16%
PT	Conurbation	Leeds Urban Area Major PT Investment	11%	3%	2%	16%
Bus	Area Wide	W Yorkshire Bus Fares and Frequency	10%	2%	2%	15%
Bus	Area Wide	South and West Yorkshire Bus Fares and Frequency	8%	3%	2%	12%
Bus	Area Wide	South Yorkshire Bus Fares and Frequency	3%	3%	0%	5%

Source: Steer Davies Gleave

Demand Side Impacts

7.11 On the demand side, the construction and operation of the project will result in a significant increase in spending and economic activity in Hamilton and the province of Ontario. There are three levels of demand side economic impact that relate to how expenditure 'ripples though' the economy to provide an overall estimate of end state economic activity that results from an economic stimulus, such as a major construction project. These three levels are:

- **Direct impacts** – relating to the direct spending and employment created in each industry (i.e. on-site construction jobs during the construction phase, rolling stock manufacturing jobs etc), or operational jobs over the life of the project.
- **Indirect impacts -** relating to the spending and employment created in other industries further down the supply chain in order to produce the materials (goods) and other inputs (services) necessary for the direct inputs to the project.
- **Induced impacts -** relating to the additional spending impact generated by the **direct** and **indirect** impacts from higher wages and employment for example.

7.12 The combination of the direct, indirect and induced impacts of the project represents the **Total Economic Impact**. This is measured by business output (sales), value added (gross regional product), employment (number of jobs), and labour income (earnings)[14].

Methodology

7.13 The methodology used to estimate the economic impacts of the A-Line is consistent with that employed for the B-Line Economic Potential Study (IBI Group 2009), whereby direct and indirect impacts are estimated on the basis of scheme costs modelled as a spending stimulus within the Statistics Canada Interprovincial Input-Output Model (SCIPIOM). This model is operated by Statistics Canada and is based upon the Canadian system of Canadian National Accounts.

7.14 The direct and indirect impacts generate additional induced impacts through the increase in employment, and associated spending. A full explanation of the methodology used to estimate the economic impacts of the project is provided in Appendix D, which also presents the outputs of the model based on early-stage costs.

7.15 Retail spending has also been estimated as a proportion of total new consumer spending, which is in turn driven by the increase in employment and wages generated by the project. Data on existing consumption patterns has been used to estimate the final incidence on retail demand.

[14] These measures of economic impact represent only the incidence of spending and not the actual economic value of the project. In order to make this judgement, the spending impact needs to be compared against the counter-factual impact of reduced taxation or alternative spending, which could generate a similar economic return.

Project Costs

7.16 The direct impact of both the LRT and BRT options have been estimated on the basis of the expenditures required to deliver the scheme. A benchmarking approach has been used to develop cost estimates for both options based on a detailed consideration of the route alignment, length and number of stops, as well as the quality of the design.

7.17 The SCIPIOM work was commissioned at an early stage in project development and therefore used early stage capital and operating costs. These costs have since been revised and the model outputs have been revisited and recalculated to reflect this.

7.18 The total estimated costs of the LRT project is $706.1m in 2010 prices. Within the national account categories most of the spending for the LRT option is assumed to accrue to the Road, Highway and Airport Construction sector, followed by Other Professional, Scientific and Technical Services related to the design and management of the project. Other expenditures are made on Computer Systems Design, Urban Transit Rolling Stock and Real Estate.

7.19 The total capital cost of the BRT project is $244.1m (35% of the assumed LRT cost). The BRT option is intended to be high quality and have a similar cost structure to LRT. The only significant proportional difference between BRT and LRT costs is in the level of systems and track related costs, which are significantly higher for the LRT project.

7.20 In each case, the percentage of spending assumed to accrue to Ontario is based on an assessment of the likely balance of domestic and 'foreign' (outside Ontario) spending. For example construction is likely to be granted mainly to local suppliers, however, more technically complex components, such as vehicles and systems, may need to be purchased from outside the Province. As in the B-Line report (IBI Group 2009), it has been assumed that 25% of expenditure on vehicles will accrue to Ontario.

7.21 The operating costs of the project were estimated by benchmarking against similar projects using a per kilometre rate to estimate labour, electrical, maintenance and overhead costs. In addition, the costs reflect the required number of vehicles (28 for BRT and 17 for LRT).

7.22 For LRT, the net operating costs are equal to $11.7m per annum in 2031 (2011 prices). The majority of these costs relate to the labour required to operate the system. For BRT, the net operating costs are equal to $14.7m per annum (125% of LRT costs). As with LRT the majority of these costs relate to the labour required to operate the system. All operating costs are assumed to accrue to Ontario, therefore the modelled stimulus is the same as the total cost.

Direct, Indirect and Induced Impacts

7.23 Table 7.2 and Table 7.3 provide a summary of the direct, indirect and induced impact of the LRT and BRT options in terms of output, GDP and jobs - direct, indirect and induced economic impacts.

TABLE 7.2 SUMMARY OF CONSTRUCTION IMPACTS

	LRT			BRT		
Impact	Direct	Indirect	Induced	Direct	Indirect	Induced
GDP ($m)	153.4	98.3	79.8	53.0	34.4	27.6
FTEs	2,032	1,106	856	702	382	296
Output ($m)	542.5			187.5		

7.24 In total, the LRT construction stimulus could generate around $331m in total GDP impacts and 3,994 FTE job years over the construction period. Based on the applied assumptions the BRT construction stimulus is likely to generate a total GDP impact of $115m in total and 1,380 FTE job years. The LRT and BRT scenarios are likely to generate around $543m and $188m in additional cumulative output respectively. Overall, LRT is expected to generate around three times the level of construction stimulus of BRT.

TABLE 7.3 SUMMARY OF OPERATING IMPACTS

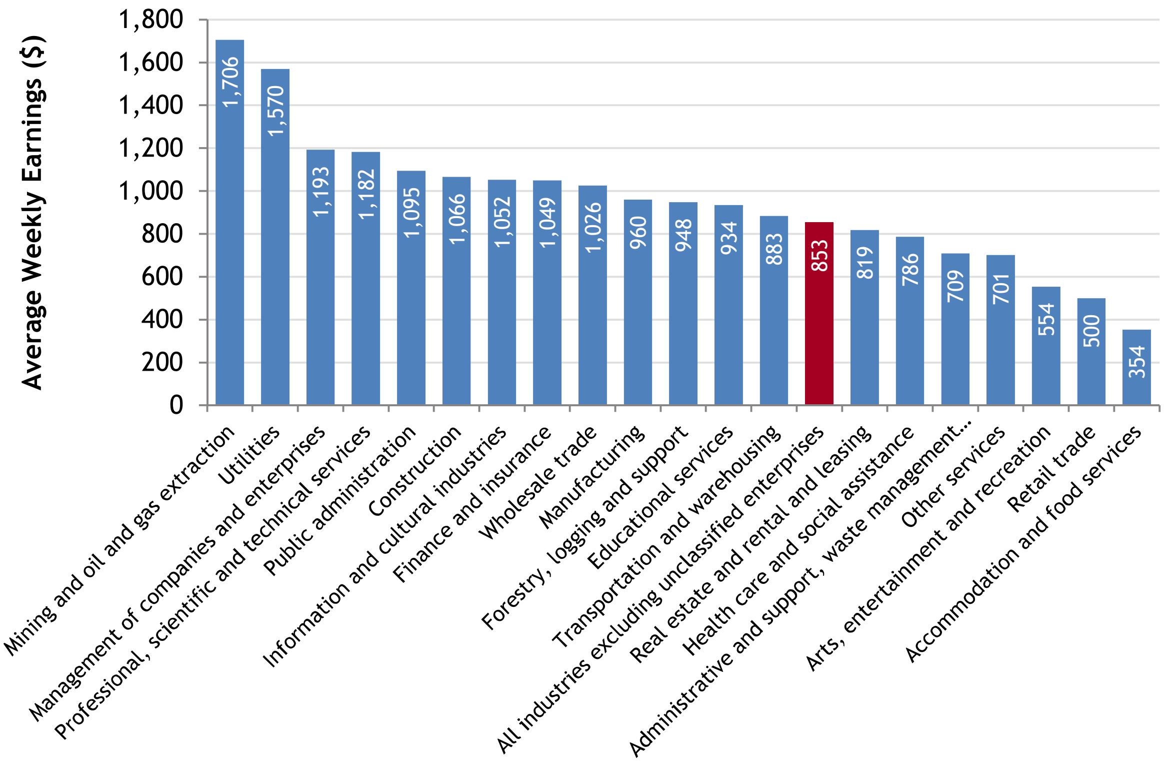
	LRT			BRT		
Impact	Direct	Indirect	Induced	Direct	Indirect	Induced
GDP ($m)	0.0	17.0	3.3	0	21.3	4.1
FTEs	0	171	46	0	215	58
Output ($m)	18.3			22.9		

7.25 The LRT operating stimulus is likely to generate around $20m per year in total GDP impacts and sustain 217 FTE jobs. The BRT operating stimulus is likely to generate $25m per year in GDP and sustain 273 FTE jobs. This is because the economic impact is directly related to the level of project spend and BRT operations cost 25% more than LRT. The LRT and BRT scenarios are likely to generate around $18m and $23m in additional output respectively.

Retail Impacts

7.26 The employment generated by the project will create further increases in spending as a result of the wage payments accruing to Ontario and Hamilton. Figure 7.1 shows average weekly earnings in Ontario across different sectors in 2010. The average wage across all classified industries is $853 per week and is highlighted in red.

FIGURE 7.1 AVERAGE WEEKLY EARNINGS BY INDUSTRY (2010)



Source: SDG estimates based on (Statistics Canada 2010)

7.27 The employment related ‘induced’ spending generated by each impact has been estimated by multiplying the new employment by the average earnings in each sector. Using this method, we estimate that the LRT construction stimulus will generate $178m[15] in cumulative spending over the construction period and the LRT operating stimulus will generate $10m in annual spending. Based on data on individual spending patterns, this spending impact has been distributed across different categories of expenditure using data from Statistics Canada. Table 7.4 provides an estimate of the LRT option induced spending impact across different sectors.

[15] Average weekly wage ($853) x weeks in a year (52.2) x additional FTE job years (3,994)

TABLE 7.4 LRT RETAIL SPENDING IMPACT

	Proportion of Spending	Construction Spending ($k)	Operation Spending ($k)
Total Expenditure	**100.00%**	177,732	9,688
Food	9.50%	16,906	920
Shelter	20.30%	36,114	1,967
Household Operation	5.00%	8,875	484
Transportation	13.50%	23,906	1,308
Health care	2.20%	3,987	213
Personal care	1.70%	3,003	165
Recreation	4.90%	8,685	475
Reading materials and other printed matter	0.30%	580	29
Education	2.00%	3,600	194
Tobacco and alcohol	1.80%	3,263	174
Total Consumption	**70.00%**	**124,339**	**6,781**
Personal Tax	**21.10%**	**37,444**	**2,044**
Personal Insurance	6.30%	11,156	610
Gifts	2.70%	4,793	262

Source: (Statistics Canada 2009)

7.28 The table shows that the LRT construction impact will generate a cumulative increase in consumption of $124.3m over the construction period. The impact will also generate $37.4m in personal tax receipts. BRT impacts can be assumed to be approximately 35% of the modelled LRT impact, which equates to a $43.5m cumulative increase in consumption over the construction period and $13.1m generated in personal tax receipts.

7.29 The LRT operating impact will generate an on-going increase in consumption of $6.8m per year. The stimulus will also generate $2.0m per year in personal tax receipts. BRT impacts can be assumed to be 125% of the modelled LRT impact, which equates to an $8.5m increase in consumption per year and $2.5m in personal tax receipts.

Tourism Impacts

7.30 Conventions and sporting events are the largest generators for tourism in Hamilton with 21,210 room-nights occupied by convention attendees in 2010 and 19,860 room-nights occupied for those attending sporting events. Hamilton's cultural attractions, art galleries and museums continue to be major tourist attractions[16].

7.31 Table 7.4 shows that the project is likely to result in a significant increase in consumer spending, including higher recreation expenditure. The LRT option is likely to generate an annual $475,000 on-going increase in recreation spending, which will increase the level of patronage and revenue for the city's retail, tourism and leisure destinations.

7.32 In the case of Hamilton, the main tourism impacts of RT would be a higher volume of visitors at destinations along the BRT/LRT route. Key sites include:

- Hamilton Farmer's Market
- Hamilton Convention Centre
- Art Gallery of Hamilton
- Hamilton Place Theatre
- Copps Coliseum
- Hamilton Waterfront (including HCMS Haida National Historic Site)
- Canadian Warplane Heritage Museum
- Hamilton Civic Museums
- Canadian Football Hall of Fame & Museum

7.33 In addition, there are several important retail and cultural destinations along the alignment that are likely to gain from increased accessibility and higher levels of patronage. These include:

- **Shopping/Retail -** e.g Hamilton City Centre, Jackson Square, Hamilton South Shopping Centre, Downtown Hamilton BIA (350 businesses; 40,000 employees)
- **Public Institutions/Civic Uses** - e.g. St. Joseph's Healthcare Centre (Charlton), St. Joseph's Hospital (mountain), Hamilton Public Library, Mohawk College, Laurel College
- **Major Employers/Places of Employment - e**.g. John C. Munro Hamilton International Airport (1,126 person-years of direct employment annually[17], Canada's largest dedicated courier/cargo airport[18]), Airport Employment Growth

[16] Tourism Hamilton (2011). "2011 Marketing Plan: Focusing our Efforts". http://www.tourismhamilton.com/insideTourHam.php?category=6

[17] Hamilton International Airport (2010), 2010 Annual Report, http://www.flyhi.ca/news-and-media/press-releases/hamilton-international-airport-2010-annual-report/

[18] http://www.flyhi.ca/airport-information/facts/

District (future), Bayfront Industrial Area, Stelco Tower, Standard Life Building, downtown Hamilton.

- **Tourist Attractions/Amenities -** e.g. Bayfront Park, Eastview Park, Dr. William Bethune Park, and those along the A-Line corridor (paragraph 7.32).

7.34 In addition to this demand impact, the RT project could play an important role in increasing the attractiveness of Hamilton as a leisure/tourism destination. 3.2 million people visit Hamilton annually and, in 2007, spent approximately $224 million in the city. This provided $7.8 million in municipal taxes and supported 2,400 jobs[19].

7.35 RT can help project an image of modernity and can also be an attractive option for tourists travelling around a city; however, there is limited evidence on the impact of RT projects on tourist activity. The effect of the project on the attractiveness of the city as a tourist destination is therefore intangible. The link between the airport and Downtown could significantly improve the accessibility of the city to potential visitors. However, the evidence that does exist suggests that the primary effect of a RT system would be to increase the accessibility and number of visitors to tourist attractions on the LRT/BRT route, rather than encouraging a net increase in the overall number of tourists.

7.36 It is possible, that the additional accessibility offered by LRT or BRT could enable tourists to visit more attractions within a given period, and hence increase the rate of spending per day. Counter to this, it is also possible that enabling tourists to visit more sites in a day could encourage them to visit all attractions within a shorter period of time, and possibly reduce the number of overnight stays.

[19] Tourism Hamilton (2011). “2011 Marketing Plan: Focusing our Efforts”. http://www.tourismhamilton.com/insideTourHam.php?category=6

Disruption During Construction

7.37 The construction of the LRT or BRT system is likely to take between three to five years, during which time there is likely to be significant disruption to business and economic activity throughout the corridor. Noise, reduced access and the removal of parking are all likely to generate significant adverse impacts on the viability of many businesses, particularly at street level. However, construction impacts will be controlled and will not be corridor-wide for the entire construction period. More specifically, a phased / rolling program and local area access plans will be employed to minimize disruption.

7.38 The land use model shows that there is a particularly high amount of occupied commercial land within the vicinity of the proposed James & Mohawk, James & Fennell and Rymal stops. These areas could see particular high levels of disruption during construction, which could benefit from construction mitigation measures. Potential mitigation could include:

- A phased construction schedule to minimise disruption
- Wayfinding to assist customers to find businesses when traffic and/or pedestrian routes become more circuitous
- Communication and awareness strategies, including:
  - Construction hotline
  - Newsletters & website
  - Advertising and promotional events to clarify the area is still “open for business”
  - Sponsored media and social events
- Financial assistance to affected businesses. These could include low interest loans or the establishment of mitigation funds to provide specific financial assistance.

7.39 These measures have been found to improve rates of business survival in several case studies including the Portland Tri-met transit system and Salt Lake City University Transit system. The measures were found to be particularly effective where they were provided with the assistance of local business representatives (Collins 2007).

Summary

7.40 The expected construction and operating impacts, as well as wider economic benefits, retail and tourism effects are summarised in Table 7.5.

TABLE 7.5 ECONOMIC DEVELOPMENT ACCOUNT SUMMARY

	LRT	BRT
Construction Impact		
GDP ($m)	331.5	115.0
FTEs	3,993	1,380
Output ($m)	542.5	187.5
Operating Impact		
GDP ($m)	20.3	25.5
FTEs	217.5	273.0
Output ($m)	18.3	22.9
Supply-Side Economic Potential ($m)[20]	69.0	39.9
Retail Impact - Construction($m)	124.3	43.5
Retail Impact – Operating ($m p.a.)	6.8	8.5
Tourism Impact	✓✓	✓✓

[20] Assumed to be 22% of conventional transport user business benefits

8 Environmental Account

Introduction

8.1 The Environmental Account looks at the effect of each RT alternative on Greenhouse Gas (GHG) and Criteria Air Contaminant (CAC) emissions in Hamilton and the surrounding region. GHG in particular is a key factor in climate change while CACs affect air quality and cause smog and acid rain. Other wider environmental issues will be assessed within the A-Line Environmental Report, of which this study will be a component.

Key inputs and assumptions

8.2 The evaluation of emissions is predicated on the changes in vehicle kilometres travelled by auto and transit as forecast by the City of Hamilton transportation EMME model and operations model respectively.

8.3 The displacement of traffic as a result of RT on the A-Line is likely to cause an increase in emissions, despite passengers transferring from auto to RT as a result of the enhanced quality of service offered. This change in GHG emissions is estimated through emission unit rates derived using the Urban Transportation Emissions Calculator (UTEC), which dictates that auto GHG emissions are 0.23kg per km in 2006, gradually reducing to 0.20kg per km by 2031.

8.4 Different transit vehicle technologies have different emission characteristics. In particular, electric powered vehicles such as LRT do not emit any local CAC, while GHG emissions depend on the source of electricity generation of power stations, which on average produce fewer emissions than combustion engines.

8.5 In lieu of more detailed information, for this estimation the unit rate cost per km of GHGs that has been applied to both LRT and BRT changes to highway mileage is $0.01, or $43 per tonne. This is confirmed by Transport and Environment Canada and the Greater Golden Horseshoe Model.

8.6 In terms of CAC evaluation, the B-Line Economic Potential Report valued air emissions based on an international review of government and academic sources conducted by HSR. These represent the social costs in an urban context, and are as follows:

- Volatile Organic Compounds (VOCs) $5,500/tonne
- Carbon monoxide (CO) $200/tonne
- Nitrous oxides (NOx) $8,200/tonne
- Sulphur dioxide (SO2) $26,000/tonne
- Particulate matter, 10 microns $1,000/tonne
- Particulate matter, 2.5 microns $19,000/tonne

8.7 For consistency these rates have been applied to the A-Line options.

Emissions

GHGs

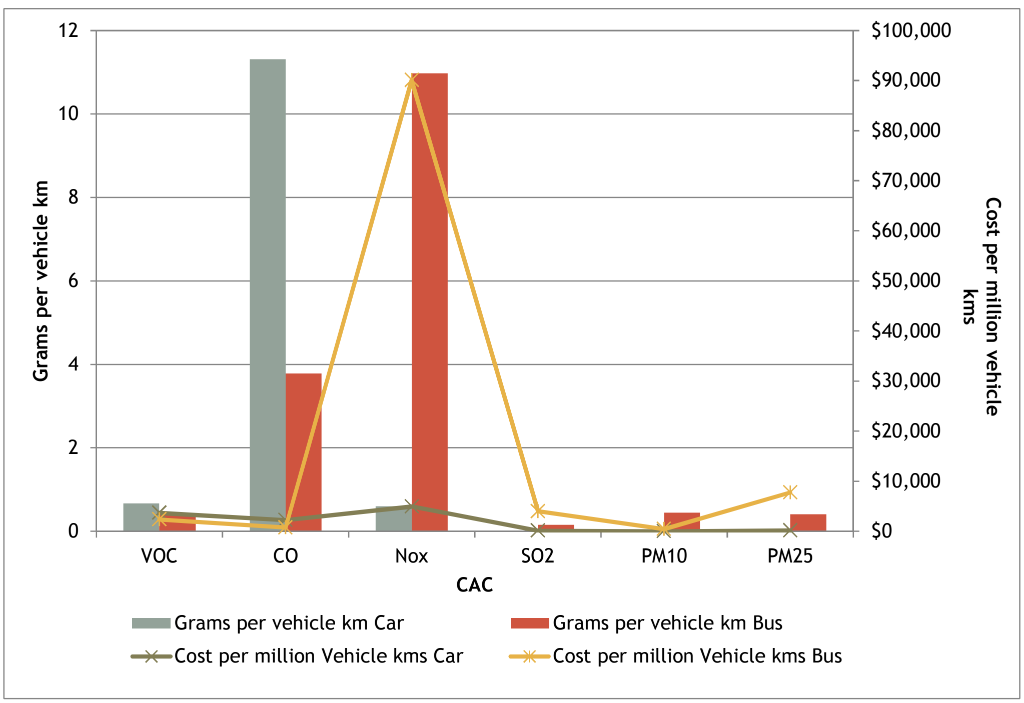
8.8 Both the LRT and BRT options create a net increase in vehicle kilometres as a result of the at-grade running of the modes and traffic lane removal. The consequential auto diversion for the LRT option creates a 0.9m increase in vehicle kilometres in 2025. This small change equates to a negligible change in GHG emissions overall.

8.9 The BRT option, however, causes a 3.9m increase in auto vehicle kilometres in 2025, which is expected to increase to 4.9m vehicle kilometres by 2031.The result of this increase in traffic diversion is $0.1m cost in GHG emissions per annum.

CACs

8.10 Figure 8.1 shows the comparative CAC emission rates for bus and car, as calculated by the Urban Transportation Emissions Calculator. As LRT operates with the use of electricity, the CAC emission rates are zero. Although CO emissions are high in autos, the cost is small compared to that of nitrous oxides, which are the major pollutants for buses.

FIGURE 8.1 COMPARATIVE CAC EMISSION RATES FOR BUS AND CAR



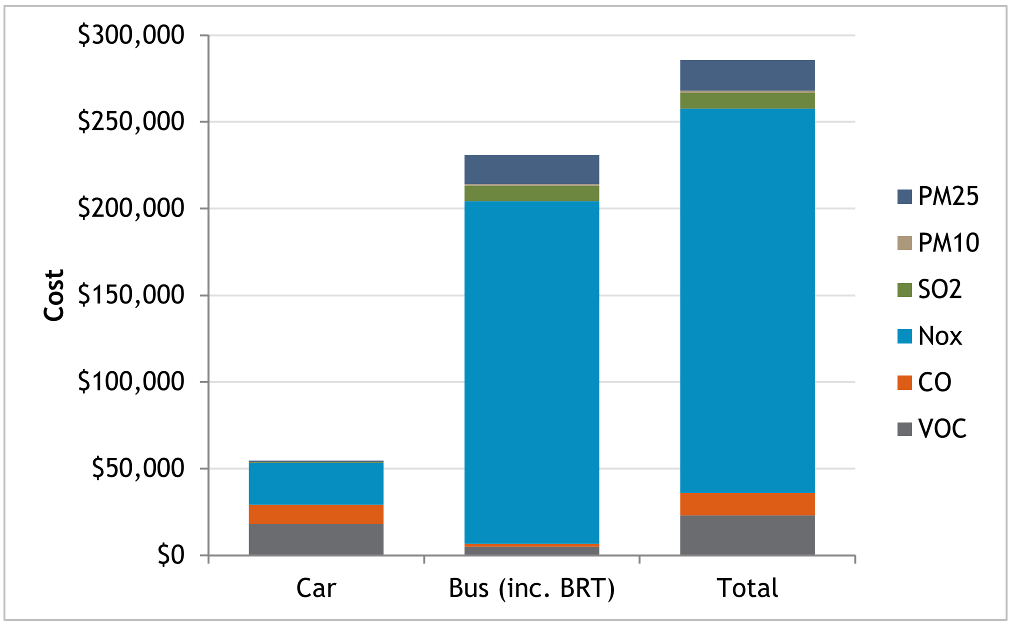
Source: B-Line Economic Potential Report

8.11 Figure 8.2 shows that the additional auto kilometres under the BRT option create a CAC emission cost of $55k per annum (in 2031). The BRT annual kilometres, net of kilometre savings on the current bus network, creates a CAC cost of $0.2m per annum, resulting in a total social cost of BRT of $0.3m in 2031.

8.12 The LRT will increase auto mileage by 1.1m kilometres, but the saving in the current bus network of 0.2m kilometres means that there will only be a slight increase in CACs in the city to the value of $77k per annum (in 2031).

8.13 In terms of emissions, the LRT option is better performing because it releases zero CACs directly and has less impact on auto mileage in the city and the resultant emissions than BRT. The BRT option would increase CAC and GHG emissions to the value of $0.4m, although this could be significantly reduced if the vehicles operated on an electricity power source, rather than finite fuel sources such as diesel.

FIGURE 8.2 CHANGE IN CAC EMISSION COSTS WITH IMPLEMENTATION OF BRT



Energy use

8.14 Research by Newman & Kenworthy (1989) discovered that out of 32 global metropolitan areas, low density, non-transit supportive cities consumed as much as eight times the fossil fuels as high density, transit supportive cities. This has been supported by further studies by (Newmand 1988) and (Karathodorou 2010). However, the degree to which transit can impact municipal energy use depends on the technology employed.

8.15 The majority of buses worldwide are diesel powered. Diesel dominates because diesel fuelled vehicles are cost effective, operationally flexible, and share a common technology and infrastructure with the much larger road freight industry.

8.16 Electricity supplied from an external source by means of overhead lines or a 'third rail' has long been used as a power source for fixed-route public transportation systems (railways, tramways and trolley buses), where the higher costs of the fixed infrastructure and vehicles are offset by lower operating and maintenance costs.

8.17 More recently a range of alternative power and fuel technologies have been considered to power buses , partly in response to growing concerns for the impact on the environment of conventional power sources and reducing the carbon footprint of public transportation operations. These include:

- **Liquefied Petroleum Gas (LPG)** – low emission fuel that is usually obtained by fossil fuel sources and manufactured during the refining of crude oil. Disadvantages would be that the capital cost of the vehicles is high, with higher operating and maintenance costs due to economies of scale.
- **Compressed Natural Gas (CNG)** – has similar advantages to LPG, but has now been somewhat superseded by events as its emissions can be bettered by the latest Euro diesels. Vehicle capital costs are higher than for LPG due to the larger and stronger storage tanks required.
- **Biofuels** – produced from crops (for example, corn, sugar cane), from agricultural waste (for example, wheat stalks, straw), or from waste oils (for example, used cooking oil). The net CO_2 emissions from the production and use of biofuels are generally lower than emissions from fossil fuels because CO_2 is absorbed from the atmosphere during the crop growth phase. Concerns have been raised about the wider environmental and social impacts of dedicating significant agricultural resources to the growing of crops solely for biofuel production, which could reduce the production of basic foodstuffs and may put food out of reach for some of the world's most impoverished people.
- **Electric Battery Powered** – (as opposed to the electric trolley bus), the improvements in battery design remain insufficient to make promotion of battery power for local bus services a realistic alternative at present.
- **Hybrid** – an energy store (battery, capacitor or flywheel) is used to power the vehicle, and regenerative braking energy is used to recharge the store. The vehicle can operate on stored energy alone for short lengths of route, thereby minimising noise and airborne emissions. The energy store is charged by the internal combustion engine which, as it can be run at constant (and optimal) power, is also capable of producing minimised emissions. It is also possible to operate using a "parallel" hybrid drive that can provide power from the internal combustion engine and energy store simultaneously in short bursts. Hamilton currently has a number of diesel electric hybrid buses in operation.
- **Fuel cell** – the latest fuel technology – this is in its infancy, with ten fuel cell buses in operation in six North American locations in August 2009. This is planned to increase to 58 within two years. The fuel cells combine hydrogen and oxygen, the only emission being water vapour. Whilst operationally successful, the problem with fuel cell applications is the high cost due to there being no economies of scale as yet. Fuelling infrastructure is also very expensive.

8.18 The fuel technology for the BRT option has not yet been decided, and a large number of factors need to be considered in order to decide on the most suitable, for example fuel availability, cost, emissions etc. Conversely, Light Rail Vehicles (LRVs) operate solely with electricity, yet the method of generation can vary, and this consideration influences the degree of sustainability of the system, much like the choice of fuel type does for BRT. The IBI Group[21] reports that the marginal cost of using energy from renewable sources is extremely small (less than half a cent per passenger, assuming optimal loading on a 300 person capacity unit); the Calgary LRT system runs at grid power neutral due to the installation of wind turbines that offset the full power requirement of the service, for example.

Potential for local energy

8.19 RT in Hamilton has the potential to utilise local energy sources and embrace sustainability. The Province's Long Term Energy Plan[22] projected that in 2010 over 75% of Ontario's power supply would be generated by renewable sources. By 2030 it is planned that Ontario will become coal free, with only 7% power generation by finite resources.

8.20 Assessing the availability of fuels other than electricity to operate BRT is less simple, because alternative fuels are not used for other fleets within the province at present. Local energy supply of petroleum and diesel should be possible as it is currently supplied for other transit fleets in the province. CNG on the other hand, is available in Ontario, but on a small, mostly private scale[23]. A full technical review would be required to explore opportunities for BRT energy provision locally before a commitment to technology or fuel type is made.

Summary

8.21 The incremental impact of the RT technologies in the Environmental Account are shown in Table 8.1. BRT has an overall negative impact on the environment through increased emissions, whereas LRT is largely net zero. LRT has a significant potential for local and renewable energy use, but the BRT energy supply, and therefore where it can be derived, is less certain.

TABLE 8.1 ENVIRONMENTAL ACCOUNT SUMMARY - 2031[24]

	LRT	BRT
GHG Emissions ($m)	0.0	-0.1
CAC emissions ($m)	-0.1	-0.3
Potential for Local Energy Use	✓✓	✓

[21] Hamilton Rapid Transit Initiative: Economic potential Study 2009.

[22] Building our Clean Energy Future – Ontario's Long-Term Energy Plan. 2011

[23] http://www.ngvontario.com/

[24] Negative numbers reflect a net cost

9 Social and Community Account

Introduction

9.1 The Social and Community Account provides insight into the implications of A-Line RT on crime and health in the area, as well as examination of the areas of social need in Hamilton and how well they are served by each alternative alignment.

Crime

9.2 Over 30,000 offences were reported in Hamilton in 2010, 24% of which were violent crimes[25]. Although Hamilton's Crime Severity Index is below the Canadian average[26], personal safety is a prominent issue in the city. As well as the concern for existing residents and employees, personal safety is a factor that can limit new investment and future development of the city.

9.3 Although formal studies are limited, there is evidence that better RT reduces crime rates. In Bogota for example, implementation of BRT decreased violent crime by 50% in two years the city[27]. Despite a different baseline, BRT or LRT in Hamilton could be expected to reduce crime rates along the corridors by promoting investment, intensifying development and creating revitalisation.

9.4 Past studies have suggested that RT stations can create a focus for high crime, but when considering up-to-date RT systems the opposite tends to be true. The expected service characteristics of the RT system on the A-Line is likely to include extensive hours of operation and amenable stop facilities, such as CCTV surveillance, that will transform the whole corridor to a busy environment with higher activity levels. This natural surveillance will aid in decreasing the risk of crime, and in particular, violent crime. As such, there will be no significant difference between the impact of LRT and BRT on crime with both expected to be equally beneficial.

Health

Accident reduction

9.5 The number of road traffic collisions in Ontario in 2009 was over 125,000, 2,000 of which resulted in fatalities (2,209 victims). 14% of these fatalities were pedestrians and almost 2% were cyclists[28]. 8% of the Ontario traffic incidents occurred in Hamilton (10,000), with 14 fatal incidents and 17 victims[29].

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[25] Hamilton Police Annual Report 2010

[26] Police reported crime statistics in Canada, 2009. Statistics Canada

[27] Institute for Transportation & Development Policy, 2003

[28] Canadian Motor Vehicle Traffic Collision Statistics: 2009. Transport Canada

[29] Hamilton Police Annual Report 2009

9.6 In the earlier section entitled Collision costs, it was stated that under the BRT option there was a potential for RT to increase the cost of collisions through traffic displacement in the city, with LRT causing a near neutral effect. Within the A-Line proximity however, implementation of RT will transform the A-Line corridor and in doing so improve safety, particularly for those using non-motorized transportation. Both the LRT and BRT services will be implemented with an urban design that considers the needs of the residents of Hamilton, ensuring pedestrian friendly corridors so that traffic-related incidents can be reduced.

Air quality

9.7 Modal shift from auto to RT can lead to two major benefits to human health in Hamilton: reducing the incidence of poor air-related diseases; and increasing physical activity.

9.8 The health effects of poor air quality are far reaching, affecting the body's respiratory systems and cardiovascular system. Along the A-Line corridor traffic use is expected to decrease as lanes become dedicated to RT. With this the RT will bring local air quality benefits, particularly in the case of LRT, which has no direct emissions.

9.9 As the Environmental Account reports, there is significant potential for BRT to increase overall emissions in the city through the displacement of autos from direct routes. The actual effect of this would require further analysis, examining where the autos are displaced to and the local congestion effects. Nonetheless, it is likely that residents and visitors of Hamilton would experience greater health benefits in the case of LRT, rather than BRT.

Physical impacts

9.10 Records show that the proportion of population in Hamilton that are obese or overweight exceed that of the province[30], and in 2005 accounted for 50% of the city's residents.

9.11 RT is a mechanism for encouraging active transportation, particularly when integrated with pedestrian and cycling facilities. A recent study calculated that taking public transit in the US is associated with walking an additional average 8.3 minutes per day and could save individuals US$5,500 in obesity-related medical costs[31].

9.12 The physical health and activity effects of RT can be further complemented and improved with enhancements to the public realm alongside the transit project. Maximum consideration should be given to the design of the urban realm in order to maximise these benefits.

Social Need

9.13 In 2009, the average household in Ontario allocated 13.4% of their income to transportation[32]. This remains essentially unchanged from the previous year. The

[30] Community Health Status Report. City of Hamilton

[31] Edwards, R.D. 2008. Public transit, obesity and medical costs: assessing the magnitudes

[32] Survey of Household Spending, 2009. Statistics Canada

Province, and nation, continues to be largely auto-dependent and it is estimated that the average annual driving cost in Canada is between $8,400 and $11,200 (assuming 18,000 kilometres driven each year)[33].

9.14 The Hamilton Social Landscape Report states that over 89,000 people were living in poverty in the city in 2006 (18.1%)[34]. The cost of car ownership for these populations would be in the order of 40-50% of household income for 1 person households and 20-30% for 4 person households. This shows that the cost of travel by auto for lower income individuals is a significant burden, resulting in many households being unable to purchase and operate an auto in Hamilton.

9.15 Implementing RT in Hamilton will allow more people to use public transportation to access their destinations and thus eliminate a degree of auto-expenditure for a cheaper alternative.

9.16 The LRT/BRT would connect a number of key destinations directly and efficiently, and substituting auto for transit for many people currently frequenting destinations along the A- and B-Line becomes a real possibility.

9.17 By providing a low-cost alternative to auto, Hamilton has the opportunity to address the issues and concerns of areas with a high social need by providing greater accessibility for those with low incomes and/or poor mobility.

9.18 Downtown Hamilton has the highest level of social need within the Greater Golden Horseshoe area, with further areas within the city also classified as having 'high need' (see Figure 9.1). This definition is made on the basis of the six indicators used to measure social need, which are:

- Proportion of single parent families
- Proportion of people aged over 15 who are classified as low income
- Proportion of people aged over 20 who have not completed high school
- Proportion of total income that comprises government transfer payments
- Proportion of active labour force that are unemployed
- Proportion of population over the age of 65

9.19 More recently, interactive maps were issued by McMaster University and the Centre for Spatial Analysis that show disparity in social health throughout Hamilton. Figure 9.2 shows the overall rankings of city areas based on the cumulative scores for 24 health, social and economic variables (listed on the right). Consistent with the Social Need index from *The Big Move* in Figure 9.1, the interactive maps shows that downtown Hamilton and areas towards the Waterfront have the lowest ranking within the city.

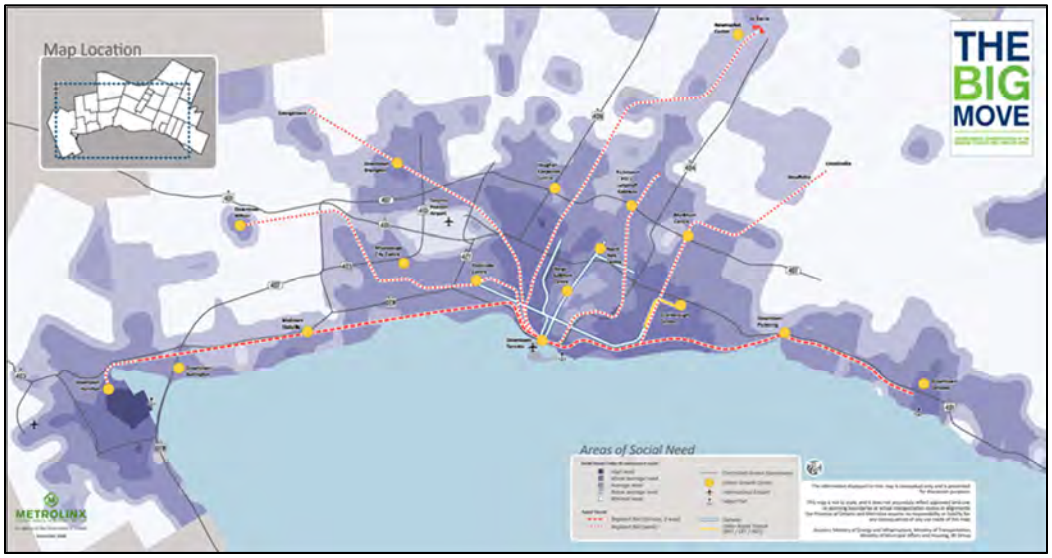
9.20 RT along the A-Line would intercept areas of high social need and therefore has the potential to connect these communities with job opportunities and amenities in Hamilton and further afield. In doing so, implementation of LRT or BRT is likely to

[33] Driving Costs 2009 Edition. Canadian Automobile Association

[34] Hamilton Social Landscape Report, May 2011. SPRC, commissioned by the United Way of Burlington and Greater Hamilton

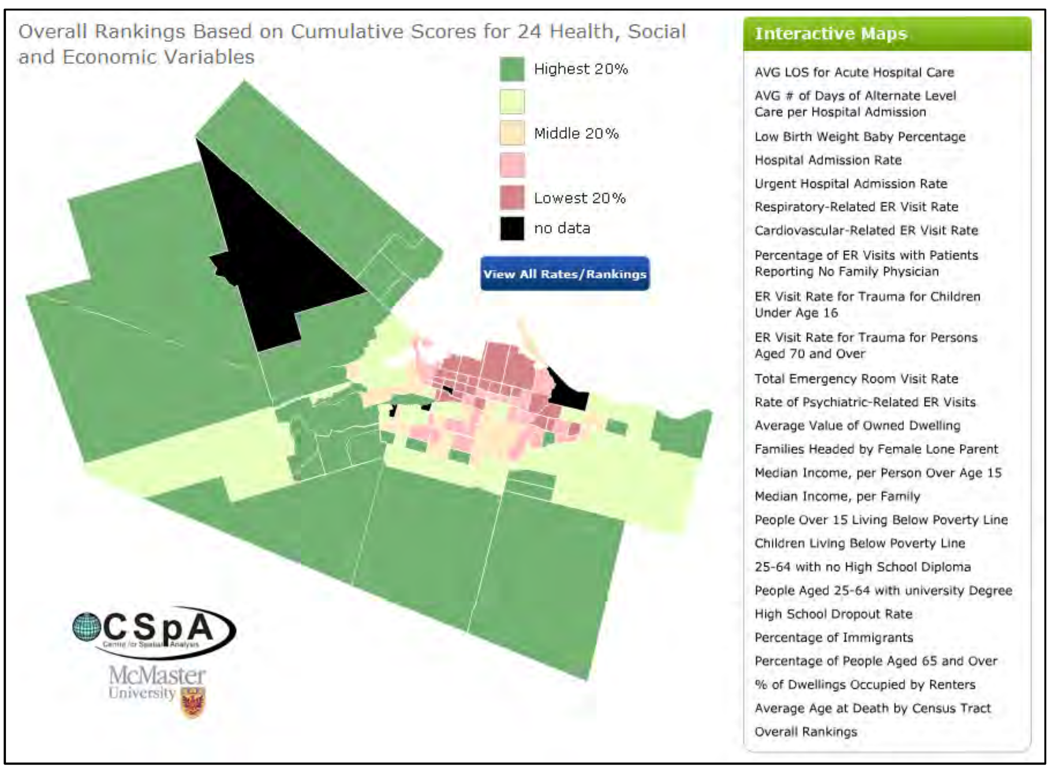
improve quality of life along the A-Line corridor and surrounding area, in particular between the downtown and the waterfront, where the need is greatest.

FIGURE 9.1 AREAS OF SOCIAL NEED



Source: *The Big Move*, Metrolinx

FIGURE 9.2 OVERALL RANKING OF CUMULATIVE SCORES FOR HEALTH, SOCIAL AND ECONOMIC VARIABLES



Source: Code Red Interactive Maps – Centre for Spatial Analysis & McMaster University

9.21 The variance between the LRT and BRT alignments show that LRT will connect the lower income area of Corktown (east of the downtown area), rather than the more affluent area of Durand that is served by the BRT routing up James Mountain Road. This suggests that the LRT would create a greater degree of benefits to high social need groups than BRT.

9.22 As stated in the *Urban Hamilton Official Plan*, the role of the urban realm has the potential to upgrade and maintain the city's civil image, economic potential and quality of life. Effective urban design has the capacity to bring identity and value to a community, and create attractive, lively and safe communities where people want to live and visit, and businesses want to establish and grow. It is vital that the implementation of RT is used as an opportunity for consideration of urban realm improvements, so these social effects are optimised and the full potential of the RT is achieved.

Summary

9.23 A summary of the Social and Community Account for LRT and BRT is shown in Table 9.1. The effects of both technologies are expected to be largely similar, although the local air quality effect of BRT may be less positive than LRT, depending on which energy source is used.

TABLE 9.1 SUMMARY OF THE SOCIAL AND COMMUNITY ACCOUNT

	LRT	BRT
Crime	✓✓	✓✓
Health		
Accident Reduction (in the corridor)	✓	✓
Air Quality (in the corridor)	✓✓	✓
Physical Impacts	✓✓	✓✓
Social Need	✓✓	✓

10 Summary of Economic Impacts

Introduction

10.1 This section considers when the various quantified indicators may occur and from these presents the overall Net Present Value and impact:cost ratio for both LRT or BRT on the A-line. A full MAE summary is also included.

Impact Profile

10.2 The economic impacts described throughout this report will occur at different stages over time. The construction of the project is likely to take around 6 years, during which time there will be significant disruption to some areas along the alignment.

10.3 The demand side spending impact described in the Economic Development Account will occur primarily during this construction period as employment and spending within the city are increased. This impact – the cumulative construction stimulus - will therefore be intense but concentrated within a relatively short period of time and dissipating once the project is completed. Depending on the availability of labour supply, particularly in the construction sector, there may be a shortage of labour and/or significant wage inflation within this sector.

10.4 The operating demand stimulus will be on-going once the project is completed and operational. Similarly the supply side effects and transport user benefits will only occur once the A-Line RT is up and running.

10.5 Once the A-Line RT is operational there is likely to be a period of 'ramp up' whereby inertia in travel behaviour means that the level of patronage and revenue take several years to reach full potential. Accordingly usage of the system will steadily increase over the first one to two years before reaching a steady state after which growth will follow broader trends in population and employment growth.

10.6 The wider impact of the project – the supply-side economic impacts and transportation user benefits will follow the same pattern, reaching a steady state after the first one to two years of operation and growing steadily thereafter. The impacts on firm productivity, agglomeration and labour supply are likely to occur over the medium term as firms respond to the increased accessibility and reduced transport costs provided by the project.

10.7 The increase in property values is likely to begin after confirmation of the project and be fully realised within five to ten years as the effect of the project becomes fully apparent to the property market.

Net Present Impacts

10.8 Comparing the costs and benefits of the project over a 30 year period (accounting for the construction period) and applying a five per cent discount rate, we have estimated the net present value (NPV) of economic impacts and the impact-cost ratio. This is shown in Table 10.1.

10.9 It is important to note that this NPV is distinct from the Benefits Case, as it considers the quantified impact of increased economic output, land use and development charges that are proportional to spending, as well as the standard cost and benefit indicators.

10.10 Some quantifications in the MAE summary table have not been included in the net economic impact summary above e.g. retail spend, wider economic impacts. This is because their calculations are subjective and would require more in-depth analysis to ensure robustness in the NPV conclusions. Nonetheless they have been included in the MAE summary to provide an idea of the potential.

TABLE 10.1 NET PRESENT ECONOMIC IMPACTS (2010 BASE YEAR)[35]

	LRT	BRT
Net Benefit Impacts ($m)	1,035.6	693.3
Net Cost Impacts ($m)	589.4	298.91
Net Present Impact Value ($m)	446.2	394.4
Impact - Cost Ratio	1.76	2.32

10.11 The results show that:

- Overall LRT provides a greater impact; however, BRT provides a higher impact on a per $ basis.
- The main difference in the impact levels between each option are the level of passenger journey time savings, and the construction and operating spend impacts.

10.12 The project is also likely to have a positive effect on productivity, labour market supply and market competition. Assuming the project achieves the median uplift from the benchmark analysis[36], the total wider economic impact of LRT could equal $69m in total. For BRT the equivalent figure is $40m. These impacts would increase the impact-cost ratio of the LRT from 1.76 to 1.87 and the BRT from 2.32 to 2.45

10.13 These findings represent impact rather than value for money, which is provided in the Benefits Case Analysis. Essentially, the relationship between project investment and impact level is that the more money spent on a project, the more impact will result in terms of jobs, GDP and output, and the more benefits will accrue to the City of Hamilton as a result. If a lower investment is undertaken, with the difference being spent elsewhere, the same amount of economic impact will occur on a national scale, but less will accrue to Hamilton and possibly the Province of Ontario.

[35] The Net Economic Impacts are distinct from the Economic Value of the project which is assessed within the benefits case.

[36] The median uplift for wider economic impacts is 17% for productivity, 3% for imperfect competition benefits and 2% for labour market impacts (22% overall).

MAE Summary

10.14 Table 10.2 summarizes the expected economic potential impacts of the LRT and BRT. All prices are current unless otherwise stated and annual values are for 2031.

10.15 The MAE shows that the LRT requires almost three times greater capital investment than BRT, although LRT costs less to operate each year and has a greater revenue:cost ratio due to higher revenues.

10.16 Fundamentally, both options will create a significant impact in Hamilton and the province through transportation user benefits, urban development and land value uplift, economic development, environment, and social and community accounts.

10.17 However, the LRT is expected to create a greater, positive impact than BRT, particularly during the construction period. This is due to the higher investment costs, which will return greater economic development impacts; choice of technology, which is expected to impact property values and urban development over a wider area; and alignment option, which, despite not optimising access to other modes and key destinations, does minimise auto displacement and negative transportation user and related environmental impacts.

TABLE 10.2 MAE SUMMARY

Account / Indicator	LRT	BRT
Financial Account		
Total capital costs ($m)	706.1	244.1
Annual net operating costs (2031) ($m)	11.7	14.7
Annual revenues (2031) ($m)	2.4	1.9
Revenue:cost ratio	0.20	0.13
Transportation User Account		
Passenger Benefits		
Annual journey time savings ($m)	37.7	21.5
Reliability & quality	✓✓✓	✓✓
Wait time	✓✓	✓✓✓
Personal Costs		
Annual automobile operating costs ($m)	-0.5	-4.0
Annual out of pocket costs ($m)	-2.4	-1.9
Annual collision costs ($m)	-0.1	-0.3
Accessibility		
Wheelchair accessibility	✓✓	✓
Key destinations	✓✓	✓✓✓
Transit capacity	✓✓	✓✓
Neighbourhood connectivity	✓✓	✓
Connection with other modes	✓✓	✓✓✓

Account / Indicator	LRT	BRT
Land Use & Urban Development Account		
Vacant population land within Buffer Zone (HA)	33	22
Vacant employment land within catchment area (HA)	56	45
Actual development units estimate (#)	1,460	652
Total residential development charge ($m)	12.3	5.5
Total commercial development charges ($m)	86.0	69.3
Component hypothecated to transit ($m)	*1.4*	*1.1*
Total property impact (Low) ($m)	43	25
Total property impact (High) ($m)	86	48
Annual property tax impacts ($m)	5.0	3.5
Economic Development Account		
Total construction impact		
GDP ($m)	331.5	115.0
Jobs (FTEs)	3,993	1,380
Output ($m)	542.5	187.5
Annual operating impact ($m)		
GDP ($m)	20.3	25.5
Jobs (FTEs)	217	273
Output ($m)	18.3	22.9
Total supply-Side economic potential ($m)	69.0	39.9
Total retail Impact - Construction ($m)	124.3	43.5
Annual retail Impact - Operating ($m)	6.8	8.5
Tax Impact - Construction ($m)	37.4	13.1
Annual Tax Impact - Operating - ($m)	2.0	2.5
Tourism Impact	✓✓	✓✓
Environmental Account		
Annual GHG Emissions ($m)	0.0	-0.1
Annual CAC emissions ($m)	0.0	-0.3
Potential for Local Energy Use	✓✓	✓

A-Line Economic Potential Impact

Account / Indicator	LRT	BRT
Social & Community Account		
Crime	✓✓	✓✓
Health		
Accident Reduction (in the corridor)	✓	✓
Air Quality (in the corridor)	✓✓	✓
Physical Impacts	✓✓	✓✓
Social Need	✓✓	✓

11 Summary and Conclusions

11.1 This study has provided a high level assessment of the economic potential impact of RT on the A-Line. Indicators have been examined for six different accounts, leading to an assessment and comparison between the LRT and BRT options relative to the Base Case. The figures used within this report are based on the design assumptions stated and are commensurate with the early development stage of work on the A-line RT.

11.2 The main headlines from the study are as follows:

- RT along the A-Line is expected to transform the corridor, delivering social benefits, such as increased personal safety and greater accessibility to employment opportunities, education, health and leisure facilities. The effect is likely to be similar under both LRT and BRT options.
- The implementation of urban realm improvements alongside the RT will be fundamental in maximising benefits in health, identity and quality of life.
- RT along the A-Line is expected to create benefits in the form of land value uplift, property tax and development charges revenue, and development and intensification of current vacant land. LRT will have a 24% - 124% greater development impact than BRT across these criteria.
- The LRT option is expected to create $540m in economic output and 4,000 FTE job years during the construction period. This is followed by further impacts in GDP and jobs throughout the operating period.
- Due to lower investment costs, the BRT construction impact will generate $187m in output and 1,400 job years over the construction period. The operating impact is expected to be 25% greater than that of LRT due to its higher operating expenditure.
- Both options have a net negative effect on emissions, although this is marginal for LRT and relatively minor for BRT. The total effect of BRT on city emissions could be reduced should the vehicles be powered with electricity, as with LRT. The potential for local and sustainable energy is also a consideration for the choice of BRT technology that would require further research beyond the scope of this study.
- Transit users are expected to benefit from journey time benefits, as well as qualitative advantages, such as better reliability, improved service quality and greater accessibility throughout Hamilton.
- Reallocation of lanes from auto to transit results in a degree of auto displacement, which creates a disadvantage for highway users under both technology options. The LRT effect is marginal, whereas the highway disbenefit from BRT is expected to be in the region of $4m per annum in auto operating and collision costs.
- BRT capital costs are approximately 35% of LRT and both options have an annual revenue-cost ratio of between 0.1 and 0.2, which means that both run an operating deficit.
- During the construction period, significant disruption is anticipated in some locations along the corridor, which coincides with the 'construction stimulus'

economic impact. The remainder of the impacts are expected to occur throughout the operating period, but with potential for land use and development impacts to occur prior to operations, once project construction commences.

- Overall, LRT has a net present impact of $446m, and BRT a net present impact of $394m over a 30 year period. The impact-cost ratio is higher for BRT (2.32) than for LRT (1.76), suggesting more value for money on a per $ basis.
- When also considering the wider economic benefits of both technologies (productivity, labour market supply and market competition), BCRs are further uplifted to 1.87 for LRT and 2.45 for BRT.
- When taking into account the full MAE LRT can be considered to offer a better overall case than BRT, especially in the context of the RT Vision.

11.3 The findings of this study indicate that BRT or LRT could create a significant net economic potential impact in Hamilton and the province in the region of $390-450m over 30 years.

11.4 When comparing the two options, the results suggest that BRT would provide a greater impact relative to its costs; however, the overall potential benefits are $342m less than that of the LRT option. Therefore, in order to recommend a preferable technology / alignment, the aims of the project are paramount: maximum benefits or maximum impact from minimal investment.

11.5 The Council's RT vision focusses on the benefits that the system could bring to Hamilton:

"Rapid Transit is more than just moving people from place to place. It is about providing a catalyst for the development of high quality, safe, environmentally sustainable and affordable transportation options for our citizens, connecting key destination points, stimulating economic development and revitalizing Hamilton".

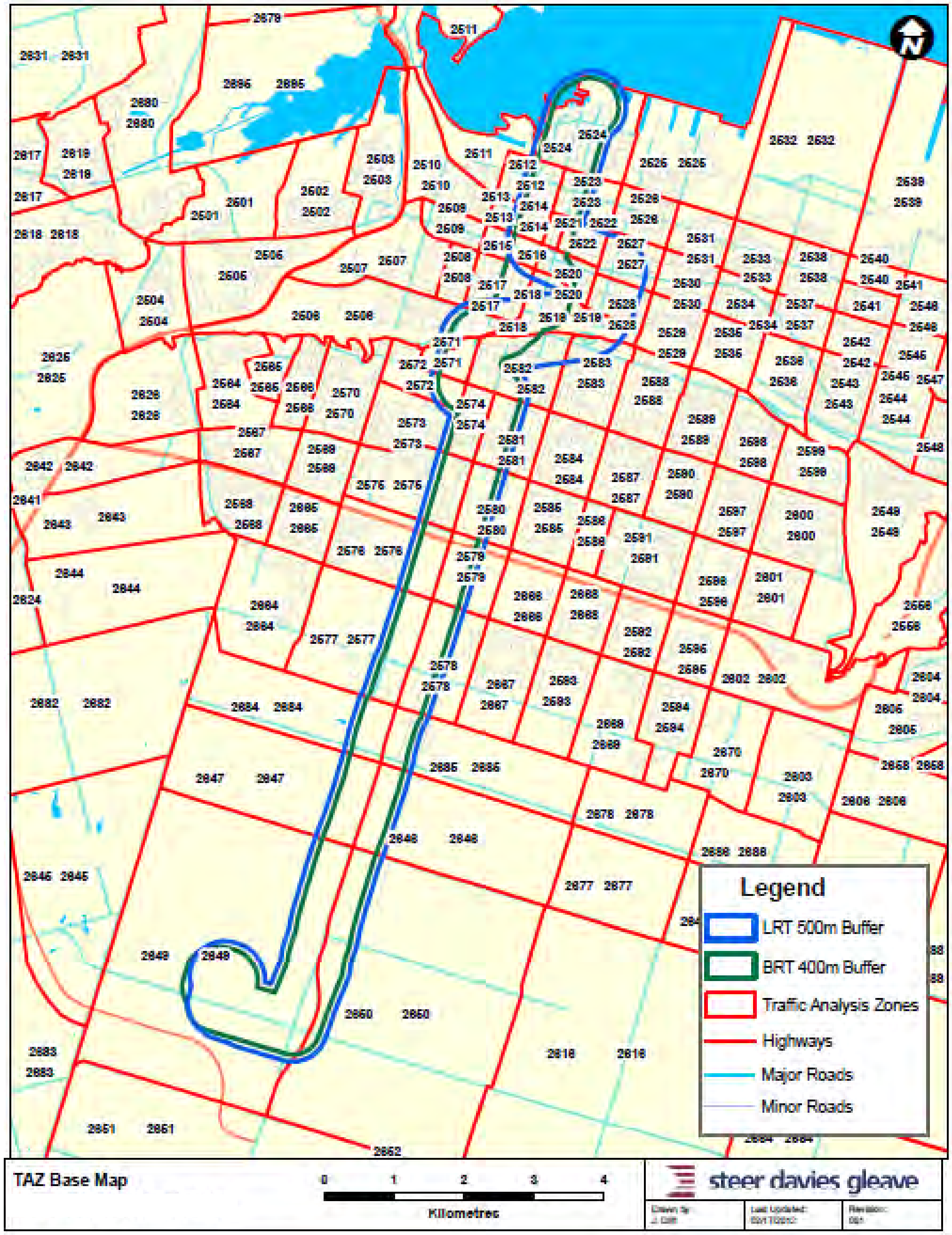
11.6 This would suggest that maximising benefits to the city is the primary aim of the project and in this respect, the LRT option would be preferred.

APPENDIX

A

TRAFFIC AREA ZONE (TAZ) BOUNDARY MAP

A1 TRAFFIC AREA ZONE MAP



APPENDIX

B

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B1 BIBLIOGRAPHY

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APPENDIX

C

LAND USE AND URBAN DEVELOPMENT ACCOUNT – SUPPORTING INFORMATION/ANALYSIS

C1 LAND USE AND DEVELOPMENT ACCOUNT – SUPPORTING INFORMATION/ANALYSIS

C1.1 This Appendix provides information and analysis to support the findings presented in the Land Use and Urban Development Account in the Economic Potential Impact Report. It includes research on the minimum densities required to support the development of a RT project, as well as analysis of the full development charge and property tax impacts of the LRT and BRT options.

Minimum Density

C1.2 There is an extensive amount of research and guidance on the level of population density required to support the development of a RT service. The following points provide a summary of this research:

- The UK Government Department of Communities & Local Government recommends a minimum of 30 developments per hectare (equivalent to 90 people per hectare) in its policy guidance for the development of sustainable communities (Department of Communities and Local Government 2011).
- A study by the UK Commission for Integrated Transport (Halcrow Group 2009) found that there is an inverse relationship between density and average travel distances. The study also found that the level of distance travelled by public transport significantly increases when average density exceeds 30 persons per hectare.
- Minimum levels of at least 15 residential units per hectare (or 38 people per hectare) in residential areas and 62 employees per hectare in commercial centres, and twice that for premium quality transport are recommended by 'Densities and Transit' research by (H. Chang 2005).
- (Zupan 1977) examines RT systems in North America and recommends a minimum residential density of 30 residential units per hectare. The study also points out that such requirements are highly variable depending on geographic, management and demographic factors including:
  - Service quality
  - Transit service quality
  - Demographics
  - Commuter financial incentives
  - 'Walkability'
  - Marketing

C1.3 The higher attractiveness of land surrounding stop areas will make this process partially endogenous, which is reflected within the applied development assumptions; however there is significant scope for planning and policy intervention to encourage the development of land around each new stop. The City's Downtown and Community Renewal Division was established to promote the revitalisation and development of properties in Hamilton's Downtown Areas, Business Improvement Areas (BIAs), and other commercial corridors throughout the City. Financial Incentive Programs in the form of loans and grants are provided to assist with redevelopment in commercial areas and could also be used to promote development around stops. Programs administered through this office include:

- **Brownfield/Erase Program** which provides a set of programs intended to "erase" brownfield sites from the city by providing grant finance and development charge discounts for specific sites.
- **Enterprise Zone Municipal Realty Tax Incentive Grant Program** for the development or rehabilitation of residential and/or commercial land and buildings within the Downtown Hamilton Community Improvement Project Area.
- **Hamilton Downtown Residential Loan Program** for the development of new residential units, the renovations to existing residential units and the conversion of existing commercial space into residential units.
- **Main Street Housing Loan and Grant Program** for converting existing built commercial space into residential units, renovations to existing residential units or the construction of new units as well as assistance with the costs of creating new residential units on vacant land.
- **Downtown Hamilton Heritage Property Grant Program** to provide financial assistance for structural/stability work to conserve and restore heritage features of properties.
- **Commercial Property Improvement Grant Program** for façade improvements which could include storefront improvements, lighting, awnings, brick repairs, painting and other treatments.

Development Charges

C1.4 Hamilton levies a development charge which is used to "recover the growth related costs associated with the capital infrastructure needed to service new development" (City of Hamilton 2011). The charge is used to fund a variety of services within the city including transit projects.

C1.5 Residential charges are made on a unit basis depending on the type of property. Commercial and Industrial space is charged per square foot. The level of charge applied to new developments is shown in Appendix Table C.1. The table shows the Urban Area Charge and the Municipal Wide charge, including the portion of this which is specifically earmarked for Transit funding.

APPENDIX TABLE C.1 HAMILTON DEVELOPMENT CHARGE RATES ($)

	Single-Detached Dwelling	**Apartment (2+ bdrms)**	**Apartment (1-bdrm)**	**Townhouse**	**Residential Facility**	**Non-Residential**
	Per Unit	Per Unit	Per Unit	Per Unit	Per Bdrm	Per Ft^2
Urban Area Charge	17,110	10,599	7,066	12,264	5,552	7.75
Municipal Wide Charge	9,817	6,027	4,028	7,036	2,897	7.44
Hypothecated to Transit	*218*	*116*	*77*	*134*	*56*	*0.23*
Total Charges	**26,927**	**16,626**	**11,094**	**19,300**	**8,449**	**15**

Source: (City of Hamilton 2011)

C1.6 The application of Development Charges to new developments is uniform across the city with the following exceptions:

- Additional fees are charged in three areas: Binbrook, Dundas & Waterdown
- The Urban Area charge is not applied in rural areas
- Charges are not applied in the Downtown area within the boundaries of Queen, Cannon, Victoria and Hunter. This broadly corresponds to TAZs 2513-2516, 2520 and 2521

C1.7 It is estimated that the LRT option generate around 1,400 new residential developments and the BRT option will generate around 700. Assuming that 40% of these developments will be in the form of 2+ bedroom apartments, 40% in the form of one bedroom apartments, 15% in the form of townhouses, and 5% in single detached houses, Appendix Table C.2 summarises the amount of residential development charges that could be generated.

C1.8 Overall, the LRT option could generate up to $12.3m in development charges by 2031, although only $82k of this could be hypothecated to transit projects (under current arrangements). The BRT alignment could generate up to $5.5m, although only $37k of this could be hypothecated to transit funding.

APPENDIX TABLE C.2 RESIDENTIAL DEVELOPMENT CHARGES

	Total New Development		Total Revenue ($)		Transit Component ($)	
Option	**LRT**	**BRT**	**LRT**	**BRT**	**LRT**	**BRT**
Single-Detached Dwelling	73	33	1,965,000	878,000	16,000	7,000
Apartments (2+ bdrms)	584	261	9,709,000	4,338,000	68,000	30,000
Apartments (1 bdrm)	584	261	6,478,000	2,895,000	45,000	20,000
Townhouse	219	98	4,226,000	1,888,000	29,000	13,000
Total	**1,460**	**652**	**12,334,000**	**5,512,000**	**82,000**	**37,000**

C1.9 Similarly it is estimated that the LRT and BRT options could generate around 56 and 45 hectares of employment land within the study area respectively. Excluding the institutional land, and the portion of this new development which occurs within the Downtown area, this drops to 53 and 42 hectares respectively. This level of new non-residential development would generate $86m of revenue by 2031 for the LRT option and $69m for the BRT option.

C1.10 However, only a portion of this revenue can be hypothecated towards transit expenditure. Based on current arrangements this is equal to $1.3m and $1.0m in the LRT and BRT options respectively. These impacts are shown in the following table (Appendix Table C.3).

APPENDIX TABLE C.3 NON-RESIDENTIAL DEVELOPMENT CHARGES

	LRT	**BRT**
Total Employment Space (ha)	56	45
Excluding Downtown Areas (ha)	53	42
Sq Ft	5,659,000	4,562,000
Total Charge ($)	85,960,000	69,297,000
Component hypothecated to transit($)	**1,302,000**	**1,049,000**

C1.11 Overall an LRT project could generate a total of $86m in development charges by 2031. Only $1.3m of this could be hypothecated towards transit funding under current arrangements. A BRT project could generate a total of $69m in development charges by 2031. Only $1.1m of this could be hypothecated towards transit funding under current arrangements.

C1.12 In addition, the project is likely to refocus new development on high density brownfield sites within the core of the city. This will reduce the cost of providing new services and infrastructure to green field building. There is also significant evidence that denser, more urbanised developments are more sustainable in terms of transport and energy demands. This will tend to reduce the on-going infrastructure costs for the city.

C1.13 For example, (Newmand 1988) show that low density cities tend to show significantly higher levels of car use and gasoline consumption. Hong Kong, with a density of 300 persons per hectare, has an average gasoline consumption of under 5,000 MJ per capita. In contrast Atlanta, with a density of less than 50 persons per hectare, has an average fuel consumption of over 100,000 MJ per capita. (Karathodorou 2010) estimates a per capita energy demand elasticity with respect to urban density of between -0.33 to -0.35.

Tax Impacts

C1.14 In addition to development charges, the redevelopment of vacant property could provide a significant source of additional revenue from annual property taxes. As part of this study it has been estimated that around 1,400 new residential developments could be created by 2031 with the LRT option and 600 with the BRT option. It has also been estimated that around 56 hectares of employment land would be redeveloped in the LRT option and 45 in the BRT option.

C1.15 This newly developed property will become liable for property tax and generate a significant amount of revenue for the city, based on the assumption that the newly developed properties achieve the average property value in the rest of the study area. Appendix Table C.4 and Appendix Table C.5 provides a summary of the tax impacts.

APPENDIX TABLE C.4 LRT PROPERTY TAX IMPACTS

Type of Development	Total Ft^2	Average Value ($ Per Ft^2)	Tax Rate	Total Tax Income ($)
Residential	2,118,013	41.72	1.48%	**1,307,241**
Commercial	600,109	45.59	3.92%	**1,071,226**
Industrial	4,482,841	10.59	5.56%	**2,641,309**
Total	**7,200,964**			**5,019,776**

Source: (City of Hamilton 2011)

APPENDIX TABLE C.5 BRT PROPERTY TAX IMPACTS

Type of Development	Total Ft^2	Average Value ($ Per Ft^2)	Tax Rate	Total Tax Income ($)
Residential	1,027,490	41.72	1.48%	**634,168**
Commercial	165,678	45.59	3.92%	**295,744**
Industrial	4,384,890	10.59	5.56%	**2,583,596**
Total	**5,578,058**			**3,513,508**

Source: (City of Hamilton 2011)

C1.16 Based on these assumptions the LRT option could generate $5.0m per year in additional property taxes. The BRT option could generate $3.5m per year. Over half of this revenue is from industrial property taxes in both options.

APPENDIX

D

ECONOMIC DEVELOPMENT ACCOUNT METHODOLOGY

D1 ECONOMIC DEVELOPMENT ACCOUNT METHODOLOGY

D1.1 The methodology used to estimate the economic impacts of the A-Line is consistent with that employed for the B-Line Economic Potential Study (IBI Group 2009), whereby direct and indirect impacts are estimated on the basis of scheme costs modelled as a spending stimulus within the Statistics Canada Interprovincial Input-Output Model (SCIPIOM). This model is operated by Statistics Canada and is based upon the Canadian system of Canadian National Accounts.

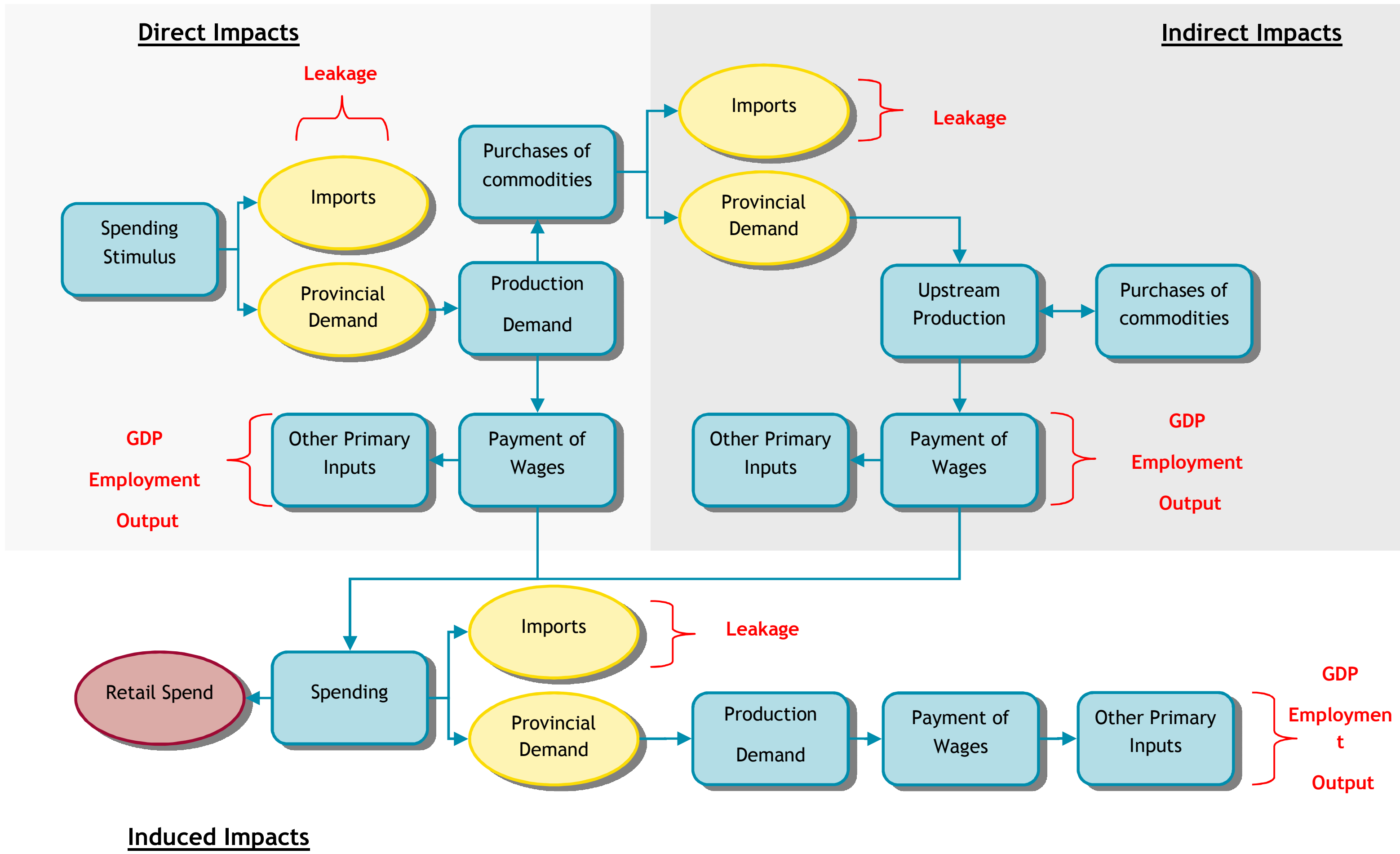
D1.2 The direct and indirect impacts generate additional induced impacts through the increase in employment, and associated spending. This effect has been estimated using the Type II multipliers estimated by the SCIPIOM model. Data on average wages (Statistics Canada, 2011), and spending patterns from Statistics Canada (Statistics Canada, 2009) have also been used to estimate spending and retail impacts. All prices are current (2011). The process is illustrated in Appendix Figure D.1

D1.3 The model traces the direct spending impact back through the supply chain, taking account of the export leakage to other provinces and abroad. For example spending on construction projects often requires the purchase of materials, such as metal, wood and manufactured goods. These industries thus receive a second order boost in demand from the initial stimulus which continuously dissipates through the supply chain as an indirect and induced impact.

D1.4 The interprovincial input-output model represents the flows of goods and services between the various industries across each province, and Canada. The multipliers provide an aggregate measure of the average demand impact of one industry on all other industries. There are separate multipliers for output, employment, and income which are applied to the direct impacts to obtain an estimate of the indirect and induced impacts for each category.

D1.5 The BRT option is intended to be high quality and similar to LRT in many respects and the structure of the costs is therefore similar. Therefore, the proportional spending patterns between the two technologies are the same, with the exception of systems and track related costs, which are significantly higher for the LRT project. Taking this into account, the BRT economic impact can be estimated based on the assumption that its multiplier impact will be proportional to the LRT multipliers. As such, the analysis for the LRT option only is presented only.

APPENDIX FIGURE D.1 DIRECT, INDIRECT AND INDUCED IMPACTS



Source: Adapted from Statistics Canada, 2009

Project Costs

D1.6 The direct impact of both the LRT option has been estimated on the basis of the expenditure required to deliver the scheme. A benchmarking approach was used to develop cost estimates for the option based on a detailed consideration of the route alignment, length and number of stops, as well as the quality of the design.

D1.7 The SCIPIOM is an external tool and so the LRT input data had to be supplied at an early stage of the project process. Since then the LRT capital and operating costs have been updated, which has resulted in a discrepancy between the LRT capital and operating estimates used in this analysis and those reported in the Financial Account of the A-Line Economic Potential Impact Report. This change in costs is shown in Appendix Table D.1.

APPENDIX TABLE D.1 COMPARISON OF LRT COSTS BEFORE AND AFTER ECONOMIC ANALYSIS

	Primary Estimate for Economic Analysis	Updated Secondary Estimate for Economic Potential Impact Report	Percentage Change
Capital Cost ($m)	671.0	706.1	+5%
Operating Cost ($m p.a.)	7.1	11.7	+65%

D1.8 The economic analysis presented in this Appendix therefore underestimates the benefits that will accrue to LRT, and has been adjusted in the main body of the report in order to accurately portray the likely impacts of both LRT and BRT with the most up to date cost estimates. This also allows a more accurate comparison between the economic impact of both modes.

D1.9 For the remainder of this Appendix, the costs used in the earlier stage of the economic analysis are referred to in order to describe the methodology used to estimate the potential economic impact of the project options.

D1.10 The breakdown of LRT capital costs are presented in Appendix Table D.2. The table shows the total cost of each scheme element, and the proportion of 'impact' expenditure assumed to accrue within Ontario. Each cost item has also been classified into a national account category for the SCIPIOM model[37].

D1.11 The total estimated costs of the LRT project used within the economic model is $671m in 2010 prices. Within the national account categories most of the spending for the LRT option is assumed to accrue to the Road, Highway and Airport Construction sector ($159m), followed by Other Professional, Scientific and Technical Services ($66m)

[37] The most detailed 'Worksheet' Level disaggregation has been used to model the impacts of the project as a 'commodity'[37] shock.

related to the design and management of the project. Other expenditures are made on Computer Systems Design, Urban Transit Rolling Stock and Real Estate.

D1.12 The percentage of spending assumed to accrue to Ontario is based on an assessment of the likely balance of domestic and 'foreign' (outside Ontario) spending. For example construction is likely to be granted mainly to local suppliers, however, more technically complex components, such as vehicles and systems, may need to be purchased from outside the Province. As in the B-Line report (IBI Group 2009), we have assumed that 25% of expenditure on vehicles will accrue to Ontario.

APPENDIX TABLE D.2 LRT CAPITAL COST BREAKDOWN

Item	% Ontario	Cost ($)	Impact ($)	Sector
Preparatory works	75%	55,206,000	41,404,000	Road, highway and airport runway construction
Guide way	75%	148,032,000	111,024,000	Road, highway and airport runway construction
Completion Works	75%	9,335,000	7,001,000	Road, highway and airport runway construction
Stations	75%	9,880,000	7,410,000	Non-residential building construction
Trackwork	75%	71,140,000	53,355,000	Iron and steel railway construction material
Systems	50%	115,713,000	57,856,000	Computer systems design and related services
Maintenance Facility	75%	28,836,000	21,627,000	Non-residential building construction
Vehicles	25%	78,803,000	19,701,000	Locomotive, railway and urban transport rolling stock
Design & Management	50%	130,006,000	65,003,000	Other professional, scientific and technical services
Property	75%	24,099,000	18,074,000	Real estate commissions and management fees
Total		671,050,000	**402,455,000**	

= Costs superseded by later estimates

11.7 The operating costs were estimated by benchmarking against similar projects using a per km rate to estimate labour, electrical, maintenance and overhead costs. Appendix Table D.3 provides a summary of the net annual operating costs of LRT (subtracting the cost savings from reduced bus operation throughout the city).

APPENDIX TABLE D.3 LRT NET OPERATING COST BREAKDOWN (PER ANNUM)

Item	Cost ($)	Sector
Labour	4,661,000	Urban Transit Systems
Electrical Power	353,000	Electric Power Generation, Transmission and Distribution
Vehicle Maintenance	847,000	Other Transportation Equipment Manufacturing
External Costs / Overheads	1,201,000	Other Professional, Scientific and Technical Services
Total	**7,062,000**	

= Costs superseded by later estimates

D1.13 The net operating costs (used in the analysis) are equal to $7.1m per annum in 2025 (2011 prices). The majority of these costs relate to the labour required to operate the system, which is estimated at $4.6m per year. All operating costs are assumed to accrue to Ontario, therefore the modelled stimulus is the same as the total cost.

Results

11.8 The results of the SCIPIOM modelling for the original LRT construction and operating cost estimates are shown in Appendix Table D.4 and Appendix Table D.5 respectively. The tables show the direct, indirect and total economic impact across GDP, Full Time Equivalent Jobs (FTE's) and industry output across 25 industry sectors. The construction costs have been entered as a commodity stimulus and represent the cumulative impact of the project over the construction period, which is likely to be between two to five years from the start of construction. The operating costs have been entered as an industry stimulus which better represents the continuous nature of the expenditure. This type of stimulus only generates an indirect impact effect within the model. All values are in the 2011 price base.

Construction Stimulus

D1.14 Appendix Table D.4 shows that the direct impacts of the LRT option could generate $146m GDP, with indirect impacts equal to $93m and a combined impact equivalent to $239m. This cumulative impact will be distributed over multiple years as the project is constructed.

D1.15 The table shows that the direct impacts are focussed on Construction and Professional, Scientific and Technical Services. This is related to the high incidence of costs within these sectors, for example for groundwork, depot and guideway construction. Considering the indirect impacts, the effects are more dispersed throughout the sectors, with an $18m impact accruing to the Manufacturing sector as a result of the increased demand for vehicle components, for example. Other significant indirect impacts of the LRT are apparent in the Finance, Insurance, Real Estate and Renting sectors, which see $15m impact. Overall the impact is greatest within the Construction sector ($76m), followed by Professional, Scientific and Technical Services ($65m).

D1.16 The LRT option is likely to directly generate around 1,931 full time equivalent (FTE) job years[38]. Indirect impacts further down the supply chain are likely to generate around 1,051 FTE jobs years, and in combination the project will generate around 3,000 FTE job years.

D1.17 The distribution of the job creation impact is very similar to the GDP impact, with most of the direct jobs generated in Construction (1,009) and Professional Scientific & Technical Services (689). There are much smaller numbers in other sectors. The distribution of indirect jobs is much more dispersed, representing the wide range of secondary inputs into the project. The LRT indirect impacts will generate 263 FTEs in Professional Scientific & Technical Services and 177 FTEs in Manufacturing. There are much smaller numbers of jobs generated throughout the other sectors. Overall the largest job impact is in the Construction sector (1,029) followed by the Professional Scientific and Technical Services sector (952).

Operation Stimulus

D1.18 Appendix Table D.5 shows that the total annual operating cost stimulus of the LRT option generates an indirect impact of $10.6m GDP per year and $11.1m in output. The table shows that the vast majority of this impact ($8.6m) falls on the Transportation and Warehousing sector, with minor impacts evenly distributed across the other sectors.

D1.19 The operation of the project is likely to generate around 104 jobs, with a similar distribution across the sectors to GDP. 77 FTE jobs will be created in the Transportation and Warehousing sector and 5 each in Construction and Retailing..

[38] A job year represents a single job lasting one year. Thus 10 job years can be considered as one job for 10 years or 10 jobs for one year.

APPENDIX TABLE D.4 LRT CUMULATIVE CONSTRUCTION IMPACTS – GDP, JOBS & OUTPUT

Code	Industry	GDP at Basic Prices ($k)			FTE Jobs			Output ($k)
		Direct	Indirect	Total	Direct	Indirect	Total	Total
1A	Crop and Animal Production	0	171	171	0	4	4	436
1B	Forestry and Logging	0	69	69	0	1	1	189
1C	Fishing, Hunting and Trapping	0	0	0	0	0	0	0
1D	Support Activities for Agriculture and forestry	0	16	16	0	0	0	32
21	Mining and Oil and Gas Extraction	1	5,583	5,584	0	38	38	8,987
22	Utilities	0	1,535	1,535	0	6	6	2,632
23	Construction	73,856	1,767	75,623	1,009	20	1,029	191,344
3A	Manufacturing	5,141	17,752	22,893	50	177	227	76,283
41	Wholesale Trade	1,884	8,312	10,196	20	88	108	17,753
4A	Retail Trade	207	2,635	2,842	4	51	55	4,450
4B	Transportation and Warehousing	2,557	5,426	7,983	29	76	105	17,578
51	Information and Cultural Industries	6,121	5,882	12,003	50	43	93	20,829
5A	Finance, Insurance, Real Estate and Rental and Leasing	8,871	15,308	24,179	68	92	160	42,748
54	Professional, Scientific and Technical Services	46,411	18,869	65,279	689	263	952	110,809
56	Administrative and Support, Waste Management and Remediation Services	264	5,363	5,626	4	105	109	8,002
61	Educational Services	0	226	226	0	6	6	303
62	Health Care and Social Assistance	0	114	114	0	1	1	152
71	Arts, Entertainment and Recreation	145	271	416	4	7	11	750
72	Accommodation and Food Services	53	934	987	1	26	27	1,974
81	Other Services (Except Public Administration)	0	1,440	1,440	0	28	28	2,285
F1	Operating, Office, Cafeteria and Laboratory Supplies	0	0	0	0	0	0	0
F2	Travel, Entertainment, Advertising and Promotion	0	0	0	0	0	0	0
F3	Transportation Margins	0	0	0	0	0	0	4,593
NP	Non-Profit Institutions Serving Households	0	24	24	0	0	0	39
GS	Government Sector	287	1,690	1,977	3	18	21	3,314
	Total	**145,797**	**93,386**	**239,183**	**1,931**	**1,051**	**2,982**	**515,480**

(Results superseded by costs changes)

APPENDIX TABLE D.5 LRT ANNUAL OPERATION IMPACTS – GDP, JOBS & OUTPUT

Industry	GDP at Basic Prices ($k)			FTE Jobs			Output ($k)
	Direct	Indirect	Total	Direct	Indirect	Total	Total
Crop and Animal Production	0	2	2	0	0	0	5
Forestry and Logging	0	1	1	0	0	0	2
Fishing, Hunting and Trapping	0	0	0	0	0	0	0
Support Activities for Agriculture and forestry	0	0	0	0	0	0	1
Mining and Oil and Gas Extraction	0	8	8	0	0	0	12
Utilities	0	146	146	0	1	1	260
Construction	0	343	343	0	5	5	545
Manufacturing	0	134	134	0	1	1	626
Wholesale Trade	0	146	146	0	2	2	255
Retail Trade	0	237	237	0	5	5	371
Transportation and Warehousing	0	8,167	8,167	0	77	77	7,188
Information and Cultural Industries	0	77	77	0	1	1	140
Finance, Insurance, Real Estate and Rental and Leasing	0	282	282	0	2	2	467
Professional, Scientific and Technical Services	0	138	138	0	2	2	216
Administrative and Support, Waste Management and Remediation Services	0	153	153	0	3	3	217
Educational Services	0	3	3	0	0	0	4
Health Care and Social Assistance	0	50	50	0	1	1	67
Arts, Entertainment and Recreation	0	3	3	0	0	0	6
Accommodation and Food Services	0	10	10	0	0	0	20
Other Services (Except Public Administration)	0	132	132	0	3	3	216
Operating, Office, Cafeteria and Laboratory Supplies	0	0	0	0	0	0	0
Travel, Entertainment, Advertising and Promotion	0	0	0	0	0	0	0
Transportation Margins	0	0	0	0	0	0	27
Non-Profit Institutions Serving Households	0	4	4	0	0	0	6
Government Sector	0	228	228	0	2	2	468
Total	0	10,263	10,263	0	104	104	11,116

(Results superseded by costs changes)

Induced Impacts

D1.20 Using the type II multipliers estimated in the SCIPIOM model we have estimated the impact of the induced spending on job creation and GDP. Appendix Table D.6 provides a summary of these effects for the LRT and BRT scenarios.

APPENDIX TABLE D.6 INDUCED IMPACTS

Impact	Construction	Operation
FTE Jobs	813	28
GDP ($m)	75.8	2.0

■ = Results superseded by later cost estimates

Summary

D1.21 Appendix Table D.7 and Appendix Table D.8 provide a summary of the direct, indirect and induced impact of the LRT option in terms of output, GDP and jobs - direct, indirect and induced economic impacts, based on early cost estimates.

APPENDIX TABLE D.7 SUMMARY OF LRT CONSTRUCTION IMPACTS

Impact	Direct	Indirect	Induced
GDP ($m)	145.8	93.4	75.8
FTEs	1,931	1,051	813
Output ($m)		515.5	

■ = Results superseded by later cost estimates

D1.22 In total, the LRT construction stimulus based on early-stage cost estimates would likely have generated around $315m in total GDP impacts, 3,795 FTE job years, and $516m in total output over the construction period.

APPENDIX TABLE D.8 SUMMARY OF LRT OPERATING IMPACTS

Impact	Direct	Indirect	Induced
GDP ($m)	0	10.3	2.0
FTEs	0	104	28
Output ($m)		11.1	

■ = Results superseded by later cost estimates

D1.23 The LRT operating stimulus based on early-stage cost estimates would likely have generated around $12m per year in total GDP impacts, $11m in additional output, and sustain 132 FTE jobs.

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