May 2016

London
CANADA

shift

London's Rapid Transit Initiative

Business Case

DRAFT

IBI | WSP

Table of Contents

List of Exhibits

EXECUTIVE SUMMARY

Executive Summary

Shift is a bold and important transportation and city-building initiative for London. It focuses on developing Rapid Transit as a core mobility option in a multi-modal transportation system that will help London continue to grow towards a prosperous and sustainable future.

Rapid Transit is a natural evolution of the transit system in London. The current transit system provides more than 24 million trips per year, but is unable to keep up with current demand, let alone projected future need. London is Canada's 11th largest city, and the largest city in Canada without a Rapid Transit system.

London's Municipal Council has set aggressive targets for infill and intensification, and Rapid Transit will play a major role in helping the City to achieve these targets, growing inwards and upwards. This form of growth will reduce infrastructure requirements, minimize intrusion into agricultural lands, reduce energy consumption and greenhouse gas production, offer walkable and healthy communities and help to revitalize urban neighbourhoods, main streets and the Downtown.

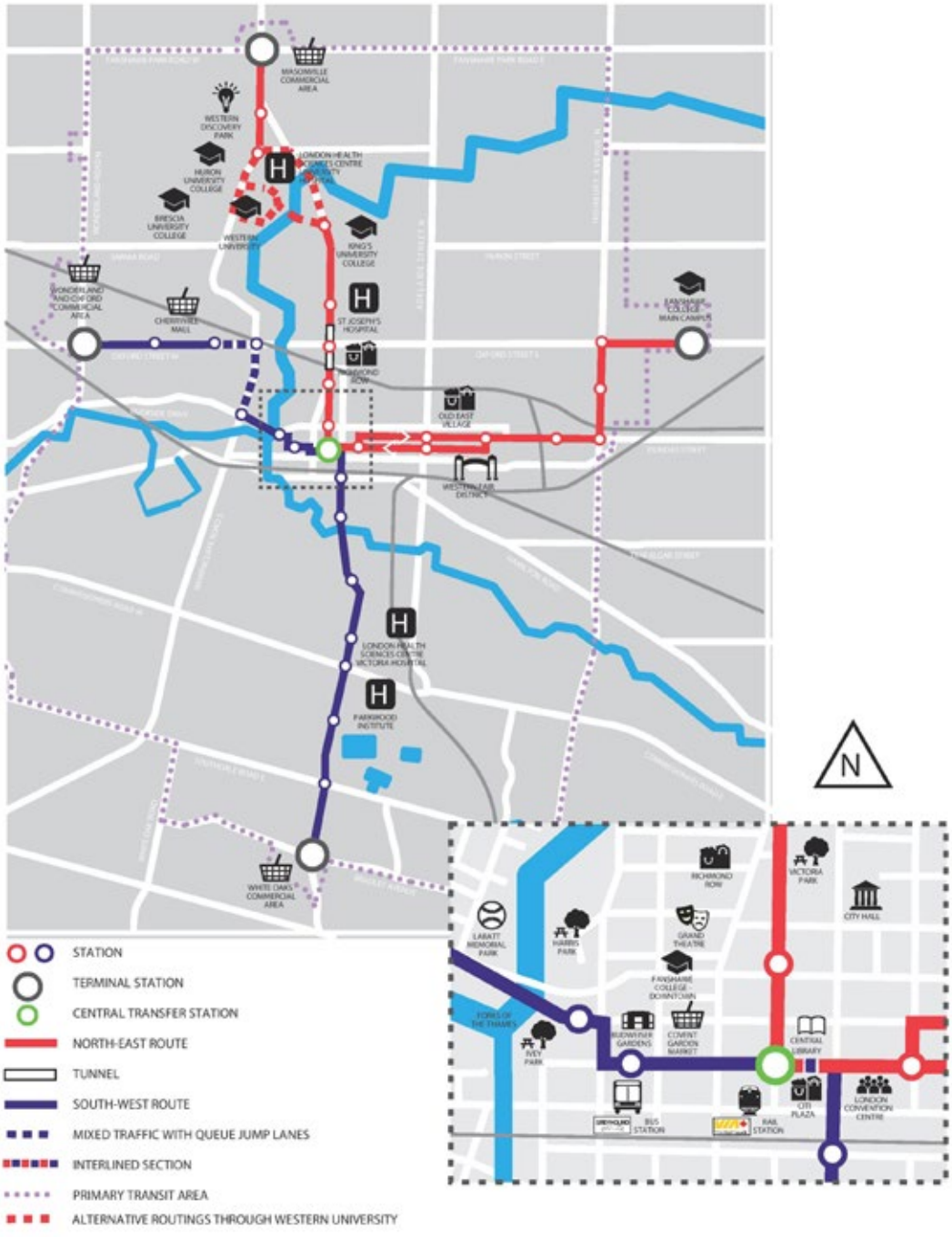
Considerable work has gone into identifying a Rapid Transit system that is right for London. This includes a comprehensive Transportation Master Plan (TMP), which established the transportation need for Rapid Transit, and the draft London Plan (Official Plan), which sets out complimentary land use policies and an urban structure plan that builds upon and supports Rapid Transit. An Environmental Assessment (EA) is currently underway to detail route alignments and alternative design concepts. Extensive consultation has been central to all of these planning processes with more than 14,000 Londoners being involved to date.

The network consists of two Rapid Transit corridors that will connect key hubs across the city: a North-East line, and a South-West line. These corridors are identified on Figure 1. As a system, these corridors comprise 23.7 km of Rapid Transit along London's busiest corridors, connecting neighbourhoods, businesses and institutions in our city.

Through the Environmental Assessment, four alternatives were shortlisted for detailed evaluation. These alternatives consist of different combinations of Bus Rapid Transit (BRT) and Light Rail Transit (LRT) ranging from Base BRT to Full LRT.

This business case evaluates the four Rapid Transit Alternatives and concludes that the Full BRT alternative offers the greatest value for Londoners as it meets the city's ridership needs, provides significant benefits in terms of economic growth, community development and revitalization, delivers considerable air quality and GHG emission reductions and modernizes the transit system by making it more attractive, reliable and convenient for residents to move around the city. The Full BRT alternative results in the highest benefit to cost ratio and is the best value solution from an affordability and financial return on investment perspective.

Figure 1: Rapid Transit Corridors



Note: This network is based on a preferred routing through the Western University Campus. This routing is still under review with the University and may be subject to change once their review process is complete.

Economic Environmental Scan

Both the Government of Canada and the Government of Ontario have signalled that municipalities should be looking for both "shovel ready" and "shovel worthy" projects that can be implemented immediately while also providing longer term economic benefits to Canadian families and businesses.

Shift is shovel ready. A partnership with the federal and provincial government will kick-start significant pre-engineering and design work that will draw on private sector expertise in London and across Southwestern Ontario. Construction can commence immediately following Environmental Assessment approvals and detailed design. As a result, significant construction activities could start as early as 2019.

Shift is shovel worthy. Rapid Transit forms the cornerstone of the City of London's long-term Official Plan, the London Plan, and will serve as a catalyst for job creation, city-building, and improvement in the quality of life for the 2.5 million Ontarians living in the Southwest. Fundamentally, Rapid Transit will put Ontarians to work and keep them there over the long-term.

Key Benefits of London's Rapid Transit Initiative

With a metropolitan population approaching half a million people, London is the urban hub of Southwestern Ontario, a region with 2.5 million people.. Over the next 20 years, London will continue to grow by an estimated 77,000 new residents and 43,000 more jobs. The existing transportation system does not have the capacity to accommodate this growth nor is transit currently an appealing choice for many residents. Rapid Transit is a tool for shaping growth while providing enhanced capacity and improved travel options.

Implementing a Rapid Transit network in London will:

- Connect major economic activities – Western University, Fanshawe College, hospitals, financial institutions, manufacturing and a rapidly growing high-tech industry all stand to benefit from Rapid Transit. London is quickly becoming a centre for innovation in the knowledge based economy. Strengthening inter and intra-city connectivity through Rapid Transit will help businesses recruit and retain skilled talent in London's growing economy.
- Address existing and increasing transit capacity shortfalls - Corridors where Rapid Transit is planned currently have numerous bottlenecks, a result of the presence of rivers and railways, which limit the movement of transit vehicles. The Rapid Transit network will address these bottlenecks, improving transit speeds, transit service frequency, reliability and capacity. Along the rapid transit corridors, existing LTC service is operating above capacity during peak periods. This has resulted in crush loading and a requirement for passengers to wait for the next bus in some instances. This has significant impacts on existing service quality and can deter transit ridership over the long term. Rapid Transit will address this issue by providing more vehicle capacity, improved service frequency, and improved headway consistency.

- **Support healthy communities and active transportation -** Almost 40% of London's future population and 65% of London's jobs would be within walking distance of the proposed Rapid Transit system. Rapid transit stands to significantly change the transportation mode choice of Londoners as they move to and from their homes and their places of employment. Public Transit and active transportation are closely connected. Since every transit trip starts and ends with an active transportation component, the success of a Rapid Transit system is dependent on the pedestrian and cycling connections approaching the stations. London's Cycling Master Plan, *London ON Bikes*, which will be completed this year, will provide a focus on connecting people to transit by improving cycling and pedestrian connections to stations.
- **Help strengthen London's connectivity across Ontario** by rail, road, air and intercity bus. Rapid Transit would provide the local connections to these broader provincial networks supporting travel to London's major employers and institutions, as well as allowing greater access to other parts of Ontario for London residents. With the implementation of potential High Speed Rail in the Toronto-Windsor Corridor, these benefits would be significantly amplified. Ontarians from Windsor to Brampton and Waterloo to Sarnia will benefit from more convenient and efficient access to London's world class amenities, including access to health and education services provided by the Province.
- **Reduce costs needed to expand the road network -** London's Transportation Master Plan identifies a strategic program of road improvements representing a constrained approach to road widening, contingent on the implementation of Rapid Transit. This road program represents a savings over what would be required under a do-nothing scenario.
- **Support broader city-building in London -** The draft London Plan envisions a city that grows in a compact way – taking advantage of existing infrastructure, minimizing energy costs, reducing emissions, allowing for healthy lifestyles and minimizing intrusion into our agricultural lands. Municipal Council has established an intensification target of 45%, with 75% of that intensification to occur within the central portion of the city (defined as the Primary Transit Area). Rapid transit is a fundamental requirement to support and stimulate this shape of growth. Rapid transit will allow for urban regeneration and the Downtown Vision to be realized. This, more compact, form of growth is less costly to service – both in terms of the required infrastructure investment and the ongoing operating costs of maintaining this infrastructure.
- **Help Achieve Provincial and Federal greenhouse gas reduction goals -** Rapid transit will reduce greenhouse gas emissions by shifting trips from automobiles to more energy efficient rapid transit. Over the evaluation period, the project will save some 194,649 tonnes of CO2 emissions. Rapid transit also better enables London's ability to respond to the emerging carbon-pricing market.

Plan Foundation: The Strategic Case

Rapid Transit is identified in the current Official Plan, and also represents a cornerstone of the planned city structure in *The London Plan* (draft). Rapid Transit is also a key strategic initiative within CityCouncil's 2015 – 2019 Strategic Plan. The 2015 – 2019 Strategic Plan identified the Rapid Transit Implementation Strategy as a means to deliver convenient and connected mobility choices as part of a strategic area of focus called "Building a Sustainable City."

The Rapid Transit initiative was built on four guiding principles as summarized in Table 1. The prioritization of these objectives throughout the study has influenced the preliminary preferred plan. Overlaid on these guiding principles is the overarching goal of ensuring fiscal responsibility and affordability.

These guiding principles were adopted early in the Environmental Assessment process and influenced both the development of the problem statement as well as the identification and evaluation of alternatives. A survey of residents served to highlight that London's Rapid Transit plan needed to address more than just transportation and mobility, and represents an opportunity to transform the city.

The process to generate and short-list alternatives was iterative in that alternatives were initially evaluated independent of technology. Criteria at the early stages focused on land use, growth, connecting destinations, and the potential to increase transit ridership. Alternatives were then refined and assessed against more detailed criteria including travel times, potential for reducing congestion, implementability, ability to influence development, social need, and fit with surrounding community.

The initial evaluation was then followed by an evaluation of technology options, namely Light Rail Transit (LRT) and Bus Rapid Transit (BRT), to develop the final short-list of network alternatives. These technologies have been widely proven as effective transportation solutions in areas where current buses are operating in mixed traffic are at capacity. The application and implementation of these technologies also continues to improve as best practices in their design and operations evolve.

There are several new technologies and services emerging and making their way into the mobility marketplace, such as ridesharing, on demand micro-transit, and eventually driverless mobility. Although these represent user friendly and innovative transportation solutions, these services, even with their most idealistic application, are not recognized as being capable of substituting the need for high capacity rapid transit between major origins and destinations. In the case of London, the corridors that are recommended for rapid transit represent the highest capacity corridors in the city for moving people. These corridors will continue to form the main arteries of transportation in the city as the land uses within them continue to intensify.

The rapid transit system that is built will be one that is flexible and adaptive and that will hold relevance by integrating with and optimizing emerging and future transportation technologies and services to ultimately improve transportation services across the city. As new technologies and the services emerge, the City will have an opportunity to leverage them to ensure that they become part of an integrated mobility system, with rapid transit as the backbone.

This iterative process ensured the rationale for Rapid Transit, and the ability to address the four guiding principles, was not unduly influenced by stakeholder biases toward a particular technology.

In addition to the Business-as-Usual (BAU) scenario, four alternatives were carried forward for detailed analysis and development of the Business Case:

- **Alternative 1:** Base BRT
- **Alternative 2:** Full BRT
- **Alternative 3:** Hybrid of BRT and LRT
- **Alternative 4:** Full LRT

Table 1: Guiding Principles and Objectives

PRINCIPLES	OBJECTIVES
ECONOMIC DEVELOPMENT & CITY BUILDING FOCUS	• Attract talent, employment and external investment • Enhance London's ability to attract in-migration • Stimulate and promote infill and intensification • Growth management – reduce sprawl • Downtown revitalization • Connect and invigorate institutions • Job growth to sustain economic prosperity • Lift property values along corridors and at stations
TRANSPORTATION CAPACITY & MOBILITY FOCUS	• Congestion mitigation and prevention • Improve mobility options for all residents • Shift mode choices away from personal automobiles • Improve travel times • Improve service reliability and user experience • Integration with active modes • Connections to regional transportation hubs • Improve transportation safety
COMMUNITY BUILDING & REVITALIZATION FOCUS	• Accessibility for all residents • Improve walkability and the public realm • Develop a stronger sense of place • Develop stronger civic pride • Improve air quality and CO2 emissions reduction • Create walkable and healthy communities • Regenerate urban environments (urban neighbourhoods and main streets)
EASE OF IMPLEMENTATION & OPERATIONAL VIABILITY	• Minimize disruptions and impacts during construction • Maintain operational flexibility • Maintain infrastructure adaptability • Minimize ongoing operating costs

Project Costs: The Financial Case

Capital costs for each Rapid Transit alternative were developed as part of the on-going Environmental Assessment process. Capital costs include allowances for infrastructure, vehicles, estimated property impacts, transit facilities and contingencies. The total capital costs for the different alternatives range from $250 million for the Base BRT alternative to $1.02 billion for the Full LRT alternative.

Operating costs were developed for each year to 2050 taking into account a phased implementation of Rapid Transit. In current dollars, operating costs range from approximately $11.1 to $13.8 million per year at full implementation, depending on the alternative. The Hybrid BRT/LRT alternative affords slightly lower operating costs than the Full BRT alternative in the longer term as fewer vehicles are required to provide the same capacity. However, BRT alternative represents a lower risk in terms of operating costs as service levels are easier to scale to demand over time.

It is assumed that capital costs will be shared by federal, provincial and municipal government with the City paying for all of the ongoing operating and maintenance costs.

The City of London has already committed $125 million towards the capital costs. The City is also investing approximately $60 million in projects that will support the implementation of Rapid Transit including a new grade separation of Adelaide Street (which will be required to allow construction of the rail tunnel on Richmond Street) and a widening of the Western Road/Wharncliffe Road corridor, including two grade separation replacements, which will provide for traffic relief during construction, remove bottlenecks in the delivery of local transit services, and help mitigate auto capacity impacts from the implementation of Rapid Transit.

Value of Rapid Transit: The Economic Case

London is the largest economic centre in Southwestern Ontario outside of the Greater Golden Horseshoe. The city is within two hours of downtown Toronto by rail – a time that will improve as planned improvements to intercity rail are made (including the potential for high speed rail).

London is home to major financial, education and health care institutions including the world renowned Western University, Fanshawe College and London Health Sciences Centre. As these institutions are well served by the rapid transit corridor, it is anticipated that rapid transit will be within walking distance of 65% of all employees, thus serving as a critical means for moving London's labour force in the future.

As the urban hub of Southwestern Ontario, investments in to the city will improve the economic, social and environmental conditions across the entire region. Rapid Transit will better link Londoners and those in the region to various provincial and federal services in areas such as health, education, immigration settlement, social housing as well as to their jobs, families and communities.

London's economy is also in transition and has seen rapid growth in technology-focused companies moving to the city. Finding employees to fill these jobs has been a challenge, as millennials want to live in cities that provide attractive urban neighbourhoods and a range of transportation options including Rapid Transit.

This Business Case serves to quantify the key economic benefits of Rapid Transit for London. Economic benefits of the four alternatives are highlighted in Table 2.

All Rapid Transit alternatives will produce significant benefits in terms of transit user time savings and other transportation and environmental benefits. The Full BRT alternative yields the highest Benefit to Cost Ratio (BCR) which is estimated to be $1.6 in benefits for every $1.0 spent. This compares to a BCR of 1.3, 1.1, and 0.8 for the Base BRT alternative, Hybrid alternative, and Full LRT alternative respectively.

The benefits from the Full BRT alternative consist of the $945.7 million from the internal, transportation and environmental user account (social cost savings from reduced transit travel times, reduced auto-operating costs, safety benefits etc.) including $20.5 million of GHG emissions savings. Together, the combined benefits exceed the capital and operating costs associated with the Full BRT alternative by $343.7 million in terms of net present value.

When the benefits of wider economic benefits are included in the process (economic uplift, GDP as a result of jobs in London and Ontario), the BCR for the Full BRT Alternative increases to 2.2.

When comparing BRT and LRT alternatives, it is important to recognize the impact that LRT would have on city image, enhancing London's ability to attract immigration, improved transit user experience, and the ability to attracting external investment and talent. A future conversion to a higher capacity technology, such as LRT, is appropriate once ridership levels are better matched to the capacity of the technology. As such, a long term strategic goal has been established to convert the Full BRT network to introduce LRT technology when such ridership levels are achieved.

1.1 Implementation Plan: Delivery and Operations Case

The Rapid Transit system will be implemented in a phased approach. Following the completion of the Environmental Assessment and Detailed Design, construction would commence on the West-South corridors in 2019 with the opening of these corridors in 2023. Implementation of rapid transit in the North-East corridor is more complex due to the need to construct a grade separation on Richmond Street. As such, the full completion of these corridors is targeted to open by 2027. In the interim, a "Quick-start" service would be implemented on the North-East corridors utilizing buses in mixed traffic, with transit signal priority, and rapid transit station spacing and service headways.

The City of London will implement the Rapid Transit Initiative in partnership with senior levels of government. As a major funding partner, it is anticipated that the Province of Ontario, through Infrastructure Ontario, will assist with the detailed planning, design and delivery of the Rapid Transit system. Roles and responsibilities will be confirmed as discussions on funding advance.

Table 2: Summary of Costs and Benefits

DESCRIPTION	BASE BRT	FULL BRT	HYBRID	FULL LRT
FINANCIAL CASE (in Millions 2016$)				
Total Capital Costs (2016$)	270	500	880	1,150
Total Capital Costs (NPV 2016$)	249.8	440.2	781.5	1022.7
Total Operation Costs (NPV 2016$)	264.2	234.9	215.6	224.0
Total Costs (NPV 2016$)	514.1	675.1	997.1	1246.7
Total Additional Revenue (NPV 2016$)	45.6	73.1	83.1	85.6
Net Revenue-Costs (NPV 2016$)	-468.5	-602.0	-914.0	-1161.0
ECONOMIC CASE (NPV in Millions 2016$)				
Internal Benefits				
Transit User Time Savings	520.3	787.9	787.9	787.9
External Benefits				
Unperceived Automobile Costs Savings	13.5	21.7	24.6	25.4
Network Wide Road User Savings	41.1	65.9	75.0	77.2
Safety Savings	6.7	10.8	12.3	12.7
GHG Emissions	12.8	20.5	23.3	24.0
Air Quality	0.4	0.7	0.8	0.8
Health (Walking)	23.8	38.2	43.4	44.7
Sub-total	98.3	157.8	179.4	184.8
Total Benefits (Internal+External)	618.6	945.7	967.3	972.7
B/C Ratio (External and Internal Benefits)	1.3	1.6	1.1	0.8
WIDER ECONOMIC BENEFITS (NPV in Millions 2016$)				
Short Term GDP Gains	150.7	272.9	482.6	626.0
Long Term GDP Gains	9.9	8.8	8.0	8.3
Land Value Uplift	80.0	90.0	110.0	115.0
Sub-total	240.6	371.7	600.6	749.3
Total B/C Ratio	1.8	2.2	1.7	1.5
ADDITIONAL QUALITATIVE BENEFITS				
Catalyst for TOD	✓	✓✓	✓✓1/2	✓✓✓
Ease of Implementation and Constructability	✓✓	✓✓1/2	✓✓	✓1/2
Potential Impact on City Image	✓	✓	✓✓1/2	✓✓✓
Urban Regeneration Benefits	✓	✓	✓✓1/2	✓✓✓
Operational and Infrastructure Flexibility	✓	✓✓	1/2	✓
Qualitative User Benefits (Ride Quality and Attractiveness)	✓	✓	✓	✓✓✓

✓= Slightly positive impacts ✓✓ = Positive Impacts ✓✓ = Very Positive Impacts

Public and Stakeholder Feedback

Significant public and stakeholder engagement has occurred as part of the Shift Rapid Transit Initiative, and other city initiatives. Over 14,000 people have been consulted on the Rapid Transit Plan to date in addition to those providing input through other City processes.

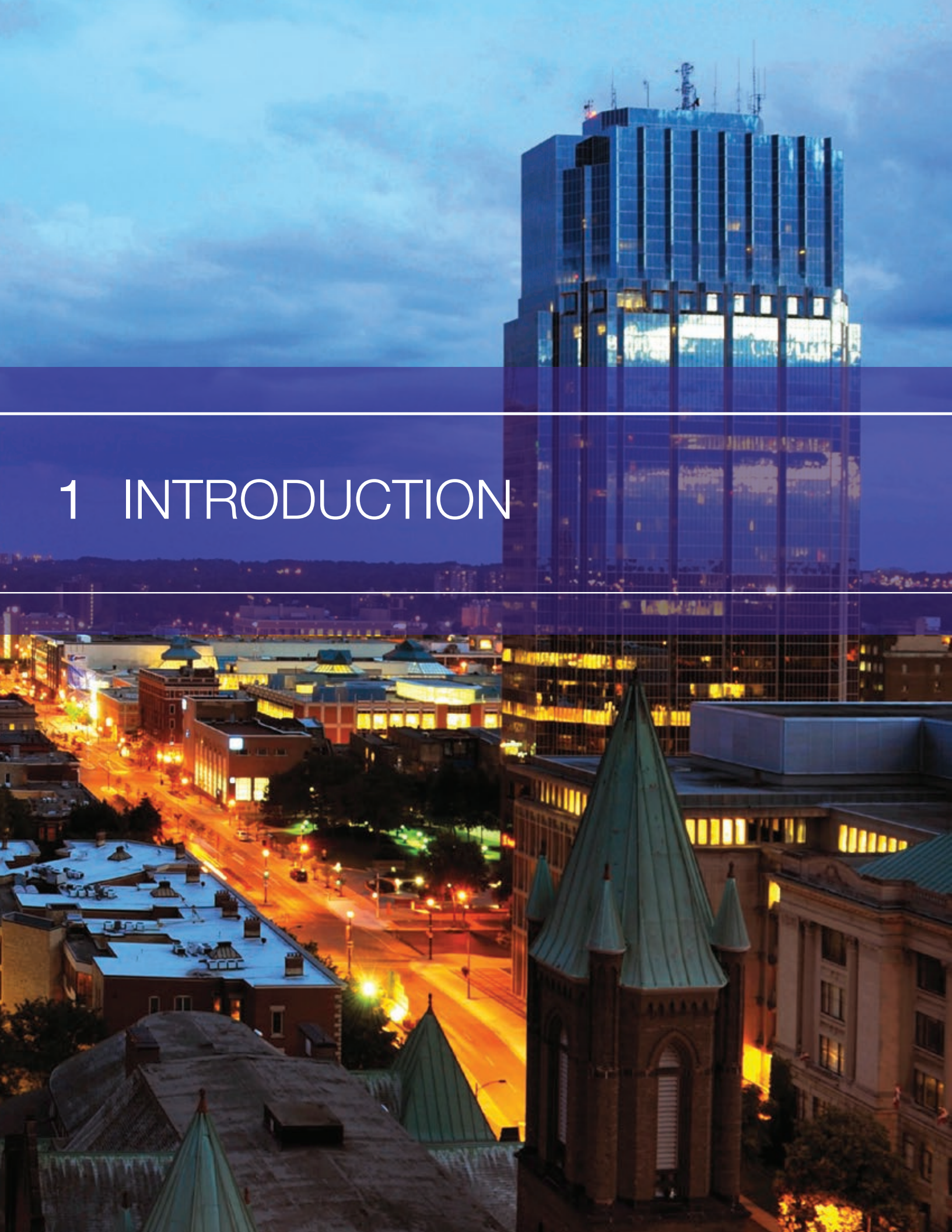
Public consultation events were held at three points leading up to the selection of the preliminary preferred alternative and well over 100 meetings were held with different stakeholder groups ranging from youth groups to business leaders.

Throughout the consultations, there has been near unanimous support for rapid transit. There is also strong consensus on the preferred corridors, though some members of the public would like to see a larger rapid transit network extending to other areas of the City. Input received on technology options was varied. Many members of the public and key stakeholders feel that LRT could provide a higher quality service and is important from a city-building perspective. However, many residents expressed strong support for the Full BRT alternative on the basis that it provides significant transportation benefits, meets the short to medium term ridership requirements, has less construction related implementation impacts, can be completed sooner, is less expensive and provides the best return on investment.

Conclusion

London's Rapid Transit Initiative will be a transformational project that creates local, regional, provincial and national economic benefits. London's Rapid Transit project achieves the goals of improving mobility, building strong communities and promoting economic development.

Based on the results of this Business Case, it can be concluded that implementation of Full BRT alternative in the preferred corridors would provide the best financial return on investment and is the best overall value solution from a mobility, city building, economic development and financial affordability perspective. At a capital cost of $500 million ($440.2 million in Net Present Value), this alternative would produce over $1.3 billion in transportation, environmental and economic benefits over the project lifespan. The Full BRT alternative can be implemented in a phased approach and can be adapted to rail-based or other technologies over the longer term as ridership grows, technologies and trends advance, and as funding becomes available.



1 INTRODUCTION

1.0 INTRODUCTION

1.1 Background

In 2013, the City of London approved a new Transportation Master Plan (Smart Moves: A New Mobility Transportation Master Plan for London) with an outlook towards the year 2030. Rapid Transit is the primary recommendation of the Smart Moves Transportation Master Plan.

Rapid Transit is identified in the current Official Plan, and represents a cornerstone of The London Plan and Council's 2015 – 2019 Strategic Plan. The 2015 – 2019 Strategic Plan identified the Rapid Transit Implementation Strategy as a means to deliver convenient and connected mobility choices as part of a strategic area of focus called "Building a Sustainable City."

In 2014, an Environmental Assessment (EA) was initiated for the Rapid Transit Initiative. The first phase of the Rapid Transit EA includes the development of a Rapid Transit Master Plan. The purpose of the Rapid Transit Master Plan is to confirm the problem and opportunity statement, further define and evaluate corridor and technology options, and to fulfill the legislative requirements of the Environmental Assessment Act. The draft Rapid Transit Master Plan served to inform the development of this Business Case.

Through the Environmental Assessment, four alternatives were shortlisted for detailed evaluation. These alternatives consist of different combinations of Bus Rapid Transit (BRT) and Light Rail Transit (LRT) ranging from Full BRT to Full LRT.

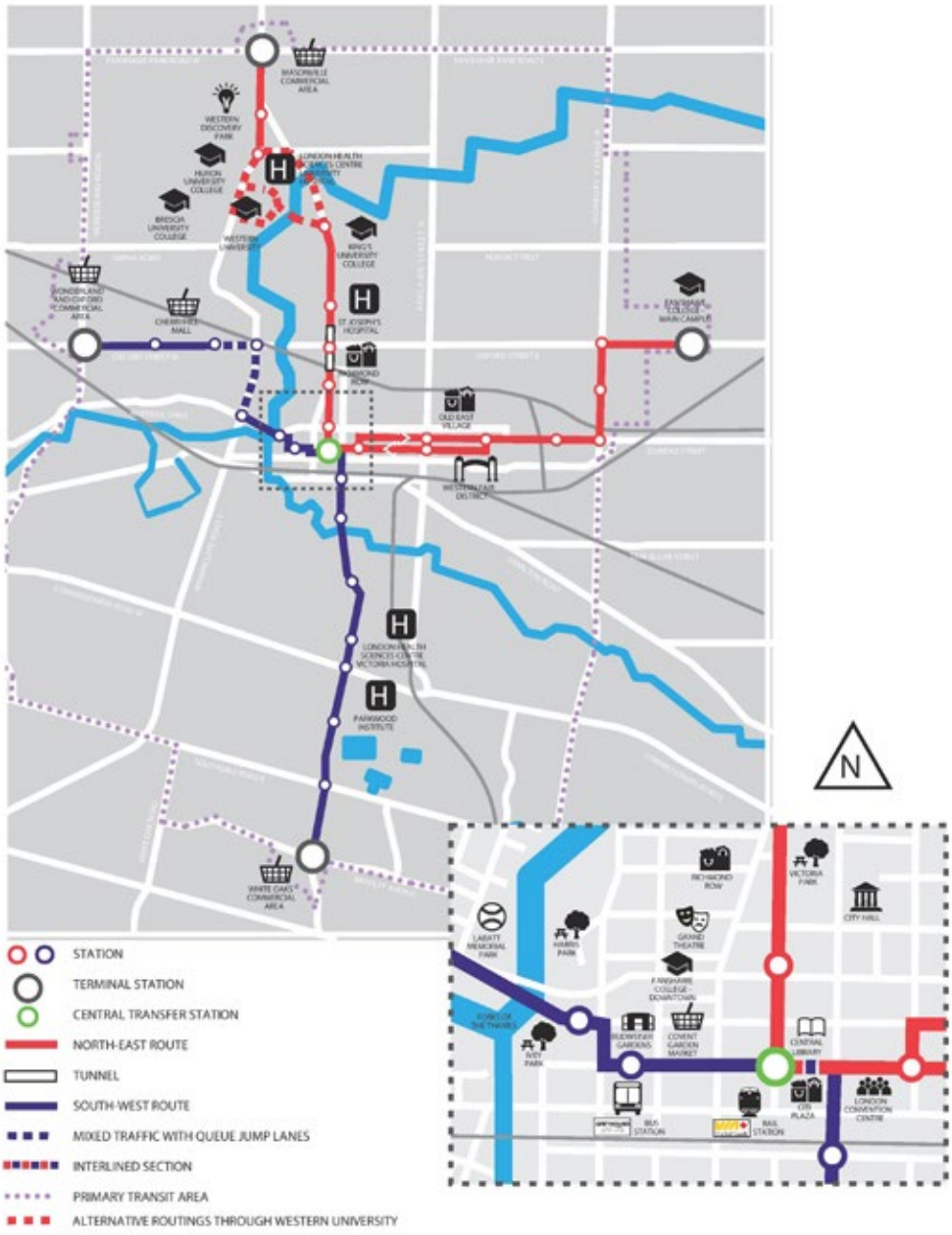
In addition to the Business-as-Usual (BAU) scenario, four alternatives were carried forward for detailed analysis and development of the Business Case:

- **Alternative 1:** Base BRT
- **Alternative 2:** Full BRT
- **Alternative 3:** Hybrid of BRT and LRT
- **Alternative 4:** Full LRT

The next stage of the Environmental Assessment will be completed over the course of 2016 and serve to develop preliminary designs for the preferred Rapid Transit alternative.

The Rapid Transit Master Plan network is comprised of two interconnected corridors: a North-East corridor, and a South-West corridor (See Exhibit 1.1). As a system, these corridors comprise 23.7 km of Rapid Transit along London's busiest corridors, connecting neighbourhoods, businesses and institutions in the city.

Exhibit 1-1: Rapid Transit Corridors



Note: This network is based on a preferred routing through the Western University Campus. This routing is still under review with the University and may be subject to change once their review process is complete.

1.2 Business Case Approach and Organization

This Business Case follows the architecture and process developed by Metrolinx as presented in the Business Case Development Manual (August 2015).

As outlined in that document, the Business Case Development architecture seeks to ensure that Business Case development activity answers core questions:

- Is the investment supported by a robust case for change that fits with wider public policy objectives?
- Does the investment show sufficient value for money to proceed?
- Is the investment financially affordable and what are the financial implications?
- Is the investment achievable, and what are the engineering and operational issues and challenges?

The business case includes the following sections:

- **Strategic Case –** Rationale and alignment with wider policies
- **Financial Case –** Assesses the costs and affordability of the project
- **Economic Case –** Assesses the economic benefits of the project
- **Sensitivity Analysis –** Provides an analysis of the sensitivity of several assumptions
- **Deliverability and Operations**

This Business Case also recognizes the minimum federal requirements under the Building Canada Fund which are as follows:

- Proponents must demonstrate the economic advantages and the broader public benefits of the project.
- Projects must be part of an official, integrated land-use and transportation development plan or strategy. Where applicable, projects must be consistent with the approved plans of regional transportation bodies.
- Proponents must demonstrate that their proposal is based on current or projected demand and the intended results must be substantiated.
- If the project includes an Intelligent Transportation System (ITS) component or system, that the ITS component or system is compliant with the ITS Architecture for Canada.

2 STRATEGIC CASE

2.0 Strategic Case

2.1 Problem and Opportunity Statement

The City of London is facing a number of problems which Rapid Transit can help solve:

- **Transit Travel Times and Service Frequencies -** Existing transit travel times are not competitive against auto travel. Service frequencies on many routes are often 15 minutes or longer during the afternoon peak, making transit an inefficient option for choice commuters. By implementing a frequent and fast Rapid Transit spine and by enhancing service in support of the spine, the transit network can become an attractive option to commuters;
- **Land Use and Density -** Large portions of the existing urban area consists of large single-use, low-density tracts of land. In many areas, drivers are incentivized to use their vehicle by the availability of free parking. These factors are not conducive to active modes or conventional transit services. Rapid Transit will create an environment that supports investments in dense, mixed-use residential and commercial developments along its corridors and at Transit Village nodes;
- **Growth Management -** The London Plan (draft) forecasts 77,000 new residents and 43,000 more jobs by 2035. If the previous growth trend continues, large tracts of agricultural and rural lands will be consumed, requiring large capital and operating investments to build and maintain the new infrastructure required to support it. Transit oriented development provides a tool to help promote growth through intensification and make efficient use of existing infrastructure. In an assessment of three different grow out scenarios, the City of London recognizes that a more compact pattern of growth, compared to a sprawling form, has the potential to save London tax payers on major servicing, operating, and infrastructure costs over the longer term.
- **Growing Congestion-** The volume of auto trips will grow by 25% by 2030. Recommended improvements identified in the TMP will accommodate much of the demand with only small impacts to travel time (-3% to 10%). Many of these are more expensive over their lifecycle compared to transit, some are infeasible once the roadway is expanded to its limits, and most are inconsistent with the goals of developing a multi-modal transportation network. Rapid Transit is efficient at carrying large volumes of passengers compared to private vehicles, thereby reducing the need for future roadway construction. Rapid transit can help to change people's travel behaviours and mode choices.

A number of opportunities exist which also support further examination of Rapid Transit:

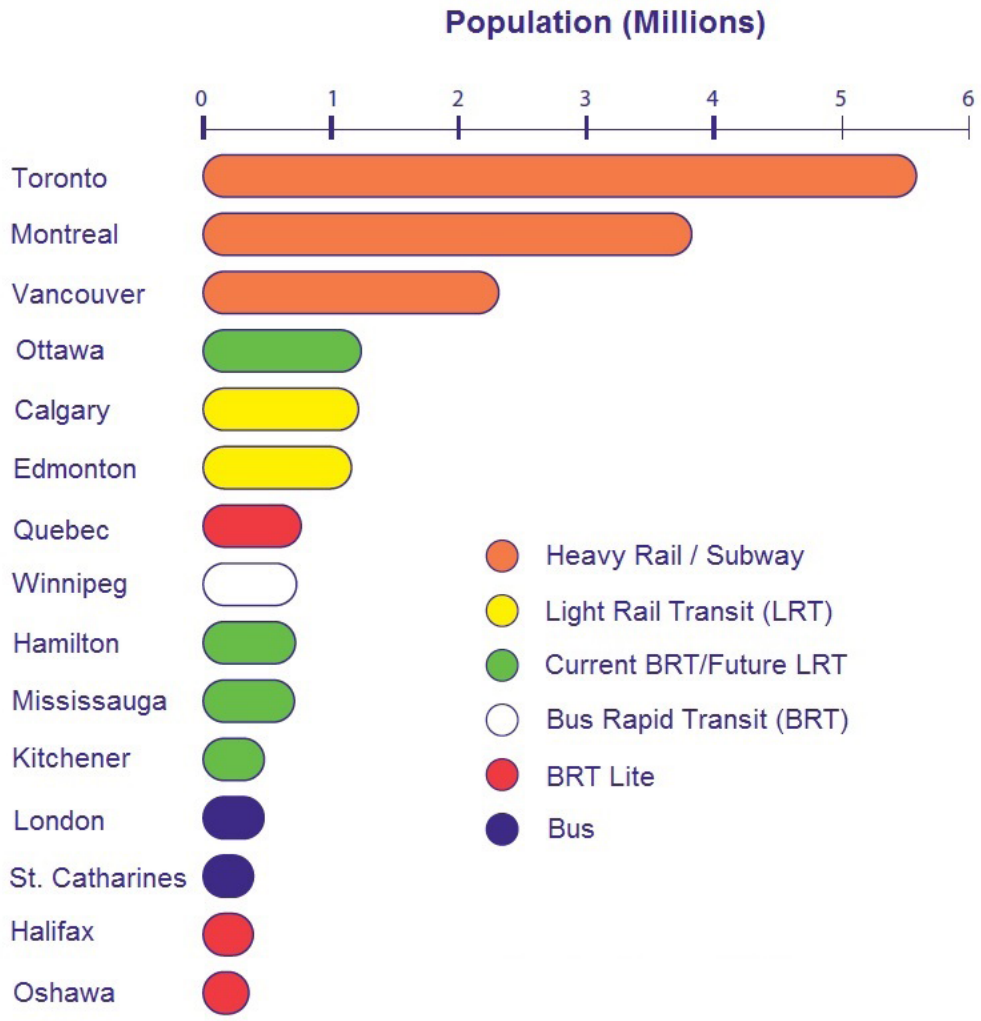
- **Existing Transit Ridership and Growth -** During the p.m. peak travel period, more than half of all passenger boardings occur along a small number of corridors, indicating strong community acceptance of transit. Overall ridership grew to 24.1 million trips in 2014, accounting for 12% of all trips made. Rapid Transit will help build ridership

by attracting choice riders who are more influenced by travel time, convenience and comfort than by cost;

- **Commuter Travel Habits-** In 2011, the average auto and transit trip lengths were both 5.0 km, a transit-friendly distance. This indicates that many existing trips could be competitively made by Rapid Transit (RT). There is also a high untapped potential for transit activity in Downtown London and along the preferred RT corridors, as 2/3 of all trips in London originate along these corridors;
- **Existing Policy-** London's TMP and Official Plan identified the need for a multi-modal transportation network to support all forms of travel. Rapid Transit will provide service for trips not suited for active transportation or conventional transit service;
- **Catalyst for Change-** Rapid Transit investments are a catalyst for urban rejuvenation and inclusive community building; that can lead to new private sector investments. These types of actions are necessary if the City is to achieve its growth vision. This reflects the strong link between transportation, land use and urban form; and,
- **Land Use and Density-** Density downtown and along the potential Rapid Transit corridors are three to seven times higher than the city average, with multiple major activity nodes present. Many corridors have a good foundation for Rapid Transit, which will only grow.

Currently, London is Canada's largest city that does not have an existing or funded Rapid Transit system. Canada's largest urban centres and the rapid transit that is either planned for or existing in these centres is identified in Exhibit 2-1. London carries more riders per capita than comparable cities, including Mississauga, Waterloo Region, Hamilton, and York Region. Furthermore, the proposed Shift plan is consistent in design and projected ridership with other Rapid Transit projects across Ontario, including the Queen Street BRT in Brampton, the B-Line LRT in Hamilton, the Hurontario LRT in Mississauga, and the ION LRT in Waterloo Region.

Exhibit 2-1: Rapid Transit in Canada's Largest Cities



London is well-connected within Ontario by rail, road, and air. The implementation of Rapid Transit will provide a local link to these larger networks. When complete, 65% of London's jobs will be within walking distance of Rapid Transit, and connect a number of major economic activities in London, including universities, colleges, hospitals, financial institutions, manufacturing, and a rapidly growing high-tech industry.

2.2 Municipal Planning Framework

2.2.1 2015 – 2019 Strategic Plan

The 2015-19 Strategic Plan for the City of London sets out our direction for the future. It identifies Council's Vision, Mission, Values, Strategic Areas of Focus and the specific strategies that define how Council and Administration will respond to the needs and aspirations of Londoners. The Plan guided the City's first ever multi-year budget for 2016-19, and it is through the multi-year budget process the Plan will be put into action.

The 2015 – 2019 Strategic Plan identifies the Rapid Transit Implementation Strategy as a means to deliver convenient and connected mobility choices as part of a strategic area of focus called "Building a Sustainable City."

2.2.2 The London Plan (draft Official Plan)

The London Plan (draft) is the City's new Official Plan and identifies City Structure that is based upon rapid transit. The City Structure Plan identifies three different policy areas within the city that will accommodate increasing levels of urban density and higher levels of transit investment:

- **The Urban Growth Boundary –** The boundary between urban and rural London, and is the area within which all future urban development will occur.
- **The Built Area Boundary -** This area circumscribes those lands that have been built-out. Council has set a target for 45% of all new development over the next 20 years to be located within this fixed boundary – this development within the Built Area Boundary is defined as intensification.
- **Primary Transit Area -** This more centrally located area is targeted to accommodate 75% of all intensification over the next 20 years. This area circumscribes the entire rapid transit system and will provide the highest level of transit accessibility and service in the entire City. There will be a focus on improvements to the pedestrian realm and investment in cycling and active transportation facilities.

To support this vision and to catalyze growth in strategic areas, the City Structure Plan also establishes Rapid Transit corridors radiating from the Downtown to four Transit Villages. The Transit Villages are slated to become higher density, mixed-use neighbourhoods and business areas. They will be centrally located around Rapid Transit stations to support a broad array of uses and create great destinations to live, shop, work and play. The corridors will support appropriate intensification along the routes, and encourage active transportation and transit options.

The designated corridors align to those developed in previous studies. The land use designation traverses the full northern and southern corridors, while on the western corridor it reaches to Wonderland Road and along the eastern corridors it extends to Fanshawe College, with potential to extend to the airport in the future. Rapid Transit is also identified for future consideration along Wharncliffe Road with a future Transit Village anchoring the south-west area of the city.

The London Plan identifies the amount and location of growth that is expected by 2035, which is projected to be 77,000 new residents and 43,000 more jobs. By 2035, it is projected that London will be home to 458,000 residents and 241,000 jobs. It is possible that growth could be higher if London is able to exceed its forecasts of net migration. Rapid transit could help to achieve this target.

2.2.3 Transportation Master Plan

The overarching goal of the 2030 TMP is to provide more attractive travel choices for those who live, work, and play in London. If more attractive mobility choices are available to the citizens of London, they are more likely to alter their existing travel patterns and reduce their collective dependency on the automobile. Over the long term, this shift in behaviour can reduce the need for costly and disruptive road improvement projects to commuters and goods movement, maintain good roadway level of service, and provide overall environmental benefits.

The 2030 TMP study is guided by a Council-supported vision that is transit-focused, as transit is most effective where there is sufficient land use density to support and generate ridership. Historically, London has grown at its fringe, with only a small portion of growth occurring within its existing, urbanized boundary. The TMP's transit-focused visions establishes a growth management framework that focuses on intensification of the existing city, as opposed to greenfield expansion. This transit-focused growth framework is at the core of the TMP, and is supported by new transportation policies and infrastructure to achieve this vision.

There are five "Smart Moves" identified that form the basis for the Transportation Master Plan; each play a role in supporting achievement of the plan's goals. Each supports an economically stable and vibrant downtown core, and re-establishes the city centre as the city's primary economic engine. The five "Smart Moves" were identified as:

1. Rethinking Growth to Support the Transportation Master Plan;
2. Taking Transit to the Next Level;
3. Actively Managing Transportation Demand;
4. Greater Investment in Cycling and Walking Infrastructure; and,
5. More Strategic Program of Road Network Improvements.

This Business Case is concerned with the second "Smart Move"; that is; taking transit to the next level. A key component of the TMP growth plan is a Rapid Transit network that consists of two primary corridors. A north-south corridor and an east-west corridor.

The TMP determined that implementing Rapid Transit along these corridors could be supported if two conditions were met:

- If growth continued at 1% annually, the current historical trend; and,
- If 40% of the growth is directed to downtown and along the transit corridors. If higher annual growth is realized, the identified corridors could be upgraded to higher capacity Rapid Transit or additional Rapid Transit corridors could be justified.

Other transit improvements were also recommended by the TMP to increase transit ridership and modal share. These include:

- More frequent service on all main routes;
- Restructured routes to feed the RT services; and,
- Making transit easier for the passengers through broader use of technology, more fare options, and expanded use of real-time information.

2.2.4 Downtown Plan

Our Move Forward: London's Downtown Plan sets out a public investment plan for the next 20 years. Approved in April 2015, the plan includes a number of transformational projects. These include Dundas Place, a shared street concept for this major east-west downtown corridor, and Back to the River, a plan to connect Downtown London to the nearby river system.

Rapid Transit is a key component of the Downtown Plan. Rapid Transit provides the necessary capacity to allow for a reallocation of road space from cars.

2.3 Existing Transportation Conditions

London's road network suffers from a number of geographical challenges. The city is bisected by two major rail corridors and the Thames River, which has historically limited the number of continuous north-south and east-west corridors, in particular, corridors that lead to and from the downtown core.

Although London does not suffer from the same levels of congestion as larger cities, the constrained road network restricts motorized vehicle movement during peak periods. Based on future growth forecasts and assuming no investment in Rapid Transit, auto trips are projected to increase by 30% by 2030. This growth will lead to increased congestion and less predictable travel times.

Some of the busiest bus routes on the LTC network are operating above capacity, and in some cases, passengers are not able to board at their stop due to buses operating at crush loads. The routes that are experiencing these capacity issues are primarily the ones that serve Western University (Northern Corridor), Fanshawe College (Eastern Corridor), and the downtown (both corridors).

Existing peak passenger loads of approximately 1,500 riders per hour are currently experienced in the Northern corridor. Although these riders will likely be distributed between rapid transit and local routes, BRT and LRT are capable of accommodating all of these passengers. Although some BRT system in North America can handle up to 10,000 passengers per hour, a reasonable planning capacity for BRT in London is 2,250 passengers per hour assuming 75 persons per bus and 2 minute headways. LRT capacity at the same 2 minute headway and 170 passengers per vehicle would provide a capacity of 5,100. LRT systems elsewhere in the world using larger vehicles can achieve 13,000 pass/hr.

Ridership on LTC has increased steadily over the past two decades, but further growth is constrained by a number of factors including system capacity and the relative travel times compared to driving. Currently, transit trips typically take twice as long as the equivalent auto trip, and in some cases significantly more. A compounding disadvantage to transit is that most auto drivers are not required to pay for parking.

Each day, approximately 67,500 trips are made during the afternoon peak hour, of which, 6,520 trips are made by transit. Over two-thirds of auto trips in the afternoon peak originate within the identified corridors, and nearly half of those are destined for locations within the corridors. This presents a large opportunity to convert auto users to transit users. Currently, nearly 90% of transit users originate within the rapid transit corridors. By upgrading to Rapid Transit, there is an opportunity to provide better service to a majority of transit users. The southwest portion of the city has the largest number of trips, but only experiences a mode share of 3% due to dispersed and transit unfriendly conditions. There is an opportunity to intensify along corridors in the Southwest and increase this modal share.

Exhibit 2-2 and Exhibit 2-3 below illustrate travel times in minutes, in free flow traffic, between major trip generators in London by automobile and by transit. Exhibit 2-4 expresses these travel times as a ratio of transit travel times to auto travel times. It can be seen from this analysis that, on average, it takes twice as long to get from one centre to another via transit as it does to take an automobile. This difference makes it difficult to attract choice riders to the transit service. In order to increase the transit modal share, the amount of time it takes to get from centre to centre on transit needs to be significantly reduced.

Exhibit 2-2: Auto Travel Time (in minutes), 2015

Origin	DESTINATION					
	Downtown	Western	Fanshawe College	Masonville	Oakridge Mall	White Oaks
2015						
Downtown	-	13	14	16	12	15
Western	14	-	18	5	9	26
Fanshawe	13	17	-	17	18	16
Masonville	13	3	16	-	12	25
Oakridge Mall	8	8	13	10	-	20
White Oaks	15	26	17	26	21	-

Exhibit 2-3: Transit Travel Times (in minutes), 2015

Origin	DESTINATION					
	Downtown	Western	Fanshawe College	Masonville	Oakridge Mall	White Oaks
2015						
Downtown	-	24	34	25	20	21
Western	24	-	22	12	20	32
Fanshawe	34	22	-	33	37	48
Masonville	25	12	33	-	34	38
Oakridge	20	20	36	34	-	39
White Oaks	21	32	48	38	39	-

Based on 2015 LTC service schedules plus a 5 minute access/ transfer penalty

Exhibit 2-4: Ratio of Transit Travel Times to Auto Travel Times, 2015

Origin	DESTINATION					
	Downtown	Western	Fanshawe	Masonville	Oakridge Mall	White Oaks
2015						
Downtown	-	1.8	2.4	1.6	1.7	1.4
Western	1.7	-	1.2	2.4	2.2	1.2
Fanshawe	2.6	1.3	-	1.9	2.1	3.0
Masonville	1.9	4	2.1	-	2.8	1.5
Oakridge Mall	2.5	2.5	2.8	3.4	-	2.0
White Oaks	1.4	1.2	2.8	1.5	1.9	-
Average	2.00					

2.4 Guiding Principles and Objectives for Rapid Transit

The Rapid Transit initiative was built on four guiding principles. Each of these principles can be addressed through a list of objectives. The prioritization of these objectives and the ability for each solution to achieve these objectives has been the basis for measurement throughout the study. Overlaid on these guiding principles is the overarching goal of ensuring fiscal responsibility and affordability.

These guiding principles were adopted early in the Environmental Assessment process and influenced both the development of the problem statement as well as the identification and evaluation of alternatives. A survey of residents served to highlight that London's Rapid Transit plan needed to address more than just transportation and mobility, and represents an opportunity to transform the city. The preliminary preferred Rapid Transit solution can be evaluated based on its ability to address these principle's objectives. The corresponding objectives of each principle are identified in Exhibit 2-5. An analysis of the ability of the preliminary preferred Rapid Transit solution to meet the objectives is detailed in Appendix A of this business case (Project Scorecard).

Exhibit 2-5: Guiding Principles

PRINCIPLES	OBJECTIVES
ECONOMIC DEVELMENT & CITY BUILDING FOCUS	• Attract talent, employment and external investment • Enhance London's ability to attract in-migration • Stimulate and promote infill and intensification • Growth management – reduce sprawl • Downtown revitalization • Connect and invigorate institutions • Job growth to sustain economic prosperity • Lift property values along corridors and at stations
TRANSPORTATION CAPACITY & MOBILITY FOCUS	• Congestion mitigation and prevention • Improve mobility options for all residents • Shift mode choices away from personal automobiles • Improve travel times • Improve service reliability and user experience • Integration with active modes • Connections to regional transportation hubs • Improve transportation safety
COMMUNITY BUILDING & REVITALIZATION FOCUS	• Accessibility for all residents • Improve walkability and the public realm • Develop a stronger sense of place • Develop stronger civic pride • Improve air quality and CO2 emissions reduction • Create walkable and healthy communities • Regenerate urban environments (urban neighbourhoods and main streets)
EASE OF IMPLEMENTATION & OPERATIONAL VIABILITY	• Minimize disruptions and impacts during construction • Maintain operational flexibility • Maintain infrastructure adaptability • Minimize ongoing operating costs

2.5 Rapid Transit Alternatives Considered

The project alternatives identified in this report were shortlisted in the Rapid Transit Master Plan. These four alternatives all cover the same corridors. The corridors were selected through the evaluation process of the Rapid Transit Master Plan.

A summary description of each alternative is provided below.

Base Case: Business As Usual: The Base Case assumes the City of London will continue operating transit in a consistent manner with today's operations; gradually adding service as demand organically increases. Grade-separated and exclusive right-of-ways for transit vehicles are not considered in the Base Case. Under the Base Case scenario, the London Transit Commission (LTC) will continue to run its current fleet of buses with limited signal priority, and with peak headways of approximately 15 minutes on busier routes. It is assumed that capacity is increased at a level commensurate with a change in demand. Under the Base Case scenario, all existing routes remain in service. Ultimately, the Base Case Scenario does not address the Strategic Principles of Rapid Transit that are at the core of the overall vision of the City.

Alternative 1: Base BRT Network Alternative. The BRT network previously developed through the TMP and LTC business case was refined to reflect updated conditions. This alternative does not include dedicated transit lanes in a number of constrained corridors (Wellington Street) and retains the at-grade crossing of the Canadian Pacific Railway (CP) tracks on Richmond Street in the Richmond Row area.

Alternative 2: Full BRT Network Alternative. This BRT network alternative incorporates additional road widening along the corridors and a number of major structural projects, including a Richmond Street Rapid Transit Tunnel under the CP railway and fully separated transit lanes on Wellington Street between Commissioners Road and Horton Street. This alternative also includes allowances for a replacement bridge over the North Thames River on University Drive, pending finalization of alignments through Western University.

Alternative 3: Hybrid of BRT and LRT Network Alternative. This alternative network incorporates LRT along the north and east corridors via downtown with BRT along the south and west corridors. It also incorporates additional widening along the corridors and a number of major structural projects, including a Richmond Street Rapid Transit Tunnel and widening of Wellington Street south of Horton Street to provide for fully separated lanes. The consideration of the north and east corridors for LRT was, to a large extent, based on ridership. These corridors have high ridership today and projected ridership growth in these corridors reaches the minimum levels for LRT to be considered. There is good potential for walk-in traffic given the major institutions and area businesses that are directly along the corridors.

Alternative 4: Full LRT Network Alternative. This alternative network incorporates LRT along all the corridors. It also incorporates additional widening along the corridors and the same structural projects as the previous two alternatives.

2.5.1 Common Elements

The following characteristics apply to all project alternatives in this Business Case:

- **Frequent Service along the Rapid Transit Corridors**, allowing riders to use the service without needing to consult a schedule.
- **Express Service and Fewer Stations,** with stations located at major trip generators.
- **Dedicated Lanes for Rapid Transit,** physically separated from other traffic where feasible.
- **Programmed Traffic Signals** to prioritize the movement of Rapid Transit vehicles.
- **Enhanced Stations:** Stations with larger, more prominent waiting areas, shelters, seating, bike racks, and fare payment equipment.

These common elements are defining characteristics of Rapid Transit. The characteristics which vary across the alternatives evaluated in this Business Case Assessment (BCA) are related to development attractiveness, ridership attractiveness, system capacity, and operating speeds.

3 FINANCIAL CASE

3.0 FINANCIAL CASE

3.1 Operating Costs

3.1.1 Service Levels

Service levels were developed for each alternative based on ridership forecasts and assumed capacities of 70 passengers per vehicle for BRT and 170 passengers per vehicle for LRT. The resultant peak period service levels and capacities are provided below. For off-peak periods, a minimum policy headway of 10 minutes was assumed if not otherwise governed by ridership. In the shorter term, headways during off peak periods may be expanded to 15 minutes, and as ridership grows, the 10 minute policy headway would be initiated.

These figures were used to develop estimated operating and maintenance costs based on per revenue service hour or per revenue service km measures derived from other LRT and BRT operations. The assumed service levels are identified in Exhibit 3-1.

Exhibit 3-1: Assumed Service Levels

ATTRIBUTE	EAST CORRIDOR	WEST CORRIDOR	NORTH CORRIDOR	SOUTH CORRIDOR
Bus Rapid Transit Alternatives				
Headway (min)	5	10	5	10
Capacity per vehicle	70	70	70	70
Capacity Provided (passengers/hr)	840	420	840	420
Light Rail Transit Alternatives				
Headway (min)	7	10	7	10
Capacity per vehicle	170	170	170	170
Capacity Provided (passengers/hr)	1457	1020	1457	1020

3.1.2 Vehicle and Rolling Stock Requirements

Based on route length, revenue service hours, and the need for spare vehicles, the estimated fleet for each Rapid Transit alternative is estimated in Exhibit 3-2.

Exhibit 3-2: Vehicle and Rolling Stock Requirements

ALTERNATIVE	PEAK BRT VEHICLES*	PEAK LRT VEHICLES*
Base BRT	33	-
Full BRT	30	-
Hybrid	11	15
Full LRT	-	26

*Includes spare vehicles

3.1.3 Annual Operating Costs

Operating cost estimates are based on unit values obtained from 2014 LTC operations and supplemented from other sources where required. The diesel cost is based on a 5 year average. The sensitivity analysis for this business case includes variability in energy/diesel costs. Exhibit 3-3 provides a summary of the key operating cost inputs.

Exhibit 3-3: Operating Cost Assumptions

ITEM	AMOUNT	UNIT
Labour Cost	55	$/Service Hour
Administrative Cost	0.12	$/Service Hour
Vehicle Operating Speed (Vo)	30	km/h
Electricity Cost	0.102	$/kwh
Diesel Cost	1.05	$/L
LRT electricicty consumption	8.3	kwh/km traveled
BRT Diesel Consumption	0.6316	L/KM traveled
BRT Vehicle Maintenance	1.084	$/km traveled
LRT vehicle maintenance	0.5	$/km traveled
RT Plant Maintenance	0.26	Portion of Veh. Maintenance
LRT Route Maintenance	120,000	$/km
BRT Alignment Maintenance	50,000	$/km
Auxiliary hours	1.076	rate

From these assumptions, single year operating costs were developed. Annualized operating costs were determined for every year until 2050.

Annual operating costs are developed to account for a phased implementation of Rapid Transit, and timelines for construction. Exhibit 3-4 summarizes the gross annual operating costs by project phase and alternative (in current 2016$ dollars).
The operating costs that are used for the Business Case are the Net Present Value (2016$) of the sum of all the annualized operating costs.

Exhibit 3-4: Rapid Transit Operating Costs between 2019 and 2030 (In 2016$)

RAPID TRANSIT OPERATING COSTS BETWEEN 2018 AND 2030 (2016$)												
	BASE BRT			FULL BRT			HYBRID			FULL LRT		
Year	RT Operating Cost ($2015)	N-E	W-S	RT Operating Cost (2015 $)	N-E	W-S	RT Operating Cost (2015 $)	N-E	W-S	RT Operating Cost ($2015)	N-E	W-S
2019	$860,000	Quick Start		$860,000	Quick Start		$860,000	Quick Start		$860,000	Quick Start	
2020	$860,000			$860,000			$860,000			$860,000		
2021	$860,000			$860,000			$860,000			$860,000		
2022	$860,000			$860,000			$860,000			$860,000		
2023	$6,040,349		W-S BASE BRT	$6,040,349		W-S BASE BRT	$6,040,349		W-S BASE BRT	$6,040,349		
2024	$6,040,349			$5,484,873		W-S FULL BRT	$5,484,873		W-S FULL BRT	$5,629,798		W-S FULL LRT
2025	$6,040,349			$5,484,873			$5,484,873			$5,629,798		
2026	$6,040,349			$5,484,873			$5,484,873			$5,629,798		
2027	$13,799,000	N-E BASE BRT		$12,193,000	N-E FULL BRT		$11,082,000	N-E LRT		$11,544,000	N-E FULL LRT	
2028	$13,799,000			$12,193,000			$11,082,000			$11,544,000		
2029	$13,799,000			$12,193,000			$11,082,000			$11,544,000		
2030	$13,799,000			$12,193,000			$11,082,000			$11,544,000		
2031	$13,799,000			$12,193,000			$11,082,000			$11,544,000		

3.1.4 Capital Costs

Capital costs were estimated based on a combination of cost/km based on a review of other Rapid Transit projects in Canada and preliminary cost was applied to major network items and structures. New BRT vehicles were assumed to cost $800,000 based on recent purchases by LTC and new LRT vehicles were assumed to cost $6,300,000 based on recent costs from Edmonton, Calgary and Waterloo. Given that this project is currently in the EA stage, the level of uncertainty related to underground utilities and other costs will be better known at the preliminary design phase. A 40% cost contingency was added to the cost of construction to account for this uncertainty.

The single year cost breakdown for each alternative is identified in Exhibit 3-5. These costs are distributed across the project phasing and this phasing has implications on the Net Present Value (NPV) of the costs in 2016. These NPV Capital Costs are summarized in section 3.1.5.

Exhibit 3-5: Capital Cost Inputs (Single Year Spending Assumption)

SUMMARY OF CAPITAL COSTS (ROUNDED IN MLLIONS 2016$)				
COST COMPONENTS	SCENARIOS			
	BASE BRT	FULL BRT	HYBRID	FULL LRT
Segment Total	$129,231,000	$262,134,000	$415,937,700	$538,208,400
Maintenance Facility	$10,000,000	$10,000,000	$35,000,000	$35,000,000
Engineering (15%)	$19,384,650	$39,320,100	$62,390,655	$80,731,260
Project Management (10%)	$12,923,100	$26,213,400	$41,593,770	$53,820,840
Contingency (40%)	$68,615,500	$135,067,000	$221,968,850	$283,104,200
Vehicles	$26,400,000	$24,000,000	$103,300,000	$163,800,000
Total (Rounded)	$270,000,000	$500,000,000	$880,000,000	$1,150,000,000
Cost per KM (23.7 km RT network)	$11,000,000	$21,000,000	$37,000,000	$48,000,000

Note: These costs are not reflective of distribution of costs into future years.

3.1.5 Financial Case Summary

The financial account includes the net present value of the capital and incremental operating costs and incremental passenger revenue over the evaluation period (Exhibit 3-6). The incremental differences in fare revenues begins in 2027, when rapid transit commences. This value is based on the incremental increase in revenue when comparing the Rapid Transit alternatives to the base case. Due to phasing and the delaying of costs and benefits, the NPV of the costs and revenues are different than the single year cost breakdowns that were identified above.

The difference between fare revenues in each alternative is represented by the project increase in riders due to the implementation of Rapid Transit, multiplied by the projected average fare per person, over the life of the study.

Exhibit 3-6: Financial Account Summary

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Total Capital (NPV 2016$)	249.8	440.2	781.5	1,022.7
Total Operating (NPV 2016$)	264.2	234.9	215.6	224.0
Total Costs (NPV 2016$)	514.1	675.1	997.1	1,246.7
Total Additional Revenue (NPV 2016$)	45.6	73.1	83.1	85.6
Net Revenue-Costs (NPV 2016$)	(468.5)	(602.0)	(914.0)	(1,161.0)

The total incremental costs for the Business Case alternatives range from $514-million to $1.25-billion, with LRT-based alternatives costing more than BRT-based alternatives of the same length. Light rail transit capital costs are higher than that of bus Rapid Transit due to two primary factors:

- **Higher vehicle cost:** Even when considering the longer service life of light rail vehicles, they are still more expensive than the equivalent number of buses. Some of this increased cost is offset by the need for fewer light rail vehicles to accommodate modelled demand, compared to buses; and
- **Higher cost of infrastructure:** Unlike bus rapid transit, light rail transit requires significant additional infrastructure related to the installation of track and switches, electrification of the track or catenaries, signalization, and communications and train control.

As a result of the higher capital costs, LRT requires a much higher return in the form of transportation user benefits in order to achieve a positive benefit-cost ratio.

4 ECONOMIC CASE

4.0 ECONOMIC CASE

4.1 Transportation Inputs

4.1.1 Transportation Demand Model

The City's travel demand model, which was developed in 2013, was updated for use in the London Rapid Transit Corridors Environmental Assessment (EA). The City's model was previously updated for the Transportation Master Plan in 2013. The update involved an assessment of network coding, trip generation, distribution, mode-choice, and validation including traffic and passenger flow and travel times.

The transportation demand model used a traditional four-step modelling approach to forecast transportation network statistics used to evaluate each of the four Rapid Transit Network Alternatives. Each Rapid Transit alternative assumed an aggressive land use strategy with 40% intensification in built up areas, which was compared to a Business As Usual (BAU) scenario.

The model provided Year 2035 horizon forecasts for system wide transit ridership, auto and transit travel times, transit passenger kilometres traveled, and vehicle kilometres traveled for each alternative. Forecasts to 2050 were developed using a linear projection.

4.1.2 Ridership Forecasts

Network-wide Ridership Projections for the 2035 horizon year were extracted from the Travel Demand Model and ridership for each proceeding year to 2050 and each subsequent year back to 2015 were extrapolated using an assumption for linear growth from the base year. This Ridership growth (for the Full BRT alternative) is illustrated in Figure 4-1.

As identified in Exhibit 4-2, the difference between the ridership in each of the Rapid Transit Alternatives is relatively modest due to the fact that this represents system wide ridership and the majority of riders will continue to use the existing LTC routes, which is unaffected by rapid transit technology. The differences that are recognized here are justified by assumed differences in choice rider perception, operating speeds (only different for the Base BRT Alternative), and slight differences in intensification around the rapid transit corridors. Given the model's limitations to address these differences, the differences were calculated using first principles based on overall growth forecasts and mode split.

These ridership projections are subject to variability as future trends emerge. As new technologies and services emerge, it will be important for the City to leverage these new options and integrate them within them to promote the use of an integrated mobility system. In such systems, ridership on transit becomes less of an important performance metric compared to measuring the overall use of the mobility system, reductions in solo car trips, and increases in linked, multimodal trips. Several benefits that are calculated in this business case pivot off these values, and therefore the results of this business case are sensitive to changes in these projections.

Exhibit 4-1: Past and Projected Future Transit Ridership (1998 to 2035)

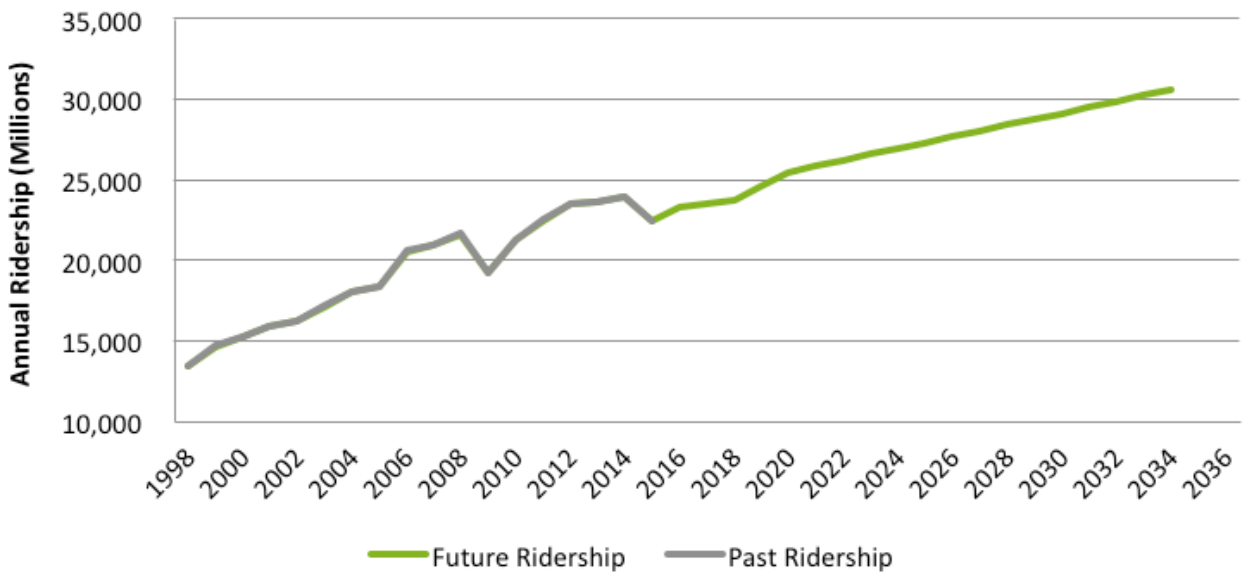


Exhibit 4-2: 2035 Annual Ridership Forecasts

CRITERIA	BAU	BASE BRT	FULL BRT	HYBRID	FULL LRT
City-Wide Transit Mode Share	15%	16%	16.6%	16.8%	16.8%
Transit Network Ridership (2035)	28,680,733	30,500,000	31,600,000	32,000,000	32,100,000

These annual network-wide ridership numbers are derived from the peak-hour output of the model results. An expansion factor was applied to the hourly ridership results to come up with the annual values. The following expansion factors were assumed:

- Peak Hour to Peak Period Conversion: 0.39 (inverse = 2.56)
- Peak Period to Daily: 3.125
- Daily to Annual: 275

These values above represent system wide ridership. Rapid Transit riders represent approximately 1/4 of these trips, while the remaining 3/4 use local LTC service.

4.1.3 Wider Transportation Network Impacts

The increases in ridership due to the implementation of Rapid Transit will reduce automobile trips and vehicle kilometres travelled (VKT) across the entire network. These reductions occur in response to both the availability of faster transit in comparison to the base case, as well as the attractiveness of various Rapid Transit alternatives vs. the base case. Exhibit 4-3 summarizes these wider network impacts in terms of reductions in auto VKT.

Exhibit 4-3: Summary of VKT Reductions

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Auto Vehicle-km Saved in 2035	12,734,869	20,434,869	23,234869	23,934,869
Auto Vehicle-km Saved (From 2019 to 2050)	330,527,736	530,377,736	603,050,464	621,218,645

4.2 Internal User Impacts

Internal User Impacts refers to the travel impacts experienced by the users of the transportation system. For the purpose of this Business Case, these are generally based on travel time savings by transit users. Additional considerations include improved reliability and reduced crowding.

4.2.1 Value of Time Savings for Transit Riders

Travel time savings to transit riders will occur as a result of the construction of separated Rapid Transit lanes. Alternatives 2, 3 and 4 provide additional travel time savings over the Base BRT alternative due to the grade separation of Richmond Street at the CP tracks and with longer sections of independent transit right of ways.

The projected travel time savings from the four quadrants of the city to downtown are shown below.

Network-wide transit travel time savings were estimated using the city-wide model. The Business as Usual Network, the Base BRT Network, and the other three Rapid Transit networks all have different transit travel times. Compared to the Business as Usual Alternative, the Base BRT assumes a transit journey travel time improvement of 3.5 minutes and the other three alternatives assume a transit journey travel time improvement of 5.3 minutes. These differences in travel speeds have been applied to the base case (BAU) transit ridership in each year to determine the total transit user travel time savings across the network. The resulting value of the time savings is calculated using an assumed value of time, based on a medium income of $18.26/hr ($2016). The present value of these network-wide travel time savings are shown in Exhibit 4-5. While Exhibit 4-5 shows network wide travel time savings, Exhibit 4-4 shows time savings along the RT corridors.

Exhibit 4-4: Projected Transit Travel Time Savings along the RT Corridors

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
From King/Clarence to:	Time Savings (min)	Time Savings (min)	Time Savings (min)	Time Savings (min)
Western University	5.5	7	7	7
White Oaks	3	4.5	4.5	4.5
Fanshawe College	7.5	7.5	7.5	7.5
Wonderland Road	1	1	1	1.5

Exhibit 4-5: Transit Travel Time Savings Across the Network

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Transit person-hours saved (2035)	1,195,030	2,533,464	2,533,464	2,533,464
Total Transit Person Hours Saved (to 2050)	59,897,299	62,034,196	62,034,196	62,034,196
Travel Time Savings- Transit (NPV in $M)	520	788	788	788

*These values represent the discounted benefits in NPV (2016$)

4.2.2 Reliability Improvements

A key feature of the preferred Rapid Transit network is the construction of a grade separation of Richmond Road at the CP tracks just north of the Downtown core. This grade separation will significantly improve reliability for transit users as schedules will be met with fewer obstacles. Based on an analysis of train frequencies, it is estimated that buses are delayed up to 10 times per day and delays can last between three to six minutes. These benefits are realized by the Full BRT, Hybrid and Full LRT alternatives, but the grade separation is not part of the Base BRT alternative.

Addressing this network constraint will significantly improve service reliability as well as safety.

4.3 External User Impacts

External impacts include impacts experienced by society as a whole, including travel time impacts of users of other modes.

4.3.1 Vehicle Safety

A mode shift of trips from autos to transit can lead to a reduction in vehicle collisions. The economic benefit of these reductions was calculated using the assumption that $0.03 in safety benefits are accumulated for every VKT reduced.

Exhibit 4-6: Safety Benefits

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Auto Vehicle-km Saved (From 2019 to 2050)	330,527,736	530,377,736	603,050,464	621,218,645
Safety Savings ($M NPV)*	6.7	10.8	12.3	12.7

*These values represent the discounted benefits in NPV (2016$)

4.3.2 Network-wide Road User Benefits

Rapid Transit will help reduce auto dependency which will help benefit other road users (drivers) that continue to drive as their primary mode of transportation. This analysis assumes that 0.01 hours are saved by network-wide road users for every VKT reduced. Exhibit 4-6 shows the results of this analysis when multiplied by the value of time assumption.

Exhibit 4-7: Network Wide Road User Benefits

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Network-wide Road User Travel Time Savings ($M NPV)*	41.1	65.9	75.0	77.2

*These values represent the discounted benefits in NPV (2016$)

4.3.3 Air Quality Improvements

Air quality benefits include reductions of criteria air contaminants caused by vehicle emissions.

The Metrolinx Business Case Guidelines suggest a simple approach to estimating air quality benefits which is to multiply VKT reduced by $0.002. These results are summarized in Exhibit 4-8.

Exhibit 4-8: Air Quality Benefits

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Value of Air Quality Benefits ($M NPV)*	0.4	0.7	0.8	0.8

*These values represent the discounted benefits in NPV (2016$)

4.3.4 Greenhouse Gas Emissions Reductions

Greenhouse gas emissions savings will be realized through a mode shift from automobiles to transit. The emissions intensity of bus-based transit can be as much as half that of a typical passenger car depending on how well transit is utilized.

LRT provides further reductions since electricity in Ontario is produced primarily through hydro-electric and nuclear power generation. All modern, urban light-rail system are electrically powered and have no local emissions. Some cities have taken the extra step to power their LRT fleet with renewable energy to reduce total emissions to near-zero throughout the vehicle lifecycle. There are also options for reducing emissions and energy consumption in the BRT alternatives, through such design choices as hybrid or electric buses, clean diesel, or biofuel.

The reduction in GHG is calculated from the auto vehicle kilometre reduction caused by each Rapid Transit alternative, multiplied by the average mass of greenhouse cases produced by automobiles per kilometre, in this case, 0.367 kg per km. The incremental differences in GHGs emitted by the transit vehicles in each alternative is not considered due to the potential for BRT vehicles to be electric in the near future.

The Metrolinx Business Case Guidelines suggest a societal cost of $155 per tonne of CO2 equivalents. This is higher than previous estimates which did not account for marginal damages from global warming.

The resultant monetary benefits of Rapid Transit are shown on Exhibit 4-9.

Exhibit 4-9: Greenhouse Gas Emissions Reductions

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Reduction in GHG Emissions (t)	121,304	194,649	221,320	227,987
Value of GHG Reduction ($M NPV*)	12.8	20.5	23.3	24.0

*These values represent the discounted benefits in NPV (2016$)

4.3.5 Health Benefits

Public transit and active transportation are closely connected. Since every transit trip starts and ends with an active transportation component, the success of a Rapid Transit system is dependent on the pedestrian and cycling connections approaching the stations. Compared to driving, transit users can achieve 25% more of their daily physical activity requirements through their commute. For the calculation of this benefit, each additional transit trip is assumed to include a 250 m walking component. This additional walking can be monetized as a health benefit to the user that can be recognized at a societal level. Exhibit 4-9 identifies the additional walking that is accumulated by the increase in transit use and the monetary benefit that it represents. Since Rapid Transit is also conducive to cycling activity, and Rapid Transit Vehicles can allow for cyclist to board with their bicycles, cycling activity is also likely to increase. However, there is not a sound method for quantifying the additional cycling activity as a result of Rapid Transit development, and therefore, the focus of the health benefits of this business case focus on walking benefits only.

Exhibit 4-10: Health Benefits (Additional Walking)

CRITERIA	BASE BRT	FULL BRT	HYBRID	FULL LRT
Additional Transit Trips	47,218,248	75,768,248	86,150,066	88,745,521
Additional Walking kms	11,804,562	18,942,062	21,537,517	22,186,380
Health Benefit ($M NPV)*	24	38	43	45

*These values represent the discounted benefits in NPV (2016$)

4.3.6 Economic Case Summary

A summary of all the Economic Case Benefit Accounts that were detailed in this section are summarized in Exhibit 4-11.

Exhibit 4-11: Economic Case Summary

DESCRIPTION	BASE BRT	FULL BRT	HYBRID	FULL LRT
ECONOMIC CASE				
Internal Benefits (NPV 2016$ in Millions)				
Transit User Time Savings	520.3	787.9	787.9	787.9
External Benefits (NPV 2016$ in Millions)				
Unperceived Automobile Costs Savings	13.5	21.7	24.6	25.4
Network Wide Road User Savings	41.1	65.9	75.0	77.2
Safety Savings	6.7	10.8	12.3	12.7
GHG Emissions	12.8	20.5	23.3	24.0
Air Quality	0.4	0.7	0.8	0.8
Health (Walking)	24	38	43	45
Sub-total	98	158	179	185
Total Benefits (Internal+External)	618.6	945.7	967.3	972.7
Net Costs (2016$)	-468.5	-602.0	-914.0	-1161.0
Benefit - Cost Ratio	1.3	1.6	1.1	0.8

4.4 Wider Economic Development Impacts

The Wider Economic Development Impacts assessment provides estimates of the impacts the construction and operation of the four different London rapid transit alternative may have on the economy in terms of direct and indirect employment, income/wages and gross domestic product (GDP), relative to the Base Case (business as usual). These impacts will be both temporary in nature, occurring over the short-term during construction of the rapid transit, as well as long-term during the ongoing operations. The Economic Development Account also considers how the four different rapid transit alternatives may stimulate business/industry growth and result in uplift in land value.

The inputs to the Economic Development Account were generated using a variety of secondary data sources, such as, but not limited to, Statistics Canada (e.g. 2011 Census, 2011 Expenditure Price Statistics, 2011 Employment, Earnings and Hours Statistics and 2005 Input-Output Multipliers), population and employment projections prepared by Altus Group and the City of London and various municipal policy and regulatory documents, studies and GIS data. Primary research was also collected through windshield surveys, analysis of air photos and reviews of real estate listings and historic transactions.

4.4.1 Short-Term Impacts (Construction)

The economic benefits associated with the construction of the four transit alternatives can be quantified in terms of the estimated number of direct and indirect person-years of employment, wages and additional GDP. It should be noted that GDP, by definition, includes wages and salaries as a sub component and therefore the estimates of GDP and income cannot be added together.

As shown in Exhibit 4-12, depending on the alternative, the construction of rapid transit in the City of London and associated transit facilities could generate an estimated 1,400 to 5,800 direct person-years of employment and between 1,100 to 4,400 indirect person-years of employment. The total impact on GDP during construction is estimated to be between $150.7 and $626.0 million.

Exhibit 4-12: Estimates of Short Term Employment, Income and GDP Impacts during Construction

		BASE BRT	FULL BRT	HYBRID	FULL LRT
Construction Cost (millions)		$249.8	$440.2	$781.5	$1,022.7
Employment Years	Direct	1,400	2,500	4,400	5,800
	Indirect	1,100	1,900	3,300	4,400
	Total	2,500	4,400	7,700	10,200
Wages (millions)	Direct	$89.9	$158.5	$281.3	$368.2
	Indirect	$68.5	$117.0	$207.2	$274.2
	Total	$158.4	$275.5	$488.6	$642.3
GDP (millions)	Direct	$87.4	$160.1	$282.2	$364.7
	Indirect	$63.3	$112.8	$200.4	$261.3
	Total	$150.7	$272.9	$482.6	$626.0

*These values represent the discounted benefits in NPV (2016$)

The magnitude of short-term impacts is directly based on the capital cost of the project. The larger the construction cost the more person-years of employment, wages and increase in GDP. Alternative 1 (Base BRT) will cost the least to construct and therefore will generate the lowest level of short-term economic impacts. Alternative 4 (Full LRT) will cost the most to construct and therefore will generate the greatest economic impacts during the construction phase.

The types of industries that may benefit from the construction of the rapid transit (directly or indirectly) will vary depending on the type of rapid transit mode. For example, both rail and bus-based alternatives would have similar impacts on industries for the construction of the runningway and stations but for the bus-based alternatives (Alternatives 1, 2 and 3) a greater proportion of the short-term impacts would be on the manufacturing of transit vehicles, as a large number of buses would be required to accommodate demand. Alternatives utilizing light rail (Alternatives 3 and 4) would create short-term impacts in different industries, including rail manufacturing and specialized manufacturing segments that produce advanced technology required for rail transit such as transit signals and other systems.

4.4.2 Long-Term Impacts (Operations)

The economic benefits associated with the ongoing operations of rapid transit can also be quantified in terms of the estimated number of direct and indirect person-years of employment, income (i.e. wages/salaries) and additional GDP. These long-term economic benefits are directly tied to the annual operating costs and can be impacted by changes in ridership, operational subsidy, and service standards. The operating costs estimated for the four alternatives, and consequently the long-term economic impacts, reflect a minimum level of service to accommodate projected ridership demand.

Salary information from the London Transit Commission and Statistics Canada was used to generate estimates of direct person-years of employment and wages over the operating period of 2025 to 2050. As shown in Exhibit 4-13, depending on the project alternative, operation of the rapid transit service could generate between 130 and 160 direct person-years of employment annually and between $7.0 and $8.7 million in direct wage income (2015$). The bus-based alternatives, which require more vehicles due to lower vehicle capacity, would generate more long-term employment and wage impacts due to higher operating costs (including more operators), compared to the LRT-based alternatives.

Exhibit 4-13: Estimates of Annual Long Term Employment, Income and GDP Impacts

		BASE BRT	FULL BRT	HYBRID	FULL LRT
Annual Operating Costs (millions)		$13.8	$12.2	$11.1	$11.5
Employment Years	Direct	160	140	130	130
	Indirect	80	70	70	70
	Total	240	210	200	200
Wages (millions)	Direct	$8.7	$7.7	$7.0	$7.3
	Indirect	$4.6	$4.0	$3.7	$3.8
	Total	$13.3	$11.7	$10.7	$11.0
GDP (millions)	Direct	$6.2	$5.5	$5.0	$5.2
	Indirect	$3.7	$3.3	$3.0	$3.1
	Total	$9.9	$8.8	$8.0	$8.3

Note: all figures are net present values (2015 $) over a period of 2025 to 2050 and numbers have been rounded.

As noted, Statistics Canada Input-Output Multipliers were applied to generate estimates of indirect employment (between 70 and 80 person-years of employment) and indirect wages (between $3.7 and $4.6 million). The multipliers were also used to establish potential growth in direct and indirect GDP (total growth estimated to range between $8.0 and $9.9 million, depending on the alternative). Alternative 3 (Hybrid) has the lowest estimated incremental operating costs and therefore will generate the lowest long-term economic impacts – in terms of the number of direct and indirect jobs and associated wages. The higher maintenance costs associated with the full fleet of BRT vehicles in Alternative 1 (Base BRT) will generate the greatest ongoing economic impacts.

4.4.3 Long-Term Impacts – Increase in Land Values

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

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

Martin Luther King, Jr. East Busway (Pittsburgh) - Properties located 1,000 ft. from a BRT station were found to be valued approximately $9,745 less than properties located 100 feet away (Source: Federal Transit Administration, 2009). Based on median housing values within neighbourhoods served by the Busway, this roughly translates into a 3% to 5% increase in property value (Source: IBI Group based on Trulia, Inc. 2011 data). The value of commercial properties within 30 metres of a BRT station were valued at almost $10,000 more (2012 USD) compared to commercial properties 300 metres away (Source: Perk and Catala 2009 and www.wrirosscities.org).

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

Franklin and Gateway EmX BRT Line (Eugene, Oregon) – For every walking minute that separates a property from an EmX station along the Franklin corridor there is a premium of approximately 0.18 to 0.11% (Source: Hodel & Ickler, 2014).

RTA Health Line (BRT), Cleveland - To-date the BRT has helped stimulate development projects between Public Square and University Circle valued at $4.3 billion (Source: gettherepgh.org).

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

Dallas Area Rapid Transit (DART) - Near LRT stations, property value increases of 12% and more were seen compared to properties outside of a one quarter mile from LRT stations (Source: Weinstein & Cloward).

RTD Light Rail (Denver) - Historically Denver has seen a 15% to 20% premium for properties located near transit (Source: Citiventure Associates, 2008).

Hiawatha LRT Line (Minneapolis) – Real estate prices along the Metro Transit LRT have rose 83% between 2000 and 2004 as opposed to the city average of 61% (difference of 20%). The LRT has resulted in the conversion of older industrial buildings (Sources: www.reconnectingamerica.org and Transportation Riders United, 2008).

A number of other factors play an important role in the impact transit investment can have on property values, intensification and economic development. For example:

- Uplift in land value is closely tied with the levels of population and employment growth and market demand for various types of housing (e.g. lower density suburban vs higher density urban).

- The higher the level of ridership and passenger usage of stations/stops the greater the impact on the value of retail, commercial and institutional lands and lease rates.
- Studies have found that transit investment tends to have a larger impact on land values in lower and middle-income areas, or neighbourhoods with high proportions of students, seniors and young adults.
- Research suggests that the greatest uplift in land value has been realized in areas where transit service is being introduced (opposed to an upgrade to existing service) or in situations where the rapid transit line is serving either a very dense urban area or a large geographic area and has particularly high daily ridership levels.

The City of London anticipates it will grow by 77,350 people between 2011 and 2031, reaching a total population of 443,500 by 2031. This represents population growth of 21% over the next twenty years. The ReThink London Land Needs Background Study forecasts that 42,375 new residential units will be required to accommodate this population growth, with 39% (16,738) of the new units to be constructed within the 'Built Area' of municipality:

- 88% high-density (11,581 units);
- 21% medium-density (3,596 units); and
- 9% low-density (1,561 units).

Based on population forecasts prepared by the City of London for its ten traffic superzones, we estimate that over the period of 2011 to 2034, of the growth that will be constructed in the existing "Built Area", between 60% and 70% of this growth could occur within 500 m of the proposed rapid transit corridors. This would translate into the need for thousands of new residential units. The City of London has a large supply of vacant or underutilized lands within 500 m of the proposed rapid transit corridors which could accommodate transit-oriented development.

Following a review of the City's new draft Official Plan (The London Plan) and the land designations (Place Types) and density permissions along the proposed rapid transit corridors, estimates of the amount of land which will be required to accommodate the anticipated population growth (i.e. new buildings and units) were prepared. Those residential developments which have been recently built or are planned and underway were taken into consideration.

The city of London's economy is currently heavily dominated by information technology, medical research, manufacturing and insurance. Higher education facilities such as Western University and Fanshawe College play a major role in London's economy, adding close to 1.5 billion dollars annually. In past years the city has struggled with high vacancy rates specifically in the downtown core area. The Canadian Market Outlook (2015) conducted by CBRE suggests that the vacancy rates seen in recent years in London will continue, with marginal gains, but acknowledged that the City's attempt to revitalize the downtown core by waiving development charges for certain types of developments is a positive way to stimulate growth.

The introduction of rapid transit should also help stimulate economic development and growth as it will help connect people to jobs and establish clusters of industry in proximity to transit stations. Businesses and major institutions within close proximity to the transit corridors can be expected to benefit from improved access to skilled workers and customers, increased productivity and competitiveness resulting from a reduction in travel times and transportation costs. The City of London anticipates its employment base will grow by 43,000 jobs between 2015 and 2035 and that millions of square feet of new commercial, institutional and industrial space will be required. It is estimated that when complete, 65% of London's jobs will be within walking distance of rapid transit.

We estimate that uplift in land value of between $80 and $115 million, depending on the technology that is used, could be realized along the proposed rapid transit corridors if the City of London grows as anticipated or achieves even greater levels of population and employment growth. Some vacant or largely underutilized properties will see a major uplift in value and others will see little to none. The average uplift in land value along the corridors is anticipated to range from 2% to 10%.

4.5 Additional Qualitative Benefits

There are a number of objectives that are part of the guiding principles of this project that were identified in Exhibit 2-4 that were not measured in any of the monetized benefits cases. These are benefits that are qualitative in nature and relate to the ability for Rapid Transit to address the guiding principles of the City. These benefits are related to improving the City's image, attracting external investment, providing a catalyst for intensification and Transit Oriented Development (TOD), and other benefits to the transit rider, such as rider comfort, aesthetic appeal, and journey attractiveness.

The ability for each of the Rapid Transit Alternatives to achieve these goals is summarized in Exhibit 4-15.

Exhibit 4-14: Additional Qualitative Benefits

	BASE BRT	FULL BRT	HYBRID	FULL LRT
Catalyst for TOD	✓	✓✓	✓✓1/2	✓✓✓
Ease of Implementation and Constructability	✓✓✓	✓✓1/2	✓	✓1/2
Potential Impact on City Image	✓	✓	✓✓1/2	✓✓✓
Urban Regeneration Benefits	✓	✓	✓✓1/2	✓✓✓
Operational and Infrastructure Flexibility	✓✓	✓✓	✓1/2	
Qualitative User Benefits (Ride Quality and Attractiveness)	✓	✓	✓✓	✓✓✓

✓= Slightly positive impacts ✓✓ = Positive Impacts ✓✓✓ = Very Positive Impacts

5 SENSITIVITY ANALYSIS

5.0 SENSITIVITY ANALYSIS

There are several variables in this business case that are forecasts of future year conditions based on the industry standard assumptions of today. Given the uncertainty of the economic climate, the trends that are emerging in transportation technology and user preferences, and given the limitations of the travel demand model because of these uncertainties, these variables will inevitably differ from current forecasts.

The purpose of this sensitivity analysis is to identify these variables and change their assumptions to see what the impact will be on the benefits and costs of the business case. The sensitivity analysis is summarized in Exhibit 5-1.

Exhibit 5-1: Sensitivity Analysis

VARIABLE	IMPACT ON TOTAL BENEFITS/NET COST				
	CHANGE	BASE BRT	FULL BRT	HYBRID	FULL LRT
Unchanged B/C Ratio	0%	1.83	2.19	1.72	1.48
Intensification and TOD*	-5%	1.77	2.13	1.68	1.46
	+5%	1.90	2.24	1.75	1.51
Energy Costs (Diesel and Electricity)	-50%	1.96	2.32	1.82	1.58
	+50%	1.79	2.18	1.75	1.52
Value of GHG Emissions Savings	- 50%	1.86	2.23	1.77	1.54
	+50%	1.89	2.26	1.79	1.56
Land Value Uplift	- 50%	1.79	2.17	1.72	1.50
	+50%	1.96	2.32	1.84	1.60
Discount and Inflation rates	- 1.5%	1.89	2.27	1.80	1.56
	+1.5%	1.86	2.23	1.77	1.54
Ridership	- 5%	1.53	1.92	1.55	1.36
	+5%	2.19	2.49	1.89	1.61

*Differences in intensification could result in changes to the ridership assumptions. For example, 45% intensification vs 40% means that 5% more of the 77,000 new residents will be living in the built urban area and primary transit area. If we assume that this 5% has a transit ridership mode split of 25% instead of 5%, at 1.44 trips per person/day there would be 1,109 more daily riders or 304,975 more annual riders in 2035. (77,000*0.05*1.44*0.25 – 77,000*0.05*1.44*0.05 = 1109).

Changes in the variables identified in the sensitivity analysis do not result in significant changes to the Total Benefits/Net Costs ratio. This is due to the fact that several cases make up this ratio, and therefore changes to any one of those cases do not have significant impacts on the overall B/C ratio. Changes in these variables do, however, have significant impacts on the cases that they affect.

6 DELIVERY AND OPERATIONS

6.0 DELIVERY AND OPERATIONS

6.1 Current Project Management

The Rapid Transit initiative is being led by the City of London and is overseen by a Steering Committee consisting of representatives from Roads and Transportation, Environmental and Engineering Services, Planning, and Community and Economic Development, together with the London Transit Commission (LTC).

As funding commitments are confirmed, it is planned that a Rapid Transit Office will be formed to oversee the project implementation.

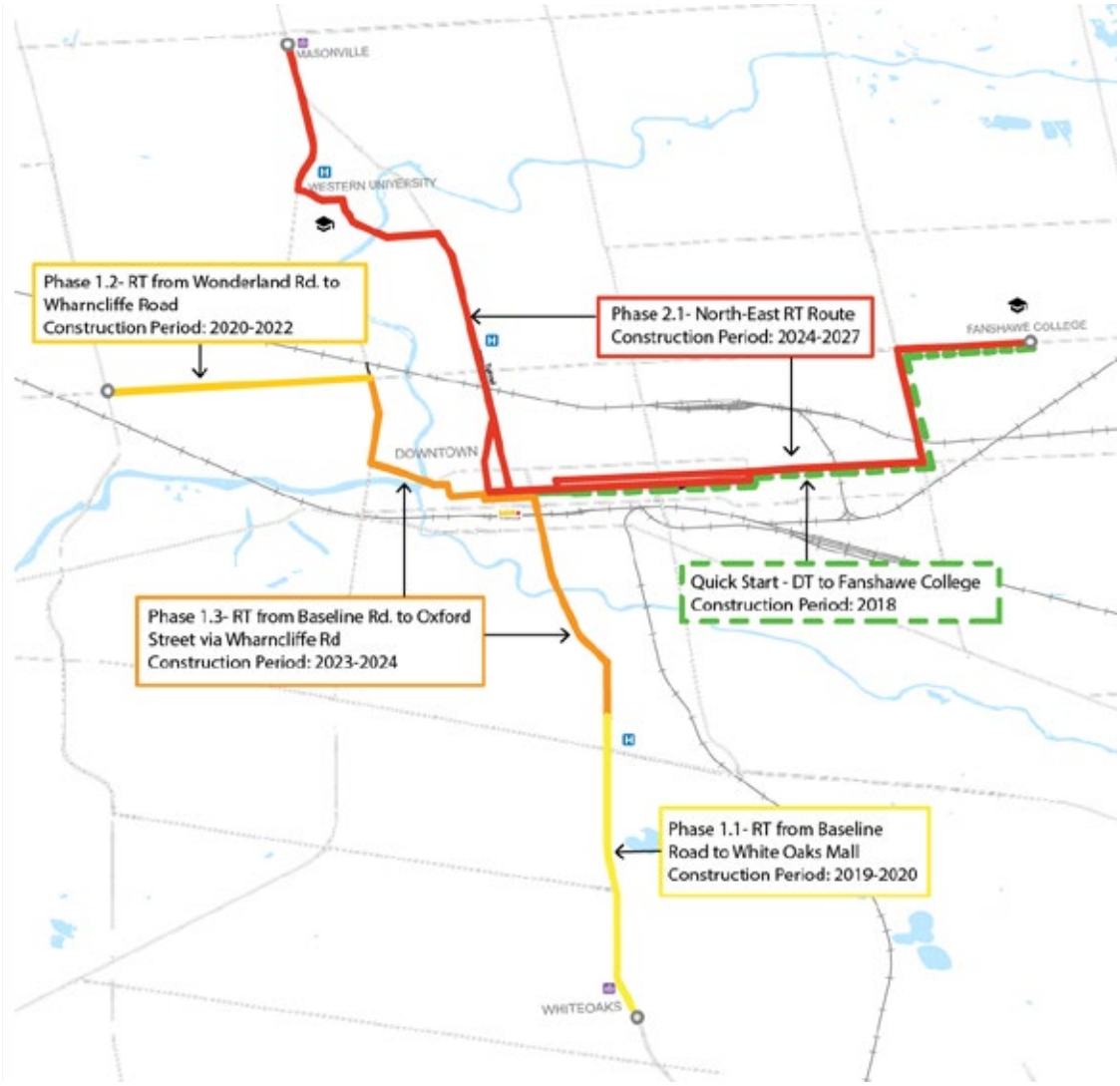
6.2 Project Timelines

Planning Rapid Transit has been on-going since the completion of the Transportation Master Plan in 2010. An Environmental Assessment was initiated in the Fall of 2014 and is planned to be completed by the end of 2016. At the present time, the EA is following the Class Environmental Process, but there is an option to utilize the Transit Project Assessment Process (TPAP) to accelerate environmental approvals.

Following the completion of the EA, the project will move to detailed design. This stage is expected to take up to two years meaning that some segments of Rapid Transit could commence construction in 2019.

The current implementation plan, shown on Exhibit 6-1, anticipates that construction would start on the west and south corridors first as these corridors are less complicated. Construction on the east and north corridors would then commence in 2023. The phasing plan accounts for the City's commitment to deliver other transportation projects, including improvements on other corridors which are a pre-requisite for Rapid Transit. Recognizing the time to implement the full Rapid Transit System, a quick start initiative is proposed for the Fanshawe College to Downtown corridor. The phasing plan can be adjusted depending on the final alternative that is selected.

Exhibit 6-1: Preliminary Phasing Plan



6.3 Funding and Procurement Strategy

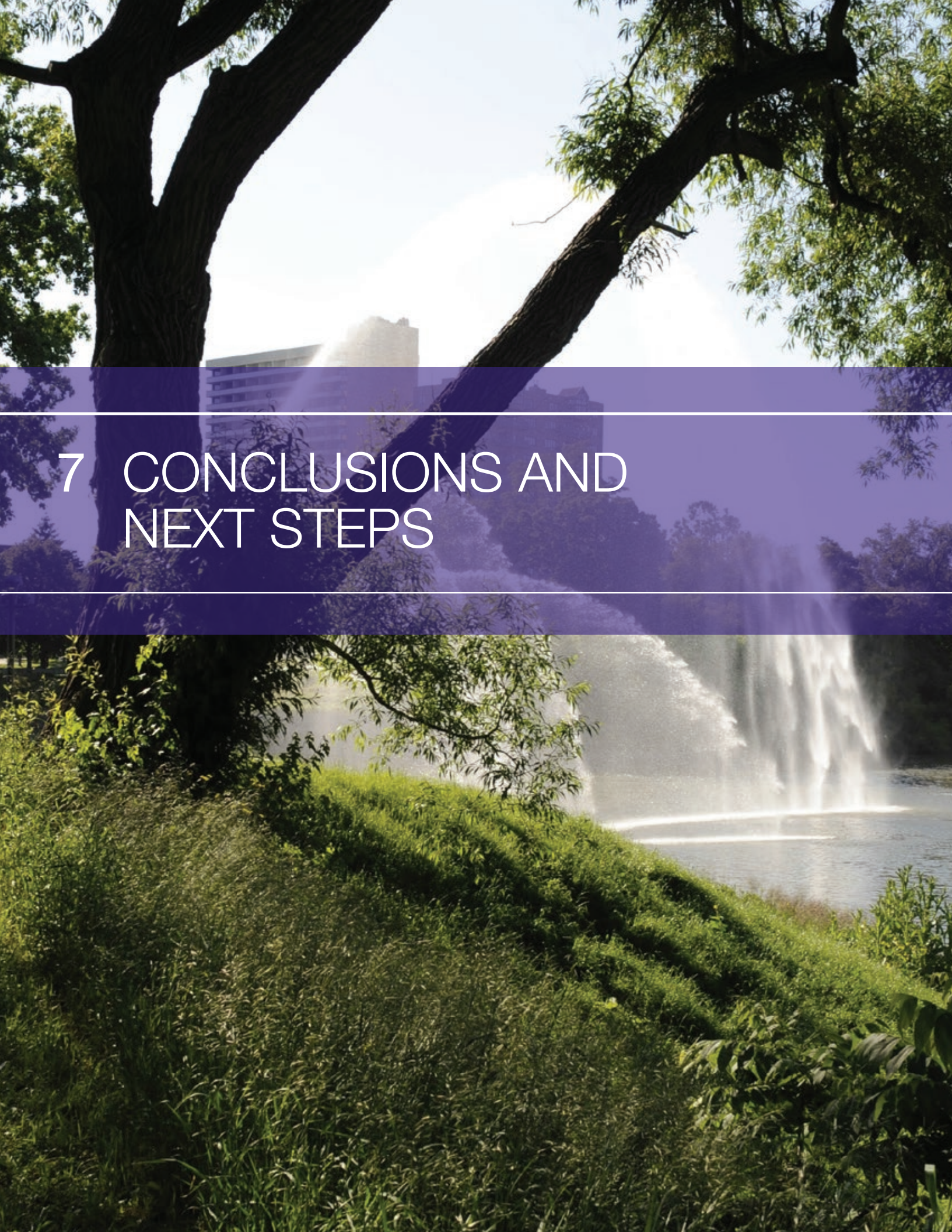
London's Rapid Transit Initiative will be a transformational project that creates local, regional, provincial and national economic benefits. London's Rapid Transit project achieves the goals of improving mobility, building strong communities and promoting economic development. However, Rapid Transit in London is only possible with significant investment from other orders of government. This follows a well-established precedent of governments working together to invest in public transit in Canada's cities. The City of London will work with funding partners to develop a detailed funding plan, including procurement alternatives.

The Province of Ontario has committed $15 billion to public transit projects outside the Greater Toronto and Hamilton Area (GTHA) as part of the Moving Ontario Forward initiative. The Province has profiled London's rapid transit project as a potential project under Moving Ontario Forward. Budget 2016 commits to "cost-sharing the capital costs of municipal transit projects such as London rapid transit" (Budget 2016, pg. 71).

The Government of Canada, in its 2016 Budget, announced a two phase infrastructure program that will see $20 billion invested into transformational public transit infrastructure over the next decade. Phase 1 (2016-2018) includes an investment of $3.4 billion under the Public Transit Infrastructure Fund (PTIF) in short-term capital repair investments prioritized toward municipal public transit infrastructure. Under the Government of Canada's PTIF Phase 1 program, "the Government will fund up to 50 per cent of eligible costs for projects" (Budget 2016, pg. 92). This is a welcome change from the traditional one-third formula under past federal programs. The Government of Canada has announced its intention to work with provinces and municipalities to develop Phase 2 (2019-2026) of the Fund and to announce the final details of this plan within the year.

The estimated capital cost of the Full BRT system is $500 million. This investment could be phased in over 10 years, beginning in 2017. London City Council has committed $125 million towards the capital costs and will pay for all the ongoing operating and maintenance costs. The City is also investing approximately $60 million in projects that will support the implementation of Rapid Transit including a new grade separation of Adelaide Street (which will be required to allow construction of the rail tunnel on Richmond Street) and a widening of the Western Road/Wharncliffe Road corridor, including two grade separation replacements, which will provide for traffic relief during construction, remove bottlenecks in the delivery of local transit services and help mitigate auto capacity impacts from the implementation of Rapid Transit.

The City of London will be working with its provincial and federal partners throughout 2016 to profile our Rapid Transit Initiative. Upon Council approval of the Rapid Transit Business Case, a revised formal funding request would be advanced to the federal and provincial governments, seeking their investment to make a transformative improvement to London's transit system.



7 CONCLUSIONS AND NEXT STEPS

7.0 CONCLUSIONS AND NEXT STEPS

Through the Environmental Assessment process, four alternatives were shortlisted for detailed evaluation. These alternatives consist of different combinations of Bus Rapid Transit (BRT) and Light Rail Transit (LRT) ranging from Base BRT to Full LRT. This business case evaluates the four Rapid Transit Alternatives and concludes that the Full BRT alternative offers the greatest value for Londoners as it meets the city's ridership needs, provides significant benefits in terms of economic growth, community development and revitalization, delivers considerable air quality and GHG emission reductions and modernizes the transit system by making it more attractive, reliable and convenient for residents to move around the city. The Full BRT alternative results in the highest benefit to cost ratio and is the best value solution from a mobility, city building, economic development, financial affordability and return on investment perspective.

Based on the results of this Business Case, it can be concluded that implementation of Full Bus Rapid Transit in the preferred corridors would provide a high return on investment. At a capital cost of $500 million ($440.2 million in Net Present Value), this alternative would produce over $1.3 billion in transportation, environmental and economic benefits over the project lifespan. The Full BRT alternative can be implemented in a phased approach and can be adapted to rail-based or other technologies over the longer term where supported by ridership. The summary of all the benefits and costs that were calculated as part of this business case report are show in Exhibit 7-1.

Next steps in the project development include validating and refining the Business Case in partnership with the Province, confirming investment funding envelopes and completing the Environmental Assessment.

Exhibit 7-1: Benefits and Costs Summary Table

DESCRIPTION	BASE BRT	FULL BRT	HYBRID	FULL LRT
FINANCIAL CASE (in Millions 2016$)				
Total Capital Costs (2016$)	270	500	880	1,150
Total Capital Costs (NPV 2016$)	249.8	440.2	781.5	1022.7
Total Operation Costs (NPV 2016$)	264.2	234.9	215.6	224.0
Total Costs (NPV 2016$)	514.1	675.1	997.1	1246.7
Total Additional Revenue (NPV 2016$)	45.6	73.1	83.1	85.6
Net Revenue-Costs (NPV 2016$)	-468.5	-602.0	-914.0	-1161.0
ECONOMIC CASE (NPV in Millions 2016$)				
Internal Benefits				
Transit User Time Savings	520.3	787.9	787.9	787.9
External Benefits				
Unperceived Automobile Costs Savings	13.5	21.7	24.6	25.4
Network Wide Road User Savings	41.1	65.9	75.0	77.2
Safety Savings	6.7	10.8	12.3	12.7
GHG Emissions	12.8	20.5	23.3	24.0
Air Quality	0.4	0.7	0.8	0.8
Health (Walking)	23.8	38.2	43.4	44.7
Sub-total	98.3	157.8	179.4	184.8
Total Benefits (Internal+External)	618.6	945.7	967.3	972.7
B/C Ratio (External and Internal Benefits)	1.3	1.6	1.1	0.8
WIDER ECONOMIC BENEFITS (NPV IN MILLIONS 2016$)				
Short Term GDP Gains	150.7	272.9	482.6	626.0
Long Term GDP Gains	9.9	8.8	8.0	8.3
Land Value Uplift	80.0	90.0	110.0	115.0
Sub-total	240.6	371.7	600.6	749.3
Total B/C Ratio	1.8	2.2	1.7	1.5
ADDITIONAL QUALITATIVE BENEFITS				
Catalyst for TOD	✓	✓✓	✓✓1/2	✓✓✓
Ease of Implementation and Constructability	✓✓	✓✓1/2	✓✓	✓1/2
Potential Impact on City Image	✓	✓	✓✓1/2	✓✓✓
Urban Regeneration Benefits	✓	✓	✓✓1/2	✓✓✓
Operational and Infrastructure Flexibility	✓	✓✓	1/2	✓
Qualitative User Benefits (Ride Quality and Attractiveness)	✓	✓	✓	✓✓✓

✓= Slightly positive impacts ✓✓ = Positive Impacts ✓✓✓ = Very Positive Impacts

Appendix A: Project Scorecard

ECONOMIC DEVELOPMENT AND CITY BUILDING		
OBJECTIVE	**METRIC**	**ANALYSIS**
Growth Management	Land Value Uplift and Intensification	Based on population forecasts prepared by the City of London for its ten traffic superzones, the project team estimates that over the period of 2011 to 2034 between 60% and 70% of the growth within the built up area could occur within 500 meters of rapid transit. This would translate into the need for thousands of new residential units. The City of London has a large supply of vacant or underutilized lands within 500 m of the proposed Rapid Transit corridors which could accommodate transit-oriented development. Investment in transit often results in changes in land values. Case study research has shown for the most part these changes are positive (i.e. increased property values) as lands become more desirable in their existing form and/or redevelop into higher density, higher order uses. Over the past few decades, construction of transit systems in Canada, the United States and Australia has been seen to result in property value increases ranging from 2% to over 60%. An analysis of land potential identified the potential for $90 Million in land value uplift.
Attract talent, employment and external investment	Employment Years Wages GDP	The economic benefits associated with the construction of Rapid Transit can be quantified in terms of the estimated number of direct and indirect person-years of employment, wages and additional GDP. It should be noted that GDP, by definition, includes wages and salaries as a sub component and therefore the estimates of GDP and income cannot be added together. Short Term Employment and GDP Impacts During Construction: 8,700 Employment Years and $543.5 Million increase in GDP . Long Term: 200 Employment Years and $8 Million increase in GDP per year.

<table>
<tr><th colspan="4">TRANSPORTATION CAPACITY AND MOBILITY FOCUS</th></tr>
<tr><th>OBJECTIVE</th><th>METRIC</th><th colspan="2">ANALYSIS</th></tr>
<tr><td rowspan="7">Transit Service Quality and Reliability</td><td rowspan="7">Improved Travel Times</td><td colspan="2">Between origins and destinations along the Rapid Transit network, which include some of the highest trip generators in the city, significant travel time improvements will be realized:</td></tr>
<tr><td>From King/Clarence To</td><td>Transit Today</td><td>Full BRT</td></tr>
<tr><td>Western</td><td>22</td><td>15</td></tr>
<tr><td>White Oaks</td><td>20</td><td>15.5</td></tr>
<tr><td>Fanshawe College</td><td>22</td><td>14.5</td></tr>
<tr><td>Wonderland Road</td><td>11</td><td>10</td></tr>
<tr><td colspan="2">At the network level these reductions in travel time can be used to calculate a total value for improved travel times for the entire lifecycle of the project. The total value for transit user times savings equals $788 Million.

Congestion reduction benefits will also be realized by auto users. These benefits accrue to $66 Million in network road user benefits.</td></tr>
<tr><td>Improved Mobility Options for all Residents</td><td>Qualitative</td><td colspan="2">Low floor boarding's and accessible stations. Improves accessibility for all users.</td></tr>
<tr><td>Transit Service Quality and Reliability</td><td>Congestion Mitigation</td><td colspan="2">Some of LTC's business bus routes are operating beyond their capacity, resulting in unreliability and overcrowding. This will not be addressed without providing a separate right of way for transit.

Transit travel times will be reduced for the majority of transit users. By applying a value of time to the transit travel time savings, a benefit of $788 million can be realized.</td></tr>
<tr><td>Improved Service Reliability and User Experience</td><td>Qualitative</td><td colspan="2">Reliability is an important part of an attractive transit system. Independent right of ways will help to maintain more consistent headways and more reliable schedule adherence.

Eliminating the conflicts between Rapid Transit and existing high frequency freight rail lines is also a crucial aspect of improving reliability that this Rapid Transit alternative will address through the grade separation along Richmond Street.

Based on an analysis of train frequencies, it is estimated that buses are delayed up to 10 times per day and delays can last between three to six minutes.

Light Rail Vehicles (LRV) generally provides a smoother ride, and more seating capacity than Rapid Transit buses. LRVs are also quitter and have higher aesthetic quality, making them more attractive to existing and potential riders.</td></tr>
<tr><td>Integration with Active Modes</td><td>Qualitative</td><td colspan="2">Rapid Transit and active transportation work together to represent alternative transportation. All transit journeys begin and end with walking or cycling. Rapid transit vehicles can allow for cyclists to bring their bicycle on board or attached them to racks outside the vehicle.</td></tr>
</table>

Connections to Regional Transportation	Qualitative	Rapid Transit will improve transit connections to the VIA Rail Station and the Airport. Given the concentration of services in the downtown, the VIA Rail system will be well served by Rapid Transit and local transit connections. Although Rapid Transit infrastructure will go as far east as Fanshawe College, direct shuttle buses from Fanshawe Station to the Airport can provide the final leg to ensure frequency and direct transit connections to the airport.
Improved Safety	Safety Benefits (Accident Reduction)	Rapid Transit will be effective at reducing auto VKT, which is directly associated with accident rates. Fewer auto VKT has been calculated to result in $31 million in safety savings from a reduction in accidents.

COMMUNITY BUILDING AND REVITALIZATION – HEALTHY COMMUNITIES		
OBJECTIVE	**METRIC**	**ANALYSIS**
Accessibility for All Residents	Qualitative	Rapid Transit Vehicles and Stations are design to provide easier access for people with accessibility issues. Low Floor vehicles that are level with station platforms allow a barrier free access for strollers, and mobility aids.
Walkability, Urban Design and Public Realm	Qualitative	The design and development of a Rapid Transit system will go hand in hand with improvements to London's public realm, including best practices in urban design. Part of a successful Rapid Transit system is that it is comfortable and convenient to access by foot from surrounding areas. 60% of London residents will live within 800 m of Rapid Transit
Sense of Place and City Pride	Qualitative	This will represent the largest public infrastructure project in London's history. This will be a statement on London's willingness to progress forward and become a vibrant city in the future.
Designing Healthy Communities	Walking Benefits	Transit use is strongly associated with active forms of transportation. Each transit trip includes approximately 250 m of walking on average. Each km of additional walking can result in $2.96 in societal health benefits. $38 million In health benefits can be realized with the implementation of Rapid Transit
Reduce GreenjHouse Gas Emissions	GHG emissions Reductions and improve air quality	The reduction in Green House Gas Emissions and Improved Air Quality are two of the quantifiable environmental benefits of building a Rapid Transit system. Rapid Transit can reduce GHG emissions by 195,000 Tonnes through the reduction of automobile trips over the project life cycle. $20.5 Million savings in the social cost of carbon . $0.7 Million in Air Quality Benefits

EASE OF IMPLEMENTATION AND OPERATION VARIABILITY		
OBJECTIVE	**METRIC**	**ANALYSIS**
Minimizing Disruptions and Impacts during Construction	Phasing and Construction Impacts	A strategic phasing plan will spread the impacts of construction out over time.
Operational Flexibility	Qualitative	The Corridors with the most potential for intensification and urban revitalization will be further leveraged with Rapid Transit. If the growth potential in these corridors is fully realized, BRT will be capable of expanding capacity to match demand as well as expand services beyond the dedicated transit right-of-way. On the South and West Corridors, due to lower demand, BRT is well suited to be able to adapt to service levels that match demand, while maintaining service frequencies that are sustainable and that provide high quality service.
Infrastructure Adaptability	Qualitative	As transportation technologies are rapidly adapting, such as advancements in autonomous vehicle technology, BRT infrastructure can be updated to communicate with these vehicles and potentially share the independent right-of-way for their operations.

Appendix B: Input Assumptions

PARAMETER	VALUE	REFERENCE
Discount Rate	3.50%	Metrolinx 2015
Inflation Rate	2.00%	Metrolinx 2015
Base Fare	$ 1.37	LTC 2015 Average Fare
Discount Year/Price Base	2015	Project Assumption
Evaluation Period	2016-2050	Project Assumption
Value of Time	$ 18.26	50% of median total income divided by 2,080
kg of CO2 per km	0.37	https://www.ec.gc.ca/financement-funding/default.asp?lang=En&n=2B809ABC-1
Average Cost of CO2 per kg	$ 0.155	Metrolinx, 2015
Auto Operating Costs per km	$ 0.06	Metrolinx, 2015
Air Quality Benefits	$ 0.002	Metrolinx 2015
Walking Benefit per km	$ 2.960	
Safety benefits per vkt	$ 0.030	Metrolinx 2015
Netowkr-wide Savings	0.01	Metrolinx 2015
QuickStart Ratio	0.25	Metrolinx 2015

shift

MOVING LONDON FORWARD

Kate Graham
Director, Community
and Economic Innovation
Tel: 519-661-2500 ext. 5879
kgraham@london.ca

Edward Soldo, P. Eng.
Director of Roads
and Transportation
City of London
Tel: 519-661-2500 ext. 4936
esoldo@london.ca

City of London
P.O. Box 5035
London, Ontario
Canada N6A 4L9

shift@london.ca

@shiftldnont

facebook.com/shiftldnont

@shiftldnont

Accessibility
If any information is required in an accessible format, please contact City of London Accessibility at 519-661-2500 ext. 7308 or email accessibility@london.ca

Privacy
Under the *Municipal Freedom of Information and Protection of Privacy Act* , unless otherwise stated in the submission will become part of the public record.