Millennium Line Broadway Extension (MLBE) Project

Business Case

March 2018

partnerships
British Columbia

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EXECUTIVE SUMMARY

RECOMMENDATION

This Business Case recommends the implementation of the Millennium Line Broadway Extension (MLBE or the Project), a $2,827 million, and 5.7 km Advanced Light Rapid Transit (ALRT or SkyTrain) extension to the existing Millennium Line SkyTrain system from its current terminus at VCC-Clark Station to a new western terminus station at Arbutus Street.

Figure 1. Proposed Millennium Line Broadway Extension

The Project will represent a significant transit expansion in the Metro Vancouver region (the Region), addressing key gaps in the existing rapid transit network and completing the first phase of a longer-term vision to extend rapid transit to the University of British Columbia (UBC).

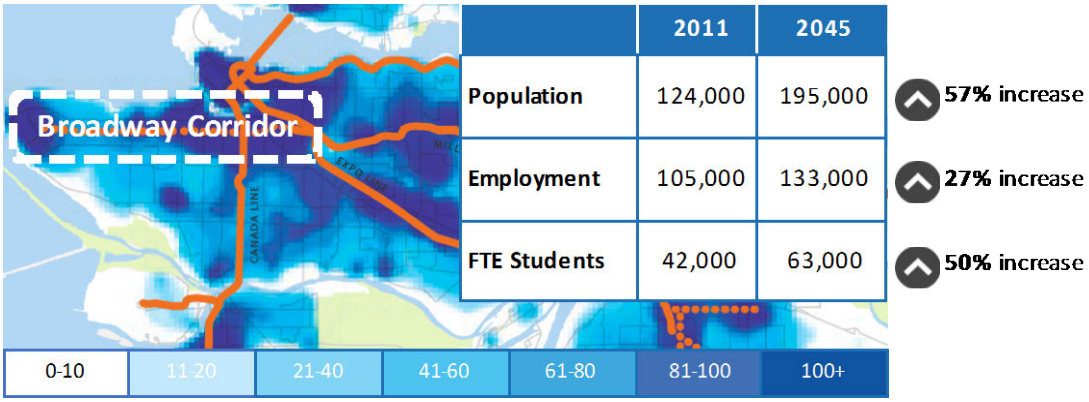
It will support economic, urban, and environmental development within the Region, provide more people with a sustainable transportation choice, connect urban centres, and increase rapid transit mode-share.

CURRENT TRANSIT CANNOT MEET DEMAND ALONG THE BROADWAY CORRIDOR

The Broadway Corridor (the Corridor)[1] is the second largest employment centre in British Columbia and a priority area within the Region. It is the most densely developed area in the Region not served by rail rapid transit, and is facing significant affordability and transportation challenges, as it addresses current and projected growth over the next 30 years:

[1] Defined as the area within the Region extending approximately from Victoria Drive (East) to the University of British Columbia (West).

Figure 2. Current and Projected Population in Broadway Corridor



	2011	2045	
Population	124,000	195,000	57% increase
Employment	105,000	133,000	27% increase
FTE Students	42,000	63,000	50% increase

Transit demand within the Corridor has exceeded the capacity of existing transit services. An estimated half-million bus passengers are passed up every year by full buses, dissuading many people from using transit within the Corridor. Traffic congestion is significant (59% of trips are made by automobile), which impacts the reliability of existing transit services to meet the needs of transit customers. It also creates congestion for local transportation and commercial traffic, which relies on the Corridor to serve local businesses.

The gap in the regional transit network along the Corridor also creates a bottleneck at the existing Commercial-Broadway SkyTrain Station to accommodate transfers between Expo Line, Millennium Line, and bus riders, including the capacity constrained 99 B-Line bus that services the Corridor from Commercial Drive to UBC.

These existing and growing capacity challenges will have long-term impact on the ability for the municipalities, the Region, and the Province of B.C. (the Province) to achieve their targeted economic and urban development objectives, as well as climate change targets that include GHG reduction through increased transit mode share.

STRATEGIC ANALYSIS OF POTENTIAL PROJECT ALTERNATIVES

Between 2009 and 2011, the Province through the Ministry of Transportation and Infrastructure, TransLink, the City of Vancouver, UBC, and Metro Vancouver evaluated more than 200 technology and alignment options for the Corridor as part of the UBC Line Rapid Transit Study. Based on the detailed analysis of options and input from the public, three potential project alternatives were shortlisted: a light rail transit line, a SkyTrain extension, or a combination of the two. The study concluded that the SkyTrain technology would best serve the needs of the Corridor.

Based on the strength of this study and public input, the Mayors' Council proposed a phased SkyTrain extension to Arbutus Street as part 10-year Vision (Mayors' Vision). The Mayors' Vision was endorsed by over 140 groups representing environmental, business, labour, health, transportation, and education interests.

A subsequent strategic options analysis of the phased project alternatives confirms the conclusions of the UBC Line Rapid Transit study:

- An LRT option would neither perform well against Project objectives, nor would be cost effective given the abbreviated alignment to Arbutus;
- An elevated SkyTrain extension may include some financial benefits, but included prohibitive negative urban and social impacts; and
- A tunneled SkyTrain alternative is best suited to address the challenges and achieve the Project objectives.

PROPOSED SCOPE OF MILLENNIUM LINE BROADWAY EXTENSION

The proposed 5.7 km MLBE will extend the Millennium Line's elevated guideway approximately 700 metres westward from its existing terminus at VCC-Clark Station and will continue underground to join Broadway near Main Street, where it will travel under Broadway to a new terminus at Arbutus Street. Six underground stations are proposed (listed east to west):

- **Great Northern Way Station**: Located near the tunnel entrance, within proximity of the Great Northern Way Campus, Emily Carr University of Art and Design, and the high tech and new media hub envisioned as part of the False Creek Flats Plan.
- **Main Station**: Located within proximity to the Mount Pleasant Industrial Zone and the Mount Pleasant neighbourhood.
- **Cambie Station**: Located near Cambie Street, and designed to integrate with the Canada Line's Broadway-City Hall Station.
- **Oak Station**: Located within proximity of Vancouver General Hospital, BC Cancer Agency, Canadian Cancer Society, and BC Cancer Research Centre.
- **Granville Station**: Located within proximity of second most dense residential neighbourhood along the Corridor, South Granville shopping district, and Granville Island.
- **Arbutus Station**: Designed to support terminus operations and provide sufficient space for transit integration.

It is recommended that the MLBE be fully integrated with existing SkyTrain systems and protocols. To accommodate the addition of the Project to the existing SkyTrain network and address broader capacity improvements addressed in the Mayors' Vision, TransLink has initiated the Expo and Millennium Upgrade Project (EMUP), which is the subject of a separate business case. As such, the scope of the MLBE Project does not include vehicles or storage and maintenance facilities.

BENEFITS OF THE MLBE FOR THE PROVINCE AND REGION

The Project is estimated to have a benefit to cost ratio of 1.64. It will address the identified challenges and provide distinct benefits including system continuity for SkyTrain riders, integrated transfers to Canada Line and the 99 B-Line bus services (from Arbutus Street to UBC), and technological integration. Key benefits of the Project include:

- Providing significant benefits to transit riders in the form of increased capacity, travel time savings, greater reliability, and improving customer experience;
- Improving transportation options and economic development potential;

- Filling a critical gap in the regional transit network, thereby easing congestion at other transfer points;
- Utilizing a grade-separated (mostly underground) right of way to improve reliability and eliminate conflicts with other vehicle traffic, bicycles, and pedestrians;
- Reducing greenhouse gas emissions by reducing automotive vehicle kilometers travelled (VKT) and replacing diesel bus B-Line service with electric SkyTrain service; and
- Improving affordability by enabling greater mobility at reduced cost for residents across the region and encouraging transit-oriented urban development and housing availability.

The Project is forecasted to serve daily ridership in 2030 of 143,000 to 163,000 passengers, growing to 167,000 to 191,000 daily passengers by 2045.

PROCUREMENT ASSESSMENT

A range of feasible procurement options and structures, including both traditional and alternative models, were identified and analyzed as to their appropriateness for the Project. Based on both the qualitative and quantitative analyses, a Design Build Finance (DBF) procurement approach, with $450 million in private financing during implementation, is recommended for the Project. The analysis shows that the DBF model will best:

- Manage and mitigate key project risks;
- Maximize competition, providing innovation and efficiencies;
- Maximize cost and schedule certainty; and
- Provide the best value for money (expected to be in the range of $48 million, NPC October 2017).

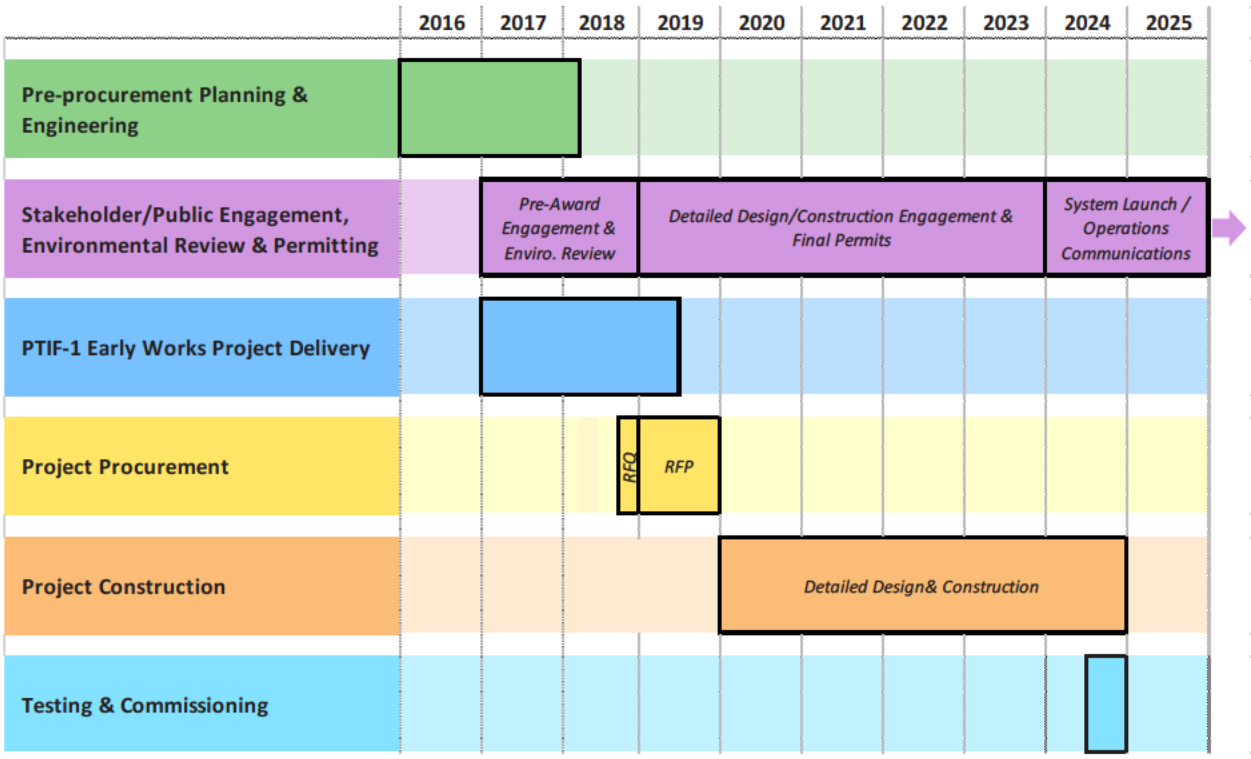
Market sounding feedback was generally positive and supportive of the Project as envisioned.

PROJECT SCHEDULE AND COSTS

As shown below, it is anticipated that an RFQ will be issued in the fall 2018 followed by the issuance of an RFP to the short-listed proponents in the winter 2018/19. A five-year Project construction phase is expected to begin in 2020 with the MLBE commencing service by 2025.[2]

[2] Implementation activities of the DBF Contractor are expected to commence in 2020. Certain Owner's Works, including various Advance Works, will proceed prior to award of the DBF contract.

Figure 3. Proposed Schedule



The estimated cost of the Project, including planning, construction, and financing, is $2,827 million (nominal dollars), as shown below:

Table 1. Capital Project Cost Allocation – (Nominal $ million)

Capital	Allocation
Proponent, including contingency	[redacted]
Owner, including contingency	[redacted]
Property purchase	[redacted]
CoV Properties & Rights	[redacted]
BC Hydro Early Works	[redacted]
Provincial Interest During Construction (IDC)	[redacted]
Total Capital Budget*	**$2,827**

*Capital budget does not include expensed planning costs of [redacted] million that were incurred during 2016/17 and 2017/18 prior to Provincial project approval.

PROJECT FUNDING

The Project has already secured funding of [redacted] million for the BC Hydro Early Works from the Government of Canada and the Province under the Public Transit Infrastructure Fund (PTIF) Phase 1.

Provincial funding of 40% is being provided for Phase 2 of the overall Mayor's Vision (MLBE, Surrey-Newton-Guildford LRT, Expo and Millennium Upgrade Program and other priority projects), however ownership of discrete assets within the Vision will be split between the Province and TransLink, in order for both parties to capitalize their respective contributions. Provincial and TransLink funding will therefore be directed towards the assets they will own.

The Province currently owns the vast majority of the existing SkyTrain system and leases it to TransLink to operate. As the MLBE project is an extension to the existing provincially owned Millennium Line, the Province will own and fund this asset. Additional funding for the Project (PTIF2) will be provided by the Government of Canada and in-kind land contributions from the City of Vancouver, as identified in the table below:

Table 2. Capital Project Funding Allocation by Source (Nominal $ million)

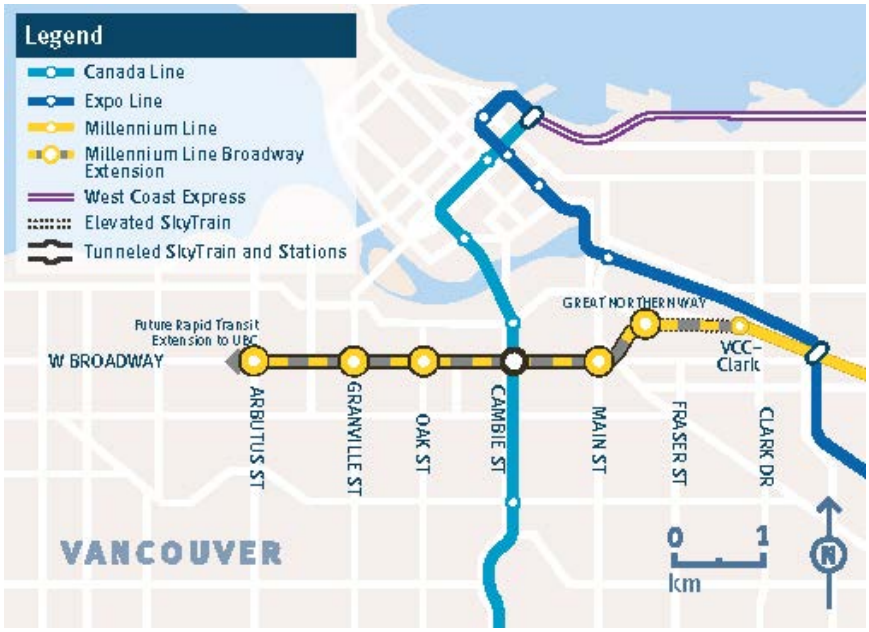
Funding Source	PTIF Phase 1 Received (BC Hydro Early Works)	Additional Requested (PTIF 2)	Total Allocation
Government of Canada	[redacted]	[redacted]	[redacted]
Provincial Government	[redacted]	[redacted]	[redacted]
CoV In-kind contribution of Properties & Rights	[redacted]	[redacted]	[redacted]
Total Capital Budget	[redacted]	[redacted]	**$2,827**

TransLink led the Project through the conceptual development and planning phases. The Province will deliver the Project.

1 INTRODUCTION

This Business Case recommends the implementation of the Millennium Line Broadway Extension (MLBE or the Project), a $2,827 million, and 5.7 km Advanced Light Rapid Transit (ALRT or SkyTrain) extension to the existing Millennium Line SkyTrain system from its current terminus at VCC-Clark Station to a new western terminus station at Arbutus Street.

Figure 4. Proposed Millennium Line Broadway Extension



It is recommended that the Project utilize the same rapid transit technology (SkyTrain) currently operated by TransLink on the existing Millennium and Expo Lines. The Project proposes to transition from the existing elevated station at VCC-Clark to a tunneled alignment where it will run underground beneath the Broadway Corridor, as shown in the above figure, to the new terminus station at Arbutus Street. In total, the Project recommends six new underground stations to provide fast, frequent, reliable, and convenient access for transit passengers to key locations along the Corridor, including both current and future educational, research, and health care facilities, as well as retail, commercial, and residential developments.

The Project will represent a significant investment for transit expansion in the Region and will complete the first phase of a longer-term vision to connect rapid transit to UBC.

This Business Case, while focused primarily on the justification for funding the Project, provides an overview of the regional context and rationale to the extension of the SkyTrain network within the Corridor, along with a detailed description of the planning history and options assessment leading to the recommendation of the Project.

1.1 PURPOSE

This Business Case is intended to provide information and analysis to support a funding decision by the Province. It has been developed to:

- Demonstrate the need and provide background information with respect to the MLBE Project;
- Describe in detail the options analysis, planning process, and recommended Project scope to meet the identified need;
- Describe in detail the procurement analysis conducted for the Project; and
- Recommend a procurement approach and implementation strategy.

The document consists of the following five main sections:

Part A - Rationale for the Project: Describes the need for the Project. This includes a description of the strategic context and an overview of the Project.

Part B - Delivery of the Project: Describes the Project, including a service delivery options analysis based on a technology assessment and route comparisons, and recommends a preferred Project scope. This part provides the concept design and capital cost for the project.

Part C - Procurement Options Analysis: Analyzes and compares the procurement methods considered. This section uses qualitative and quantitative analysis based on the results of financial modeling, risk quantification, risk analysis, and Multiple Criteria Analysis (MCA) of the procurement options, to ensure the Project goals and procurement objectives are satisfied.

Part D - Implementation Plan and Funding Analysis: Identifies funding sources and recommends the preferred procurement approach. Part D also includes the procurement plan, schedule, and budget.

Part E - Recommendation: Summarizes the recommendation to proceed with this Project.

PART A – RATIONALE FOR THE PROJECT

This section of the Business Case provides context for the Project and presents an overview of the challenges along the Corridor in particular.

This section concludes that:

- For 50 years, the Metro Vancouver Region's development has aligned closely with its strong vision to create a livable region of dense urban centres connected by an effective transportation network.
- In the next 30 years, the Region faces challenges to sustain its vision and accommodate a projected one million more residents and 600,000 new jobs.[3]
- The Corridor is one of two priority areas for public transportation improvements (along with the South of Fraser area). It is the second largest business centre in British Columbia, with the largest hospital in Western Canada (VGH) and an emerging technology sector.
- The Corridor represents a significant gap in the current rapid transit system in the Region. The lack of a rapid transit system along the Corridor places greater pressure on other services, forcing riders to transfer either at downtown stations or to connect via rapid bus routes, which cannot accommodate the current ridership and cannot be further expanded.
- The Project will address the needs of the Region and overcome existing challenges to improve Corridor accessibility, and the Project will promote urban and economic development that will benefit the entire Region.
- The Project will support the realization of proposed environmental and housing affordability commitments for the Province.

[3] Metro Vancouver, Regional Growth Strategy, Updated July 28, 2017

2 STRATEGIC CONTEXT

This section identifies the background and strategic context for the Project.

2.1 PROVINCE OF BRITISH COLUMBIA

The Province has identified several priority areas to improve the quality of life for residents of British Columbia and address key environmental and economic issues. These include:

- Building affordable housing;
- Addressing climate change; and
- Improving transportation network reliability.

These priority areas serve as factors in the proposed design of the Project and its recommendation to the Province. The following subsections identifies how rapid transit can address these areas.

2.1.1 Affordable Housing

The 2018 Throne Speech noted that government is making the "largest investment in affordable housing in B.C.'s history, including social housing, student housing, seniors housing, Indigenous housing and affordable rentals for middle-income families. Government will enact reforms to bring down barriers to affordable housing, and will work with partners to get them built. We will enable local governments to plan for affordable rental housing by zoning areas of their communities for that purpose. And working with local governments, we will plan for and build housing near transit corridors."

This was reflected in "Homes for BC", the 30–Point Plan for Housing Affordability for British Columbia.

In that plan, Government committed to expanding transit and building communities, and working with local governments to facilitate housing affordability and density along transit lines. Ministry of Municipal Affairs and Housing staff are working closely with TransLink and the cities of Vancouver and Surrey to develop baseline data, key performance indicators, and a collaborative process for development along the new transit corridors in these communities to ensure provincial objectives are met. Innovative partnerships and projects through the HousingHub are currently being explored.

2.1.2 Climate Change

Transportation accounts for 37% of British Columbia's total emissions. The Province is undertaking multiple strategies to address climate change and reduce greenhouse gas emissions to align with the Pan-Canadian Clean Growth and Climate Change Framework. This includes the development of new 2030 climate change targets. Investing in new rapid transit in the Region will support the achievement of the Province's climate change target.

2.1.3 Transportation and Public Transit Infrastructure Fund

In June 2016, the Province and its federal partners signed a bilateral funding agreement (June 2016) under the initial phase of the Public Transit Infrastructure Fund (PTIF) to commit more than $314 million in Provincial funds and $460 million in federal funds towards transit investment in the Region and British Columbia. These commitments include funds towards the development of the MLBE. This agreement specifically recognizes that funding rapid transit will create new opportunities to build housing for

people that is affordable, with lower carbon footprints, in stronger communities that are connected to the places people need to access for work, school, shopping and recreation.

In 2017, the Province committed to support the Regional Transportation Investment – a Vision for metro Vancouver (Mayors' Vision), through 40% funding of the capital cost of the Vision and the federal government through its Investing in Canada Infrastructure Program (ICIP) has committed $2.2 billion in funding through the next phase of PTIF. A bilateral agreement was signed between the Province and the Federal government on April 2, 2018 confirming the funding commitment through PTIF.

Further, the agreement reaffirms the Province's and the Government of Canada's commitment to action through transit and rapid transit expansion as a means to reduce traffic congestion, air pollution, and GHG emissions while continuing to grow the regional and provincial economy.

2.2 METRO VANCOUVER REGION

For over 50 years, Metro Vancouver has focused its land and transportation planning efforts on the development of a livable and sustainable region of urban centres connected by a robust transportation system. The Region's leaders have successfully and consistently aligned growth and development with land use and transportation plans, strategies, and investments.

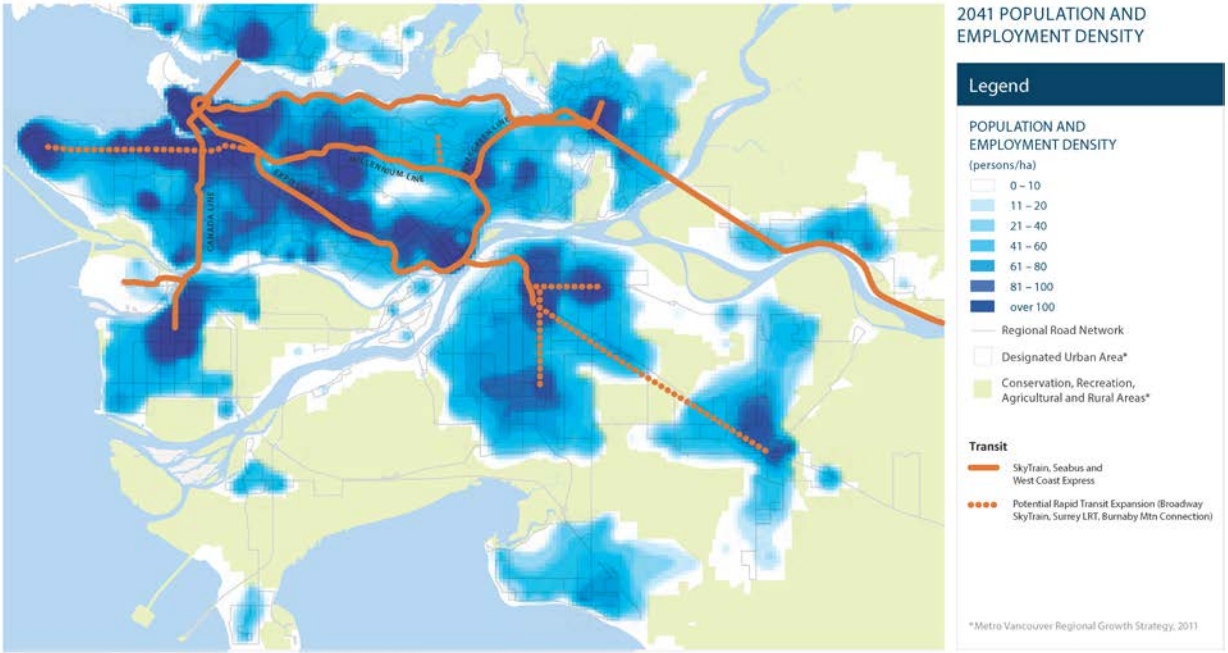
These plans helped guide major investments in the regional transit system throughout the past three decades, including the Expo and Millennium SkyTrain Lines and their extensions, West Coast Express commuter rail, the Canada Line, and B-Line / express bus services and infrastructure.

In 2011, the Region's leaders adopted *Metro Vancouver 2040* as the new regional growth strategy (Regional Growth Strategy or RGS). The RGS contains strategies to advance five goals related to urban development: the regional economy, the environment and climate change, housing and community amenities, and integrating land use and transportation. It also identifies a rapid transit extension along the Corridor as a key priority.

Central to these strategies is focusing growth in urban centres and designated frequent transit development areas, as seen in the denser areas adjacent to rapid transit lines in the following figure. Over the 30-year time frame of the RGS (2011-2041), population is forecasted to grow by over one million residents (from 2.3 million to 3.4 million), at an average rate of over 35,000 new residents each year. This growth will significantly influence the density of urban centres within the Region.

At the same time, the Region is forecasted to add 600,000 jobs (a 50% increase from 1.2 to 1.8 million) by 2041. The RGS will focus population and job growth in proximity to the current and future rapid transit network.

Figure 5. 2041 Population and Employment Density with Current & Planned Rapid Transit Network.



The increased population will drive housing demand and impact affordability within the Region. In response to the rising housing costs, many residents are changing their expectations for housing. Some choose to purchase smaller condominiums in medium to high-density neighbourhoods that are reliant on transit and other transportation options, while others choose to move further from the urban core to more car dependent parts of the Region.

Many residents will need to commute longer distances between municipalities to reach their jobs. These longer commutes, combined with the increased urban density, will increase traffic congestion, increase transportation costs, and reduce mobility for Region's residents. If left unmanaged, this growth will make the Region less livable, affordable, and accessible, especially for low-income individuals. In the long term, the Region could be challenged to attract and retain highly skilled employees required to support economic growth and innovation.

Metro Vancouver, TransLink, and the City of Vancouver will also be challenged to achieve their ambitious transit mode share targets (in line with other international urban cities):

- Metro Vancouver and TransLink have set a target of achieving half of all trips in the Region by sustainable modes (transit, walking and cycling) by 2045. [4]
- The City of Vancouver has set a target of half of all trips in the City by sustainable modes by 2020 and two-thirds of all trips by sustainable modes by 2040. [5]

The percentage of daily trips by walking, cycling, or transit in the Region is 27% (2011 values). To move toward a target of 50% mode-share would require an additional 3.2 million daily trips by sustainable modes by 2045.[6] Mixed-use development including residential, employment, shopping and services allow for short trips by walking, cycling and conventional bus transit; however quick, convenient rapid transit is needed to serve longer trips.

While Metro Vancouver has managed to concentrate some of its population and employment close to rapid transit, there are still major residential and commercial areas in the Region that are underserved, and these represent significant gaps within the regional transportation system. Two priority areas include:

- The Corridor; and
- The South of Fraser.[7]

TransLink is responsible for developing a system to meet the objective of aligning transportation infrastructure and services closely with land use decisions, within these priority areas.

[4] TransLink, "Regional Transportation Strategy: Strategic Framework", 2013.
[5] City of Vancouver, "Transportation 2040", 2012
[6] TransLink, "Regional Transportation Strategy: Strategic Framework", 2013
[7] South of Fraser is composed of City of Surrey, City of Langley, Township of Langley, Corporation of Delta, City of White Rock and Tsawwassen First Nation.

2.3 TRANSLINK

Governed by the South Coast British Columbia Transportation Authority Act, the South Coast British Columbia Transportation Authority (TransLink) is Metro Vancouver's regional transportation authority. TransLink is responsible for the regional transportation system, which includes regional transit, cycling, and commuting options.

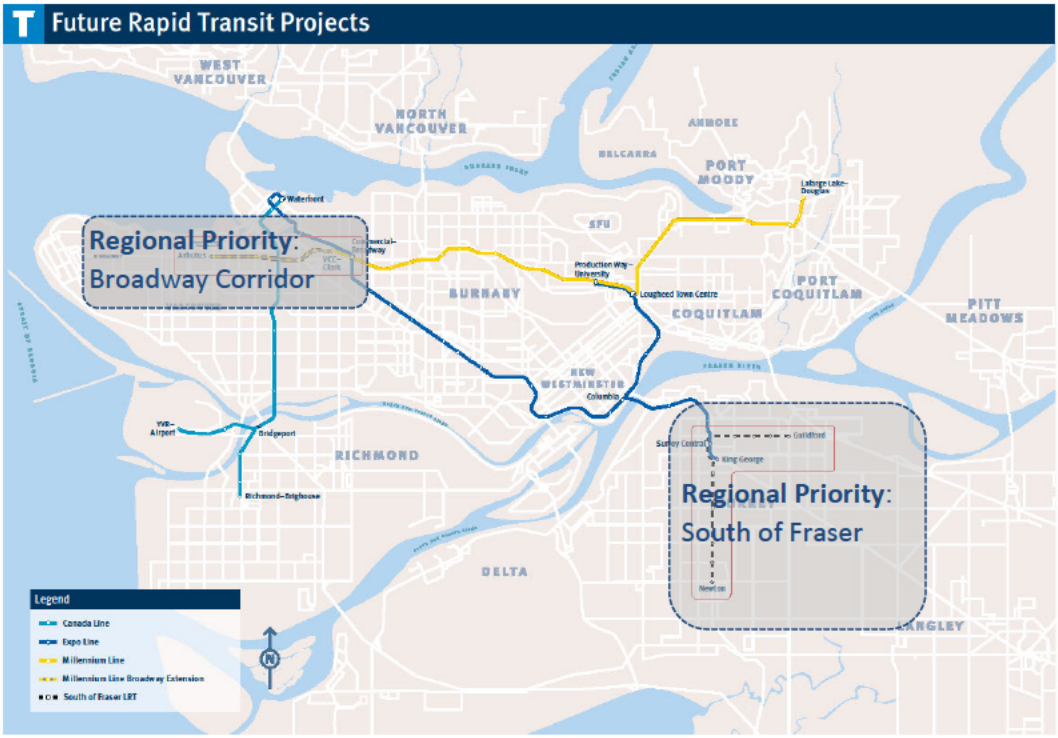
TransLink's mandate states that TransLink is responsible to plan the regional transportation system to achieve sustainable growth targets as set out in the Regional Growth Strategy. [8] In fulfilling this mandate, TransLink is tasked with developing a regional transportation strategy that highlights a series of priority projects that can help meet the targets.

Major rapid transit investments in the past decades have been made possible with federal, provincial, and regional funding. These investments include the Expo Line (1985) and its extensions, Millennium Line (2002), Canada Line (2009), and the recent Evergreen Extension (2016).

The rapid transit network is supplemented by an extensive network of express bus, local bus, and paratransit services, a commuter rail service extending east to Mission, and a SeaBus service providing a vital connection to the North Shore. Taken together, TransLink's service area encompasses more than 1,800 square kilometres, the largest transit service area in Canada. The following figure shows regional rail transit connections including the two priority areas currently underserved by the regional transportation system.

[8] *South Coast British Columbia Transportation Authority Act*, http://www.bclaws.ca/civix/document/id/complete/statreg/98030_01

Figure 6. Key Regional Transit Priorities



To address the regional priority areas and other issues outlined in the RGS, TransLink developed the Regional Transportation Strategy (2013) that sets out the vision, goals, principles, strategies, and actions to help guide transportation decisions in the Region over the next 30 years.

This strategy highlighted rapid transit investments on key corridors South of the Fraser and along Vancouver's Broadway Corridor. It has since been endorsed by the Mayors' Council on Regional Transportation (Mayors' Council) with the publication of Transportation Investments: A Vision for Metro Vancouver (Mayors' Vision).

2.4 BROADWAY CORRIDOR

The Corridor (shown in the figure below) is a regionally important corridor that includes the largest university (UBC) and the largest hospital (VGH) in Western Canada. With more than 105,000 jobs along the Corridor, Broadway is the second largest job centre in British Columbia, and a key source of employment for residents throughout the Region. The demand for job space in the Corridor is high with roughly 30,000 new jobs anticipated by 2045.[9]

BROADWAY CORRIDOR AT A GLANCE	2011*	2045**
Population	124,000	195,000
Employment	105,000	133,000
FTE Students (UBC)	42,000	63,000

Source: * Statistics Canada 2011 (City of Vancouver data), UBC 2011 (UBC/UEL data).
** City of Vancouver 2016, UBC 2016.

Figure 7. Broadway Corridor – Areas Served

High tech clusters (light blue) are emerging in the Corridor as shown in the above figure. These clusters typically draw commuters to the area for work and support connections between centres of education, innovation and research (e.g. UBC, Great Northern Way Campus, Simon Fraser University) and high-tech employers within the Corridor.

[9] **Note:** City of Vancouver projections are based on observed rates of change, existing zoning and known redevelopments. Assumptions are not made with future rates of change, zoning changes, or major developments and as such are inherently conservative.

Broadway Corridor by the Numbers:	
29.3 million ft²	Commercial Floor Space
40	% of Vancouver's Health Care Business
25	% of City's Technology Businesses

The Corridor is also home to a number of growing medium and higher density neighbourhoods including Grandview-Woodland, Kitsilano, Mount Pleasant, and Southeast False Creek. Within the past decade, land use plans have been approved by the City of Vancouver for these neighbourhoods that have increased the capacity for growth in the Corridor. Land use planning is also underway in the industrial area of False Creek Flats, which represents a large employment opportunity connected to rapid transit. There are currently over 125,000 people living in the Corridor with a further 70,000 expected by 2045.[10]

At present, the Corridor is one of the busiest transit corridors in North America, with over 100,000 transit trips a day, 55,000 of which are on the 99 B-Line express bus– one of the busiest bus routes in North America. Almost half (47%) of all people commuting to and from work in Central Broadway (the central part of the Corridor between Main Street and Burrard Street) come from outside of the City of Vancouver.[11]

In addition to high transit demand, Broadway is the only continuous east-west truck route in the City of Vancouver. It is one of the busiest routes for goods movement in the City of Vancouver with roughly 800 trucks passing through Central Broadway everyday (8 a.m. to 8 p.m.). [12] Traffic congestion is significant on Broadway even with peak period parking restrictions and dedicated bus lanes. Some parts of the Corridor experience up to 30,000 vehicles per day.[13]

The introduction of rapid transit to the Corridor is a key component of Vancouver's strategy to support economic development and improve affordability in the region. As part of its Metro Core Jobs and Economy Land Use Plan (2007), the City of Vancouver created policies to encourage additional office space while preserving industrial uses and allowing residential development where appropriate. Furthermore, the City has committed to review land use policies and zoning in the Corridor once a rapid transit line is fully funded.

Already, a number of commercial rezonings and major developments have been approved in the Corridor in anticipation of future rapid transit services. A rapid transit service will help these developments to attract tenants and increase the likelihood of future high-density developments.

[10] City of Vancouver, 2012
[11] Statistics Canada, 2006 Census
[12] City of Vancouver, 2012
[13] East of Main on East Broadway, 2015.

3 EXISTING CHALLENGES

This section highlights some of the challenges associated with the lack of a rapid transit in the Corridor such as:

- Constraints on economic development potential in the Region;
- Capacity, reliability, and travel times of existing transit services;
- Bottlenecks at key transit transfer points; and
- Inability to achieve mode share and environmental targets.

Transit needs in the Corridor already exceed the capacity that a bus system can provide.

A higher capacity solution will allow the Region to reach its economic potential and environmental objectives.

3.1 LIMITING ECONOMIC DEVELOPMENT POTENTIAL

Effective infrastructure can enable economic growth and urban development, especially within research and technology sectors.[14] As identified in this section, existing transit connections are insufficient to support the current demand in the Corridor and within the regional transit network. This limits the connections and associated development between the Region's biggest centres of innovation and research (UBC, Simon Fraser University, and the growing Great Northern Way Campus that includes BCIT and Emily Carr University of Art and Design) and the high tech and biomedical employment centres in the Corridor.

The lack of rapid transit limits the scale of broader urban development that can be supported within the Corridor. Research shows that quality transit connections are essential in attracting employers as well as skilled workers, and are a key factor for companies looking to set up new offices. For example, the American Public Transit Agency found that in a global marketplace "A failure to provide sufficient [transit] capacity for future employment in high growth industry clusters will have consequences in terms of lost productivity or foregone employment growth."[15] Without rapid transit and improved connectivity, the Corridor will face additional challenges to attract and retain employment opportunities for the Region. Rapid transit is essential to serve the existing population and jobs as well as the growth anticipated in the Corridor. The Corridor is a key east-west route for goods movement and more trucks will be required as growth brings more residents and jobs. In the absence of viable rapid transportation alternatives, traffic congestion along the Corridor will increase and slow the movement of goods thus hindering the economic viability and competitiveness of the Corridor.

A lack of rapid transit connectivity in the Corridor limits the Region's economic growth and poses challenges for goods movement servicing the Corridor.

[14] APTA, The Role of Transit in Supporting High Growth Business Clusters in the U.S.; APTA. 2014. Economic Impact of Public Transportation Investment, 2013.
[15] APTA, The Role of Transit in Supporting High Growth Business Clusters in the U.S.; APTA. 2014. Economic Impact of Public Transportation Investment, page 2.

3.2 CAPACITY, RELIABILITY AND TRAVEL TIMES OF EXISTING TRANSIT SERVICES

The Corridor is served by an express bus service, the 99 B-Line, and the 9 local bus service. Together, these services make the Corridor the busiest bus route in North America. More than 100,000 transit riders travel in the Corridor each day, with the 99 B-Line transporting over 55,000 daily passengers. With buses operating at maximum frequency (every three minutes) during peak periods, the Corridor has reached the limit of capacity that can be provided with buses in mixed traffic.

Figure 8. Morning queues for the 99 B-Line service heading west at Commercial-Broadway Station.

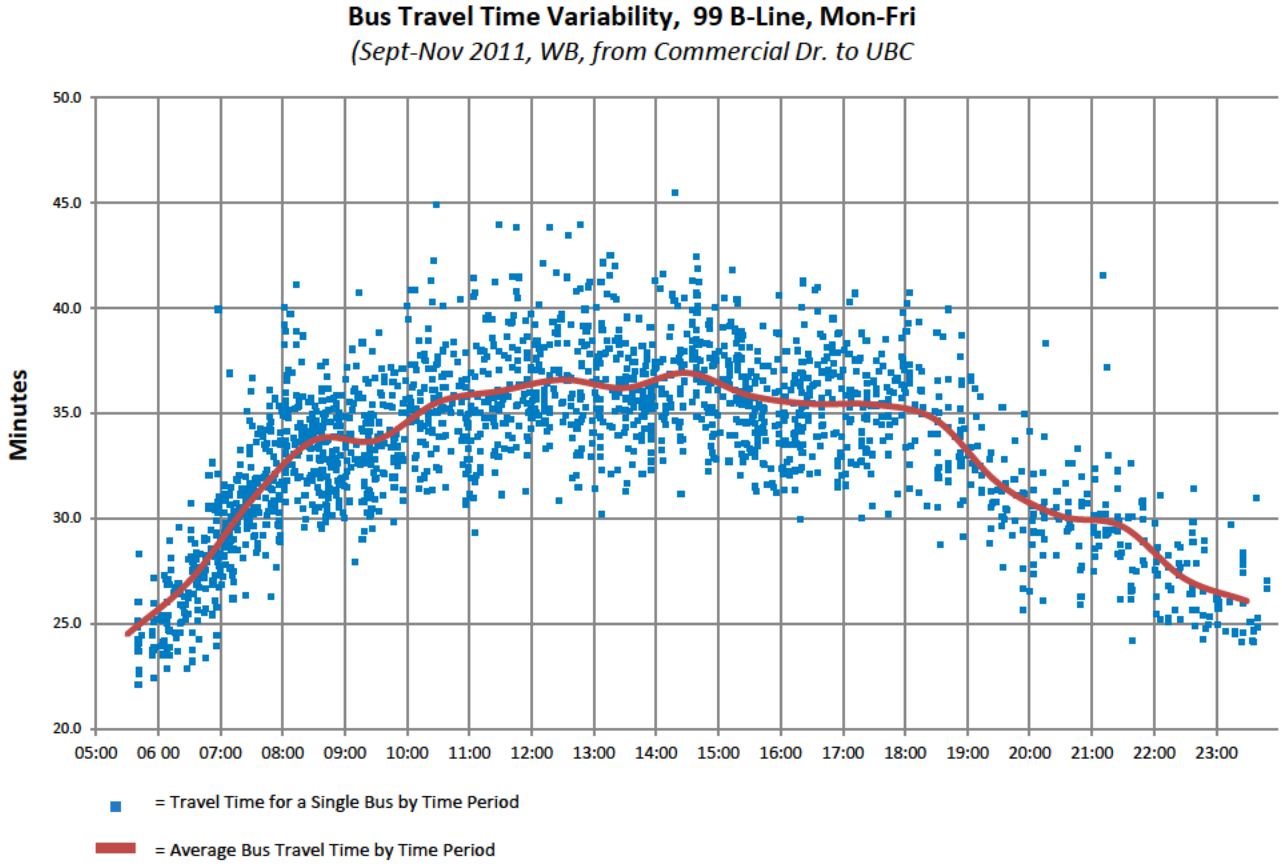
The current demand for transit far exceeds the current capacity of existing bus services. Half a million passengers of the 99 B-Line are passed by every year by buses at capacity. The accompanying delays, line-ups, and pass-ups dissuade many people that travel to and from the Corridor from taking transit. Instead, many of these individuals choose automobiles, a transportation mode viewed as more efficient and time reliable. Approximately 59% of all trips to and from the central part of the Corridor are made in automobiles.[16]

Current travel utilizing the 99 B-Line can best be described as unpredictable. Traffic congestion on Broadway is significant even with peak period parking restrictions and dedicated bus lanes – especially between Commercial Drive and Burrard Street. The ability to maintain a standard frequency of buses (headway) and consistent travel time through congested streets is difficult and results in bunching of buses and gaps in service. Despite transit service frequency scheduled for every three minutes during peak periods, it is not uncommon for transit customers to wait for much longer, followed by two or three buses arriving together.

Traffic congestion on Broadway also affects travel times on the 99 B-Line. Average travel speeds are a reflection of travel time and are markedly different between the east and west part of the Corridor. Average 99 B-Line travel speeds through the eastern part of the Corridor (Commercial Drive to Arbutus Street) during the morning peak period are 24.8 km/h while the western part of the Corridor (Arbutus Street to UBC) are 39.1 km/h. Congestion contributes to the variability of travel time of each 99 B-Line trip. The variability in travel time can be up to 15 minutes for travel from Commercial-Broadway Station and UBC, as shown in the following figure.

[16] TransLink, 2011 Trip Diary Survey

Figure 9. Bus Travel Times on the 99 B-Line westbound, Monday to Friday



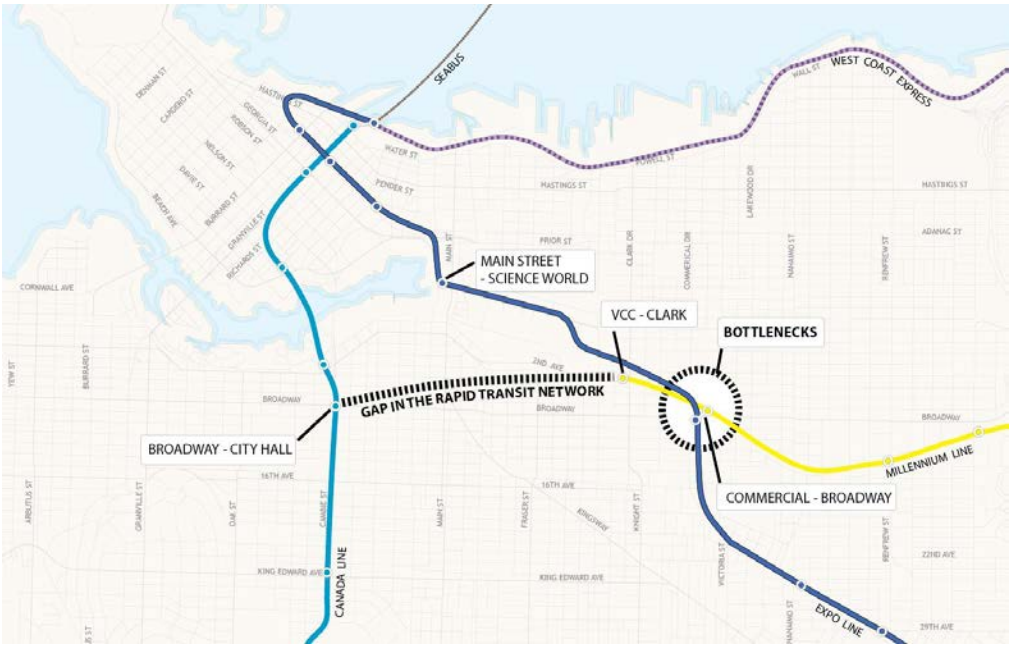
The City of Vancouver and TransLink conducted a joint review of the 99 B-Line bus service and concluded that while there are some strategies that could offer minor improvements outside of the peak travel periods, there is no scenario in which the current express bus system can meet today's peak period demand let alone the anticipated growth and demand for all trip types.

The capacity, reliability, and travel time of existing bus transit services on Broadway cannot be improved and is insufficient to handle the needs of today, let alone the needs and goals of a growing region.

3.3 EXISTING GAPS AND BOTTLENECKS IN RAPID TRANSIT NETWORK

The existing rapid transit network has a significant gap between the terminus of the Millennium Line at VCC-Clark Station and the Canada Line (figure below). The gap impedes the ability of passengers to travel between urban centres, and places enormous pressure on the transfer station at Commercial-Broadway. In addition, the gaps worsen transit crowding on the Expo Line between Commercial-Broadway Station and Main Street-Science World Station, the most overcrowded segment on the SkyTrain system.

Figure 10. Gap in Rapid Transit Network



With 90,000 SkyTrain passenger trips and 60,000 bus passenger trips using the station every day, Commercial-Broadway Station is the Region's biggest transit bottleneck and struggles to accommodate the number of passengers at many times of day.[17] Currently:

- All passengers heading to and from downtown must take the Expo Line through or transfer at Commercial-Broadway Station from the B-Line or Millennium Line.
- SkyTrain passengers (Expo Line and Millennium Line) heading to Central Broadway, Canada Line, or UBC transfer to the 99 B-Line bus at Commercial-Broadway.
- Some Expo Line and Millennium passengers utilize the Expo Line into downtown to transfer to the Canada Line.

Because of the current network, the busiest segment of the existing SkyTrain system is between Commercial-Broadway Station and Main Street-Science World Station. This segment of the rapid transit system is operating at or above capacity at peak periods of the day and is a key driver behind the costly, but necessary Expo Line upgrades. The MLBE will further help by relieving capacity challenges along the existing Expo Line, by providing a direct link between the Millennium Line and Canada Line.

As long as there is a gap in the regional transit network along Broadway, there will be continued pressure on Commercial-Broadway Station and the Expo Line heading into downtown.

[17] TransLink, "Commercial-Broadway Station Phase 2 Upgrades: Stakeholder and Public Engagement Report. Detailed Design Round: June 2 to 16, 2014", 2014.

3.4 ASSIST IN ACHIEVING MODE SHARE AND ENVIRONMENTAL TARGETS

As noted in Section 2.2, the City of Vancouver and Metro Vancouver have both set ambitious mode share and environmental targets for the Region. However, current transit capacity limits the ability to achieve these mode share targets in Vancouver.[18]

The Corridor continues to demonstrate high automobile use, largely due to a lack of transit capacity. While the population and employment density are comparable to downtown Vancouver, approximately 59% of all trips to and from the central part of the Corridor were made in automobiles compared to only around 35% to and from downtown Vancouver. There is a latent, un-met demand for transit services in the Corridor demonstrated by relatively high automobile mode share, and existing transit services that operate at or over capacity.

The reduction of automobile use through mode share improvements can be expected to be a central element in achieving anticipated climate change targets. Current automobile use in the Broadway Corridor hinders both mode share and greenhouse gas reduction targets. Without a rapid transit solution in the Broadway Corridor, the Region would be challenged to meet its targets.

Transit capacity in the Corridor is limiting the ability to increase transit mode share and affecting the Region's ability to meet its environmental targets.

[18] City of Vancouver, "Transportation Panel Survey: 2015 Final Report", 2016.

4 PROJECT OBJECTIVES AND OUTCOMES

Informed by previous studies conducted for the Corridor, the following high-level objectives and outcomes for the Project have been identified. These high-level objectives have been used to guide the evaluation of technology and alignment options. They have also been used to establish more specific, measurable objectives, to gauge the success of the Project.

Table 3. High Level Objectives and Outcomes

Account	High Level Project Objective	Resulting Project Outcome
Financial	An affordable and cost-effective service.	The Project demonstrates an effective use of public funds.
Transportation	A fast, reliable and efficient service that meets current and future capacity needs, supports achieving transportation targets, and integrates with and strengthens the regional transit network and other modes.	The Region achieves its transportation targets, and strengthens the regional transit network.
Economic Development	A service that encourages economic development through construction related (direct and indirect) job creation and tax revenue, and minimizing impacts on goods movement during operations.	The Project encourages economic development and improves goods movement within the Broadway Corridor.
Urban Development	A service that supports current and future land use development along the Corridor and integrates with the surrounding neighbourhoods through high quality urban design.	The Project supports current and future land use development along the Corridor, and supports the reduction of urban congestion.
Environment	A service that contributes to meeting wider environmental sustainability targets and objectives by attracting new riders, supporting changes to land use and reducing vehicle kilometers travelled.	The Project contributes to meeting wider environmental sustainability targets and objectives.
Social and Community	A safe, secure and accessible service that also improves access to rapid transit for all and brings positive benefit to the surrounding communities, while managing impacts of rapid transit on heritage and archaeology.	The Project increases foot traffic within the Corridor, and supports the development of public spaces and vibrant communities.
Deliverability[19]	A service that is constructible and operable, and publically acceptable.	The Project is publicly accepted, through all phases, and perceived as a positive development for the Region.

The measurable Project objectives and outcomes and their accompanying measures and indicators can be found in Section 12.6 of this business case.

[19] As defined in Translink. (2012). UBC Rapid Transit Study Phase 2 Evaluation Report

PART B – DELIVERY OF THE PROJECT

This section summarizes the analysis undertaken to determine a viable solution that will address the context, challenges, and objectives identified in Part A, and enable the Province and Region to develop infrastructure that benefits its residents and businesses.

Key points addressed in this section, include:

- The Province, TransLink, and the City of Vancouver have spent more than 15 years evaluating over 200 technology and alignment alternatives to address the rapid transit needs in the Corridor. The parties agree that SkyTrain technology comprehensively responds to the Project's objectives. This recommendation has been endorsed by a wide range of stakeholders.
- The Mayors' Council conducted further analysis and determined that, within the next 10 years, the capital investment for the Corridor is best served by initially focusing on the area between VCC-Clark Station and Arbutus Street.
- The Project will be a 5.7 km (total length) extension of the Millennium Line SkyTrain service, along Broadway from VCC-Clark Station to Arbutus Street. The Project will include six stations positioned at significant intersections along the Corridor.
- Building on the previous evaluations, a Multiple Account Evaluation (MAE) demonstrates that the proposed extension to Arbutus Street provides a strong benefit-to-cost ratio against the alternatives options and a Business As Usual (BAU) scenario.
- The Project is forecasted to generate $2,948 million (Present Value) in benefits through improved travel time, travel cost savings, urban development, environmental and economic benefits, and other incremental benefits.

5 ASSESSMENT OF POTENTIAL PROJECT ALTERNATIVES

The alternative technology and alignment options evaluated in this Business Case are the result of over 15 years of analysis by provincial and municipal governments.

This section summarizes the analysis undertaken to determine the recommended Project alternative. It includes:

- A summary of the historical analysis of more than 200 technology and alignment alternatives, and its resulting recommendation of three short-listed options.
- A summary of the Mayors' Council rationale and decision to phase development along the Corridor.
- A summary of a subsequent analysis to compare the short-listed options, and validate the decision for the preferred Project alternative.
- An updated MAE to compare the preferred Project alternative against Business As Usual.

Provincial and local governments have spent more than 15 years evaluating over 200 technology alternatives to address the rapid transit needs in the Corridor.

A tunneled SkyTrain alternative represents the best alternative for the Region and Province. This recommendation has been endorsed by a wide range of community groups.

5.1 IDENTIFICATION AND EVALUATION OF POTENTIAL OPTIONS

Between 2009 and 2011, TransLink and the Province sponsored a study with five partners – the City of Vancouver, Metro Vancouver Regional District, UBC, the University Endowment Lands, and the Musqueam First Nation. This UBC Line Rapid Transit Study considered more than 200 technology and alignment options for rapid transit from Commercial-Broadway Station to UBC. The Study was conducted in two phases and included extensive public consultation with:

- 3,800 feedback questionnaires
- 240 comments submitted online
- nine workshops with 940 attendees
- Multiple stakeholder meetings with local business groups
- Two drop-in stakeholder engagement sessions
- One webinar

During this study, 200 technology and alignment options were short-listed to seven options, which were then evaluated using a MAE framework. From March to April 2011, the study team presented preliminary design concepts and evaluation results for the seven short-listed options to the public for input. Approximately 540 people participated in four in-person workshops, an online webinar, seven small group meetings and two drop-in sessions. Input was received and tracked through workshop minutes and more than 1,500 feedback questionnaires. Furthermore, a TransLink Listens survey (an online advisory panel of regional residents) of over 1,800 people was used to gauge the public acceptability of each option. All short-listed options were evaluated against a Business As Usual (BAU) scenario, which assumed that the study area would continue to be served by the 99-B Line.

At the conclusion of the Study, the following top three options were identified for further analysis, with SkyTrain ultimately being evaluated as the highest ranked option:

Table 4. UBC Line Rapid Transit Study – Highest Ranked Options

Option	Description	Key Rationale for Shortlisting
RRT - Rail Rapid Transit (SkyTrain)	In the Region, RRT (SkyTrain) is driverless, automated and operates fully separated from other traffic in a tunnel or on elevated track, and with stations accessed by escalators, stairs and elevators. Mainly tunneled route from UBC via University Blvd, West 10th Ave, Broadway, Great Northern Way as an extension of the existing Millennium Line SkyTrain from VCC-Clark.	• This option was the top-ranked alternative in every category analyzed in the Study. • This option resulted in the greatest increase in transit trips and mode share, with the highest benefit-cost ratio, of these three options.
LRT1 - Light Rail Transit 1	Driver-operated rail vehicles powered from overhead wires running in their own right-of-way and separated from other traffic by a curb, and with stations located within the street. At-grade LRT route from UBC to Commercial/Broadway via University Blvd, West 10th Ave and Broadway.	• This option generated the second best travel times and reliability improvements after RRT and Combo1. • This option was the most cost effective option among LRT alternatives.
Combo1 - Combination Alternative 1	Combination of RRT from VCC Clark to Arbutus Street with the portion of the LRT2 route operating from UBC to Main Street/Science World.	• This option, along with the RRT option, was the most cost-effective in generating additional transit users. • This option, along with RRT, served the largest number of major activity centres within the Corridor.

5.2 DECISION TO PHASE RAPID TRANSIT DEVELOPMENT ON BROADWAY CORRIDOR

Following the assessment of technology and alignment options for the entire length of the Corridor to UBC, the Mayors' Council on Regional Transportation considered the UBC Line Rapid Transit Study technical analysis as well as regional affordability within the 10-year timeframe of their Regional Transportation Investment Vision (Mayors' Vision). The Mayors' Council determined that a phased approach to delivering Broadway rapid transit is best able to address the most significant transportation needs of the region while also responding to investment needs across the region. The Mayor's Vision confirmed that a primarily tunneled SkyTrain extension in the Corridor to Arbutus Street with the

alignment located under Broadway (MLBE) is the preferred technology and alignment to meet the projected long-term transit demand and provide the greatest reliability for the Corridor.

In developing the Mayors' Vision, the investment sub-committee of the Mayors' Council considered the findings of the UBC Line Rapid Transit Study, which noted that an extension of SkyTrain from VCC-Clark Station to Arbutus Street is cost effective and will provide a better short term benefit-cost ratio than the full scope to UBC. [20] This was a result of higher concentrations of people and jobs in Central Broadway, a more significant reduction in traffic congestion, proportionally higher ridership, and greater near-term development potential along the eastern section of the Corridor. Additionally, analysis also shows that connecting the MLBE to a shortened B-Line will provide sufficient capacity to accommodate forecast ridership between Arbutus Street and UBC over the medium term. [21]

The sub-committee concluded that while rapid transit to UBC will eventually be required, an extension to Arbutus Street will address the most critical rapid transit gap in the regional transportation network, provide the greatest benefit for investment with the first 10 years of the Mayors' Vision, and effectively balance regional needs.

The decision to terminate the MLBE at Arbutus Street as opposed to more eastern terminus locations (such as Granville Street), was based primarily on three important considerations, namely:

- **Addresses the Immediate Need for Rapid Transit Service**: Arbutus Street is the most suitable terminus along the Corridor as it is immediately west of the most dense section of central part of the Corridor, and thus provides much needed rapid transit service through the most critical section of the truncated Corridor.
- **Does Not Preclude Options for Connection to UBC**: Terminating the first phase at Arbutus Street does not limit options or preclude technology alternatives from consideration for the future rapid transit connection to UBC.
- **Space for Bus Integration**: Arbutus Street has more room for bus integration. Truncation of the SkyTrain extension at Granville Street, by comparison, would create significant challenges for bus operations. The higher variability in bus travel time between Arbutus Street and Granville Street as well as the three to four minutes required to make a left turn from Broadway onto Granville (a turning movement required if the B-Line were to terminate at Granville) have several implications, including higher bus operating costs, increased street congestion, and diminished passenger service reliability. There is greater congestion and less space to accommodate buses and passenger transfer movements at Granville compared with the Arbutus Street terminus location.

Given the regional affordability, benefit-cost ratio, and other considerations outlined above, the Mayors' Vision phased the development of the Corridor rapid transit line with a first phase project terminating at a station at Arbutus Street. The Mayors' Vision identified a tunneled SkyTrain extension as the preferred alternative for delivery within the first 10 years, which would support regional objectives for community integration, land use, and mode-share targets. Several regional organizations representing transit and transportation interests, environmental groups, medical and health alliances, business interests, labour organizations, and post-secondary institutions have since endorsed this regional investment Vision. [22]

[20] Translink. (2012). *UBC Rapid Transit Study Phase 2 Evaluation Report, Page 146 12.26.*
[21] Translink. (2012). *UBC Rapid Transit Study Phase 2 Evaluation Report, Page 146 12.25.*
[22] Better Transit & Transportation Coalition: http://www.bettertransit.info/partners

5.3 IDENTIFICATION AND EVALUATION OF POTENTIAL PROJECT ALTERNATIVES

Following the identification of a tunneled SkyTrain extension as the preferred alternative, a review was undertaken of the potential project to confirm that the UBC Line Rapid Transit Study conclusions were still valid and would apply in the context of a project scope terminating at Arbutus Street, rather than UBC, with an alignment on Broadway. A summary of this analysis can be found in the Strategic Options Analysis report (SOA).

LRT 1, a shortlisted alternative in the UBC Line Rapid Transit Study, was analyzed within the Strategic Options Analysis, which confirmed that differentiating metrics such as ridership, capacity, travel time and reliability identified in the UBC Line Rapid Transit Study were relevant even with the shorter alignment. Additionally, the introduction of the phased approach of project delivery further limited the cost effectiveness of an LRT due to the need for a new Operations and Maintenance Centre and transit storage facilities for a short length of alignment.

In addition to LRT 1, an elevated SkyTrain was evaluated against project objectives in the Strategic Options Analysis. The use of SkyTrain technology offered improvements over LRT technology in many criteria such as increased ridership, faster and more reliable travel time, and greater capacity. However, an elevated guideway down the centre of Broadway would have many negative impacts along the narrow, densely developed, and urban Corridor. There would be noise and proximity impacts to existing businesses and residents as the elevated alignment would be located very close to existing buildings. An elevated guideway would also limit future development on the Corridor, as additional setbacks would be required for new buildings constructed on Broadway, limiting developable land. Finally, the permanent loss of two travel/parking lanes and the introduction of turning restrictions on the majority of Broadway would increase congestion for non-transit users and goods movement along Broadway, and increase traffic on nearby local streets.

Following an evaluation of the alternatives noted above, the Strategic Options Analysis confirmed the conclusion reached within the Mayors' Vision, and recommended the technology selection of a tunneled SkyTrain extension to Arbutus, as the preferred alternative to address Project objectives and challenges for the Corridor.

This analysis is supported by an updated Multiple Account Evaluation (MAE), which is summarized in the following section.

5.4 UPDATED MULTIPLE ACCOUNT EVALUATION SUMMARY

Based on the information presented in the previous sections, an MAE has been developed to assess the recommended Project against Business as Usual, defined as the continuation of the 99 B-Line bus service, as currently maintained and operated. This MAE is intended to confirm the previous effort, and validate that the Project will provide a suitable benefit.

Table 5. MAE Five Point Scale

Scale	Description
✓	Significantly Worse
✓✓	Worse
✓✓✓	Same as Business As Usual
✓✓✓✓	Better
✓✓✓✓✓	Significantly Better

Note: The following table summarizes key points from the MAE. The full MAE can be viewed in the Strategic Options Analysis report.

Table 6. Summary MAE Table

Account	Alternative		
	BAU	RRT Elevated	RRT Tunneled
Financial	✓✓✓	✓✓✓✓	✓✓✓
	• No new capital cost (except fleet replacement. •	• Elevated option would have a slightly higher BCR than Tunneled. • While the BCR was slightly higher for elevated, there are feasibility issues with the implementation of this option. See SOA for additional supporting information. • Increased revenue from ridership (PV = [redacted] million) but partially offset by the loss of street parking revenue with an elevated alignment.	• Tunneled option would have a slightly lower BCR than elevated but significantly higher than other recent transit projects. • Increased revenue from ridership and parking (PV = [redacted] million) as street parking is retained with a tunneled alignment. •

Account	Alternative		
	BAU	RRT Elevated	RRT Tunneled
Transportation	✓✓✓	✓✓✓✓	✓✓✓✓✓
	• Average travel time of 28 minutes from Commercial-Broadway to Arbutus. • 2045 daily ridership forecasted at 100,000. Increased traffic congestion.	• Significant travel timesaving over BAU for Transit Users (11 minutes from Commercial- - Broadway to Arbutus). • 2045 daily ridership forecasted at 139,000. • Significant congestion impacts for non-transit users, bus users, goods movement due to loss of traffic lanes to accommodate columns. • Permanent street parking loss on Broadway.	• Significant travel timesaving over BAU (11 minutes from Commercial- - Broadway to Arbutus). • 2045 daily ridership forecasted at 167,000 (ridership increase due to direct connection between the Millennium and Canada Lines at City Hall station). • Reduction in congestion for all traffic modes on Broadway, no loss of traffic lanes. Street parking is retained on Broadway.
Economic Development	✓✓✓	✓✓✓✓	✓✓✓✓✓
	• Long-term negative economic impacts associated with the current gap in rapid transit network. Increased challenges for goods movement along Corridor.	• Addresses rapid transit gap connecting centres of innovation and employment centres. • Elevated alignment has proximity issues with Broadway facing businesses. • Loss of traffic lanes and increased congestion would hinder goods movement along Corridor.	• Addresses rapid transit gap connecting centres of innovation and employment centres. • Tunneled alignment would be more accessible and appealing for Corridor businesses. • Retention of traffic lanes and reduction in congestion would help goods movement along Corridor.
	✓✓✓	✓✓	✓✓✓✓

Account	Alternative		
	BAU	RRT Elevated	RRT Tunneled
Urban Development	• Corridor challenges to accommodate higher density land use. • No impact on property values.	• Footprint of elevated alignment in tight Broadway Corridor would further limit flexibility to improve urban realm. • Higher displacement of businesses than Tunneled option to allow transition to be elevated on Broadway. • Would limit higher density land use due to proximity of guideway to property lines.	• Tunneled alignment would allow for the full width of Broadway to be considered for urban realm improvements. • Fewer businesses are displaced as the project footprint is smaller. • Would allow higher density land use along the Corridor.
Environment	✓✓✓	✓✓✓✓	✓✓✓✓✓
	• Noise and vibration associated with the operation of the diesel powered 99 B-Line. • Negative impact on air quality. •	• SkyTrain technology would increase ridership along the Corridor, and reduce VKT and emissions in the process. Diesel bus B-Line service would be replaced with an electric rapid transit service. • GHG reductions of 9,200MT in 2030 and 8,160MT in 2045. • Significant operational noise impacts from trains on Elevated Guideway.	• SkyTrain technology would increase ridership along the Corridor, and reduce VKT and emissions in the process. Diesel bus B-Line service would be replaced with an electric rapid transit service. • GHG reductions of 9,390MT in 2030 and 8,330MT in 2045. • No Significant operational noise impacts.
Social and Community	✓✓✓	✓✓	✓✓✓✓✓
	• No difference in visual impacts. • Does not offer opportunity to improve Corridor.	• Existing buildings on Broadway would be within metres of elevated guideway and have not been designed for increased noise/visual intrusion of an elevated alignment.	• A tunneled SkyTrain would allow for improvements at street level, making the street more attractive to both business and residents. • Limiting noise and vibration would benefit existing businesses, particularly

Account	Alternative		
	BAU	RRT Elevated	RRT Tunneled
		• Loss of parking along Broadway will likely discourage trips to businesses along the Corridor.	medical and research facilities along the Corridor.
Deliverability[23]	✓✓✓	N/A	✓✓✓✓✓
	• BAU was not surveyed. Closest equivalent (best bus) preferred by 13% of participants. • Does not meet the Mayors' Council Vision.	• Does not meet the Mayors' council vision of a tunneled SkyTrain along the Broadway Corridor. • There were no public consultations that reviewed an elevated option along Broadway. • Significant construction impacts along 21 blocks of the Corridor.	• Public consultation included in UBC phase 2 report indicated that the Tunneled SkyTrain was the most acceptable option (selected by 40% of participants) of the seven alternatives considered. • Construction impacts along six blocks of the Corridor.

[23] As defined in Translink. (2012). UBC Rapid Transit Study Phase 2 Evaluation Report

5.5 RECOMMENDATION

The updated MAE confirms the previous analyses that recommended tunneled SkyTrain be undertaken along the Corridor. The tunneled SkyTrain option will address key transportation, economic, and urban development, and environmental challenges facing the Corridor and the Region.

The tunneled extension:

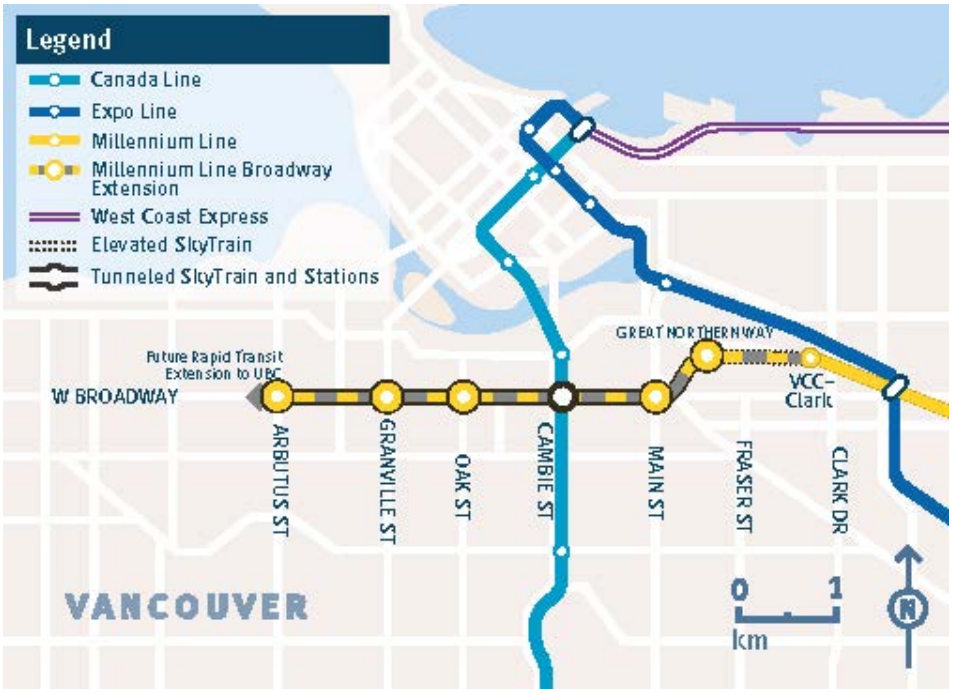
- Provides significant transit user benefits, and most effectively integrates into the existing Corridor;
- Best supports economic and urban development within the Region by providing an effective transportation solution without negatively affecting congestion, access to businesses, and livability along the Corridor during operations; and
- Has the highest level of support from the public and businesses, and is endorsed by the Mayors' Council.

Consistent with most large-scale construction projects, the MLBE will have temporary construction impacts, including disruption at surface construction locations (at station locations and elevated guideway), noise and vibration impacts, and traffic impacts. However, the long-term benefits to the development of the Corridor and to the overall regional transportation network far outweigh these impacts. This updated MAE confirms that the MLBE generates significant benefits to the Region as a whole, particularly when contrasted against the BAU.

6 PHYSICAL ASSET SCOPE

The proposed Project, as based on the analysis in Section 6, will be a 5.7 km tunneled extension of the Millennium Line along Broadway from VCC-Clark to Arbutus Station. The Project scope includes six underground stations positioned near significant intersections along the Corridor.

Figure 11. Map of Millennium Line Broadway Extension



Major underground works, such as stations and bored tunnels, are proposed to extend the existing Millennium Line system from its current terminus at VCC-Clark Station, west to Arbutus Street, under Broadway. It is recommended that all new stations are underground with entryway (head-house) structures at the surface. The key proposed MLBE scope elements are summarized below:

- **Elevated Guideway**: Construction of an approximately 700m above ground portion of the Project from VCC-Clark station to the tunnel portal near Great Northern Way.
- **Underground Civil Works**: All works within the Project right of way for vehicle tracks, including tunnel and station excavations, tunnel lining, station structural concrete works, traffic management, utility relocations, track supply/install, and stations and ancillary facilities.
- **Architectural Finishes**: All non-structural components of the stations including the head-house design and construction.
- **Integrated Systems**: Integrated systems, including automated train control, communication, and power supply systems.
- **Operations**: TransLink will be responsible for operations and maintenance, and will set service schedules and fares.

Vehicles and any additions to storage or operations and maintenance facilities are not in scope for the Project. Vehicles and corresponding improvements to the Expo and Millennium lines are part of the proposed Expo and Millennium Upgrade Program (EMUP). For more information regarding the proposed scope of EMUP, refer to Section 6.3.

6.1 PROJECT ALIGNMENT

The proposed 5.7 km MLBE will extend the elevated guideway approximately 700 metres westward from the existing terminus at VCC-Clark Station to the first station at Great Northern Way (GNW). From GNW Station, the proposed alignment will continue underground to join Broadway near Main Street, where it will travel west under Broadway to a new terminus at Arbutus Street.

Reference Case Alignment Design at a Glance*	
Total Length	5.7 km
Tunneled Portion	5.0 km
Above Grade Portion	0.7 km
Average Tunnel Depth	15 metres

* Project final design may vary from reference case design configuration, within specified requirements.

6.1.1 Considerations for Alignment

Considerations for setting the alignment directly below Broadway include, but are not limited to:

- The proposed alignment will connect significant employment nodes, including Vancouver City Hall and Vancouver General Hospital, and residential neighbourhoods. Parallel alignments do not adequately serve these destinations, and, as a result, ridership would suffer.
- Broadway's right of way is generally 30.5 metres wide, sufficient to accommodate tunnels and underground stations. Parallel avenues, at 20.1 metres wide, are insufficient to accommodate stations, and would require additional real estate.
- Other potential alignments along rail rights of way along False Creek are longer, increasing travel time, and required additional real estate.
- The proposed reference case design assumes twin bored tunnels; however, proponents may propose alternative tunneling configurations that conform with specified requirements.
- Geotechnical investigation along the Corridor indicates generally relatively shallow bedrock of variable strength. The shallow bedrock results in the reference case design with an average depth to top of rail in the tunnels of 15 metres.
- The proposed reference case design assumes the five stations directly below Broadway are implemented through a decked station construction methodology, which is defined as the excavation of the station from the surface, with the overlay of temporary traffic decking to minimize surface disruption and maintain surface traffic and transit operations. Decked station construction methodology showed several key benefits, including reduced risk and cost, improved track configuration, and shallower stations.
- The reference case design presented in this Business Case does not preclude bidders from proposing alternative approaches that conform with specified requirements.

6.1.2 Proposed Layout of the Alignment

The layout of the reference case design's alignment can be described in six sections, as shown in the following figure and described below:

Figure 12. Proposed Layout of Alignment

1. The initial portion of the alignment will consist of an elevated guideway extending from VCC-Clark Station for approximately 700 metres before transitioning to a below grade section approaching the new GNW Station. The underground section will be approximately 250 metres long.
2. The GNW area is recommended as the primary construction site/laydown area for the excavation of the bored tunnels. Based on this recommendation, the tunnel portal will be excavated on the north side of GNW, and will benefit from the natural rise in the topography and bedrock surface to the south.
3. All stations built within the Corridor will be within the range of approximately 15 metres below grade level, with the exception of Cambie Station where the MLBE must pass below the Canada Line. This depth is based on the current understanding of geotechnical conditions, and other existing conditions. The Cambie Station will serve as an interchange with the existing Canada Line Broadway-City Hall Station. A rail track crossover will be provided east of the new Cambie Station.
4. The tunnel(s) will continue westward past Cambie to Oak Station. A rail track crossover will be provided west of the new Cambie Station.
5. The tunnel(s) will continue westward to Granville Station.
6. Between Granville and Arbutus Stations, the bedrock elevation is believed to lower significantly. Therefore, Decked Station Construction is recommended for construction of the crossover tracks to the east of Arbutus Station in order to maintain the desired platform depth and to facilitate

extraction of tunneling equipment. Crossover tracks are recommended east of Arbutus Station to enable trains to transfer from outbound to inbound track at the proposed new western terminus of the Millennium Line.

6.2 STATION SCOPE

The recommended station locations were determined based on:

- Current population and employment distribution.
- Future opportunities for growth – this includes areas of growth under existing land use plans, zoning and policies as well as areas with the greatest potential for growth resulting from revised land use plans, and zoning and policies appropriate to development adjacent to a high capacity, high speed rapid transit line.
- Connections with the existing transit network.

Reference Case Station Design At a Glance*	
Platform Length	82.5 metres
Platform Width (except Cambie)	9.25 metres
Minimum Depth to Concourse	6.7 metres
Minimum Depth to Platform	12.5 metres
Maximum Depth of Platform	19.5 metres

* Project final design may vary from reference case design configuration, within specified requirements.

The recommended station spacing will be similar to that of current rapid transit stations in more urban parts of the region, such as downtown Vancouver, Metrotown, Surrey Metro Centre and Richmond City Centre. The MLBE will be designed to connect with eleven bus routes with weekday boardings of 142,550 riders (2015 data). Three of these routes are among the ten busiest in the region. The proposed stations will also connect with designated bike routes and bike parkades to further promote transit mode share.

Figure 13. Proposed Transit Integration

The following table identifies each recommended station and the underlying rationale. More information regarding the proposed station scope is provided in Appendix 1.

Note: Proposed station names are for planning purposes only and subject to change.

Table 7. Proposed Stations

Station	Rationale
Great Northern Way (GNW)	• Located within proximity of an emerging technology hub of high tech, new media, and arts and culture employment. • Located within the GNW Campus (a collaboration between UBC, SFU, Emily Carr University, and BCIT), and the new campus of the Emily Carr University of Art and Design. • Station area is subject to the City of Vancouver False Creeks Flats Plan, which seeks to generate higher density high tech and office developments within walking distance to the station.
Main Station	• Area is subject to the Mount Pleasant Community Plan, which identified areas for growth within this established historical neighbourhood. One recent development is a 21-storey mixed-use building with 78,000 ft^2 of commercial space and 220,000 ft^2 of residential space. • Located in proximity of the Mount Pleasant Industrial Zone, which permits light industrial functions and general office use, and other high tech employers. Eleven projects have been approved in the industrial zone since 2013, totalling 300,000 ft^2.

Station	Rationale
Cambie Street Station	• Designed to integrate with Canada Line's Broadway-City Hall Station, and serve as additional transfer point. • Located in proximity to Vancouver City Hall and Uptown Office District, which is subject the Vancouver's Metro Core Jobs and Economy Land Use Plan. Vancouver plans to increase higher density office developments in the region.
Oak Street Station	• Located within proximity of a healthcare hub including VGH (largest hospital in Western Canada), BC Cancer Agency, Canadian Cancer Society, and BC Cancer Research Centre • Located within proximity of new high-density offices, some of which are zoned at 173% of current maximum floor space ratio in area. • Located within Fairview Slopes neighbourhood that is primarily composed of low-to-medium rise condominiums/apartments.
Granville Street Station	• Located within proximity of second most dense residential neighbourhood along Corridor. • Located within proximity of South Granville shopping district and within walking distance of Granville Island. • Located within an area subject to the City's Metro Core Jobs and Economy Land Use Plan for future higher density development.
Arbutus Station	• Designed to permit multiple options for potential future rapid transit connection to UBC, and provide sufficient space for transit integration • Located within proximity of higher density residential neighbourhoods, including Arbutus Walk neighbourhood (five stories and higher) residential community built on the site of the former Carling brewery.

6.3 OPERATION AND MAINTENANCE SCOPE

The proposed MLBE will fully integrate with existing SkyTrain systems and protocols. It will function as part of the Millennium Line, which will extend from the Lafarge Lake-Douglas College Station in Coquitlam to the new terminus at Arbutus. The planned frequency of train (headway) for the Millennium Line is in the 3:40 to 2:30 minute range from opening day to 2045, with 2030 and 2045 values shown below:

Table 8. Anticipated Service Headways (minutes)

Year	MLBE
2030	3:10 - 3:33
2045	2:30 - 3:26

TransLink has initiated the Expo and Millennium Upgrade Program to address vehicle and system-wide scope improvements. As a result, this Project does not include vehicles or the development of a storage yard or maintenance facilities within its scope.

For operational and rail and tunnel maintenance reasons, cross over tracks are recommended at the mid-point of the Broadway extension, east and west of Cambie Station, and immediately east of the Arbutus Station platform.

The Project includes improvements at the Canada Line Broadway-City Hall Station to address the connection with the MLBE.

6.3.1 Relation to Expo and Millennium Upgrade Program (EMUP)

TransLink has initiated EMUP to support system wide improvements to the entire SkyTrain network, to support long-term development for rapid transit within the Region. It includes requirements to meet forecasted demand in 2028, inclusive of anticipated demand changes associated with MLBE. The scope of the program includes:

- The recommended acquisition of 203 vehicles, including longer five-car trains;
- The expansion of the vehicle storage facility near Falcon Way in Coquitlam;
- Upgrade to the existing Operation and Maintenance Centres 1 and 2 near Edmonds Station to expand maintenance capacity for the additional fleet and accommodate the longer five-car consists rather than building a new Operations and Maintenance facility;
- Mainline power upgrades to support longer and more frequent train service;
- Improvements to stations to improve capacity, accessibility, amenity, and neighbourhood integration; and

- A variety of system upgrades required to support more frequent service and accommodate expanded storage and maintenance facilities.

6.4 BUS OPERATING COST SAVINGS

TransLink is engaged in ongoing assessment of opportunities to improve bus service within the Region. As a result of the MLBE, the 99-B Line route will be truncated to eliminate the portion between Commercial and Arbutus and only operate between UBC and Arbutus. Other bus routes serving UBC are planned to remain unchanged.

The introduction of the MLBE and the truncation of the 99-B Line will lead to a reduction of 48,800 bus operating hours in 2030 and in 2045. Using revenue service hours and costs from TransLink's 2016 Transit Service Performance review, this equates to a total removal over the 30-year evaluation period of almost 1.5 million bus operating hours and monetary saving of [redacted]

TransLink will undertake a more detailed bus integration plan including schedule times before the MLBE project is implemented, however the truncation of the 99 B-Line is the only change currently planned and included in the analysis.

Based on ridership forecasts, it is anticipated that passenger volumes using the 9 and 99 B-Line at Arbutus will be similar or smaller than existing passenger volumes currently using these routes at Commercial Broadway. Therefore, the service levels are currently planned to be the same for all bus routes.

Other bus routes (including the #9 Broadway UBC-Boundary) will be maintained to provide local access. Although the #9 local Broadway bus service will be maintained on Broadway, it should be noted that the majority of transit trips on Broadway will use the MLBE. The following table summarizes the 2045 AM Peak hour passenger volumes using the buses on the Corridor compared to the SkyTrain indicating 81% to 92% of passengers will use the MLBE.

Table 9. 2045 Broadway Bus and SkyTrain Ridership (AM Peak Hour)

Broadway	Bus	SkyTrain	Total	% of Transit User on SkyTrain
West of Cambie	1,400	5,900	7,300	81%
East of Cambie	800	8,800	9,600	92%

7 PROJECT ASSESSMENT

7.1 CAPITAL AND OPERATING COST ESTIMATE

A capital cost estimate was prepared based on the physical asset scope described in Section 6 and detailed concept drawings prepared by the Project team. The following table presents the estimated capital costs required to deliver the scope.

Table 10. Capital Cost Estimate

Nominal	($M)
Stations	[redacted]
Tunnel & Guideway	[redacted]
System & Tracks	[redacted]
Utilities, Site Prep & Roadworks	[redacted]
Design & Construction Management	[redacted]
Owner's Cost (incl. Property & Insurance)	[redacted]
Contingency	[redacted]
Subtotal:	[redacted]
Proponent's IDC, Bid Development & SPV	[redacted]
Risk Adjustment	[redacted]
Provincial IDC	[redacted]
CoV Properties & Rights	[redacted]
BC Hydro Early Works including temporary power supply for construction	[redacted]
Total	**$2,827**

7.1.1 Cost of Properties

In addition to the properties included as part of the City of Vancouver's contribution, the Project will acquire over 80 properties, which includes permanent and temporary acquisitions, as well as access rights. Based on the analysis conducted to date, it is estimated that the net cost of the remaining acquisition will be $[redacted]

7.2 BENEFIT COST ANALYSIS

Below is a table outlining the Benefit Cost Analysis for the MLBE Project. The values shown are incremental to the BAU, reflect 30 years of project costs and benefits discounted at 6%[24], and are based on proceeding under the current project schedule. Project Costs and Benefits ($ present value millions).

Table 11. Benefit Cost Analysis Summary ($ present value, discounted at 6%)

Construction Costs	Construction Cost	[redacted]
Operating and Maintenance Costs/Benefits	MLBE O&M Cost	[redacted]
	Bus O&M Savings	[redacted]
	Operating Fare Revenue	[redacted]
Salvage Value	Salvage Value	[redacted]
TOTAL COST		**1,802**
Benefits	Journey Time Savings	2,028
	Construction Delay	-101
	Auto Operating Cost Savings	77
	Collision Cost Savings	72
	GHG Emission Changes	5
	Reliability	410
	Urban Realm	22
	Wider Economic Impacts	217
	Pass-Ups from Bus Services	218
TOTAL BENEFITS		**2,948**
BCR	**Benefit: Cost Ratio**	**1.64**

[24] BC Ministry of Transportation and Infrastructure, "Benefit Cost Analysis Guidebook: Guidelines for the Benefit Cost Analysis of Highway Improvement Projects in British Columbia," Revised August 2014.

7.2.1 Cost Overview

The following cost accounts were assessed:

Construction Cost

The construction, design, and management costs included in the estimate for the Project assume the project management and procurement preparations commence in 2018 with the Project entering revenue service in 2025. The construction cost estimate includes allowances for both supporting bus services and a portion of the hybrid buses that will be utilized during the construction phase.

While vehicle purchases and associated Maintenance and Storage Facility (MSF) requirements are part of Expo Millennium Upgrade Program (EMUP) scope, proportional costs for those components relating to the implementation of the MLBE project have been included in this benefit cost assessment.

Table 12. MLBE Program Implementation Cost

Project Cost	Nominal ($M)	Project Costs ($M, NPV)
Capital Cost Estimate (Excluding all IDCs, bid development and SPV costs; See Previous Section)	[redacted]	[redacted]
Vehicle and MSF Cost (13% of EMUP Costs)	[redacted]	[redacted]
TOTAL	**$2,703**	**$2,130**

MLBE Operations and Maintenance

The MLBE annual gross operating costs are estimated at [redacted] in 2017 dollars. The NPV of MLBE Operations and Maintenance is [redacted]

Bus O&M Savings

Bus operating cost savings from the truncation of the 99 B-Line service are estimated at 48,800 bus operating hours in 2030 and 2045 for a monetary saving of [redacted] as noted in Section 6.4. The NPV of the Bus Operations and Maintenance is [redacted] in net savings.

Operating Fare Revenue

MLBE will result in a mode transfer from auto to transit and these additional users will generate additional revenue. The regional transportation model (RTM) estimates 3,100 additional AM peak hour transit users in 2030 and 3,600 in 2045. These are converted to annual values and monetized by the average fare paid. Based on this analysis, the implementation of the MLBE is expected to increase Operating Fare Revenue by an estimated NPV of $[redacted]

Salvage Value

The salvage value is estimated, as per MoTI guidance, as a percentage of the initial capital cost with a higher percentage for projects with a longer service life. In this case, the salvage value is applied to the stations, tunnel & guideway, system & tracks and property costs. Note that salvage value applied as a reduction to the construction cost and is estimated at NPV of [redacted]

7.2.2 Quantified Benefits Overview

A description of the quantified benefits presented in the benefit cost analysis are presented below. This analysis aligns with the employment and population forecasts presented in the City of Vancouver's Official Community Plan, which identifies the following growth within 800 metres of the Project stations:

- Number of residents increasing from 28,000 in 2011 to 37,000 in 2045; and
- Number of jobs increasing from 35,000 in 2011 to 66,000 in 2045.

Journey Time Savings

The MLBE is anticipated to have $2,028 million in travel time relative to the base cases as a result of the effective transportation solution the MLBE represents.

Construction Delay

The impact of the station construction delay has been estimated based on the auto and transit volumes on the Corridor and best estimates of traffic delay to each user based on preliminary traffic modelling. These have been estimated as $101 million, and this amount is subtracted from the benefits.

Auto Operating Cost Savings

The $77 million calculated in this account represent cost savings from reductions in auto vehicle-km travelled derived from mode transfer (i.e. users that transfer from auto to transit). The predictable and reliable transit option that the MLBE offers will encourage more users to transfer transportation modes.

Collision Cost Savings

Cost savings calculated the reduction in auto collisions as result of auto vehicle kilometers travelled (VKT) travelled reductions (from mode transfer) and total $72 million.

GHG Emission Changes

Replacing vehicle trips with transit trips will also reduce VKT and result in the reduction in Greenhouse Gas (GHG) emissions.

The benefits of GHG emission reductions were derived from VKT reductions (and the cost per tonne of CO_2 expected in the future (see Strategic Options Analysis report for details on the CO_2 assumptions). The additional GHG emissions that will result from the construction of MLBE are accounted for within this account, providing a net benefit of $5M.

Reliability

The cost savings associated with increased reliability of MLBE when compared to road travel modes which subject to congestion and unreliability are valued at $410 million. As traffic congestion grows within the region and bus transit times increase, the relative performance of MLBE compared to the current system will improve.

Urban Realm

The urban realm benefits of $22 million were calculated based on the impact the Project will have on the quality and aesthetics of the surrounding urban environment as perceived by riders and local residents. Key features considered include:

- Removal of 99 B-Line buses will improve pedestrian conditions;
- High quality sidewalks through widening, improved surfacing and de-cluttering will improve the quality of the pedestrian environment, including the removal of bus stops and boarding/alighting activity;
- Improved landscaping of area around stations, including new and replacement trees and turf; and
- Cycle parking around stations will improve the convenience of cycling as a mode to access SkyTrain.

Wider Economic Impacts

Typically, a large share of economic benefits is calculated through the conventional project evaluation where a crucial assumption is that the economy outside the transportation sector is fully competitive, and therefore the sum of the direct benefits to transit users of a project is identical to the sum of the economic benefits.

However, research in recent years has identified the perfect competition assumption is unrealistic and there may therefore be economic gains or losses that conventional evaluation fails to capture. Some sectors of the economy may experience 'wider economic benefits' which include agglomeration, imperfect competition, and labour market tax revenue effects. Based on this assumption of imperfect competition, the wider economic impacts were calculated at $217 million.

Pass-Ups from Bus Services

The benefit from passenger demand not being accommodated due to bus network capacity constraints is valued at $218 million. The addition of the 5.7 km extension within the Corridor will address a critical gap within the rapid transit network. The extension will provide a second transfer point for riders transferring to/from the downtown from the east; thereby, reducing transfers and congestion at Commercial-Broadway Station and reducing volumes of passengers using the busiest segment of the Expo Line between Commercial-Broadway and Main Street-Science World stations. The large volume of

passengers currently transferring between the Expo and Canada lines will have significantly shortened journeys by avoiding travel into and out of the downtown core. This will also contribute towards reducing passenger volumes on the busiest segment of the Expo Line.

For those continuing westwards to UBC and Point Grey from the Arbutus Street terminus, the 99 B-Line transfer will be moved off the Broadway Street right-of-way to provide a more integrated and secure connection.

7.3 PROJECT IMPACT

In addition to the benefits and cost analysis, additional analysis was conducted to assess the impact of the Project, when compared to BAU. The following accounts are highlighted:

7.3.1 Transportation and Ridership Impact

Modelling was conducted to assess the potential ridership of the MLBE at key milestones. This modelling used Business As Usual figures as a foundation, with additional analysis to identify the impact of the Project on ridership. Assumptions for both the SkyTrain and bus networks were provided by TransLink, with land use forecasts provided by Metro Vancouver, and the remaining assumptions coming from the Project design team.

The addition of the 5.7 km extension within the Corridor will address a critical gap within the rapid transit network. The extension will provide a second transfer point for riders transferring to/from the downtown from the east; thereby, reducing transfers and congestion at Commercial-Broadway Station and reducing volumes of passengers using the busiest segment of the Expo Line between Commercial-Broadway and Main Street-Science World stations.

The stations with the highest demand on the extension are anticipated to be Cambie Street Station and Arbutus Station as these stations are key transfer points to the Canada Line and to the truncated 99 B-Line, respectively. Not only will transit ridership increase on the Corridor, but ridership is forecasted to also increase on the existing portion of the Millennium Line.

The forecasted daily ridership on the MLBE is presented in the table below.

Table 13. MLBE Forecast Daily Ridership

Year	Daily Ridership
2025 (Opening Day)	135,000 – 155,500
2030	143,000 – 163,000
2045	167,000 – 191,000

Note: Values for opening day interpolated from 2030 and 2045 estimates.

Based on the previous analyses, the proposed Project will have sufficient capacity to meet forecasted demand to 2045, with additional capacity for longer-term growth. As part of the SkyTrain system, the

MLBE will provide both travel-time savings and improved reliability for Millennium Line riders compared to travel by automobile or the existing B-Line. With the MLBE, a customer will be able to predictably:

- Travel from Douglas College in Coquitlam to Arbutus Station in the Corridor via the Millennium Line in less than 47 minutes. This currently takes 1 hour and 6 minutes by transit or 50 minutes or more by automobile with typical mid-day traffic conditions.
- Travel from Arbutus Station in Vancouver to King George Station in Surrey, a driving distance of 37km, in less than 47 minutes. This currently take 1 hour and 5 minutes by transit or 50 minutes or more by automobile with typical mid-day traffic conditions.

As traffic congestion grows within the Region and bus transit times increase, the relative performance of MLBE compared to the current system will improve.

7.3.2 Environmental Impact

The MLBE will increase transit ridership, as described above, and remove a significant number of automobiles from the Corridor.

Replacing vehicle trips with transit trips will reduce vehicle kilometers travelled (VKT) and result in an associated reduction in Greenhouse Gas (GHG) emissions in support of the environmental and mode share targets described in Section 2.

The table below presents the mode shares and VKT removed estimated.

Table 14. Mode Share and VKT Removed

Year	Transit Model Share - Regional	Transit Mode Share - Corridor	Vehicle Kilometres Removed (VKT)	GHG Reduction (CO_2 Tonnes) [25]
2025 (Opening Day)	17.6%	38.3%	11,500	2.3
2030	18.2%	40.7%	11,900	2.4
2045	18.3%	42.1%	12,900	2.1

Note: Values for opening day interpolated from 2030 and 2045 estimates.

The Project team is also undertaking additional analysis to study the environmental effects of the Project, as described in more detail in Section 8.3.

7.3.3 Economic Development Impact

The Project will bring greater connectivity and accessibility to a wide array of cultural amenities, employment, and educational opportunities, recreational facilities, and retail precincts along the

[25] CO_2 conversion rates sourced from Metro Vancouver and TransLink, and assumes improved vehicular performance: 2030 values = 201 g/km, 2045 values = 164 g/km.

Corridor and within a 10-minute walk from Broadway. It is currently estimated that the Project will directly and indirectly generate approximately 13,450 new jobs.

The Project will support longer-term economic growth in the Corridor. The linkage provided by the Project, between the Corridor's health care precinct, life sciences hub, burgeoning technology industry, and centres of innovation such as UBC, GNW Campus, and Simon Fraser University (connected to the Corridor via the Millennium Line) is expected to encourage significant economic growth in the future.

The MLBE Project is anticipated to increase the overall competitiveness of the Region, helping to attract talent and businesses to the Corridor, particularly for the health sciences and technology sectors, with resultant benefits for the residents and economy of the Region.

7.4 SENSITIVITY ANALYSIS

A number of sensitivity tests were carried out in order to understand the impact of various input assumptions on the project's BCR and NPV. These are summarized in the table below.

Table 15. BCR Sensitivity Analysis

Financial Account	Discount Rate = 6% (Base Case)	Discount Rate = 8%	Discount Rate = 10%	Costs +25% (Discount Rate = 6%)	Costs -25% (Discount Rate = 6%)	Demand Growth Rates +5%	Demand Growth Rates -5%
Construction Costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MLBE O&M Costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Bus O&M Costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Operating Fare Revenue	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Salvage Value	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total Costs (PV, $M)	**1,802**	**1,683**	**1,435**	**2,261**	**1,343**	**1,802**	**1,802**
Journey Time Savings	1,926	1,330	937	1,926	1,926	2,028	1,825
Auto Op Cost Savings	77	55	40	77	77	77	77
Collision Cost Savings	72	52	38	72	72	72	65
GHG Emission Changes	5	4	3	5	5	5	5
Reliability	410	292	214	410	410	410	410
Urban Realm	22	16	11	22	22	23	21
Wider Economic Impacts	217	150	106	217	217	227	206
Pass-Ups from Bus	218	156	114	218	218	218	218
Total Benefits (PV, $M)	**2,948**	**2,053**	**1,463**	**2,948**	**2,948**	**3,061**	**2,827**
Benefit/Cost Ratio	**1.64**	**1.22**	**1.02**	**1.30**	**2.19**	**1.70**	**1.57**
NPV (Benefits-Costs, $M)	**1,146**	**370**	**28**	**687**	**1,605**	**1,259**	**1,025**

7.5 ACHIEVEMENT OF PROJECT OBJECTIVES

High level and project specific measurable objectives, along with their corresponding measures/indicators, are described in Section 12.6 Performance Measure. The MAE, presented in the Strategic Options Analysis, outlines the performance of the MLBE against business as usual, and identifies how the Project will achieve the high-level objectives.

8 PROJECT STATUS

8.1 ENGAGEMENT PROGRAM

In support of the UBC Line Rapid Transit Study alternatives evaluation (referenced in Section 5.1), TransLink and its partners conducted broad public and stakeholder engagement on the shortlist alternatives from spring 2010 to late 2011. The SkyTrain option was found to be the preferred alternative for members of the public.

These alternatives formed the basis of the detailed assessment and technical analysis undertaken in support of the ultimately identified the scope of the MLBE.

Most recently, TransLink conducted two rounds of public and stakeholder engagement took place to help inform the reference case design and provide public feedback to potential proponents. The first round took place between December 2016 and February 2017 with over 400 attendees at three open houses, over 70 people at three stakeholder workshops, over 4,000 questionnaires completed (online and in-person at the open house events), and a telephone poll of 800 people across the Region.

The second round of engagement took place between May and July 2017 with nearly 900 attendees at three open houses, over 80 attendees at 15 stakeholder meetings, over 70 attendees at four stakeholder workshops, and over 3,000 questionnaires completed (online and in-person at the open house events).

As the Project progresses, the Province will undertake engagement activities to support the procurement and construction phases of the Project. Following contract award, ongoing communications and engagement with the public will include traffic and construction communications, business and community engagement functions, and other engagement and communications activities. Please refer to Section 12 for additional information about the proposed engagement and environmental review approach.

8.2 TECHNICAL PLANNING

In early 2015, work began on the Reference Case Design for MLBE. This phase consisted of the development of functional planning work that advanced the work previously completed in the UBC Line Rapid Transit Study alternatives evaluation (Phase 2). At a high level, the inputs from the alternatives evaluation included the station locations, the horizontal alignment, and the chosen service technology.

The conclusion of the design work provided a set of reference case drawings for the six stations and tunnel alignment of the MLBE. In addition, work on the regional transportation model was advanced to provide ridership calculations in support of the development of a business case.

The work continued in the development of the Business Case, which advanced the functional planning work from the Reference Case Design to a preliminary engineering level. The work further advanced and refined geotechnical, tunnel, utility, and station planning. The output of this design phase included a substantial set of preliminary engineering drawings and a compiled set of technical memorandums.

8.3 ENVIRONMENT

The Project team has undertaken initial reviews of environmental and socio-economic values associated with the Project and conducted technical studies related to noise, vibration, air quality, contaminated sites and excavated materials, traffic and transportation, and archaeology. These studies have informed both the development of the Reference Design and a due diligence environmental review of the Project.

The Project is not subject to formal Environmental Assessment under the BC Environmental Assessment Act or the Canadian Environmental Assessment Act. The Project is undertaking the Environmental and Socio-Economic Review process to evaluate potential environmental and socio-economic effects, associated with construction and operation of the Project and identify mitigation approaches.

Preliminary findings of the Socio-Economic Review process support the conclusion that potential Project-related effects on environmental and socio-economic values, during MLBE construction and operation, can be effectively mitigated through the application of standard best management practices that have proven effective in addressing similar effects on other transportation infrastructure projects.

PART C – PROCUREMENT OPTIONS ANALYSIS

Part C presents the analysis and results of the detailed assessment undertaken to determine the optimal approach to procure the Project. This section concludes that the recommended delivery model option for the Project is a DBF procurement approach.

9 APPROACH

A detailed assessment was undertaken for the Project. The result of this assessment identifies the procurement approach to best meet the Project objectives and provide value to taxpayers.

The following sections further describe in detail the procurement options analysis.

9.1 PROCUREMENT OPTIONS IDENTIFICATION

The procurement analysis begins with a discussion of the procurement objectives, followed by a review of different procurement options and considerations under both the traditional public-sector procurement approach (Public Sector Comparator or PSC) and alternative approaches.

Five procurement options were initially identified for delivering the Project. The assessment of these options is summarized in the Procurement Options Report.

A final recommendation was made to further evaluate the PSC and an alternative procurement approach that included partial private finance (the shadow bid or SB). They are:

- A Design Build (DB); and
- A Design Build Finance (DBF).

The assessment highlighted a single DB contract encompassing the full scope of design and construction activities, as the preferred PSC. Under this approach, TransLink will be responsible for all operations and maintenance (O&M) activities.

The DBF model, which includes partial private finance during the construction period and encompassed the full scope of design and construction activities was identified as the preferred alternative procurement approach. TransLink will be responsible for all operations and maintenance (O&M) activities.

9.2 PROCUREMENT OPTIONS ANALYSIS

The two shortlisted procurement options were then analyzed and contrasted using both quantitative and qualitative assessment techniques. The comparative analyses included the following:

9.2.1 Qualitative

- **Multiple Criteria Analysis**: A qualitative evaluation method that compares the relative merits of each option in terms of how well it is expected to address the procurement objectives of the Project and provide value to taxpayers. This process is summarized in Section 10.1;
- **Market Sounding**: – This activity includes a series of interviews held with sponsors and contractors chosen based on their previous involvement with various relevant transportation project procurements in Canada and internationally. A summary is found in Section 10.5.

9.2.2 Quantitative

- **Risk Analysis** – A comprehensive list of risks is identified for each phase of the Project. For procurement options analysis, a select subset of these risks is quantified for each of the procurement models, highlighting the differences in value and allocation of risk inherent in each approach. This subset of risk is an input to the financial modelling for comparative analysis and assists in determining an appropriate overall contingency for delivery of the Project. A summary of the Project Risk Report for the Project is provided in Section 10.2;
- **Financial Modelling** – With inputs including the risk valuation, project financing assumptions, timing assumptions and project costs, a financial model is developed to simulate how an owner and a potential contractor would be expected to price the Project under each procurement approach. The financial modelling allows for differences in timing and costs associated with each model to be evaluated and compared. Key financial modelling assumptions are summarized in Section 10.3; and
- **Value for Money (VFM) Calculation** – The value for taxpayers' dollars is estimated by comparing the net present cost (NPC, also referred to as net present value, or NPV) of the Project under the public sector procurement model versus the alternative. This calculation and interpretation is set out in Section 10.4.

10 PROCUREMENT OPTIONS ANALYSIS – DB VERSUS DBF

The objective of the procurement options analysis is to identify the optimal approach to procure a Project in terms of which option offers the greatest value on both a qualitative and quantitative basis. The options analyzed were the DB as the PSC and the DBF as the alternative SB approach. For clarity in this Business Case, based on the results of the procurement options assessment described in Section 9, only the DB and DBF options are compared at this stage.

The methodologies and results of the qualitative procurement options analysis undertaken for this Project are presented in this section.

10.1 MULTIPLE CRITERION ANALYSIS

The analytical framework for assessing the relative qualitative merits of each procurement option is based on a Multiple Criterion Analysis approach. The qualitative assessment sets out criterion based on the procurement objectives for the Project. Each criterion represents a desired outcome for the Project and is then assessed on the extent to which the procurement option achieves the desired outcome.

The assessment criteria and associated procurement objectives are summarized in the table below.

Table 16. Qualitative Procurement Options Assessment Criteria

Assessment Criterion	Description
Minimizing disruption to the operation of the existing rapid transit network (Millennium & Expo Lines)	*Integration of the RT network expansion has the least impact to the current and future BCRTC operations.*
Key Project risks are managed and mitigated	*Key Project risks, including geotechnical, are allocated to the party best able to manage and mitigate them.*
Competition, providing innovation and efficiencies, is maximized	*An attractive, marketable and bankable transaction that brings innovation, efficiencies and value to taxpayers.*
Cost certainty, schedule certainty and affordability are maximized over the full life of the asset	*The Project is delivered on time and on budget within fiscal and cash flow constraints.*
Ability to implement changes during the life of the Project in the most cost effective manner	*The implementation of changes in service levels or future capital investment in the asset can be achieved in the most cost effective and efficient manner.*
Corridor service quality and full life asset performance are maximized	*The asset performs effectively during operations and that O&M services along the entire network are delivered optimally.*

The selected DB and DBF procurement options were assessed in terms of how well each achieves these assessment criteria. The following scoring framework was used to indicate the absolute and relative merits of each procurement option in relation to each criterion and expectation of achieving the desired outcomes:

Table 17. Qualitative Assessment Scoring Framework

Scale	Description
x	Ineffective in satisfying the criteria.
✓	Partially effective in satisfying the criteria.
✓✓	Substantially effective in satisfying the criteria.
✓✓✓	Fully effective in satisfying the criteria.

The procurement options ranking summary is summarized in the table below.

Table 18. Qualitative Assessment Summary

Assessment Criteria	DB	DBF
Minimizing disruption to the operation of the existing rapid transit (RT) network (Millennium & Expo Lines)	✓✓✓	✓✓✓
Key Project risks are managed and mitigated	✓✓	✓✓1/2
Competition, providing innovation and efficiencies, is maximized	✓	✓
Cost certainty, schedule certainty and affordability are maximized over the full life of the asset	✓	✓✓
Ability to implement changes during the life of the Project in the most cost effective manner	✓✓✓	✓✓✓
Corridor service quality and full life asset performance are maximized	✓	✓

10.2 RISK ANALYSIS

Project risk is defined as the chance of an event or condition happening which could cause the actual project circumstances to differ from those assumed when forecasting project outcomes or objectives. Risk is an inherent part of any project, and to ensure a successful project outcome, risk must be effectively managed. The identification, allocation, measurement, and treatment, each form a key part in the quantification of project risk. The ultimate goal is to identify and allocate project risks to the party best able to manage them. An efficient or optimal allocation of risk between the owner and the contractor on this basis will ultimately provide the best value.

The following subsections summarize the process and results of the risk analysis and quantification undertaken for the Project.

10.2.1 Risk Approach and Methodology

A comprehensive assessment of Project-specific risks was conducted in accordance with the Provincial Government's risk management guidance developed in conjunction with the Province's Risk Management Branch (RMB) of the Ministry of Finance. These guidelines are consistent with the

principles, framework and process described in the ISO 31000:2009 Risk Management Principles and Guidelines.

This risk management guidance takes a systemic approach to risk, estimating the range of potential impacts on a risk-by-risk basis through the project's planning, procurement, design and construction, and operating phases. Risk analysis is dynamic and should be revisited throughout the lifecycle of the project.

10.2.2 Risk Identification and Allocation

The risk assessment process began with the identification of potential material risks and consequences that could impact the project during any of the stages of the project's life cycle. This was completed through a series of risk workshops involving members of the project team and a variety of subject matter experts. The goal of the identification phase is to create a comprehensive list of risks which could affect (either positively or negatively) the project outcome. The identified risks were then categorized into either capital or operating risks depending on when they were expected to occur.

Subsequently, each identified risk was evaluated to determine which party (the owner or the contractor) would be responsible under each procurement option. A risk can be transferred, shared, or retained with the contractor. Each specific risk is viewed through the lens of which party is best able to manage or mitigate the risk. This allocation was completed for both the DB and DBF options and is summarized in the table below.

Table 19. Summary Risk Allocation Matrix

Type of Risk	DB		DBF	
	Private Partner	Province	Private Partner	Province
Design	✓		✓	
Construction	✓		✓	
Financing		✓	✓	✓
Operations*		✓		✓
Major Life Cycle/Rehabilitation		✓		✓
Force Majeure/Relief Events	✓	✓	✓	✓
Scope Changes by the Province		✓		✓

*Note: Operation scope will be retained by TransLink.

10.2.3 Quantified Risks

During risk quantification, selected risks are valued to ensure sufficient risk reserve is included in the project's contingency. This risk adjustment included within the project budget must account for both transferred risks (which the contractor will include within its bid) and retained risks (which will form part of the owner's contingency). If a risk is transferred, it is quantified from the perspective of the contractor and what the Project team estimates would be included in a reasonable and competitive

financial proposal. If a risk is retained, it is quantified from the perspective of the Province and the cost impact the risk would have on the Project.

Risks were selected for quantification based on materiality, ability to quantify, risk rating, and consideration of past precedent projects. Best, worst, and most likely outcomes, including both cost and probability, were quantified for both procurement options to estimate an expected value for each quantified risk. Once the expected values were calculated, these impacts were then grouped by the phase in which they are likely to occur (pre-contract execution, design/construction or operations) and ultimately incorporated into the financial model as described below.

10.2.4 Incorporation into Financial Analysis

For each procurement model, an amount of transferred and retained risk was added as a cost item to the financial model as a contractor or owner cost. In this analysis, the 67th percentile of total risk was added to the model to reflect a prudent level of risk aversion given the stage of Project planning and number of unknowns related to the Project. Selecting the 67th percentile is equivalent to saying that the Project has sufficient risk money included in the budget approximately two of out every three times.

10.2.5 Summary of Risk Analysis Results

The results of the risk analysis are provided the following table, which presents probabilistic values for the selected key risks under both delivery models.

Table 20. Summary of Risk Values (NPC $ Millions at 67th percentile, discounted at 4.4%)

Financial Model Risk	DB	DBF
Capital Period		
Value of the Transferred Risk included in the private sector's cost	[redacted]	[redacted]
Value of the Retained Risk held by the Province	[redacted]	[redacted]
Total	[redacted]	[redacted]

In general, the DBF model is considered more effective in transferring risk and therefore a more comprehensive risk transfer can be achieved at a lower cost than in the DB model. This effectiveness is realized primarily through the inclusion of private finance at-risk during the construction phase of the project incentivizes the behavior of the primary contractor. Key risks that are better managed under a DBF include schedule and performance of the contractor over the term of the DBF contract.

10.3 FINANCIAL MODELLING

10.3.1 Quantitative Methodology

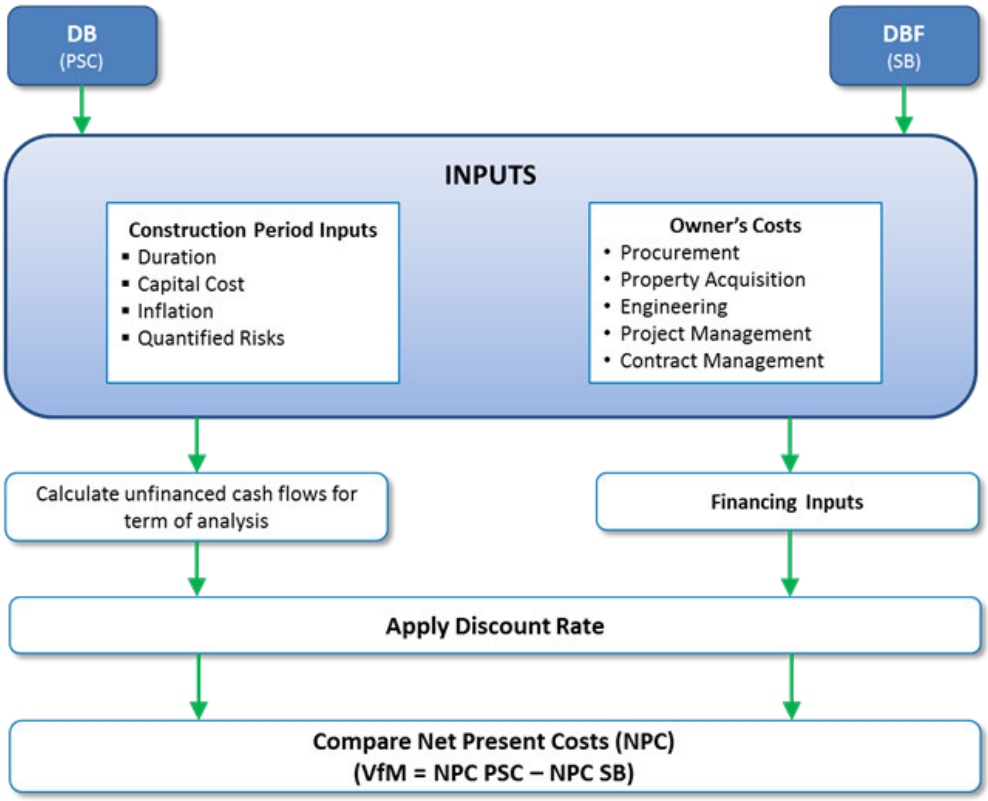
Financial modelling of the Project was undertaken using a methodology consistent with that used on previous projects. Further details on this methodology are provided in the document *Methodology for*

Quantitative Procurement Options Analysis Discussion Paper, April 2014, available at http://www.partnershipsbc.ca/publications/resources.

The Value for Money analysis involves a detailed, quantitative analysis that compares the preferred alternative approach also referred to as the SB to the preferred traditional procurement method also referred to as the PSC.

Value for money is expressed quantitatively as the difference in net present cost between the PSC and the proposed SB option. The financial modelling methodology is summarized in the figure below.

Figure 14. Overview of VFM Approach



To undertake the quantitative VFM assessment for this Project, a comprehensive risk analysis was conducted, and risk-adjusted cash flow models were prepared for the PSC (based on a DB procurement model) and the SB (DBF).

In addition, the Province's Owner's costs, including project management, were also estimated for each procurement option. The financial models assume the same Project term length in each case, and each option is required to be delivered to the same specifications and performance expectations.

The results of this quantitative comparison between the PSC and the SB, together with the qualitative criteria, are used to determine the procurement method that provides the best overall value for money.

10.3.2 Project Financial Assumptions

In addition to the costing assumptions described in Section 10.3.3, the following Financial Assumptions have been used to develop the SB and the PSC.

Table 21. Summary of Financial Assumptions

Project Variable	Modelling Assumption
Term of Agreement	5 years
Duration of Construction	5 years
Start of Design and Construction	January 2020
Construction Inflation (annual)	[redacted]

GST is not included in the capital cost estimate and the financial model does not take into account GST movements since it is a working capital item and the value is immaterial to the analysis (for purchases, GST is paid on items and is subsequently refunded; for billings, GST is collected and then remitted).

This section identifies the key financing assumptions included in the SB. The SB assumes that the private sector will finance $450 million of the capital costs during the construction period. The $450 million in private finance is invested in the Project early to provide sufficient security in the form of unfunded value in the ground in the event construction challenges are encountered prior to substantial completion. The $450 million is repaid at completion. Private financing drawn and utilized ahead of public sector contributions provides adequate protection for base case construction period risks, based upon the analysis of significant risks.

The following table shows the project financing assumptions used in the SB model. These assumptions have been developed through discussions with the Project advisors and input from the B.C. Ministry of Finance.

Table 22. Summary of Financing Assumptions

Model Variable	DBF Assumption
Financing Assumptions	
Debt/Equity Ratio	100:00
Timing of Private Finance	At a rate of 90% of private partner expenditure until the total amount of private finance is reached
Total Amount of Private Finance	$450 million
Debt Type and Amount	
Type	Construction Term Debt
Amount	$450 million
Bond Base Interest Rate	2.14%
Interest Rate Spread	150 bps
All-in Rate	3.64%
Debt Arrangement Fee	1.50%
Interest Earned on Cash Balances	1.00%

10.3.3 Capital Costs

The estimated capital cost of the Project, including planning, construction, and private financing is in the order of $2,703 million (nominal) under the SB including [redacted] million for BC Hydro early works, and $100 million for City of Vancouver properties and rights. It excludes Provincial IDC of $124 million. This includes costs for the construction period of approximately five years. Under the PSC, the total comparable cost of the Project is $2,677 million (nominal) excluding Provincial IDC. The Project budget breakdown is as follows:

Table 23. Project Costs - Excluding Owner's IDC (Nominal $ millions)

Project Costs $M (nominal)	PSC	SB
Construction (including owner's costs)	[redacted]	[redacted]
Bid Development	[redacted]	[redacted]
SPV During Construction	[redacted]	[redacted]
Warranty Holdback Letter of Credit Cost	[redacted]	[redacted]
Proponent's IDC	[redacted]	[redacted]
Project Costs Not Including Owner's IDC [26]	$2,677	$2,703

[26] Excluding City of Vancouver properties and rights contribution in kind and BC Hydro early works

10.3.4 Discount Rate

The discount rate reflects the time value of money. Discounting enables nominal project cash flows from the PSC and SB that differ in timing and amount to be discounted back to a common reference date. The common reference date for this analysis is October 1, 2017.

The method for determining the discount rate is consistent with the guidance on past projects where a project's pre-tax internal rate of return (Project IRR) of the privately financed procurement model (DBF for this Project) is the appropriate rate. The Project IRR of the DBF model is 4.4%.

Table 24. Value for Money Comparison at Project Discount Rate (Net Present Costs)

Public Sector Comparator DB Procurement	NPC ($M)		Shadow Bid DBF Procurement	NPC ($M)
Total Construction Cost - DB Contractor	[redacted]		Completion Payment	[redacted]
Warranty Holdback – Letter of Credit Cost	[redacted]			
Bid Development Cost	[redacted]			
Total Construction and Operation Cost	[redacted]		**Total Payment**	[redacted]
Transferred Construction Period Risk	[redacted]			
Total Transferred Risk	[redacted]			
Retained Construction Period Risk	[redacted]		Retained Construction Period Risk	[redacted]
Owner's Costs	[redacted]		Owner's Costs	[redacted]
			Public Contribution to Contractor's Costs	[redacted]
Total Owner's Cost	[redacted]		**Total Owner's Cost**	[redacted]
Total PSC Cost	[redacted]		**Total Shadow Bid Cost**	[redacted]
			Value for Money ($)	**$48**
			Value for Money (%)	**2.1%**

10.4 VALUE FOR MONEY CALCULATION

In financial terms, the value for taxpayers' money is established by calculating and comparing the estimated NPC of a project based on a particular procurement approach to the established NPC based on the traditional public-sector procurement. The results of the value for money assessment are summarized in the above table.

10.4.1 Value for Money – Sensitivity Analysis

To assess the value for money's sensitivity to the discount rate, the financial model was recalculated for the increase and decrease of the discount rate by one percent.

Table 25. Discount Rates Used in VFM Sensitivity Analysis

Discount Rate	VFM
5.4% (Base Discount Rate + 1%)	$61M
4.4% (Base Discount Rate)	$48M
3.4% (Base Discount Rate - 1%)	$34M

To assess the value for money's sensitivity to the interest rate, the financial model was re-run for the increase and decrease of the base interest rate by one percent without changing the Base Discount Rate.

Table 26. Interest Rates Used in VFM Sensitivity Analysis

Interest Rate	VFM
3.14% (Base Interest Rate + 1%)	$31M
2.14% (Base Interest Rate)	$48M
1.14% (Base Interest Rate - 1%)	$66M

10.4.2 VFM Updating

In accordance with PBC practice and as demonstrated on various past projects, the Project team will undertake a new capital cost estimate, risk assessment and VFM refresh whenever significant new information is available regarding the scope, design, stakeholders, funding and risks associated with the Project. The following are points in time that a VFM refresh is recommended.

- Prior to issuance of procurement documents as new information derived from the Project development and advance work that will be obtained prior to procurement, discussed in previous sections of this report.
- Once a preferred proponent has been selected, taking into account the proponent's technical and financial proposals as well as any preliminary comments they may have provided on the draft Project Agreement.
- Immediately after contract execution based on the signed contract and finalized price for the Project.

At the completion of the competitive selection process, a report will be produced describing the selection process, the outcome and the final VFM results.

10.5 MARKET SOUNDING

Market sounding is a structured interaction with market participants, undertaken during the planning stages of the Project, to both generate interest in the Project and gather specific feedback on Project attributes and proposed contracting strategy and methodology.

10.5.1 Market Sounding Findings

An initial market sounding was undertaken in September 2016. This early market sounding sought feedback on different project delivery models, while exploring a range of technical, commercial, and financial considerations. The market sounding confirmed that the expected timing of Project procurement and implementation does not pose any obstacles to participation in the competition.

While there are a number of large projects currently in or nearing procurement across Canada and in the United States, participants indicated they had adequate capacity and expressed a strong interest in the project. When queried about the potential of other major transit projects being procured concurrently (e.g. Surrey LRT), the majority of participants did not view this as an issue.

Market participants provided valuable feedback that will be considered further in the in development of Project documentation and processes. Feedback included views on suggested technical investigative work, the mitigation of risks in relation to third party (and third party interfaces), risk allocation between owner and Project Co., traffic management, financing, timelines, warranty length, and geotechnical baselining. There continues to be strong interest in the Project among virtually all market participants interviewed.

Based on the information gathered during the market sounding, the Project team will be incorporating several of the suggestions from the participants into the Project planning, technical works, and procurement documents, including:

- Conducting geotechnical studies, utility relocations, and other advanced works along the project alignment;
- Liaising with utility owners and other stakeholders;
- Strategic acquisition of permanent and temporary lands in advance of the procurement; and
- Developing project specifications related to traffic management that would clearly define the traffic management regime relating to allowable traffic modifications in advance of procurement.

Based on suggestions and concerns from the market, the Project team will endeavor to clearly define not only the specific and functional requirements that the base design must meet, but also:

- Clearly define what scope items are open to innovation and how much innovation would be acceptable. The owner's use of collaborative and commercial confidential meetings (CCMs) to indicate level of design innovation is within compliance to ensure efficient design effort by proponents.
- Make available data relating to utilities and geotechnical data during the procurement phase.

11 RECOMMENDED PROCUREMENT OPTION

Based on the foregoing qualitative and quantitative analysis, a DBF procurement approach, with $450 million in private financing injected upfront, is recommended for the Project. The analysis shows that the DBF model will best:

- Manage and mitigate key project risks;
- Maximize competition, providing innovation and efficiencies;
- Maximize cost and schedule certainty; and
- Provide VFM (expected to be in the range of $48 million).

PART D – PROCUREMENT PLAN AND FUNDING IMPACT

Part D describes the next steps that will be undertaken in the procurement process to implement the Project, based on the approach identified as the preferred procurement method in the previous section. This section provides a procurement plan for the Project, a preliminary schedule for implementation, and discusses the accounting implications of the Project.

12 PROCUREMENT PLAN

12.1 RECOMMENDED PROCUREMENT PROCESS

Based on the DBF preferred procurement model selected for the Project, the recommended competitive selection process is a two-stage approach including a request for qualifications (RFQ) followed by a request for proposals (RFP).

12.1.1 Request for Qualifications

The RFQ is the first phase of the selection process. RFQ respondents are expected to demonstrate their experience, qualifications, capacity and capability to undertake the Project. They are evaluated on their experience and strength in delivering projects of similar type and complexity as the Project. Based on this evaluation, a shortlist of up to three respondents will be invited to participate as proponents in the RFP phase of the selection process.

12.1.2 Request for Proposals

The second stage of the procurement process is the RFP. The RFP package includes a detailed description of the Project, a draft contract, proposal submission requirements and details relating to how the proposals will be evaluated.

The Project team anticipates implementing an interactive, two-stage RFP evaluation process such that proponents submit a technical proposal, which is evaluated based on the Province's stated performance requirements set out in a draft contract, in advance of their financial proposal. All proponents submitting technical proposals satisfying the RFP requirements will be invited to submit a financial proposal.

Throughout the procurement process, a Fairness Advisor is retained to monitor the selection process and will provide a written report at the conclusion.

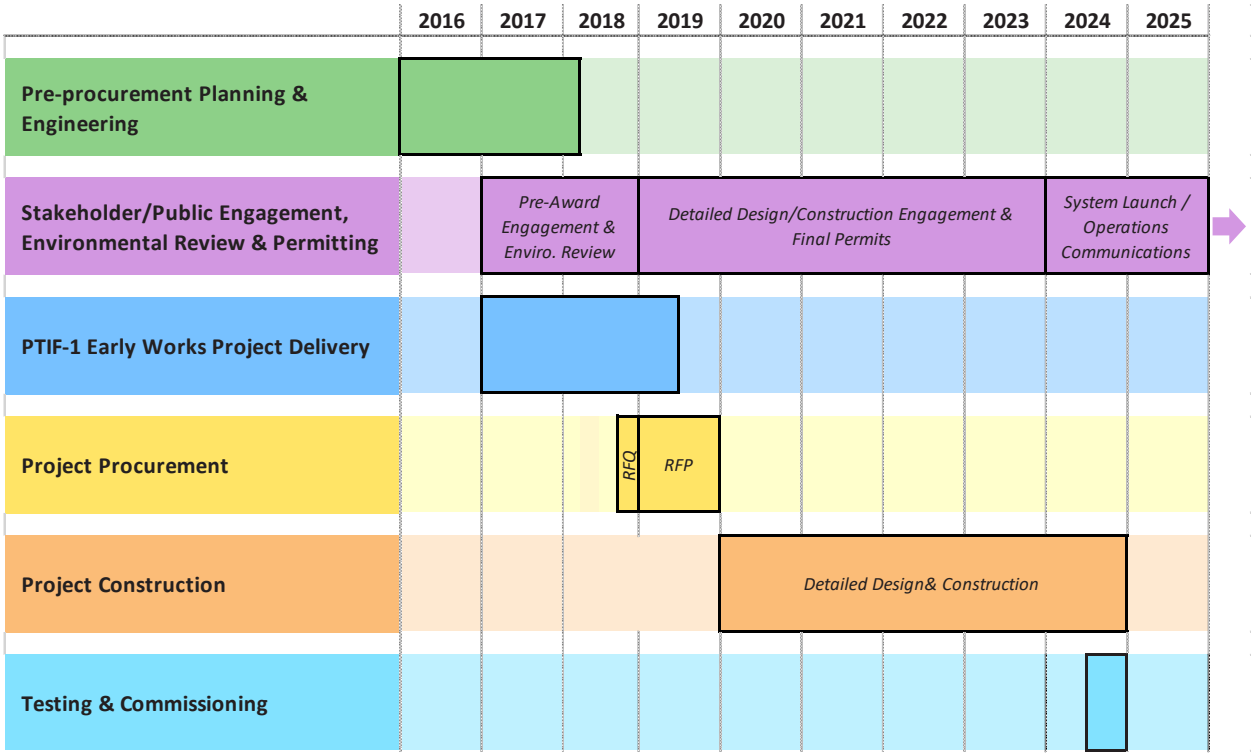
12.1.3 Post-Procurement Contract Administration

The Province's implementation team will protect the Province's interests and ensure the Project is designed and constructed in accordance with the contract requirements.

12.2 PROCUREMENT SCHEDULE

This schedule represents key activities and milestones critical to advancing the Project through to construction.

Figure 15. Project Schedule



Highlights of the schedule are as follows:

- Consultation with Aboriginal groups, the public, and stakeholders participating in the period leading up to and during the RFQ period.
- RFQ issuance is planned for fall 2018 with a proponent shortlist expected by winter 2018/2019.
- The RFP is planned for issuance in early 2019, with a preferred proponent expected to be selected and a contract awarded by the end 2019 early 2020.
- Based on the current schedule, it is anticipated that contractor mobilization will begin in 2020, with the design of the transit expansion continuing following award. The in service date is scheduled for 2025.

12.3 PROJECT GOVERNANCE

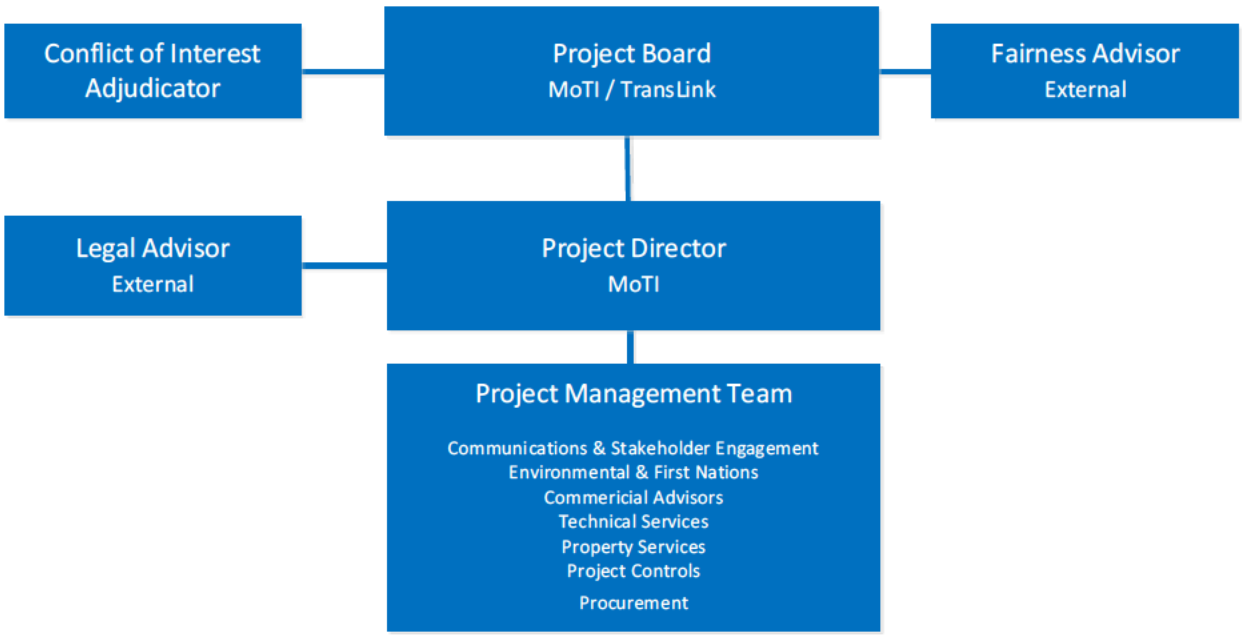
A Project Board (the Board) will be established to provide guidance and oversight to the project delivery team. The Board's objective is to provide sound project governance through appropriate oversight of material aspects of the Project; informed and timely decision making; effective risk management; and sound financial management and transparency.

12.3.1 Procurement Governance Structure

The Project will be delivered by the Province. The Board will ensure the Project complies with decisions and direction of government and will provide guidance with respect to significant events during project procurement and delivery.

A high-level governance structure for the Project is shown in the figure below.

Figure 16. Project Governance Structure



12.4 PROJECT DELIVERY

12.4.1 Properties

The Project will establish a property acquisition program to ensure property owners undergo a transparent and fair process and confidentiality of negotiations are respected. The Project will make all efforts to minimize disruption and inconvenience to property owners. The property acquisition program will allow access to properties in advance of construction and aims to ensure that properties are available for the contractor prior to their requiring access.

12.4.2 Environment

As stated previously the Project is not subject to formal Environmental Assessment under the BC Environmental Assessment Act (BCEAA) or the Canadian Environmental Assessment Act (CEAA). The Project team has undertaken the ESR process to evaluate potential environmental and socio-economic effects the Project, and identify mitigation strategies.

The primary objective of the ESR process is to advance the MLBE Project in a way that protects environmental and socio-economic values/elements through:

- A clear and transparent process for identifying and protecting environmental and socio-economic values; and
- Opportunities for public, First Nations, stakeholder, and government agency input on the scope of values to be reviewed in the ESR and approaches for mitigating potential Project-related effects.

The ESR process developed to support the MLBE Project includes several features associated with the BC Environmental Assessment Office (EAO) process for conducting environmental assessments under BCEAA. The scope of the ESR includes but is not limited to elements such as noise, vibrations, air quality, vegetation, wildlife, archaeology etc.

12.4.3 First Nations

The Project is located within the traditional territory of the Musqueam Indian Band and the Tsleil-Waututh and Squamish First Nations. The Project team has engaged with Musqueam, Tsleil-Waututh, and Squamish Nation since November 2016 through face-to-face meetings and sharing of project information and updates. In addition, the following Aboriginal groups located outside of the Project area have been identified through the provincial Consultative Area Database as having potential interests in the project area. As such, project information has been, and will continue to be shared with the following Aboriginal Groups:

- Stó:lō Nation
- Stó:lō Tribal Council
- Hul'qumi'num Treaty Group

To date, the Project team has consulted with First Nations through the distribution of formal notification letters outlining the Project activities taken and planned by the Project team, key information, project deliverables, and an anticipated schedule. The Project team has attended meetings with Aboriginal Groups, as arranged, which included a presentation on the Project, distribution of supporting material/documentation, and an opportunity to discuss issues of concern.

Specific engagement activities undertaken by the Project team include/will include:

- Sharing information about the Project, the ESR process, and related studies;
- Seeking comments on the Draft ESR Terms of Reference;
- Providing opportunities to identify issues of interest or concern with the Project and the associated ESR process;
- Providing draft copies of the ESR Technical Data Reports and the ESR Summary Report;
- Documenting and responding to issues raised during engagement activities and throughout the engagement process.

As part of the ongoing ESR process, the Project team will provide draft copies of the ESR technical data reports and ESR Summary Report for First Nation review and comment prior to finalization. Participating First Nations will also be engaged in discussions related to the development and implementation of effective mitigation measures to address any issues of concern raised during the ESR and related engagement process.

12.4.4 Utilities

The Project team has identified major utilities and has prepared the reference case design to minimize and mitigate utility impacts on construction and schedule. Bored tunnels will minimize utility impacts by typically going under major utilities. In station areas, certain major utilities are planned to be protected, monitored, and supported. Re-alignment of certain major utilities is planned, including the Metro

Vancouver sewer adjacent to Cambie Station. Further investigation and utility owner discussion will support more detailed planning, cost estimates and schedules.

12.4.5 Traffic

The traffic management plan will outline construction hours and other constraints to be met by the DBF contractor in the development of their construction plan. The objective of the traffic management plan will be to minimize disruption to both businesses and traffic during construction.

12.4.6 Advance Works

The Project's scope includes advance works in preparation for major construction activities and to help advance the Project schedule. Dedicated BC Hydro power supply for construction is being implemented as a separate early works project through Phase 1 of the PTIF program. Other potential advance works may include certain utility works.

12.5 COMMUNICATIONS AND CONSULTATION

The Project's communications and engagement program will meet or exceed best practices, provide multiple opportunities and methods for participation, report back on the feedback received, and outline how input informs decision making.

Communications strategies and tools will:

1. Effectively notify, engage, and consult communities and stakeholders.
2. Inform impacted and interested groups and individuals about relevant information and events.
3. Anticipate, address, or manage issues during every step of the Project.

12.6 PERFORMANCE MEASUREMENT

Baselines and performance measures are fundamental to the monitoring and accountability of the Project when assessing whether Project objectives are being achieved. The Project has developed a framework for evaluation that includes specific performance measures for each Project goal as shown in the table below.

Account	Criteria	Objectives	Measures
Financial	**Affordable**	Achieve schedule and cost certainty	Actual Project cost vs budget.
	Risk Management/ Allocation	Risks are allocated to party best able to manage them	Actual vs Planned.

Account	Criteria	Objectives	Measures
Transportation	**Transportation User Effects**	Reduce travel time on the corridor	Average transit travel times: • Broadway-Commercial to City Hall: 6 mins • Broadway-Commercial to Arbutus: 11 mins
	Reliability	Ensure speed and reliability of the system	System availability as good as or better than existing SkyTrain system.
	Ridership	Increase ridership on the MLBE in line with forecasted ridership by providing an efficient and reliable mode of transportation.	Annual Trips, Average Daily Ridership vs ridership projections within business case.
	Transit Mode-Share	Increasing transit mode share	Annual mode share change.
	Operational Safety	Meet all applicable safety requirements (e.g. BC Railway Safety Act)	Receive operating certificate.
Economic Development	**Job Creation During Construction**	Project will create jobs during construction.	Labour reports during construction period.
	Employment Creation	The opening of an efficient transit option along the Corridor will encourage further economic development.	Change in employment within 400m and 800m of stations, as measured every five years.
Urban Development	**Encourage Development within Corridor**	Increase access to transit for residents within the Corridor, and residents travelling to/from the Corridor.	Number of residents and jobs located within 400m and 800m proposed rapid transit stations measured every five years.
	Access to Transit	Increase the number of people that live or work within walking distance of stations/stops	The change in number of residents that live within 400m and 800m of MLBE.
Environment	**Reduce Greenhouse Gases**	By encouraging mode change from vehicles to transit, reduce greenhouse gas emissions	Annual VKT removed and GHG saved.

Account	Criteria	Objectives	Measures
Social and Community	**Station Locations Optimized**	Project stations are positioned near major locations within the Corridor for health, education, and technologies sectors.	Assessment of trip diary and travel between key educational, health care, and technological centres.
	Accessibility	Rapid transit network within the Project corridor will be accessible for individuals with disabilities.	Increase in number of riders with accessibility needs.
	Residential Impacts - Safety within Stations	Stations provide appropriate security, lighting, *Crime Prevention Through* Environmental *Design* (CPT ED)	Stations are built to this standard
Deliverability	**Project Engagement with Stakeholders**	Minimize the impact of transit on traffic congestion and impact on businesses during construction.	Stakeholder feedback during construction
	Project Schedule	Achieve schedule certainty	Operating date vs planned.

13 FUNDING

13.1 PROJECT COSTS

The Funding and Affordability Analysis sets out the total funding required for the Project during the construction and operating phases for a DBF delivery model: where the funding comes from, when it will be available, and how it will be used. The analysis also describes the financial impact on the Province during both the construction and operation phases of the Project.

The estimated cost of the Project, including planning, construction and financing, is $2,827 million in nominal dollars, including interest during construction.

Based on the application of the Office of the Comptroller General (OCG) policy for capital projects procured as public private partnerships, the total capitalized asset cost includes all costs estimated for the construction period including contingencies for risk, proponent bid development costs, administrative and financing fees, other direct costs incurred during the project development, and construction period and IDC. The $2,827 million project budget breakdown is as follows:

Table 27. Construction Cost Allocation (Nominal $ millions)

Capital	Allocation
Proponent, including contingency	[redacted]
Owner, including contingency	[redacted]
Property purchase	[redacted]
Evaluation of CoV Properties & Rights	[redacted]
BC Hydro Early Works	[redacted]
Provincial IDC	[redacted]
Total Capital Budget*	**$2,827**

*Capital budget does not include expensed planning costs of [redacted] that were incurred during 2016/17 and 2017/18 prior to Provincial project approval.

Table 28. Cash flow by Cost Category by Provincial Fiscal Year (Nominal $ millions)

Cost Category	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Total
Proponent Costs incl Contingency	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Eligible Owner's Cost incl Contingency	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Owner's Insurance Costs	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Ineligible Owner's Cost	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PTIF Phase 1 – BC Hydro Early Works	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Property Acquisition	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
City Properties and Rights	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Provincial IDC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Private Finance IDC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$2,827

13.2 SOURCES OF FUNDING

The total capital cost for the Project is estimated at $2,827 million, which includes interest during construction. The expected allocation of capital funding is shown in the table below.

The Project has already secured funding of [redacted] for the BC Hydro Early Works from the Government of Canada and the Province under the Public Transit Infrastructure Fund (PTIF) Phase 1.

Provincial funding of 40% is being provided for Phase 2 of the overall Mayor's Vision (MLBE, Surrey-Newton-Guildford LRT, Expo and Millennium Upgrade Program and other priority projects), however ownership of discrete assets within the Vision will be split between the Province and TransLink, in order for both parties to capitalize their respective contributions. Provincial and TransLink funding will therefore be directed towards the assets they will own.

The Province currently owns the vast majority of the existing SkyTrain system and leases it to TransLink to operate. As the MLBE project is an extension to the existing provincially owned Millennium Line, the Province will own and fund this asset. Additional funding for the Project (PTIF2) will be provided by the Government of Canada, and in-kind land contributions from the City of Vancouver, as identified in the table below:

Table 29. Funding Allocation by Source (Nominal $ million)

Funding Source	Allocation
PTIF Phase 1 (Early Works)	[redacted]
Government of Canada	[redacted]
Provincial Government	[redacted]
Government of Canada	[redacted]
Provincial Government	[redacted]
City of Vancouver	[redacted]
Total Project Capital Budget	**$2,827**

13.2.1 Federal Funding

The Project is requesting additional funding of [redacted] or 40% of eligible capital costs from Phase 2 of the Public Transit Infrastructure Fund (PTIF). The Government of Canada has already provided $8.5 million in project funding for BC Hydro Early Works through Phase 1 of the Public Transit Infrastructure Fund. The financial analysis presented in this document has assumed the federal contribution is received as progress payments throughout the construction phase of the Project and as a substantial completion payment for the pro-rata of the $450 million private financing.

13.2.2 Provincial Funding

The Province, through the BC Transportation Financing Authority (BCTFA), will borrow [redacted] during the construction of the project and will borrow an additional [redacted] after completion to repay the private financing of the DBF contractor. The Province has already provided [redacted] in funding for the BC Hydro Early Works through Phase 1 of the Public Transit Infrastructure Fund. Total provincial debt on completion of the project is expected to total [redacted]

13.2.3 City of Vancouver Contribution

The City has undertaken actions to reduce Project costs and remove or reduce Project risks. These actions include:

- **Strategic acquisition of property along the Corridor:** The City will provide access rights for these properties, as required by the Project either temporarily or permanently, subject to a Municipal Master Agreement to be executed between the City and the MLBE Project.
- **Statutory rights of way and other covenants:** The City has acquired various rights through development and rezoning conditions; access rights will be provided, as required by the Project, subject to the Municipal Master Agreement.

The estimated value of the City's properties and rights of [redacted] has been included as a separate line item in the cost and funding tables within the Business Case. The estimated value to the project of the City of Vancouver lands and rights was established using an agreed upon property valuation methodology.

Table 30. Summary of City of Vancouver's Property Contributions

Element	Number of Properties	Estimated Value to Project
Strategic Property Acquisitions	[redacted]	[redacted]
SROWs and Other Secured Covenants	[redacted]	[redacted]
Total City Properties & Rights Contribution		[redacted]

13.2.4 Private Financing

Under the recommended DBF procurement model, the private partner is anticipated to finance a portion of the construction costs, and will be repaid at the end of construction, once the Project is operational. Analysis was done that determined an optimal level of private finance of $450 million is required to secure effective risk transfer and provide sufficient security for the Province.

For the purposes of the financial analyses in this Business Case, it was assumed that this amount will be will repaid in full at the end of construction.

13.3 PROJECT FUNDING REQUIREMENT SUMMARY

The following table summarizes the cash flow required for the project during the procurement and construction, including interest during construction:

Table 31. Capital Funding Required by Source by Provincial Fiscal Year (Nominal $ millions)

Capital	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	Total
Federal	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Provincial/Private	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Sub-Total: Funding Required	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
City of Vancouver In-kind Properties & Rights	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PTIF Phase 1 – Early Works	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total Capital Budget	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	$2,827

PART E – RECOMMENDATION

This business case demonstrates the need for the Millennium Line Broadway Extension Project to address transportation challenges along the Corridor. The Project will provide significant user benefits and support transportation options and economic development potential in the region.

This Business Case recommends proceeding with the Project at an estimated total cost of $2,827 million using the recommended DBF procurement model.