shift

London's Rapid Transit Initiative

Business Case

NOTE:

This is the initial draft Business Case dated February 2016.

The final City Council approved Business Case is dated May 2016.

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Executive Summary

Shift is a bold and important initiative for transportation for London. It focuses on rapid transit as the mobility core of a transportation system that along with cars, bikes and pedestrians will help London grow and prosper.

The network consists of two Rapid Transit corridors that will connect key hubs across the City: a North-East Light Rail Transit (LRT) line, and a South-West Bus Rapid Transit (BRT) line.

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.

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 the land use policies and urban structure to ensure the success of 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 40,000 Londoner's being involved to date.

In November 2015, Council provided unanimous direction to advance a Hybrid LRT/BRT System as the preliminary preferred option. This $880 million capital project would see 22 km of Rapid Transit along London's busiest corridors, connecting neighbourhoods, business and institutions in our city.

Key Benefits of London's Rapid Transit Initiative

London is the urban hub of Southwestern Ontario, with a population today of 475,000 in the metropolitan area and serving a region of 2.5 million people. Over the next 20 years, London will continue to grow by 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 an attractive choice for all 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:

- **Serve to connect major economic activities** – universities, colleges, hospitals, financial institutions, manufacturing and a rapidly growing high-tech industry. There is significant marketing potential associated with these connections – one being a "knowledge-based city". Connecting Rapid Transit to economic growth is also critical to encouraging students who are educated in London to stay in London
- **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, reliability and capacity.

- **Support healthy communities and active transportation.** Almost 40% of London's future population and jobs would be within walking distance of the proposed Rapid Transit system.
- **Help connect London to other parts of 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 part of Ontario for London residents. With the implementation of High Speed Rail in the Quebec-Windsor Corridor, these benefits would be significantly amplified.
- **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 transformation of London's Downtown Plan**. Over the next decade, London's Downtown will be transformed to include a much greater emphasis on pedestrians and active transportation. Rapid transit provides the additional capacity to allow the Downtown Vision to be realized.

Plan Foundation: The Strategic Case

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"

The Rapid Transit initiative was built on four guiding principles. The prioritization of these objectives throughout the study has influenced the 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 potential to increase transit ridership. Alternatives were then refined and assessed against more detailed criteria including travel times, congestion reduction potential, 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. This iterative process ensured that 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 the development of the Business Case

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

The process was informed by extensive public and stakeholder engagement. Public consultation events were held at three points leading up to the selection of the preferred alternative and well over 100 meetings were held with different stakeholder groups ranging from youth groups to business leaders. Over 400 people visited Public Information Centre #3 and four drop-in sessions held at City Hall throughout December 2015.

The **Hybrid Option** was deemed to best address London's vision and was well received by the public and stakeholders.

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 $280 million for the Base BRT option to $1.1 billion for the Full LRT option.

Operating costs were developed for each year to 2049 taking into account a phased implementation of rapid transit. In current dollars, the Hybrid alternative will require approximately $11 million per year in additional operating costs at full implementation. Operating costs for each of the alternatives are similar. The Hybrid option affords slightly lower operating costs than the Full BRT option as fewer vehicles are required to provide the same capacity.

It is assumed that capital costs will be shared by federal, provincial and municipal government. The City of London has already committed $125 million towards the capital costs and will pay for all of the ongoing operating and maintenance costs.

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 – a time that will decrease with planned improvements to intercity 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. The growth of these institutions, and the economy as a whole, will be greatly accelerated with the implementation of rapid transit.

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

This Business Case serves to quantify the key economic benefits of the rapid transit project. Economic benefits of the preferred alternative area highlighted I the following table.

Exhibit 0.1: Key Economic Benefits

CATEGORY	ESTIMATED BENEFITS
Internal Benefits	$879 million in savings realized through transit travel time savings
External Benefits	77.2 million in external transportation user benefits $16.1 million in GHG emissions savings and $43 M\million in societal health benefits
Short Term Economic Gains	$543 million GDP gain 8,700 employment years
Long Term Economic Gains (Annual Gains)	$8 million GDP gain 200 employment years
Land Use Uplift	$110 million in land value uplift created by redevelopment and intensification of properties in proximity to rapid transit

These economic benefits compare to a net cost (Additional Revenues-Additional Costs) of $914 million for the hybrid rapid transit alternative.

The preferred option consisting of Hybrid BRT and LRT is estimated to require $341 million more in capital funding than the Full BRT alternative. The value associated with this option includes:

- $19.3 million in operating cost savings to 2049. Relative savings will increase over time and as ridership grows
- $10 million in additional fares over the horizon period as a result of increased ridership

- $235 million more in short term GDP gains as a result of higher construction activity
- Potential for up to $20 million increased land value uplift

Other economic benefits that are more difficult to quantify for the preferred alternative include the impact on City image and attracting investment and talent. Such benefits are evident in the Waterloo Region since the start of construction of their LRT system.

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 2018 with the opening of these corridors in 2022. During this time a "Quick-start" service would be implemented on the North-East corridors utilizing buses in mixed traffic with transit priority. The implementation of Light Rail Transit in the North-East corridor is targeted to open by 2026.

The City of London will be the sponsor for the Rapid Transit Initiative in partnership with London Transit Commission (LTC). It is expected that as major funding partner, 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 the discussions on funding are advanced.

1 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 re-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.

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 corridor and their impacts.

The Rapid Transit Master Plan has identified a preliminary preferred alternative consisting of two Rapid Transit corridors that will connect key hubs across the City: a North-East Light Rail Transit (LRT) line, and a South-West Bus Rapid Transit (BRT) line (See Exhibit 1.1). The preferred alternative includes 13.2 km of LRT and 10.6 km of BRT and will be implement in conjunction with enhancements to the base transit network as well as supporting active transportation improvements.

In November 2015, Council provided unanimous direction to advance a Hybrid LRT/BRT System as the preliminary preferred option.

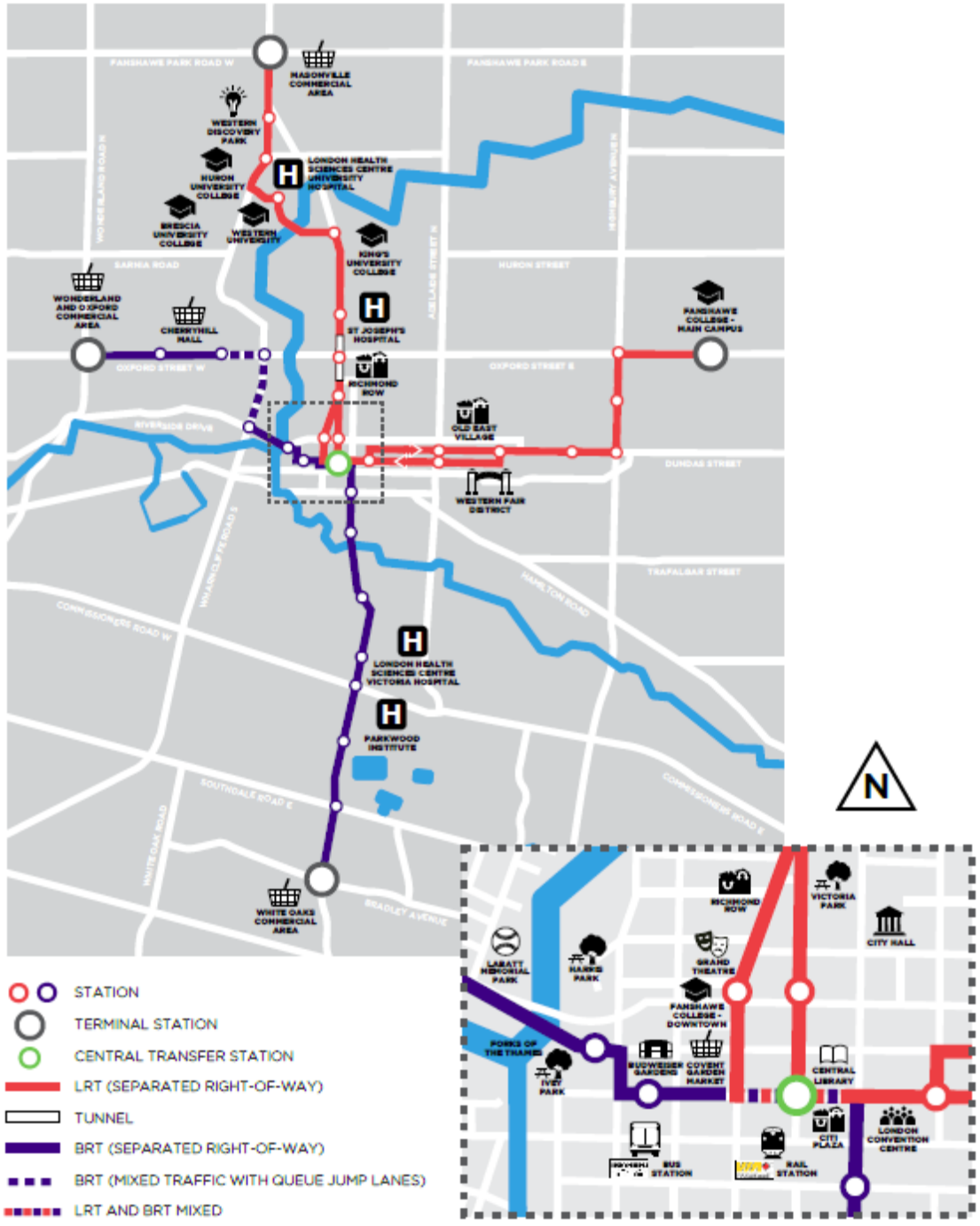
1.2 Business Case Approach and Organization

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?

Exhibit 1.1: Preferred Rapid Transit Concept



The business case process includes eight key steps:

- Step 1 - define a problem statement
- Step 2 - define objectives and outputs against which the intervention can be measured and monitored
- Step 3 - define a base case
- Step 4 - define a baseline future year transportation network
- Step 5 - develop options
- Step 6a - assess contribution to strategic objectives
- Step 6b - assess deliverability and operational solutions
- Step 6c - assess lifecycle costs and benefits at current prices
- Step 7 - Assemble the Business Case evidence
- Step 8 – Continuously refine and develop the Business Case

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 ITS component or system, that the ITS component or system is compliant with the ITS Architecture for Canada.

2 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 PM peak, making transit an unattractive option for choice commuters. By implementing a frequent and fast Rapid Transit 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 trends continued, large tracts of agricultural and rural lands would 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 and make efficient use of existing infrastructure; and,
- **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 compare to private vehicles, thereby reducing the need for future roadway construction.

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

- **Existing Transit Ridership and Growth**- During the PM peak, 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 than by cost;
- **Commuter Travel Habits**- The average auto and transit trip lengths were both 5.0 km in 2011, a transit-friendly distance. This indicates that many existing trips could be competitively made by Rapid Transit. There is also a high untapped potential for transit activity along the preferred RT Corridors as 2/3 of all trips in London originate along these corridors;
- **Existing Policy-** London's TMP and OP identified the need for a multi-modal transportation network to support all forms of travel. Rapid Transit service 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 along them. 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. Further to that, 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-Brampton, and the ION LRT in Waterloo Region.

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 London's 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 will guide 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 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"

2.2.2 The London Plan (draft Official Plan)

The London Plan (draft) is the City's new Official Plan and identifies an urban structure and articulates a broad vision for the City. The vision is based on the concept that the city is made up of Hybrid areas and areas of stability, both of which will accommodate different types of growth. 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 –** This area defines the boundary between urban and rural London, and is the area within which all future urban development will occur.
- **The Primary Transit Area** - More centrally located within the existing built up area of London, this is an area that will accommodate a majority of the residential intensification and transit investment within the city. This area will also focus on improvements to the pedestrian realm and investment in cycling and active transportation facilities.
- **Central London** - This area has several significant cultural heritage areas and contains London's Downtown. This area will be the focus for high density intensification where appropriate as well as hold a high standard for urban design, walkability, and accommodate all modes of transportation.

To support this vision and to catalyze growth in strategic areas, the City Structure Plan also establishes a series of 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 that are 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 considerations along Wharncliffe Road with a future Transit Village anchoring the south-west area of the city.

The London Plan identified 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. 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.

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 that will help achieve this vision.

There are five "Smart Moves" identified that form the basis for the Transportation Master Plan, that each play a role in supporting the achievement of the plan's goals. Each of them 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 LRT 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.

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 PM peak hour, of which, 6,520 trips are made by transit. Over two-thirds of auto trips in the PM 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 corridor, largely at Western University and Fanshawe College. By increasing this service 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 2.1 and Exhibit 2.2 below illustrate travel times in minutes between major trip generators in London. Exhibit 2.3 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 2.1: Auto Travel Time (in minutes), 2009

Origin	Destination					
	Downtown	UWO	Fanshawe College	Masonville	Oakridge Mall	White Oaks
2009						
Downtown	-	13	14	16	8	15
UWO	14	-	18	4	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 2.2: Transit Travel Times (in minutes), 2009

Origin	Destination					
	Downtown	UWO	Fanshawe	Masonville	Oakridge Mall	White Oaks
2009						
Downtown	-	23	22	20	16	20
UWO	19	-	30	14	18	42
Fanshawe	22	37	-	35	23	41
Masonville	20	14	35	-	27	40
Oakridge Mall	15	18	21	29	-	46
White Oaks	19	43	43	38	44	-

Exhibit 2.3: Ratio of Transit Travel Times to Auto Travel Times, 2009

Origin	Destination					
	Downtown	UWO	Fanshawe	Masonville	Oakridge Mall	White Oaks
2009						
Downtown	-	1.77	1.57	1.25	2.00	1.33
UWO	1.35	-	1.67	3.5	2.00	162
Fanshawe	1.69	2.18	-	2.06	1.28	2.56
Masonville	1.54	4.67	2.19	-	2.25	1.6
Oakridge Mall	1.88	2.25	1.62	2.90	-	2.30
White Oaks	1.27	1.65	2.52	1.46	2.10	-
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 preferred Rapid Transit solution can be evaluated based on its ability to address these principle's objectives. The corresponding objectives of each principles is identified in Exhibit 2.4.

Exhibit 2.4: Guiding Principles

GOALS OF RAPID TRANSIT	OBJECTIVES
ECONOMIC DEVELOPMENT & CITY BUILDING FOCUS	• Attract TOD and promote intensification • Growth Management • Attract Regional and Foreign Investment • Job Growth and GDP Gains
TRANSPORTATION CAPACITY & MOBILITY FOCUS	• Congestion Mitigation and Prevention • Improved Mobility Options for all Residents • Improved travel times • Improved Service Reliability • Integration with Active Modes • Connections to Regional Transportation • Improve Safety
COMMUNITY BUILDING & REVITALIZATION FOCUS	• Accessibility for All Residents • Walkability, Urban Design and Public Realm • Sense of Place and City Pride • Improved Air Quality and reducing emissions
EASE OF IMPLEMENTATION & OPERATIONAL VIABILITY	• Minimizing Disruptions and Impacts during Construction • Maintain Operational Flexibility • Maintain Infrastructure Adaptability

The analysis of the ability that the preferred rapid transit solution has at meeting the objectives is detailed in Appendix A of this business case.

2.5 Rapid Transit Alternatives Considered

The project options that are identified in this report were short listed 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 option is provided below.

- **Base Case: Business As Usual**: The Base Case assumes that 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 rights-of-way 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 181 standard and 14 articulated buses with limited signal priority, 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.
- **Option 1: Base BRT Network Alternative**. The BRT network previously developed through the TMP and LTC business case was refined to reflect updated conditions. The 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.
- **Option 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.
- **Option 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 selection 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.

- **Option 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 options 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 ticket vendors.

These common elements are defining characteristics of rapid transit. The characteristics which very across the alternatives that are evaluated in this BCA are related to development attractiveness, ridership attractiveness, system capacity, and operating speeds.

3 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.

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 (pass/hr)	840	420	840	420
Light Rail Transit Alternatives				
Headway (min)	7	10	7	10
Capacity per vehicle	170	170	170	170
Capacity Provided (pass/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 option is estimated as follows:

Exhibit 3.2: Vehicle and Rolling Stock Requirements

OPTION	PEAK BRT VEHICLES	PEAK LRT VEHICLES	OFF PEAK BRT VEHICLES	OFF PEAK LRT VEHICLES
Base BRT	33	-	13	-
Full BRT	30	-	11	-
Hybrid	11	15	6	5
Full LRT	-	26	-	11

*Includes 6 spare vehicles per route

3.1.1 Annual Operating Costs

Operating cost estimates are based on unit values obtained from existing LTC operations and supplemented from other sources where required. 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 Alignment 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 2049.

Annual operating costs are developed to account for a phased implementation of rapid transit, and timelines for construction. Exhibit 3.4 summarizes the annual operating costs by project phase and alternative (in current $2015 dollars).

The operating costs that are used for the Business Case are the Net Present Value ($2015) of the sum of all the annualized operating costs.

Exhibit 3.4: Rapid Transit Operating Costs between 2018 and 2030 (In $2015)

Rapid Transit Operating Costs Between 2018 and 2030 (in 2015 $)												
	Hybrid			**Full BRT**			**Base BRT**			**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
2018	$860,000	Quick Start		$860,000	Quick Start		$860,000	Quick Start		$860,000	Quick Start	
2019	$860,000			$860,000			$860,000			$860,000		
2020	$860,000			$860,000			$860,000			$860,000		
2021	$860,000			$860,000			$860,000			$860,000		
2022	$6,040,349		W-S BASE BRT	$6,040,349		W-S BASE BRT	$6,040,349		W-S BASE BRT	$6,040,349		
2023	$5,484,873		W-S FULL BRT	$5,484,873		W-S FULL BRT	$6,040,349			$5,629,798		W-S FULL LRT
2024	$5,484,873			$5,484,873			$6,040,349			$5,629,798		
2025	$5,484,873			$5,484,873			$6,040,349			$5,629,798		
2026	$11,082,000	N-E LRT		$12,193,000	N-E FULL BRT		$13,799,000	N-E BASE BRT		$11,544,000	N-E FULL LRT	
2027	$11,082,000			$12,193,000			$13,799,000			$11,544,000		
2028	$11,082,000			$12,193,000			$13,799,000			$11,544,000		
2029	$11,082,000			$12,193,000			$13,799,000			$11,544,000		
2030	$11,082,000			$12,193,000			$13,799,000			$11,544,000		

3.1.2 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.

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 2015$. These NPV Capital Costs are summarized in section 3.1.3.

Exhibit 3.5: Capital Cost Inputs (Single Year Spending Assumption)

Summary of Capital Costs (Rounded)				
	Scenarios			
Cost Components	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	$11,000,000	$21,000,000	$37,000,000	$48,000,000

3.1.3 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. 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 option 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	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Total CAPEX (NPV 2015$)	249.8	440.2	781.5	1,022.7
Total OPEX (NPV 2015$)	264.2	234.9	215.6	224.0
Total Costs (NPV 2015$)	514.1	675.1	997.1	1,246.7
Total Additional Revenue (NPV 2015)	45.6	73.1	83.1	85.6
Net Revenue-Costs (NPV 2015$)	(468.5)	(602.0)	(914.0)	(1,161.0)

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

4.1 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 by AECOM 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 that are 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 2049 were developed using a linear projection.

4.1.2 Ridership Forecasts

Ridership Projections for the 2035 horizon year were extracted from the Travel Demand Model and ridership for each proceeding year to 2049 and each subsequent year back to 2015 were extrapolated using an assumption for linear growth from the base year. As identified in Exhibit 4.1, the difference between the ridership in each of the Rapid Transit Alternatives is relatively modest due to the fact that each alternative used the same land use projection. The differences, are therefore simply a function of differences in the operating speeds that were assumed by the model. Given the uncertainties associated with future trends, the model has significant limitations. These the ridership projections are subject to considerable variability. 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: 2035 Annual Ridership Forecasts

CRITERIA	BAU	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Transit Network Ridership (2035)	28,680,733	30,500,000	31,600,000	32,000,000	32,100,000

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

options vs. the base case. Exhibit 4.2 summarizes these wider network impacts in terms of reductions in auto VKT.

Exhibit 4.2: Summary of VKT

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Auto Vehicle-km Saved (2035)	12,734,869	20,434,869	23,234,869	23,934,869
Auto Vehicle-km Saved (Accumulative to 2049)	330,527,736	530,377,736	603,050,464	621,218,645

4.2 Internal User Impacts

Internal User Impacts refer to the travel impacts experienced by the users of the transportation system. For the purpose of this Business Case, these include 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. Options 2, 3 and 4 provide additional travel time savings over the base BRT Option due to the grade separation of Richmond Street at the CP tracks and the widening of the Wellington Street through the constrained section from Baseline Road to Horton Street.

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. The Business as Usual Scenario assumes a transit journey time of 44.5 minutes, the Base BRT assumes a transit journey travel time of 41 minutes and the other three scenarios assume a transit journey travel time of 39.2 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. The resulting value of the time savings is calculated using an assumed value of time of $18.26/hr (2015$). The present value of these travel time savings are shown on Exhibit 4.4.

Exhibit 4.3: Projected Transit Travel Time Savings

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: 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 4.4: Transit Travel Time Savings

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: 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 2049)	59,897,299	62,034,196	62,034,196	62,034,196
Travel Time Savings-Transit (NPV $M)	520	788	788	788

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. 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 option, but the grade separation is not part of the Base BRT Option.

Addressing this network constraint will significantly improve reliability.

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 will result in a reduction in vehicle collisions. The economic benefit of these reductions was calculated using the assumption that $.03 in safety benefits are accumulated for every VKT reduced.

Exhibit 4.5: Safety Benefits

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Safety Savings ($M)	6.7	10.8	12.3	12.7

4.3.1 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 .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 4.6: Network Wide Road User Benefits

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Network-wide Road User Travel Time Savings ($M NPV)	41.1	65.9	75.0	77.2

4.3.2 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 4.7

Exhibit 4.7: Air Quality Benefits

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Value of Air Quality Benefits ($M NPV)	0.4	0.7	0.8	0.8

4.3.3 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 options, through such design choices as hybrid or electric buses, clean diesel, or biofuel.

The reduction in GHG is calculated from the vehicle kilometre reduction caused by each rapid transit option, multiplied by the average mass of greenhouse cases produced by automobiles per kilometre, in this case, 0.367 kg per km.

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 4.8.

Exhibit 4.8: Greenhouse Gas Emissions Reductions

CRITERIA	OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Reduction in GHG Emissions (t)	121,304	194,649	221,320	227,987
Value of GHG Reduction ($M)	12.8	20.5	23.3	24.0

4.3.4 Health Benefits

Public Transit and active transportation are closely connected. Since ever 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 as 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.

Exhibit 4.9: Health Benefits

	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 (NPV Millions $)	24	38	43	45

4.3.5 Economic Case Summary

A summary of all the Economic Case Benefit Accounts is summarized in Exhibit 4.10.

Exhibit 4.10: Economic Case Summary

Description	Base BRT	Full BRT	Hybrid	Full LRT
ECONOMIC CASE				
Internal Benefits (NPV 2015$)				
Transit User Time Savings	520	788	788	788
External Benefits (NPV 2015$)				
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
Benefit - Cost Ratio				
Net Costs (2015 $)	(468)	(602)	(914)	(1,161)
Total Benefits (Internal+External)	619	946	967	973
Benefit - Cost Ratio	**1.32**	**1.57**	**1.06**	**0.84**

4.4 Wider Economic Development Impacts

Definition of Direct and Indirect Impacts: Transportation Infrastructure Projects

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

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

This section provides estimates of the impacts the construction and operation of the four different London rapid transit options 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 options 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 options 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 4.11, depending on the project option the construction of rapid transit in the City of London and associated transit facilities could generate an estimated 1,600 to 6,500 direct person-years of employment and between 1,200 to 4,900 indirect person-years of employment. The total impact on GDP during construction is estimated to be between $168.9 and $698.9 million.

Exhibit 4.11: Estimates of Short Term Employment, Income and GDP Impacts during Construction

		OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: FULL LRT
Construction Cost (millions)		$280	$497	$880	$1,142
Employment Years	Direct	1,600	2,800	5,000	6,500
	Indirect	1,200	2,100	3,700	4,900
	Total	**2,800**	**4,900**	**8,700**	**11,400**
Wages (millions)	Direct	$100.8	$178.9	$316.8	$411.1
	Indirect	$76.7	$132.1	$233.3	$306.2
	Total	**$177.5**	**$311.0**	**$550.1**	**$717.3**
GDP (millions)	Direct	$98.0	$180.7	$317.8	$407.2
	Indirect	$70.9	$127.3	$225.7	$291.7
	Total	**$168.9**	**$308.0**	**$543.5**	**$698.9**

Note: All figures are net present values (2015 $) and numbers have been rounded.

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. Option 1 (Base BRT) will cost the least to construct and therefore will generate the lowest level of short-term economic impacts. Option 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 options would have similar impacts on industries for the construction of the runningway and stations but for the bus-based options (Options 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. Options utilizing light rail (Options 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 project options, 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 2049. As shown in Exhibit 4.12, depending on the project option, 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 options, 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 options.

Exhibit 4.12: Estimates of Annual Long Term Employment, Income and GDP Impacts

		OPTION 1: BASE BRT	OPTION 2: FULL BRT	OPTION 3: HYBRID	OPTION 4: 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 2041 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 $12.0 and $13.7 million, depending on the option). Option 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 Option 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 lands value. Case study research has shown for the most part these changes are positive (i.e. increased property values) as lands become more desirable in their existing form and/or redevelop into higher density, 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 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 on based 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).

Boston BRT – The value of properties within proximity of the BRT stations have increased by 7.6% (Source: Perk et al. 2012 and http://www.wrirosscities.org).

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. This represents populating 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 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, IBI Group estimates that over the period of 2011 to 2034 between 60% and 70% of future residential growth could occur within 400 to 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 400m to 500 m of the proposed rapid transit corridors which could accommodate transit-oriented development.

Following a review of the City's new 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 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 of London 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 sq. ft. 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.

IBI Group estimates that uplift in land value of between $75 and $110 million could be realized along the proposed rapid transit corridor 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 and others will see little to none. The average uplift along the corridors may range from 2% to 10%.

5 Sensitivity Analysis

There are several variables in this business case that are forecasts of future year conditions that are 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	CHANGES TO TOTAL BENEFITS/NET COST				
Energy Costs (Diesel and Electricity)	Change	Base BRT	Full BRT	Hybrid	Full LRT
	- 50%	1.96	2.32	1.82	1.58
	+ 50%	1.79	2.18	1.75	1.52
Value of GHG Emissions Savings	Change	Base BRT	Full BRT	Hybrid	Full LRT
	- 50%	1.86	2.23	1.77	1.54
	+50%	1.89	2.26	1.79	1.56
Land Value Uplift	Change	Base BRT	Full BRT	Hybrid	Full LRT
	- 50%	1.79	2.17	1.72	1.50
	+50%	1.96	2.32	1.84	1.60
Discount Rate and Inflation Rate	Change	Base BRT	Full BRT	Hybrid	Full LRT
	- 1.5%	1.89	2.27	1.80	1.56
	+1.5%	1.86	2.23	1.77	1.54

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 therefor changes to any one of those cases does 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.

An example of how a change in costing assumptions affects the financial case is identified below:

The LTC Service Plan to 2019 includes service upgrades to build up to Rapid Transit. These service upgrades include Express Routes that run along the future RT lines and mimic the service that RT will provide. If costs savings from removing these routes are recognized, the accumulated operation Costs in (NPV 2015$) will go from $215 million to $157.1 million for the Hybrid Option. The B/C ratio of Internal Benefits to Net Costs would increase from 0.92 to 0.86 if this benefit was recognized.

6 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 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.

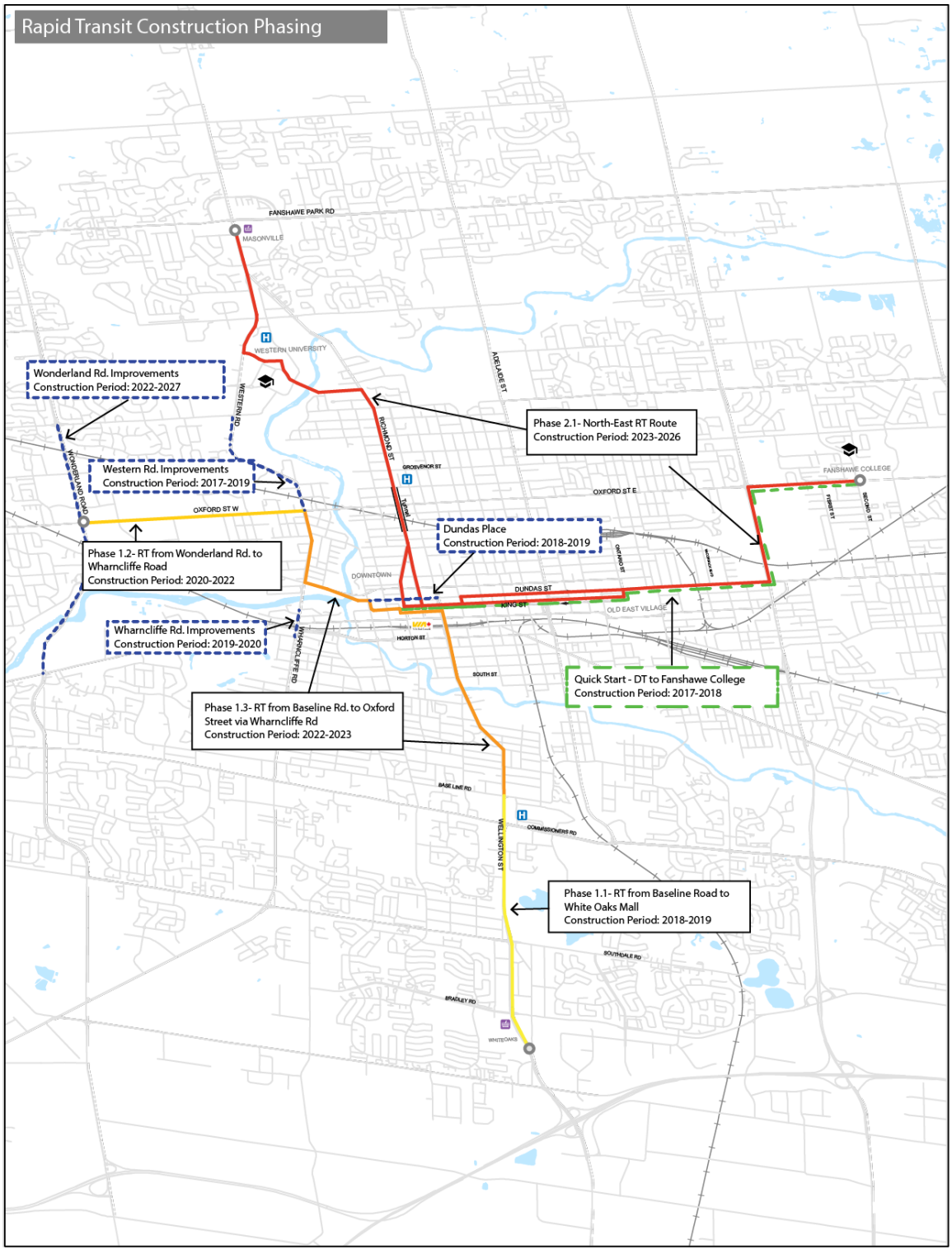
6.2 Project Timelines

Planning Rapid Transit has been on-going since the completion of the Transportation Master Plan in 2010. An Environmental Assessment was initiated in fall 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 2018.

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 to Downtown corridor.

Exhibit 6.1: Preliminary Phasing Plan



6.3 Funding and Procurement Strategy

The City of London will work with funding partners to develop a detailed funding plan, including procurement alternatives.

The Province of Ontario plans to allocate $15 billion to public transit projects outside the Greater Toronto and Hamilton Area (GTHA) as part of the *Moving Ontario Forward* initiative. Historically, projects outside of the GTHA have been funded through 1/3 partnerships with the provincial and federal governments as the projects are municipally driven, owned, and operated.

7 Conclusions and Next Steps

This Business Case outlines the costs and benefits of London's Rapid Transit initiative. The estimated capital cost of the Hybrid LRT/BRT system is $781.5 million (NPV 2015$). The estimated annual operating and maintenance cost to 2049 is $215.6 million (NPV 2015$).

Investment in the Rapid Transit initiative will, first and foremost, enable the City of London to achieve its Strategic Vision to become a more sustainable city. This includes concentrating development along rapid transit corridors, which in turn provides more residents and business with access to high quality transit and reduces travel effort.

The Business Case projects that the combined transportation user benefits, economic benefits and societal benefits are well over $1 billion. The summary of all the benefits and costs that were calculated as part of this business case report are is show in Exhibit 7.1.

Next steps in the project development include validating and refining the Business Case in partnership with the Province, confirming 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 (NPV 2015$)				
Total CAPEX (NPV 2015$)	249.8	440.2	781.5	1022.7
Total OPEX (NPV 2015$)	264.2	234.9	215.6	224.0
Total Costs (NPV 2015$)	514.1	675.1	997.1	1246.7
Total Additional Revenue (NPV 2015)	45.6	73.1	83.1	85.6
Net Revenue-Costs (NPV 2015$)	-468.5	-602.0	-914.0	-1161.0
ECONOMIC CASE (NPV 2015$)				
Internal Benefits				
Transit User Time Savings	520.3	787.9	787.9	787.9
B/C Ratio with Internal Benefits	1.1	1.3	0.9	0.7
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
Benefit - Cost Ratio (NPV 2015$)				
Net Costs (2015 $)	-468.5	-602.0	-914.0	-1161.0
Total Benefits (Internal+External)	618.6	945.7	967.3	972.7
Benefit - Cost Ratio	1.3	1.6	1.1	0.8
Wider Economic Benefits (NPV 2015$)				
Short Term GDP Gains	168.9	308.0	543.5	698.9
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	258.8	406.8	661.5	822.2
Total Benefits Cost Ratio	1.9	2.2	1.8	1.5

Appendix A – Project Scorecard

ECONOMIC DEVELOPMENT AND CITY BUILDING		
Objective	**Metric**	**Analysis**
Growth Management and TOD Potential	Land Value Uplift and	Based on population forecasts prepared by the City of London for its ten traffic superzones, IBI Group estimates that over the period of 2011 to 2034 between 60% and 70% of future residential growth could occur within 400 to 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 400m to 500 m of the proposed rapid transit corridors which could accommodate transit-oriented development. Investment in transit often results in changes in lands value. Case study research has shown for the most part these changes are positive (i.e. increased property values) as lands become more desirable in their existing form and/or redevelop into higher density, 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 BRT and/or LRT can also result in increased interest and demand for land and uplift in land valueAn analysis of land potential identified the potential for $110 Million in land value uplift.
Ability to attract new business and regional and foreign 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>Transit Service Quality and Reliability</td><td>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:

<table>
<tr><th>From King/Richmond To</th><th>Transit Today</th><th>Hybrid</th></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>
</table>

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 $75 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 the suite of quality transportation options for those who cannot drive</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 times savings, a benefit of</td></tr>
<tr><td>Improved Service Reliability</td><td>Qualitative</td><td colspan="2">Reliability is an important part of an attractive transit system. Independent right of ways will be able 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.</td></tr>
</table>

		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.
Integration with Active Modes	Qualitative	Rapid transit and active transportation work together to represent alternative transportation. All transit journeys begin and end with walking or cycling. LRT Vehicles can allow for cyclists to bring their bicycle on the vehicle.
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 west 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 wheelchairs.
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 Rhealm, 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 250m of walking on average. Each km of additional walking can result in $2.96 in societal health benefits. $43.4 Million In health benefits can be realized with the implementation of rapid transit
Reduce Green House Gas Emissions	GHG Emissions Reductions and	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 162,000 Tonnes through the reduction of automobile trips over the project life cycle. $23.3 Million savings in the social cost of carbon. $0.76 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 LRT. If the growth potential in these corridors is fully realized, LRT will be capable of expanding capacity to match demand. On the South and West Corridors, due to lower demand, a 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, rapid transit infrastructure can be updated to communicate with these vehicles and potentially provide an independent right-of-way for their operations.