Burnaby Mountain Gondola Transit
Business Case Report

October 2011

Prepared for TRANSLINK

Prepared by CH2MHILL

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Exhibits

EXECUTIVE SUMMARY

In 2009, an initial feasibility study analyzing the use of a gondola to upgrade transit service to Simon Fraser University's (SFU) Burnaby Mountain campus concluded that a gondola could improve travel time, service frequency and reliability – and drastically reduce greenhouse gas emissions – all at a cost comparable to the current diesel bus service. On the basis of that finding, TransLink committed (in June 2010) to developing a full business case.

The questions considered in this document and its companion report (the Burnaby Mountain Gondola Transit Technology and Alignment Alternatives Assessment) included:

1. Is a transit service upgrade to Burnaby Mountain justified?
2. If so, what would be the best alternative technology?
3. If a gondola is the preferred option, what would be the best alignment and station location, on campus and integrating with SkyTrain?
4. How much would a gondola cost to build and run, and how would that compare to business-as-usual diesel bus service over a 25-year period?
5. Would the benefits of an alternative system justify the costs?

Is an upgrade to Burnaby Mountain transit service justified?

The SFU Burnaby campus and the growing community of UniverCity constitute a major regional transit destination, accounting for more than four million trips per year. As early as 2021, forecast growth of SFU and UniverCity, as well as a shift of mode share, could double the current daily transit ridership (25,000 trips) and exceed the capacity of frequent bus service.

This demand indicates a need to review alternative technologies, particularly given the unique topographical challenges imposed by the mountain-top terminus. As it is, SFU, SFU Community Trust, and TransLink have already planned a $10-million upgrade to the campus bus exchange.

Continuing to serve Burnaby Mountain with diesel powered buses will result in:

- Poor travel times and low reliability in winter, discouraging ridership growth;
- Increased traffic impacts and noise as bus frequency increases;
- Rising greenhouse gas (GHG) and criteria air contaminant (CAC) emissions;
- Need for new, and costly, layover and recovery facilities for buses and drivers; and,
- Operating costs that increase in direct proportion to the service levels.

These factors do not optimally support TransLink's Transport 2040 strategies:

- Make early investments that encourage development of communities designed for transit, cycling, and walking;
- Optimize the use of the region's transportation assets and keep them in good repair; and,
- Build and operate a safe, secure, and accessible transportation system.

What would be the best alternative transit technology?

The nearest rapid transit option currently available to the Burnaby Mountain area is the SkyTrain Millennium Line, which passes within 2.7 kilometre (km) at its Production Way – University Station. However, the elevation difference is 300 metres (m), suggesting that conventional transit may not be the best way to connect these two points. Residential neighbourhoods and conservation areas between the station and mountain further limit the range of solutions.

In reviewing alternatives, the study team used the current diesel bus service as the base case. It then considered ground-based technologies ranging from trolley buses and light rail to funicular and other rail systems, such as SkyTrain. Finally, it looked at aerial technologies, including an aerial tram (as used on Grouse Mountain) and a three-rope gondola system (like the Peak-2-Peak at Whistler/Blackcomb).

The ground-based systems offered little to no improvements in travel time, were more expensive, and had the greatest negative impact on conservation and residential areas. Among the aerial systems, the 3S and Funitel gondolas fared best. These systems:

- Provide long spans between towers, limiting residential and conservation area impacts;
- Operate in a wide range of weather, including high wind, snow, and ice (overcoming the average annual 10 days of weather disruption suffered by the current service);
- Provide scalable capacity at very low marginal cost to meet near- and long-term demand; and
- Limit energy consumption, air emissions, and noise (a gondola would be quieter than background noise when passing over residential areas).

What would be the best alignment and station location, on campus and integrating with SkyTrain?

The study then reviewed four aerial routes, one from the Lake City Station, two variations from the Production Way – University Station and one from the anticipated Burquitlam Station on the planned Evergreen SkyTrain extension. Of these, “Route 2”, one of the Production Way-University options, emerged as the preferred option when considering the combined factors of residential impact, environmental impact and affordability, and the ability to integrate on the mountaintop and at SkyTrain. It would also minimize travel time, cutting the 15-minute bus trip to less than 7 minutes.

How much would a gondola cost to build and run, and how would that compare to business-as-usual diesel bus service over a 25-year period?

Two ropeway suppliers were contacted to establish costs for gondola construction and operation. More conventional estimating practices were used for civil works, producing a capital cost estimate of $120 million, with annual operating costs of $3 to $3.5 million (all in 2011 dollars). Over 25 years, this combined for a life-cycle cost of $157 million – approximately $10 million (net present value) more than the estimated costs of maintaining and expanding the bus service. Longer-term capital costs were estimated to be lower than diesel buses.

Would the benefits of an alternative system justify the costs?

The study calculated the monetary value of the following benefits:

- 1.5 – 1.6 million annual hours of travel time savings for current riders
- 500,000 annual hours of auto travel time savings for those expected to switch to the more efficient system (155,000 without Evergreen)
- 26.1 – 29.2 million fewer vehicle kilometres travelled annually
- $4.1 – 4.5 million in lower auto operating costs
- $3.1 – 3.4 million in reduced collision costs
- 6,900 – 7,100 tonnes in reduced GHG emissions (~$130,000 in potential carbon credits)
- Common Air Contaminant (CAC) reductions

The total value of these benefits, over the 25-year life-cycle, totalled more than $500 million, creating a benefit-cost ratio (BCR) of 3.6. A BCR greater than 1.0 indicates that benefits surpass costs. A BCR of 3.6 indicates that significant benefits would result from implementing the project when considering a 6% real discount rate. Even when considered without the Evergreen Line, a BCR of 3.25 was projected.

A market sounding with potential builders and operators concluded that a gondola could be built cost-effectively using either DB+OM (design-build and operate-maintain in a joint procurement) or DBFOM (design, build, finance, operate, maintain) strategies. A traditional procurement (design-build with TransLink to operate and maintain) is also considered feasible. If the project is approved, the exact procurement method would be determined based on market conditions at the time of procurement.

Accordingly, this business case indicates that the benefits of improved service exceed costs, making a gondola a cost-effective means of meeting existing and future travel demand and promoting transit usage. The project also meets transportation, financial, environmental, urban development, social and community, and deliverability objectives.

ACRONYMS AND ABBREVIATIONS

ATOR	Application Terms of Reference
BAU	business as usual
BCEAO	British Columbia Environmental Assessment Office
BCMOT	British Columbia Ministry of Transportation and Infrastructure
BCR	benefit cost ratio
BMGT	Burnaby Mountain Gondola Transit
BRT	Bus Rapid Transit
CAC	criteria air contaminant
CMBC	Coast Mountain Bus Company
DB+OM	design-build + operate-maintain
DBFOM	design, build, finance, operate, maintain
EA	environmental assessment
EIA	environmental impact assessment
EPP	Environmental Protection Plan
ERP	Emergency Response Plan
FTN	Frequent Transit Network
GHG	greenhouse gas
GLT	Guided Light Transit
ha	hectare(s)
IFS	Initial Feasibility Study
km	kilometre(s)
LID	Low Impact Development
LRT	Light Rail Transit
m	metre(s)
NPV	net present value
OCP	Official Community Plan
O&M	operations and maintenance
PAC	Project Advisory Committee
pphpd	passengers per hour per direction
PRT	Personal Rapid Transit

PSC	Public Sector Comparator
PTP	Provincial Transit Plan
PV	present value
RGS	Regional Growth Strategy
ROW	right-of-way
RRT	Rail Rapid Transit
RTD	Regional Transportation District
SFU	Simon Fraser University
VfM	value for money
VIA	visual impact assessment

1. INTRODUCTION

Forecast growth of both the Simon Fraser University (SFU) campus and the UniverCity neighbourhood on Burnaby Mountain will increase transit demand in 2021 and 2041, beyond the peak capacities that can be met by frequent bus service. This increasing demand indicates the need to review alternative technologies to meet the future requirements, particularly given the unique topographical challenges imposed by the mountain-top location of the campus and neighbourhood.

Higher level policies need to be taken into account when reviewing potential solutions for addressing the transit needs of Burnaby Mountain to ensure that any actions are consistent with overall goals. The Provincial Climate Action Program and Transit Plan have set aggressive targets in terms of reductions in emission and gains in transit mode share. TransLink has adopted these targets and has further formulated strategies to achieve these – as well as supporting goals – in its Transport 2040 planning process.

The consideration of alternative transit solutions for Burnaby Mountain speaks directly to three of the strategies outlined in Transport 2040:

- Make early investments that encourage development of communities designed for transit, cycling and walking (SFU and UniverCity are good examples of this community type)
- Optimize the use of the region’s transportation assets and keep them in good repair (through potential reallocation of diesel bus service to areas with gentler grades and an overall reduction in transit operating costs for serving the mountain).
- Build and operate a safe, secure, and accessible transportation system

The region’s SkyTrain rapid transit network is closest to the mountain at the Production Way – University Station of the Millennium Line, located approximately 2.7 km from the mountain’s current transit hub. The next station to the west, at Lake City Way, is only slightly farther from the mountain. The Evergreen Line will have a station at Burquitlam, also a similar distance from the transit hub. The Business Case focuses on alternatives linking one of these three stations to the transit hub with a higher-order transit system.

The purpose of the Burnaby Mountain Gondola Transit (BMGT) business case is to assess the feasibility and financial merits of implementing higher-order transit to Burnaby Mountain. The business case is organized as follows:

- Project Description and Investment Recommendation
  - The justification for investigating a high capacity rapid transit system to link SkyTrain with Burnaby Mountain is provided. Included are summaries of the assessments of technology and route alignment options
  - The project benefit-cost analysis is presented

- Regulatory Approvals Process
  - A description of planning work done to date is provided
  - The regulatory/approval framework for the Project is given, with particular attention given to the expected Environmental Assessment (EA) process requirements
- Financial and Procurement Analysis
  - Results from quantitative and qualitative approaches to determine the most effective means of procuring the Project are presented
- Funding and Affordability
  - The affordability of the project is summarized

This document is prepared by CH2M HILL and PricewaterhouseCoopers LLP as the lead consultants on the study, with input from subconsultants including Art Pearce and Gmuender Engineering, and Partnerships BC. At TransLink’s request, CH2M HILL has removed commercially sensitive information that could affect the viability of later competitive procurement processes.

2. PROJECT DESCRIPTION AND INVESTMENT RECOMMENDATION

2.1 Strategic Alignment and Priority

2.1.1 Background

In 2009, SFU Community Trust sponsored a report to assess the feasibility of an aerial ropeway transit system to connect Burnaby Mountain, home of the province's second largest university with over 20,000 students, staff, and faculty, to the rapid transit network. The Initial Feasibility Study (IFS) concluded that:

- An aerial ropeway system could provide a transit connection between Burnaby Mountain and Production Way – University SkyTrain Station with sufficient capacity to serve existing and projected travel demand;
- Transit travel time, reliability, and frequency would be improved;
- Environmental impacts would be lower than the existing bus services; and,
- Life-cycle costs over the evaluation period would be of a similar magnitude to continuing to provide and expand bus service, but long-term gondola costs would be lower.

TransLink received the IFS for information but concluded that further analysis to confirm the technology and preferred alignment, develop a concept for integration of the lower terminal with the SkyTrain station, stakeholder consultation, engagement with the lift manufacturers to develop the technical requirements (if a gondola is the preferred technology), and to examine financing arrangements would be needed to fully assess the project. To answer these questions, in June 2010, TransLink committed to developing a business case for the project as part of its 2011 Transportation and Financial Plan.

2.1.2 Regional Policy Context

The Metro Vancouver region and the Province of British Columbia (BC) are on the forefront of regional transit planning and sustainability initiatives. The Province's Climate Action Program and Transit Plan have set aggressive targets in terms of emission reductions and gains in transit mode share.

Specific to the transit needs of the Burnaby Mountain Community (both the SFU campus and UniverCity) and to the aspiration to provide sustainable transportation choices, four regional planning documents have direct relevance to this study in that they all support efficiency increases, emission reductions, and mode shift to transit:

- Metro Vancouver's Regional Growth Strategy (RGS) (Metro Vancouver 2040 – Shaping Our Future), the regional plan for the Metro Vancouver region.

- Transport 2040, TransLink's long-term transportation strategy, which presents a vision where over half of regional trips are made by sustainable modes (walk, cycle, transit).
- TransLink 2011 Base Plan and Outlook, Transportation and Financial Plan for 2011 to 2012 and Outlook for 2014 to 2020.
- Provincial Transit Plan (PTP), the province-wide plan for transit expansion to support reductions in GHG emissions through investments in rail and bus rapid transit (to encourage higher transit mode share in conjunction with supportive land use) and energy-efficient transit.

Specifically, Burnaby Mountain is a major regional destination, accounting for about 2.3% of regional transit trips. Providing a high-quality rapid transit connection, reducing GHG emissions from transit operations, and encouraging additional transit ridership the project would support the following RGS strategies:

- *Strategy 1.2 (Focus growth in urban centres and frequent transit development areas)*
- *Strategy 3.3 (Encourage land use and transportation infrastructure that reduce energy consumption and GHG emissions, and improve air quality)*
- *Strategy 5.1 (Coordinate land use and transportation to encourage transit, multiple occupancy vehicles, cycling, and walking)*
- *Strategy 5.2 (Coordinate land use and transportation to support the safe and efficient movement of vehicles for passengers, goods, and services)*

2.1.3 Local Policy Context

The City of Burnaby's Official Community Plan (OCP) strives to meet the existing and emerging needs of the City by balancing economic development opportunities with protection of the environment, and community needs. It sets out a path to create a more complete community that brings people, jobs, services, and amenities together in more accessible ways.

Provision of a rapid transit link between the existing SkyTrain system and the top of Burnaby Mountain supports the objectives of Burnaby's OCP in developing an environmentally aware community that offers transportation choice and economic opportunity. Some specific relevant OCP directions include:

- Improved transportation services to commercial, educational, and other activity centres, including local transit and more opportunities to cycle or walk to activities, as well as the introduction of additional community service uses in established and developing residential centres;
- Incorporating environmental considerations as an integral part in assessing growth management options, land use plans, transportation plans, and development proposals;
- Preserving and enhancing the ecological systems and diversity of the City and, in turn, the Region;
- Defining new development opportunities along the Lougheed LRT Corridor linking the two town centres at Brentwood and Lougheed;

- Recognizing a general merging of commercial and industrial business interests and an associated demand for the expansion of business centre opportunities responsive to this need;
- Accommodation of a number of strategically located, high amenity business park centres oriented to smaller, corporate headquarter facilities and businesses involving combinations of research, sales/service, light manufacturing and management/ administration in proximity to the Lougheed LRT Corridor and other areas with planned transit improvements;
- Seek a close integration of land use with the delivery of improved transit;
- Promote an improved road system to move more people in fewer cars and make the most of existing roadways;
- Promote alternate modes of travel to increase the choice of transportation available to people; and,
- Include sensitivity to the environmental impacts of transportation and close involvement of the public in transportation decisions which affect people's lives.

A high quality transit service would help provide stimulus to redevelop the industrial areas around Lougheed Highway with more intensive land uses, as planned by the City for the Lake City area through the business centres directions in its OCP.

High quality transit would also serve the projected population growth at UniverCity (current population at 3,000 and projected to grow to 10,000) and the projected population at SFU (currently 20,000 and projected to grow to 30,600 by 2030).

2.2 Needs Identification

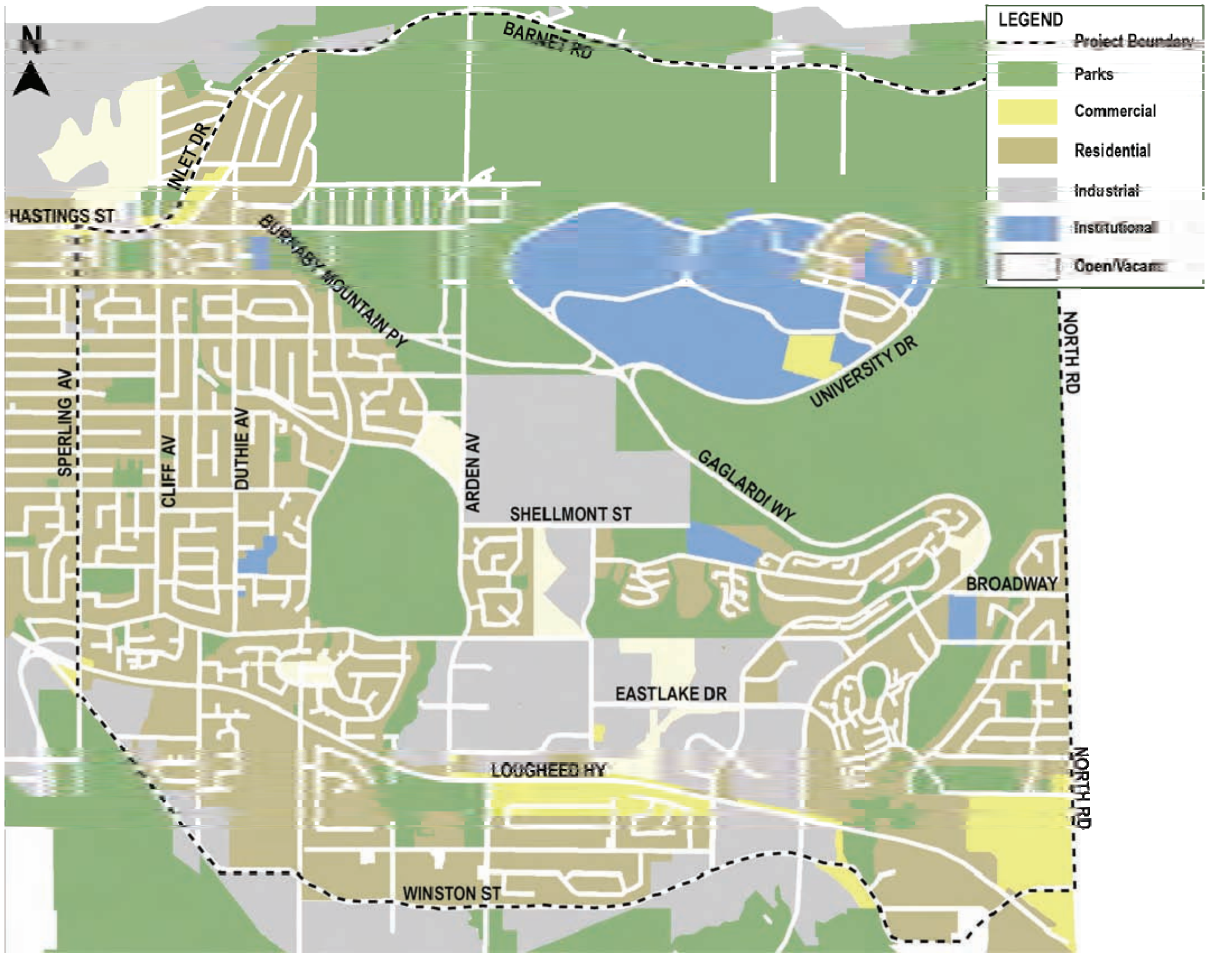
2.2.1 Study Area

The mandate of the business case is to investigate transit alternatives that would allow a reduction in bus service levels connecting the SkyTrain system with Burnaby Mountain. This mandate limits the extent of the study area to the corridors connecting the SkyTrain stations nearest Burnaby Mountain to the mountain.

The study area, shown in Exhibit 2-1, covers most of the northeast quadrant of the City of Burnaby and the west part of Coquitlam along Clarke Road as shown in the following map. The study area is limited to the east by Clarke Road and North Road, to the north by Barnet Road, to the west by Sperling Avenue, and to the south by Winston Street and Government Street.

The study area is part of the TransLink Burnaby/New Westminster service area with the latest Area Transit Plan completed in February 2003, shortly after the opening of the Millennium Line.

Exhibit 2-1 – Study Area Limits and Land Use



Topography and Land Use

Burnaby is the third largest city in British Columbia with an estimated 2010 population of 227,400 according to BC Stats.

The elevation of Burnaby ranges from sea level to a maximum of 365 m atop Burnaby Mountain.

Burnaby is centrally located within Metro Vancouver and occupies 92 square kilometres (km^2) or approximately 4% of the land area of Metro Vancouver.

The City of Burnaby is organized by quadrants, each having its own town centre. Burnaby's town centres:

- Are the focus of each quadrant
- Form the commercial backbone of the city
- Provide an abundance of higher density housing opportunities
- Are served by rapid transit (SkyTrain)

Each town centre is intended to provide complete communities within each quadrant where residents have the option to drive, walk, bike, or take transit to a local town centre where they can access the mix of goods and services to meet their daily needs. Burnaby has promoted its town centres as preferred locations for business, telecommunications, and other office uses. In addition to town centres, the study area also features urban villages, multi-family neighbourhoods, and single family residences.

SFU represents a major institutional land use atop Burnaby Mountain with the university enclave occupying about 81 hectares (ha) almost exclusively within the ring road. The OCP for SFU has the capacity for up to 510,000 square metres (m^2) of university development over the long-term. SFU offers significant residential (population) and institutional (employment) capacity for expansion.

Burnaby's OCP makes provision for high amenity business centres as well as incorporating the population growth at UniverCity.

There are also areas of industrial land including petro-chemical storage facilities on the lower slopes of Burnaby Mountain. Burnaby's OCP anticipates that this category of industrial land will remain stable and is generally not considered suitable for conversion to other uses.

These urban areas are surrounded by the Burnaby Mountain Conservation Area and other municipal parks which account for nearly 50% of the study area. Exhibit 2-2 shows key activity centres within the study area.

Exhibit 2-2 – Map of Activity Centres within Study Area

Zoning within the study area includes a number of different residential, park, institutional, commercial and industrial zoning types. Comprehensive development zoning has been applied in some areas occupied by multi-family residential, commercial, and mixed uses.

The City of Burnaby makes extensive use of comprehensive development zoning to give site-specific approval of multi-family residential, commercial, and mixed use developments.

Population and Employment

Regional employment and population growth will influence the demand for transportation. The RGS forecasts an increase in population of 63% between 2006 and 2041 for the Burnaby/New Westminster sector, and an increase in employment of 53% during that same period.

Within the study area, activities at SFU and UniverCity generate almost all travel demand to and from Burnaby Mountain. By 2030, the total population on the mountain is expected to increase 70% over 2007 levels as shown in Exhibit 2-3.

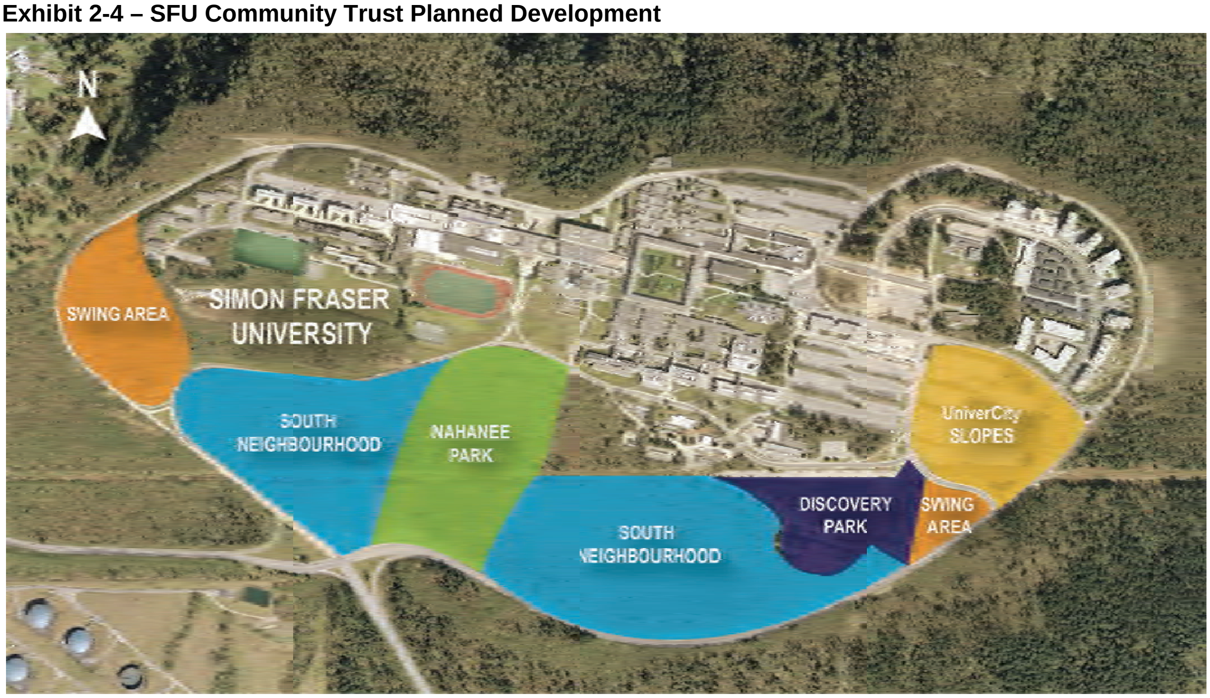
Exhibit 2-3 – Burnaby Mountain Population Projections

Time Horizon	SFU Population		Mountain Residents		Total Population
	Students (FTE)	SFU Staff (FTE)	Dormitories	UniverCity	
2007	17,109	3,000	1,768	2,200	23,309
2030 (OCP)	25,000	5,600	5,600	10,000	39,375

SFU Community

UniverCity is an award-winning sustainable community to the east and south of the SFU campus. It is being developed by the SFU Community Trust to create an endowment for education and research at SFU. The development includes multi-unit residential buildings and commercial development to serve the community and students. Exhibit 5-2 shows the future land use plans for UniverCity.

Exhibit 2-4 – SFU Community Trust Planned Development



Transportation

Road Network

The study area is generally well served with arterial routes, a provincial highway, transit and rapid transit routes and a network of pedestrian and cycling routes. To the north is Barnet Road that transects the study area to connect Port Moody with northwest Burnaby along Hastings Street. To the south and delineating the area is the Provincial Highway 1, part of the Trans-Canada Highway corridor. Lougheed Highway is a major east-west arterial while, North Road and Sperling Avenue provide north-south connections at the east and west edges of the study area. These arterial routes are designated as truck routes.

The road network is depicted in Exhibit 2-5.

Exhibit 2-5 – Road Network within Study Area

Road access to SFU is limited to Hastings Street/Burnaby Mountain Parkway from the west and Gaglardi Way from the south. These two routes intersect with University Drive East to form the primary access point to the campus. From this intersection, traffic can travel on University Drive East to enter either the eastern or western/northern sides of the campus.

Just east of Duthie Avenue, Hastings Street becomes Burnaby Mountain Parkway and provides access to the SFU campus for traffic originating from northern Burnaby and Vancouver.

Gaglardi Way is the primary route used by traffic originating from the south and east of Burnaby Mountain. A major portion of the traffic using this route comes from Highway 1 via the Gaglardi Way interchange.

In the context of this business case, it is important to note that no additional road connections are planned to Burnaby Mountain. The only access is provided via Gaglardi Way and Burnaby Mountain Parkway. There is no redundancy in the road network at this location. A major accident has the potential to significantly affect or block all vehicular access – both private automobile and transit bus – to SFU.

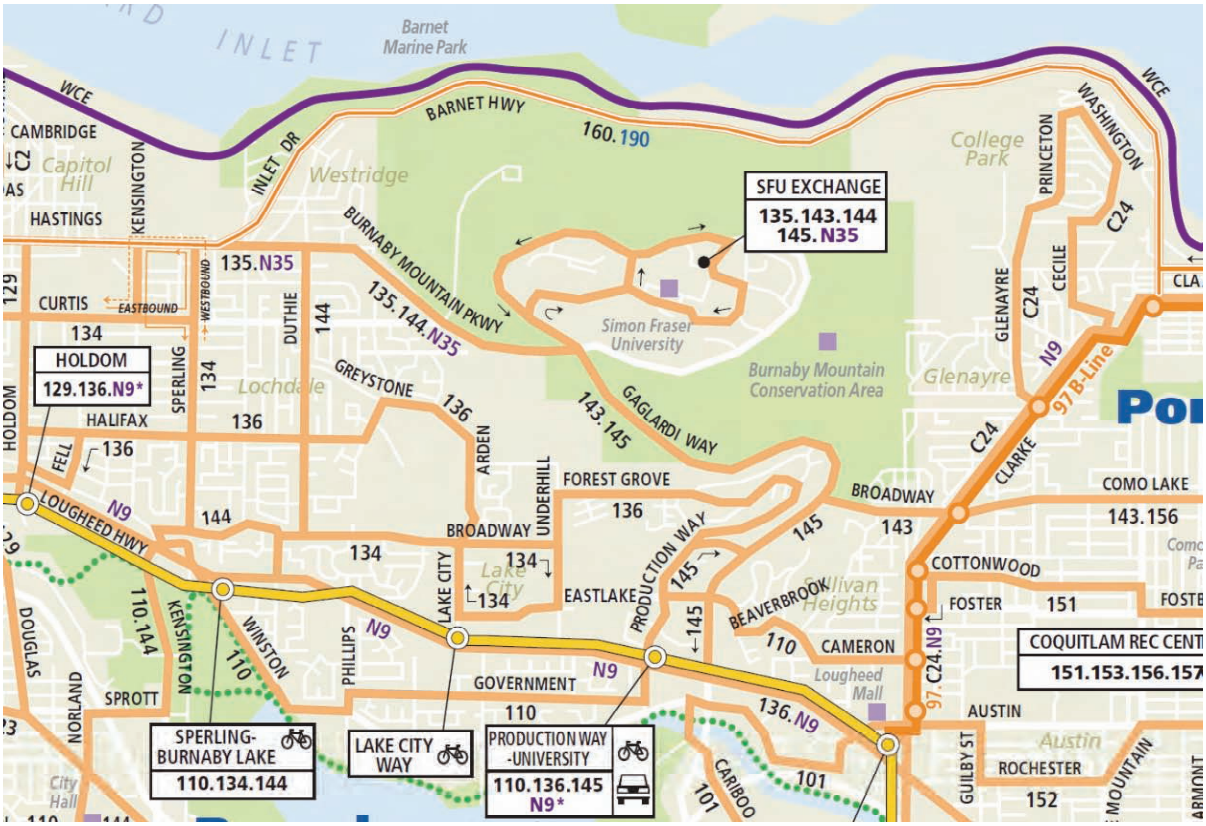
Existing Transit Service

The transit network is shown in Exhibit 2-6, showing the major transit nodes and connections.

Exhibit 2-6 – Transit Network within Study Area

TransLink through its subsidiary Coast Mountain Bus Company (CMBC) operates four bus routes carrying over 4 million person trips annually to serve SFU. The four bus routes are shown in Exhibit 2-7.

Exhibit 2-7 – Map of Existing Burnaby Mountain Bus Routes



In order of decreasing share of trips, the bus routes serving Burnaby Mountain are as follows:

- Bus route 145, the busiest transit route serving Burnaby Mountain, links the SFU Bus Exchange to the Production Way – University SkyTrain Station on the Millennium Line and carries half of the transit commuters to and from the mountain. The route from SkyTrain to the Exchange is approximately 7.1 km, versus a straight-line distance of 2.7 km. Travel time between SkyTrain and SFU is approximately 15 minutes. This route is typically operated with articulated buses.
- The second-highest ridership bus, route 135, carries commuters to and from downtown Vancouver along Hastings Street. Although ridership to SFU is half that of route 145, this route requires over twice as many buses as route 145 at peak hours due to the much longer travel time from downtown. Much of the service provision on this route is driven by the downtown-related demand at the western end of the route. This route is typically operated with articulated buses.
- Route 143 from Coquitlam Station is the only direct transit service to and from Burnaby Mountain for the Tri-cities region (Coquitlam, Port Coquitlam, and Port Moody). This route, a 35-minute bus trip at peak times, will eventually be partially replaced by the Evergreen Line SkyTrain extension. This route is typically operated with a mix of standard and articulated buses. The bus integration plan for the Evergreen Line assumes that route 145 will be extended to Burquitlam Station from the SFU Bus Exchange, leaving the 143 as a local route along Como Lake Avenue between Coquitlam Centre and Burquitlam. While there is strong commitment to construction of the Evergreen Line, the schedule is uncertain due to funding issues.

- Bus route 144 travels from Metrotown to the Sperling – Burnaby Lake SkyTrain Station on the Millennium Line in 26 minutes and then continues to the SFU Exchange in an additional 19 minutes. The low passenger loads of route 144, with less than one-tenth of the total ridership to and from Burnaby Mountain, can be explained by the fact that the commuting time from Metrotown to Production Way via SkyTrain and then by bus 145 to the SFU Bus Exchange is a shorter duration. As a result, route 144 ridership is likely limited to passengers accessing mid-route at local stops away from a SkyTrain station. However, crowding on the 145 may lead some passengers to divert to the 144, despite its lower frequency and longer travel time. This route is operated exclusively with standard buses.

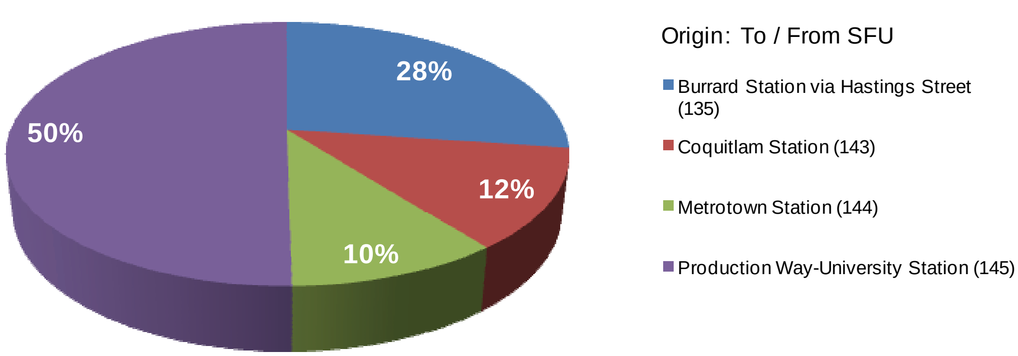
Distribution of Bus Ridership

The key link to Burnaby Mountain is bus route 145 which carries half of the daily ridership to the top of the mountain. Exhibit 2-8 shows the ridership of each bus route serving the mountain, the share of total transit trips to and from the mountain that it accounts for, the share of riders using that route that are related to mountain trips (that is, the number of daily riders on that route travelling to and from the mountain divided by the route's total boardings), and the number of buses assigned to each route. Exhibit 2-9 graphically presents the distribution of ridership by route. The data shown is for fall 2009; preliminary fall 2010 data show little change in the figures.

Exhibit 2-8 – Transit Serving SFU/Burnaby Mountain (Fall 2009)

Bus Route	Origin: to/from SFU	Share of Transit Trips to/from SFU	Route Daily Ridership	Share of Route Riders Related to SFU	Daily Ridership Related to Burnaby Mtn	Current Peak Bus Allocation
135	Burrard Station (via Hastings Street)	27%	21,900	31%	6,800	22
143	Coquitlam Station	12%	4,500	69%	3,100	6
144	Metrotown Station	10%	6,600	39%	2,600	10
145	Production Way – University Station	50%	13,300	95%	12,600	10

Exhibit 2-9 – Distribution of Burnaby Mountain Transit Ridership by Route



Future Transit Infrastructure

The Evergreen Rapid Transit Line, although not directly serving SFU or Burnaby Mountain, will provide rapid transit service along North Road to Lougheed Station from Port Moody and Coquitlam. While it is expected to be in operation in the near future, ridership estimates for the gondola were developed for the years 2021 and 2041 under both and Evergreen Line and no Evergreen Line scenarios.

Transit use on Burnaby Mountain is expected to grow as both the SFU population and the UniverCity population increase. There is also potential to increase the transit mode share to and from the mountain, particularly among SFU staff and faculty and UniverCity residents.

It is assumed that the University staff population will increase in proportion to the student population. The SFU OCP projects that the mountain population will almost double from the 2007 values to the current OCP capacity. With expanded activity, transit ridership can generally be expected to grow. Currently, TransLink is expected to meet this future demand with the continued use of standard and articulated diesel or compressed natural gas (CNG) buses.

To support the growth in ridership and bus service to Burnaby Mountain, SFU, SFU Community Trust, and TransLink have planned an upgrade to the existing bus exchange on campus, located at the intersection of University High Street and Highland Crescent at an estimated cost of $10 million.

Capacity Requirements

A number of model runs have been conducted to forecast ridership demand to Burnaby Mountain. The findings to date are summarized in Exhibits 2-10 and 2-11 below. The results are grouped by with and without Evergreen Line scenarios. In order to determine the demand for rapid transit, the model runs assumed that a gondola would operate per the conclusions of the IFS, in other words a 3S type system between Production Way – University Station and the SFU Bus Exchange. This establishes the level of demand that the technology solutions should have the capacity to meet but allows for the analysis to be repeated should the assessment suggest that a different technology/alignment combination with differing performance characteristics also be examined.

For modelling purposes, the gondola was assumed to operate 35-passenger cabins every 34 seconds and offer a one-way travel time of 7 minutes. Bus service levels in the model were kept at a very high level to assess the maximum bus service demand that might remain following gondola introduction. The bus service levels in the scenarios with the Evergreen Line were based on the bus integration plan for the Evergreen Line and therefore assume that Route 145 is extended to operate between Production Way and Burquitlam stations, via SFU, and therefore replaces the 143 between SFU and Burquitlam. Ridership forecasts include the horizon years 2021 and 2041. The basis of comparison in each scenario is defined as a Business as Usual (BAU) scenario and represents the anticipated transit service if buses remain the key transit service serving Burnaby Mountain

Initial findings indicate the following:

- The observed diversion from BAU bus service to rapid transit is significant, with over 80% of Burnaby Mountain transit trips expected to use the rapid transit link.
- The peak hour gondola volumes are generally consistent with the expected volumes described in the IFS.

- The overall diversion of bus ridership to rapid transit is considered to be conservative, since the frequency of competing bus service has not been optimized in order to illustrate the effectiveness of rapid transit relative to an intense parallel bus service.
- Demand for rapid transit is slightly lower in the absence of the Evergreen Line, with peak rapid transit volumes in 2041 without the Evergreen Line being 92% of those with the Evergreen Line.

The preliminary findings from the model runs (with Evergreen) were used to define the required system capacity: that is, 2021 peak requires 2,900 passengers per hour per direction (pphpd) and 2041 peak requires 3,400 pphpd. Note that the peak AM hour load figures in the tables are for the peak location, wherever it occurs on the route. For the 135 this location is close to downtown Vancouver, so the service requirements are driven by that end of the route and not by demand to Burnaby Mountain.

The model results suggest that implementation of a gondola (or other technology with similar travel time and frequency) between Production Way – University Station and Burnaby Mountain would allow the elimination of route 145 given the small demand that remains for it after implementation of the gondola. The local stops served by the 145 near Production Way – University Station are also served by routes 110 and 136 and these would continue. (Customers using the sole unique 145 stop at NB Gaglardi at Broadway (near Centaurus Circle) would be required to walk to Route 136 stops on Forest Grove Drive or Route 110 stops on Eastlake. The affected area would still be largely within 400 m of transit service at these stops.) Route 144 between Sperling – Burnaby Lake Station and Burnaby Mountain would also continue in order to maintain a direct service to Burnaby Mountain from the residential area south of Hastings, to provide local service on the Burnaby Mountain summit plateau, and to provide an alternative to the gondola for passengers who have concerns about riding it.

The scenarios without the Evergreen Line show a modest reduction in demand for the 143 to SFU, but it is assumed to remain in place. In scenarios with the Evergreen Line, the portion of the 143 between Burquitlam Station and SFU were replaced by the higher-frequency extension of the 145. The gondola would attract sufficient ridership from this route to allow consideration of its reduction or elimination.

Exhibit 2-10 – Ridership Forecasts with Evergreen Line

Year	Route	Service	BAU (Without Gondola)				With Gondola			
			Peak Headway (min)	AM Peak Hour Boardings	Estimated Daily Boardings	Peak Volume (pphpd)	Peak Headway (min)	AM Peak Hour Boardings	Estimated Daily Boardings	Peak Volume (pphpd)
2021	135	SFU – Downtown	4.0	2,081	24,200	946	4.0	1,420	16,500	421
	144	Metrotown Stn – SFU	10.5	1,119	13,000	293	10.5	1,079	12,600	293
	145EG	Production Stn – SFU – Burquitlam Stn	3.0	2,045	23,800	1,049	3.0	78	900	48
	BMGT	Burnaby Mtn Gondola	n/a	n/a	n/a	n/a	0.6	3,255	37,900	2,844
2041	135	SFU – Downtown	3.0	2,379	27,700	988	3.0	2,124	24,700	558
	144	Metrotown Stn – SFU	8.0	1,620	18,900	492	8.0	1,598	18,600	492
	145EG	Production Stn – SFU – Burquitlam Stn	2.5	2,657	31,000	1,282	2.5	107	1,200	60
	BMGT	Burnaby Mtn Gondola	n/a	n/a	n/a	n/a	0.6	4,174	48,600	3,341

pphpd: passengers per hour per direction

Exhibit 2-11 – Ridership Forecasts without Evergreen Line

Year	Route	Service	BAU (Without Gondola)				With Gondola			
			Peak Headway (min)	AM Peak Hour Boardings	Estimated Daily Boardings	Peak Volume (pphpd)	Peak Headway (min)	AM Peak Hour Boardings	Estimated Daily Boardings	Peak Volume (pphpd)
2021	135	SFU – Downtown	4.0	2,070	24,100	891	4.0	1,440	16,800	437
	143	Coquitlam – SFU	8.0	578	6,700	373	8.0	441	5,100	344
	144	Metrotown Stn – SFU	10.5	1,139	13,300	286	10.5	1,080	12,600	287
	145	Production Stn – SFU	3.0	1,594	18,600	1,462	3.0	3	0	2
	BMGT	Burnaby Mtn Gondola	n/a	n/a	n/a	n/a	0.6	3,129	36,500	2,625
2041	135	SFU – Downtown	3.0	2,487	29,000	941	3.0	1,833	21,400	608
	143	Coquitlam – SFU	7.0	715	8,300	412	7.0	482	5,600	356
	144	Metrotown Stn – SFU	8.0	1,698	19,800	483	8.0	1,591	18,500	485
	145	Production Stn – SFU	2.5	1,983	23,100	1,709	2.5	5	100	4
	BMGT	Burnaby Mtn Gondola	n/a	n/a	n/a	n/a	0.6	4,020	46,800	3,062

pphpd: passengers per hour per direction

Travel Time and Service Requirements

A key objective of planning any rapid transit system is a reduction in travel time to and from desired destinations. For this reason, an adequate solution is one in which the travel time is shorter than the existing bus service between SFU and the Production Way – University SkyTrain Station (currently 13 to 16 minutes via route 145, depending on time of day).

Two of the bus routes serving Burnaby Mountain (Routes 135 and 145) belong to TransLink's Frequent Transit Network (FTN), defined by a maximum headway of 15 minutes, 15 hours per day, 7 days per week. The FTN is specified along high demand corridors and provides transit users with the assurance of service without needing to refer to a schedule.

A relatively unique factor in providing transit service to Burnaby Mountain is the comparatively severe winter weather experienced on the mountain. The mountain experiences snowfalls more often than other key destinations in Metro Vancouver, and the road network serving it is particularly susceptible to disruption in these conditions due to its exposure and grades. Transit service to the mountain is estimated to be affected to varying degrees for approximately 10 days every winter. Disruptions to service can range from substitution of standard buses for articulated buses (due to the poor handling of the latter in slippery road conditions) to a complete curtailment of transit service (due to poor conditions and road blockages caused by stuck vehicles).

Multi-modality

Information shown in Exhibit 2-12 has been extracted from the City of Burnaby's Cycling Map and shows a mix of shared vehicle/bicycle roadways and urban trails in the vicinity of Burnaby Mountain. Improved multi-modal accessibility of the transit system could increase ridership for bicycle commuters and recreational riders alike, as has been experienced since completion of the Portland Aerial Tram. Allowance of bicycles on any form of improved transit to Burnaby Mountain would be dependent on operational requirements, particularly in peak periods, and would be a factor in the design of the system. Similarly, the design of the terminus station will need to anticipate bicycle parking requirements, in particular the lower terminus which is expected to attract a high proportion of cyclists.

Exhibit 2-12 – Shared Vehicle/Bicycle Roadways and Trails

2.3 Project Purpose and Goals

The purpose of proposed rapid transit to Burnaby Mountain is to offer improved travel time, frequency, and reliability compared to existing bus service while reducing environmental impacts. This business case indicates that the benefits of improved service exceed costs and that rapid transit is a cost-effective means of meeting existing and future travel demand. The project also meets transportation, financial, environmental, urban development, social, and community and deliverability objectives. These objectives or accounts are described in further detail below.

2.3.1 Transportation

The current travel time by bus from Production Way Station to SFU is about 15 minutes not including waiting time. Travel times can vary due to the number of passengers on the bus and road conditions. Previous work has identified bus service reliability issues under winter conditions. Disruptions to service can range from substitution of standard buses for articulated buses, resulting in a decrease in capacity, to a complete curtailment of transit service in the event of road closure.

The travel demand to and from SFU will increase with the expansion of both the University Campus and UniverCity. With one common point of entry to Burnaby Mountain by road (intersection of Gaglardi Way and Burnaby Mountain Parkway) and increased demand, the need for a more reliable transportation network with redundancy becomes more important.

A significant portion of TransLink's fleet relies on fossil fuel based energy, which is subject to price volatility and potential resource scarcity.

The current bus system can only accommodate two bicycles per trip limiting the attractiveness for transit users to use their bicycles to commute to Burnaby Mountain, especially during peak periods. During off peak periods, there is high demand for bicycle rack space from recreational mountain bike use.

Project Objectives:

- Develop a rapid transit solution that offers improved reliability, frequency, and travel time relative to current bus service
- Improve all-weather (snow, ice, and wind) reliability
- Provide safe and secure service that can accommodate all users
- Encourage a mode shift to transit, walking, and cycling
- Provide a connection from the existing and planned rapid transit network to Burnaby Mountain that meets the current and future travel demands

2.3.2 Financial

A key aspect of any business case is to demonstrate the financial feasibility of a project. As described in the 2011 Transportation and Financial Plan, for the project to proceed within the resource constrained plan, no net (of existing bus service) financial contribution from TransLink is available.

Project Objectives:

- Demonstrate that a rapid transit connection linking the top of Burnaby Mountain to the existing rapid transit network is cost-effective in meeting travel demands for the corridor and reducing GHGs
- Demonstrate that replacing the existing diesel bus fleet with an alternative transit technology will provide net savings in annual life-cycle capital and operations costs

2.3.3 Environmental

Aggressive provincial and regional targets have been established for GHG and CAC air emissions, to fight climate change and air pollution. Replacement of diesel buses by innovative, electrically powered transit can contribute to achieving these targets.

A direct transit corridor from SkyTrain to SFU will cross the Burnaby Mountain and Burnaby 200 Conservation Areas and will need to limit and mitigate any disturbance to the natural environment. The transportation choices for Burnaby Mountain should be complementary to TransLink's sustainability objectives as well as those of partners. The environmental assessment process will identify the issues particular to each biophysical feature and particular land use, identify the significance of any adverse effect, and propose mitigation measures necessary to ensure the project receives an Environmental Certificate.

Consideration of noise, privacy, aesthetics, emissions, view, carbon footprint, and issues identified through the public consultation process will be included.

Project Objectives:

- Reduce the emissions of GHGs and CACs in the provision of transit service, and through mode shift away from single occupant vehicles
- Reduce the carbon footprint of the Burnaby Mountain transit system
- Provide rapid transit that minimizes adverse effects to the Burnaby Mountain and Burnaby 200 Conservation Areas
- Use sustainable methods and materials for the project
- Develop an effective environmental assessment and public consultation process to address the concerns of the community and meet regulatory requirements

2.3.4 Urban Development

Current and expected urban development at the top of Burnaby Mountain is adding to the demand for rapid transit. Improved transit service would contribute to SFU and UniverCity's aspirations to be model sustainable communities.

The remainder of the study area has a mixture of stable residential, commercial, and industrial lands and there is potential for significant re-development near the existing and planned SkyTrain Stations along Lougheed Highway and North Road.

Project Objectives:

- Rapid transit stations and infrastructure that are integrated into the urban fabric
- Support future land use plans as contained in Metro Vancouver's RGS, the Burnaby OCP and the SFU OCP

2.3.5 Economic Development

As the second largest post-secondary institution in the province, SFU's education and research activities are key drivers of economic development in Metro Vancouver and beyond. The Burnaby campus is the university's largest campus accommodating more than 20,000 undergraduate and graduate students, faculty and staff, growing to over 30,000 by 2030. SFU's campuses in Surrey and downtown Vancouver are directly served by rapid transit and students often attend classes at more than one campus.

Project Objectives:

- Provide high quality transit service that supports the growth of the SFU campus and surrounding community

2.3.6 Social and Community

SFU derives a distinct character from its mountain-top location. The UniverCity community character is also influenced by its location and its aspiration to serve as a model sustainable community. The study area also includes established residential communities and activity centres that may be impacted by rapid transit or changes to the bus services that connect Burnaby Mountain to the SkyTrain system.

SFU and the Burnaby Mountain and Burnaby 200 Conservation Areas serve as regional assets offering hiking and bicycling trails, scenic vistas, cultural institutions, and renowned architecture. Access to recreational and tourist opportunities could be enhanced by improved transit.

Project Objectives:

- Maintain transit links to the study area residential communities, employment centres, and other activity centres
- Minimize and mitigate any adverse impacts of rapid transit to established communities and the Burnaby Mountain and Burnaby 200 Conservation Areas

2.3.7 Deliverability

Construction of rapid transit through or above the study area will require acquisition of right-of-ways (ROWs) or aerial easements in a developed urban environment. Residential, commercial, and industrial properties may be impacted as well as public streets, utility corridors, and the conservation areas.

The funding currently available to TransLink in its 2011 Base Transportation and Financial Plan is sufficient to operate the existing transit system at existing service levels and to maintain that system in a state of good repair. Moreover, there are numerous projects with strong regional commitments competing for funding if and when additional sources are identified. If the Burnaby Mountain project can be delivered within the existing resources allocated to bus service it could advance toward implementation, otherwise it must be balanced against other regional priorities.

Relative to other rapid transit projects in the region, little prior planning or analysis has been completed in this corridor. A robust consultation process will be required to engage stakeholders, various levels of government, and the community. In particular, there are a number of unique physical challenges to implementing a system on steep terrain. A formal environmental assessment will be required to assess and develop mitigation strategies for environmental impacts. It may be possible to implement a harmonized federal-provincial process.

Project Objectives:

- Provide information on the project in the community and with all levels of government to support fact-based decisions
- Develop a project scope that is deliverable and sustainable

2.4 Alternative Technology Assessment

A range of technologies were considered against the base case of diesel bus service. A primary screening was used to eliminate the least viable technologies to allow closer scrutiny of more viable technologies through the secondary screening.

Known issues associated with the current diesel bus service on Burnaby Mountain that should be addressed by higher-performing alternatives include:

- Diesel drive is not well not suited for hilly terrain with high passenger volumes, especially in winter conditions.

- Traffic impacts and noise would be exacerbated if operating at increased frequencies.
- Diesel propulsion is associated with GHG and CAC emissions.
- Diesel is a non-renewable, fossil fuel resource that is subject to future supply scarcity and price volatility. Since a large portion of TransLink's fleet is dependent on diesel as a mobile fuel source, it would be prudent to explore alternatives to diesel in this setting.
- Scheduling and driver requirements with very frequent bus service result in a need for layover/recovery facilities, which are land extensive and costly to provide in urban settings.
- Operating costs are largely directly proportional to the capacity of service provided, particularly when articulated buses are already employed.

2.4.1 Primary Screening

The current service provided by diesel buses, as well as ground-based and aerial alternative technologies are listed below. They are evaluated for their technical feasibility through a Primary Screening process. The full alternatives assessment is provided in Appendix A.

- Diesel bus (Base Case)
- Ground-based technologies:
  - Bus Rapid Transit – Trolleybus
  - Light Rail Transit
  - Guided Light Transit
  - Funicular
  - Rack Railway
  - Rail Rapid Transit – SkyTrain
  - Personal Rapid Transit
- Escalator
- Aerial technologies:
  - Aerial Tram/Reversible Ropeway
  - Gondola Lifts:
    - Monocable
    - 2S
    - 3S
    - Funitel

The commentary highlights benefits and drawbacks of the alternative technologies, and evaluates their technical feasibility through a Primary Screening process.

Primary Screening Criteria

The alternative technologies are rated against the following pass/fail criteria:

Travel Time

The travel time between Production Way – University Station and the SFU Bus Exchange on a diesel bus along Route 145 (that is, the Base Case) is 15 minutes excluding boarding and alighting times. Does the alternative offer travel time savings, or at least equal performance compared to the Base Case? Any alternative that takes longer than 15 minutes will fail this test.

Operating Limit

Does the expected alignment/operation of a particular alternative fall within the proven operating parameters of that technology? This test accounts for factors such as maximum allowable grade, minimum allowable turning radius, and passenger capacity.

Surface Impact

Are the topographic, property, and/or environmental impacts of the alternative too great to overcome? This test looks at the need to purchase private property and to mitigate or compensate for potential encroachments on to environmentally sensitive lands, including the conservation areas created by the City. Included is a qualitative assessment of likely mitigation measures.

Results of Primary Screening

The results of the primary screening are tabulated in Exhibit 2-13. The following technologies are discounted:

- Trolleybus
- Light Rail Transit
- Guided Light Rail
- Funicular
- Rack Railway
- Rail Rapid Transit – SkyTrain
- Personal Rapid Transit
- Escalator
- Aerial Tram

The remaining technologies carried through to the Secondary Screening phase – in Section 6 – include the following:

- Diesel Bus (Base Case)
- Gondola Lifts
  - Monocable
  - 2S
  - 3S
  - Funitel

Exhibit 2-13 – Results of Primary Screening

Primary Screening Criteria	Travel Time	Operating Limit	Surface Impact	Overall
Trolleybus	Fail	Pass	Pass	Fail
LRT	Fail	Fail	Fail	Fail
GLT	Pass	Fail	Fail	Fail
Funicular	Pass	Fail	Fail	Fail
Rack Railway	Pass	Pass	Fail	Fail
RRT (SkyTrain)	Fail	Fail	Fail	Fail
PRT	Fail	Pass	Fail	Fail
Escalator	Fail	Pass	Fail	Fail
Aerial Tram	Pass	Fail	Pass	Fail
Monocable/2S	Pass	Pass	Pass	Pass
3S/Funitel	Pass	Pass	Pass	Pass

2.4.2 Secondary Screening

The primary screening phase filtered out alternatives that are not technically viable or would provide little or no additional benefit over the Base Case. The secondary screening phase sorts through the remaining alternatives in greater detail. Specifically, the alternatives are compared across the accounts outlined in Section 2.3 of this business case.

The evaluation is done primarily on a qualitative basis, with select criteria being quantified or monetized where possible. The results of the comparison are summarized in a structured format to facilitate understanding and decision-making. Full details are available in the companion technology and alignment assessment report and the final evaluation is summarized below in Exhibit 2-14. Note that due to the range of performance within each account, and due to the varying weighting applied to each account, the overall evaluation is not necessarily a mathematical output from the other scores.

Exhibit 2-14 – Secondary Screening – Summary Table

Criteria	Diesel Bus (Base Case)	Monocable or 2S Gondola	3S or Funitel Gondola
Financial	◑	◔	◔
Transportation	◑	◕	●
Environmental	◑	◑	●
Urban Development	◑	◕	◕
Economic Development	◑	◕	◕
Social	◑	○	◔
Deliverability	◑	◑	◑
Overall	◑	○	●

Worse ← → Better

○ ◔ ◑ ◕ ●

Overall, the 3S or Funitel gondola system was considered to have the best performance due its high-capacity, all-weather operation combined with its ability to be built well above the forest and developments, thus reducing the social and environmental impacts.

3S versus Funitel

In light of the similar performance of 3S and Funitel in the above evaluation, additional information from the suppliers has been considered. As part of the lift system evaluation two suppliers, Doppelmayr and Leitner-Poma, were contacted to provide technical input and indicative pricing.

Both suppliers recommended 3S technology in their conceptual design. Below is a summary of the rationale for choosing this technology:

1. Relatively Long Spans – 3S and funitel are comparable in this respect.
2. Comparable Wind Performance – For the span lengths considered, 3S and funitel are comparable.
3. Greater Passenger Capacity – The greater size of 3S system cabins offer advantages.
4. Power Consumption – Funitel systems consume more power than 3S.

Overall Gondola Viability

Precedent systems demonstrate that aerial ropeway systems can be integrated into urban contexts, and can stand up to the rigorous operational demands placed on them.

- The SFU campus setting offers opportunities, during periods of low demand, to schedule maintenance shutdowns.

- The exposure to climatic conditions including snow and wind at Burnaby Mountain is less severe than in ski applications.
- During off-peak periods, the system can be slowed to reduce wear and tear.
- The site is also in close proximity to shipping facilities in the event spare or replacement parts are needed.

2.5 Alternative Alignment Assessment

Based on the conclusions of the technology alternatives assessment, a review of potential alignments was developed with the assumption of a 3S system. The key objective of this assessment was to identify alignment(s) that:

- Minimize conservation area impacts
- Minimize neighbourhood impacts
- Minimize length of route – (reduce cost and travel time, avoiding kinked alignments)
- Minimize impacts of tower locations
- Maximize transit integration – with SkyTrain and SFU/UniverCity

2.5.1 Alignment Options

Four alignments linking Burnaby Mountain with the existing SkyTrain network were considered in some detail. The alignments can be described as follows:

1. Lake City Way Station to South Campus Road (across from the South Sciences Building)
2. Production Way – University Station to SFU Bus Exchange
3. Production Way – University Station to intersection of Highland Court and Tower Road
4. Burquitlam Station (on the Evergreen Line) to SFU Bus Exchange

The route alignment alternatives are shown in Exhibit 2-15. Alignments with mid-stations were initially also considered but ruled out for the following reasons:

- If a mid-station were used to allow an alignment to avoid crossing over residential areas, the mid-station would be in the Conservation Area, greatly increasing surface impacts due to additional clearing for the building and to allow the gondola to descend to it and ascend from it.
- A mid-station would ideally be located where there would be significant passenger demand to board or alight but the prospective locations would not be proximate to demand generators or network connections.
- Mid-stations require the gondola to slow down and so would generate an increase in travel time, particularly since the intent is that they would make the route less direct. Added travel time would result in less diversion of trips to the gondola from other modes, reducing environmental and economic benefits.
- Mid-stations (and a longer route) would increase project costs and so reduce the benefit to cost ratio as benefits would decrease while costs increased.

All alignments assume that full advantage of the 3S technology is made to avoid tree removal under the alignment, except at tower locations, and to locate towers in locations that minimise residential and conservation area impacts.

Exhibit 2-15 – BMGT Alignment Alternatives

2.5.2 Alignment Evaluation

The alignments are evaluated on a basis similar to that utilized for the technological alternatives. The chart following (Exhibit 2-16) summarizes the results of the evaluation with the reasons for the evaluation results described following:

Exhibit 2-16 – Alignment Evaluation Summary

Criteria	Route			
	1: Lake City – South Campus Road	2: Production Way – SFU Bus Exchange	3: Production Way – Tower Road	4: Burquitlam – SFU Bus Exchange
Length	2.8 km	2.7 km	2.7 km	2.4 km
Conservation Area Impact	◕	◔	◔	○
Residential Impact	◕	◑	○	◔
SkyTrain/Transit Integration	◔	●	◕	◔
SFU Campus & UniverCity Integration	◔	●	◔	◔
Property Acquisition Risk	○	◕	◔	◕
Safety & Approvals	○	◕	◕	◕
Cost (including property)	○	◕	◔	◔

Worse ◄——————► Better

○ ◔ ◑ ◕ ●

Route 1: Lake City – South Campus Road

This alignment travels the shortest distance over the conservation area and avoids crossing residential neighbourhoods and so performs highly on these accounts. However, the lower terminus at Lake City skews the ridership catchment to the west, reducing the potential to attract ridership from the south and east, thus its poor showing on SkyTrain/transit integration. Building a convenient connection at Lake City Way Station would also be difficult since the station is on the west side of Lake City Way close to the road, suggesting the station need either be at a higher level on the west side, to allow the gondola to cross above Lake City Way, or on the east side of the street where it would be less convenient to the SkyTrain station.

At the upper end of the route, the terminus would be across South Campus Road from the South Sciences Building as crossing above the university buildings to reach the transit hub would be challenging. The net effect of the upper and lower terminal locations is a reduction in ridership with this alternative such that it is approximately one-fifth that of alignment 2, based on initial model results. Integrating bus services, including replacement bus services when the gondola is not operating, at this upper terminal would be challenging due to the lack of an existing facility and little available land to build one.

Notwithstanding the above, the most fundamental challenges with this alternative result from its crossing the tank farm properties on the slopes of Burnaby Mountain. The tanks on these sites store refined petroleum products and the consequences of any incident at them for the gondola are such that the BC Safety Authority has indicated that they could not approve operation of a gondola above them. Furthermore, this alignment would require the purchase of aerial rights-of-way over the tank farms and the tank farm owners have indicated they would not agree to this. As the tank farms are owned by inter-provincial utilities and thus are federally regulated, TransLink has no authority to acquire property from them. This alignment is therefore not viable.

Route 2: Production Way – SFU Bus Exchange

This alignment was recommended in the initial feasibility study and continues to be the most promising. It connects directly to existing transit nodes at the upper and lower terminals and takes a direct route up the mountain, serving travel demand well from most directions, including the north-east once the Evergreen Line is in place.

The main challenge with this route is the crossing of the Forest Grove residential neighbourhood, with approximately 40 residential units below the alignment. Residents have indicated concerns about noise, safety, privacy, and visual impacts. The number of directly crossed residential properties is minimized to the extent possible as the alignment crosses part of this area above a ravine in the Burnaby 200 Conservation Area. The choice of 3S technology also permits an alignment that is about 30 m above rooftops and well above the tree canopy, which would remain intact and offer some visual screening. Potential tower locations have been identified that are at least 100 m from dwellings and minimize conservation area impacts.

The lower part of the alignment, though the industrial area, is largely above the Production Way street right-of-way and so limits property requirements. The upper part of the alignment is compatible with the street network at SFU/UniverCity and so would have little negative impact on current or future development there.

While some property would need to be acquired for this alignment, for terminals, towers and aerial rights-of-way, none of the required activities are considered a high risk given experience with precedent projects in the region, such as SkyTrain.

Preliminary discussions with the BC Safety Authority indicate that the alignment is approvable as there are precedents for ropeways over streets and buildings of the type found on this route. Some special operational measures would be required when performing maintenance activities above buildings and public areas.

Route 3: Production Way – Tower Road

This alignment is similar to alignment 2 except that the upper terminal is further east, placing it further from the SFU campus and the destinations of most riders. Because it is less effective at following existing street rights-of-way in its upper and lower sections, it offers inferior integration with SFU/UniverCity and crosses more industrial properties. Compared to alignment 2, it crosses a similar number of residential units, but there are fewer trees to provide visual screening in this segment. Overall, this alignment offers no benefits and many drawbacks relative to alignment 2.

Route 4: Burquitlam – SFU Bus Exchange

This alignment would have a lower terminal on the west side of Clark Road, opposite the planned Burquitlam Station on the Evergreen Line. The design of the Evergreen Line Station at this location is for a side platform station with no mezzanine level making a high-quality connection across the road challenging. It is assumed all passengers would need to cross Clark Road at street level or make multiple changes in grade to access the gondola terminal. For this reason this alignment scores poorly on integration. While this alignment is effective at capturing ridership originating in the east, much of the travel demand is destined to and from other directions.

The lower part of this route would cross about 500 m of single-family housing with private backyards. Approximately 30 properties would be crossed directly overhead. As a result, the alignment scores poorly on residential impacts.

The alignment makes a long crossing of the Burnaby Mountain Conservation Area for a distance of about 1,400 m. Given the topography and existing BC Hydro lines, it is likely that one or more towers would be needed in the Conservation Area in areas remote from existing road access. Given the likely level of disturbance and the high recreational use of this section of the Conservation Area, this alignment was considered inferior to the others in terms of impact on conservation lands.

On arrival at the mountain, this alignment cuts diagonally across the UniverCity development area and is likely to have a negative impact on future development since it would require establishing a new right-of-way. Other alignments take advantage of existing rights-of-way.

While this alignment is considered to be viable from an approvals perspective, it is less desirable than alignment 2 given its inferior transportation connections and higher land use and environmental impacts.

2.6 Alignment Conclusion

On the basis of this secondary screening, summarized in Exhibit 2-16, Route 2 is identified as the preferred alignment because it :

- Minimizes impacts on the conservation areas;
- Minimizes residential property crossings;
- Minimizes travel time (6.5 minutes versus 15 minutes by bus);
- Maximizes integration with transit facilities and SFU/UniverCity;
- Limits conflict with utilities; and,
- Has good potential for low impact tower locations.

2.7 Technology and Alignment Conclusion

Based on the foregoing analysis, the combination of a 3S gondola on Route 2: Production Way – SFU Bus Exchange stands out as the most promising combination of technology and alignment to carry forward to more detailed evaluation in the business case. This combination is expected to show the highest transportation benefit with lower and more manageable surface impacts relative to other options.

2.8 Description of Preferred Option

Assessment of the alternative technologies demonstrated that 3S/funitel gondola is the preferred solution. Exhibits 2-17, 2-18, and 2-19 show samples of 3S and funitel installations.

Exhibit 2-17 – 3S Gondola – Peak 2 Peak, Whistler

Exhibit 2-18 – 3S Gondola Tower – Peak 2 Peak, Whistler

Exhibit 2-19 – Funitel Gondola

(Source: http://commons.wikimedia.org/wiki/File:Hakone_ropeway_05.jpg)

The alignment evaluation process indicates that Route 2, a direct route from Production Way – University Station to the SFU Bus Exchange shown in Exhibit 2-20, is the preferred alignment.

As gondola technology is quite specialized and only two established suppliers with a track record of delivering 3S type systems exist, the project team contacted both of these suppliers to assist with confirming the design and estimating costs. The designs received from the suppliers form the basis of the preferred option. Each indicated the need for five towers; however, the specific tower locations, tower heights, and cable profiles are somewhat flexible. Further survey and analysis needs to be done to clarify the future height of the tree canopy that the cabins need to clear. More detailed design is also necessary to define the power requirements for the system.

Based on the model forecasts, the request to suppliers included an opening day capacity requirement of 3,000 pphpd, and a built-out capacity of 4,000 pphpd. Twenty-four cabins are required to meet forecast opening day demand. At full build-out, that is 2041, approximately 32 cabins would be required. The cabins would circulate continuously during operating hours, and be stored in the storage and maintenance facility at night. During peak periods, the cabin headway would be as short as 34 seconds, and the cabins would be spaced approximately 280 m apart.

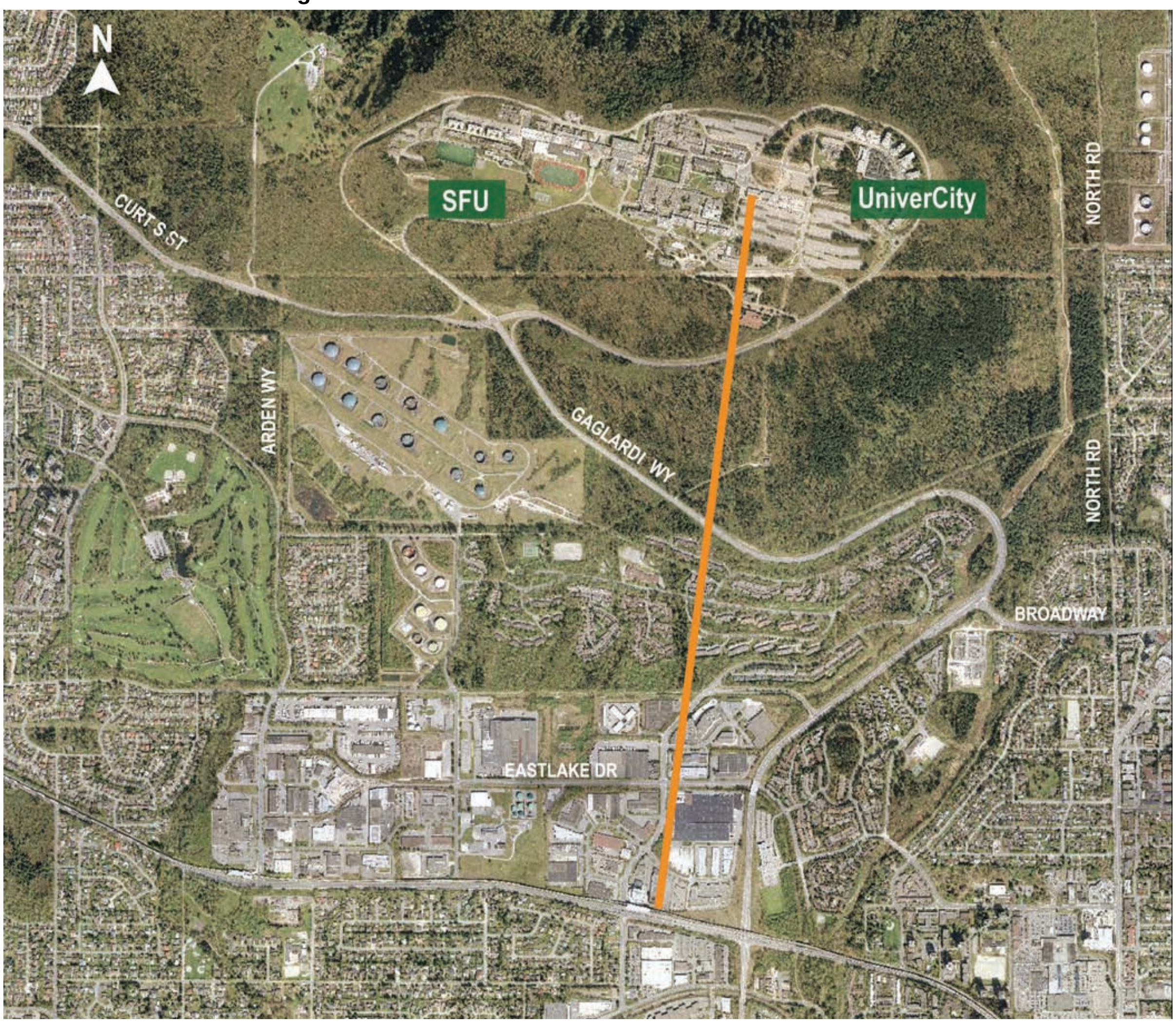
Five steel lattice towers of varying height are envisioned to support the track ropes, haul rope, and cabins/hangers. An important element of the public consultation process would be to understand aesthetic concerns with the towers and potential mitigation strategies. Once concerns and priorities are better understood, then mitigation measures can be developed. The standard tower finish is galvanized steel that, while bright when new, dulls with weathering. Typical tower heights on the order of 65 m would make the towers a prominent feature on the skyline, depending on vantage point and sightlines. A 3D visual model of the project would be created as part of a visual impact assessment (VIA) process; the VIA would be a component of the EA.

The hours of operation assumed for the evaluation would closely match the existing service with an average of 18 hours of revenue service per day – varying between 19 hours Monday to Friday, 18 hours on Saturday, and 17 hours on Sunday. These hours are subject to adjustment given the relative operating costs of buses in low demand periods. The evaluation also accounts for an annual maintenance shutdown of 1 week during the summer months, and replacement bus service during closures.

Construction of civil, mechanical, and electrical systems is anticipated to take 18 months. During this time, impacts to traffic, local residents, and businesses would be expected but limited.

Access to the lower terminus would be provided via a newly constructed concourse area linking the terminus building with the existing bus loop at Production Way – University Station. The upper terminus will be designed to provide direct access to the existing plaza area south of the SFU Bus Exchange.

Exhibit 2-20 – Preferred Alignment



The alternative assessment in Section 2.5 examined the various benefits in a qualitative fashion to screen out non-performing alternatives. The project team conducted a more detailed review of the cost and benefits of the preferred option. These are included in sections 2.9 through 2.12 below.

2.9 Preferred Option Costs

The project team estimated the capital and operating costs of the preferred option described in the previous section. Main components of the capital cost are the lift system, towers, lower and upper terminals, and land. Given the highly specialized industry behind lift systems, a number of experts and suppliers were consulted to develop indicative capital and operating costing for the project. Capital costs were derived from indicative bids and the Wolski estimating method.

The project team that derived the project costs included a ropeway system engineer and the project manager for the Portland Aerial Tram, a precedent project that was implemented in an urban environment. The team members had experience in project delivery in BC and with various delivery models.

Indicative bids were requested from three ropeway system suppliers for the aerial transit system. A technical package including a drawing showing the alignment, grades, and restrictions for tower locations and technical requirements, such as capacity and service hours, was provided. One supplier (a relatively new entrant to the market) declined to provide a bid due to their inability to provide the required capacity with their product offering. The responses received from the two other ropeway system suppliers were evaluated and the indicative prices provided were adjusted to be comparable and based on common assumptions.

From the technical information provided by the suppliers, quantities were estimated for the civil and ancillary work. The project team evaluated the required tower foundation and terminal building sizes to fit the preferred alignment, and to stay consistent with the tower locations, approximate tower heights, and the number of cabins proposed by the suppliers. Using the Wolski estimating method with local unit prices, the project costs were estimated for civil and ancillary work.

The operations costs were derived from experience operating transit in the Lower Mainland, and on the maintenance requirements stipulated by the ropeway system suppliers. The main elements of the operations estimate are labour and equipment replacement requirements. The suppliers' suggested equipment replacement schedules were verified against other projects and by the independent ropeway engineer. The labour hours include attendants during operation, and mechanics and electricians for maintenance of the equipment. The maintenance of the civil work was included as an annual percentage of the value of the infrastructure.

Exhibit 2-23 shows the capital and O&M costs that the project team assembled. Non-property costs are examined in greater detail in Sections 4.3.2 and 4.3.3.

Exhibit 2-21 – Project Costs for Preferred Option

Project Cost	
Capital (2011$ millions)	114
Annual O&M (2011$ millions)	3.4

The Project team also conducted risk identification and risk quantification workshops. All risks were identified, but only risks that could be estimated at this stage of the project were quantified. Because of the lump sum estimate of the ropeway equipment supply cost and the limited amount of design work performed at this stage of the Project, a contingency was also applied to the ropeway equipment supply. The above capital cost is inclusive of all project capital costs, risks, contingency, property acquisition, project management, procurement, and contract administration assuming full implementation of the project in 2014. This date was chosen for ease of getting estimates and is not a committed date. Contract administration during the O&M period is included in the annual O&M costs.

2.10 Bus Savings

A primary motivation for considering alternatives to bus service to Burnaby Mountain is the reduction in operating costs for bus service that could occur if bus services are replaced by rapid transit. The key routes serving Burnaby Mountain are routes 135, 143, 144, and 145 shown in Exhibit 2-7. To calculate these savings, a two step approach was used:

1. Run the regional transportation demand model with and without the gondola with pre-gondola bus service assumptions in both scenarios.
2. Revise the bus service assumptions for the scenario with the gondola based on the change in demand patterns by service observed in step 1 and rerun the model.

The transportation demand modelling work was done for 2021 and 2041 with scenarios with and without the Evergreen Line. The model showed (see Exhibits 2-10 and 2-11) that ridership on Route 145, which most closely parallels the gondola alignment, would be reduced from over 1,200 pphpd today to a handful of customers. This is expected as the gondola cuts the travel time in half and operates more frequently. Thus this route could be assumed to be eliminated. Furthermore, in the scenario with the Evergreen Line operating, a bus route from the east that is expected to be a major connection between the Evergreen Line and Burnaby Mountain (that is, the western portion of route 143) showed a drop from 430 pphpd today down to about 48 pphpd in 2021 with the gondola. This result was also expected since the travel time for passengers remaining on SkyTrain to Production Way – University, plus the gondola travel time, is competitive with the direct bus travel time. In consequence, the gondola integration scenario assumes the direct bus route is discontinued.

The other two bus routes serving Burnaby Mountain showed smaller reductions in demand. Route 135, which connects the mountain to downtown Vancouver via the major Hastings Street corridor showed a modelled reduction in demand of one-third for access to Burnaby Mountain. However, the peak volumes on this route are generated at the downtown Vancouver end of the route so a conservative approach of leaving this route unchanged was taken, though short-turning trips would be a future consideration, especially following analysis of demand patterns after the gondola is in operation.

The last route, Route #144, includes about 3.5 km of route through a residential area between its intersection with the Millennium Line SkyTrain at Sperling-Burnaby Lake and the edge of the greenbelt around the base of Burnaby Mountain. Ridership modelling showed about a 25% reduction in demand on this route to Burnaby Mountain however it operates at near minimum policy levels (every 12 minutes peak) and serves other major activity centres along its route, including Burnaby City Hall and a number of schools. This route would also be the most direct substitute for the gondola for any passengers with vertigo or other concerns. It, together with the Route #135, would also provide a local distribution function on the mountain-top for trips with origins or destinations that are some distance from the gondola terminal. Taking these factors into consideration, service levels on this route were assumed to be unchanged by the gondola.

The bus savings resulting from the service changes described were calculated using a spreadsheet model of round-trip times (including recovery/layover time) and all-day headways. Small corrections were required to the resulting estimates of vehicle hours in order to ensure the base scenario matched current scheduled hours. With this data, operating cost savings were calculated using the projected savings in vehicle hours and bus operating cost data from Coast Mountain Bus Company, TransLink's bus subsidiary. A 10% premium was applied to the average system cost per hour in order the reflect the severe duty cycles on the bus routes concerned given their heavy passenger loads and the continuous steep grades of Burnaby Mountain. This premium is based on the costs of diesel bus service in Vancouver and North Vancouver where high volumes and steep topography, respectively, increase operating costs. Operating costs for the Burnaby Mountain routes could not be directly calculated since the costs are compiled at the garage, not route, level. Reductions in the number of buses required were also estimated and the capital savings included in the analysis, as described in Section 5.6. The assumption is that these saved vehicles will either be used elsewhere in the region if TransLink is in a service expansion mode, or if not, they could be stored or used to accelerate retirements.

2.11 Preferred Option Benefits

The project team estimated a number of benefits resulting from replacing the base case diesel bus services with the preferred option of a 3S Gondola running from Production Way to the SFU bus exchange.

The benefits were estimated using the Federal Provincial Business Case Template and guidebook as references.

- Under the transportation user category, auto and transit user travel time savings are the most significant benefits. Other benefits include auto operating cost savings, collision, and parking cost savings.
- Under the transportation producer perspective the benefits result from savings in capital and O&M costs of buses not required once the preferred alternative is in place.
- In addition to the above two categories, GHG emission reductions were also considered as benefits resulting from implementing the project.

The data used in the benefit valuation are summarized in Exhibits 2-22 and 2-23 below.

Exhibit 2-22a – Data Used in Benefit Valuation (with Evergreen Line)

	Transit Travel Time Benefit (hr)				Auto Travel Time Benefit (hr)		Change in Auto VKT (km)		Auto GHG Emissions		Reduction in Bus Service Hours	Bus GHG Emissions
	Peak Hour		Annual							Annual		
Year	Existing Users	New Users	Existing Users	New Users	Peak Hour	Annual	Peak Hour	Annual	g/km	Tonne Savings	Annual	Tonnes
1	353	34	1,240,529	119,172	11	55,915	5,213	26,975,284	244	6,582	53,787	1,648
2	358	35	1,259,144	123,468	22	111,830	5,189	26,851,488	238	6,387	54,216	1,661
3	363	36	1,277,760	127,765	32	167,745	5,165	26,727,692	232	6,193	54,645	1,674
4	368	38	1,296,375	132,061	43	223,660	5,141	26,603,896	226	6,001	55,074	1,687
5	374	39	1,314,991	136,357	54	279,575	5,117	26,480,100	219	5,810	55,503	1,700
6	379	40	1,333,606	140,653	65	335,489	5,093	26,356,304	213	5,621	55,931	1,714
7	384	41	1,352,222	144,949	76	391,404	5,069	26,232,507	207	5,434	56,360	1,727
8	390	42	1,370,837	149,246	86	447,319	5,045	26,108,711	201	5,248	56,789	1,740
9	395	44	1,389,452	153,542	97	503,234	5,021	25,984,915	199	5,175	57,218	1,753
10	400	45	1,408,068	157,838	108	559,149	4,997	25,861,119	197	5,102	57,647	1,766
11	406	46	1,426,683	162,134	119	615,064	4,973	25,737,323	195	5,030	58,076	1,779
12	411	47	1,445,299	166,431	130	670,979	4,949	25,613,527	194	4,959	58,505	1,792
13	416	49	1,463,914	170,727	140	726,894	4,926	25,489,730	192	4,888	58,934	1,806
14	421	50	1,482,529	175,023	151	782,809	4,902	25,365,934	190	4,817	59,363	1,819
15	427	51	1,501,145	179,319	162	838,724	4,878	25,242,138	188	4,747	59,792	1,832
16	432	52	1,519,760	183,615	173	894,639	4,854	25,118,342	186	4,677	60,221	1,845
17	437	53	1,538,376	187,912	184	950,553	4,830	24,994,546	184	4,608	60,650	1,858
18	443	55	1,556,991	192,208	194	1,006,468	4,806	24,870,750	183	4,539	61,078	1,871
19	448	56	1,575,607	196,504	205	1,062,383	4,782	24,746,953	181	4,471	61,507	1,884
20	453	57	1,594,222	200,800	216	1,118,298	4,758	24,623,157	179	4,403	61,936	1,898
21	458	58	1,612,837	205,097	227	1,174,213	4,734	24,499,361	177	4,335	62,365	1,911
22	464	60	1,631,453	209,393	238	1,230,128	4,710	24,375,565	175	4,268	62,794	1,924
23	469	61	1,650,068	213,689	249	1,286,043	4,686	24,251,769	173	4,202	63,223	1,937
24	474	62	1,668,684	217,985	259	1,341,958	4,662	24,127,973	171	4,136	63,652	1,950
25	480	63	1,687,299	222,282	270	1,397,873	4,638	24,004,176	170	4,070	64,081	1,963

Notes:

1. Transit and Auto Travel Time Benefit, and Change in Auto VKT determined by comparing model runs with and without gondola.
2. Change in Auto VKT (where ‘Auto’ mode includes passenger cars and trucks) is used to calculate Auto Operating and Collision Cost Savings, as well as GHG Emission Reduction Savings.
3. Bus GHG emissions based on 11.43 L/hr consumption rate and service hour reductions extracted from Bus Integration Plan, and 2.68 kg CO2/L diesel fuel combustion per http://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation%20of%20CO2%20emissions%20from%20fuels.htm

Exhibit 2-22b – Data Used in Benefit Valuation (without Evergreen Line)

	Transit Travel Time Benefit (hr)				Auto Travel Time Benefit (hr)		Change in Auto VKT (km)		Auto GHG Emissions		Reduction in Bus Service Hours	Bus GHG Emissions
	Peak Hour		Annual							Annual		
Year	Existing Users	New Users	Existing Users	New Users	Peak Hour	Annual	Peak Hour	Annual	g/km	Tonne Savings	Annual	Tonnes
1	345	51	1,214,332	179,239	4	22,141	4,576	23,682,094	244	5,778	31,598	968
2	353	53	1,243,249	185,404	9	44,282	4,728	24,464,813	238	5,819	32,179	986
3	362	54	1,272,167	191,570	13	66,423	4,879	25,247,531	232	5,850	32,761	1,004
4	370	56	1,301,085	197,735	17	88,564	5,030	26,030,250	226	5,872	33,343	1,022
5	378	58	1,330,003	203,900	21	110,705	5,181	26,812,969	219	5,884	33,925	1,039
6	386	60	1,358,921	210,066	26	132,846	5,333	27,595,688	213	5,886	34,507	1,057
7	394	61	1,387,839	216,231	30	154,987	5,484	28,378,406	207	5,878	35,089	1,075
8	403	63	1,416,757	222,396	34	177,128	5,635	29,161,125	201	5,861	35,671	1,093
9	411	65	1,445,675	228,562	39	199,269	5,786	29,943,844	199	5,963	36,253	1,111
10	419	67	1,474,593	234,727	43	221,410	5,938	30,726,563	197	6,062	36,835	1,129
11	427	68	1,503,511	240,892	47	243,551	6,089	31,509,281	195	6,158	37,417	1,146
12	436	70	1,532,429	247,057	51	265,692	6,240	32,292,000	194	6,252	37,999	1,164
13	444	72	1,561,347	253,223	56	287,833	6,391	33,074,719	192	6,342	38,580	1,182
14	452	74	1,590,265	259,388	60	309,974	6,543	33,857,438	190	6,430	39,162	1,200
15	460	75	1,619,183	265,553	64	332,115	6,694	34,640,156	188	6,514	39,744	1,218
16	468	77	1,648,101	271,719	68	354,256	6,845	35,422,875	186	6,596	40,326	1,236
17	477	79	1,677,019	277,884	73	376,397	6,996	36,205,594	184	6,675	40,908	1,253
18	485	81	1,705,937	284,049	77	398,538	7,148	36,988,313	183	6,750	41,490	1,271
19	493	82	1,734,855	290,214	81	420,679	7,299	37,771,031	181	6,823	42,072	1,289
20	501	84	1,763,773	296,380	86	442,821	7,450	38,553,750	179	6,893	42,654	1,307
21	510	86	1,792,691	302,545	90	464,962	7,601	39,336,469	177	6,961	43,236	1,325
22	518	88	1,821,609	308,710	94	487,103	7,753	40,119,188	175	7,025	43,818	1,342
23	526	90	1,850,527	314,876	98	509,244	7,904	40,901,906	173	7,086	44,400	1,360
24	534	91	1,879,445	321,041	103	531,385	8,055	41,684,625	171	7,145	44,982	1,378
25	542	93	1,908,363	327,206	107	553,526	8,206	42,467,344	170	7,200	45,563	1,396

Notes:

4. Transit and Auto Travel Time Benefit, and Change in Auto VKT determined by comparing model runs with and without gondola.

5. Change in Auto VKT (where ‘Auto’ mode includes passenger cars and trucks) is used to calculate Auto Operating and Collision Cost Savings, as well as GHG Emission Reduction Savings.

6. Bus GHG emissions based on 11.43 L/hr consumption rate and service hour reductions extracted from Bus Integration Plan, and 2.68 kg CO_2/L diesel fuel combustion per http://people.exeter.ac.uk/TWDavies/energy_conversion/Calculation%20of%20CO2%20emissions%20from%20fuels.htm

Parking savings are premised on the forecast reduction in auto mode share shown in Exhibit 2-23.

Exhibit 2-23a – Data Used to Calculate Parking Savings (with Evergreen Line)

		AM Peak Trips to SFU by:		
Year	**Model Run**	**Transit**	**Auto**	**Walk/Cycle**
2021	Without BMGT	2,844	4,292	355
	With BMGT	3,300	3,876	357
	Daily Auto Trip Reduction		173	
	Monthly Auto Trip Reduction		2,601	
2041	Without BMGT	3,230	4,846	396
	With BMGT	3,828	4,349	400
	Daily Auto Trip Reduction		206	
	Monthly Auto Trip Reduction		3,108	

Exhibit 2-23b – Data Used to Calculate Parking Savings (without Evergreen Line)

		AM Peak Trips to SFU by:		
Year	**Model Run**	**Transit**	**Auto**	**Walk/Cycle**
2021	Without BMGT	2,814	4,322	355
	With BMGT	3,309	3,878	357
	Daily Auto Trip Reduction		184	
	Monthly Auto Trip Reduction		2,776	
2041	Without BMGT	3,165	4,914	396
	With BMGT	3,797	4,402	401
	Daily Auto Trip Reduction		212	
	Monthly Auto Trip Reduction		3,202	

The benefits were estimated for each of the in-service years to generate the project benefits over its lifecycle. It assumes 18 months of construction plus a 25-year initial operating period, and is based on a real discount rate of 6%. The results are summarized in Exhibit 2-24.

Exhibit 2-24a – Present Value of Project Benefits (with Evergreen Line)

Category	Benefit Type	Benefit Estimate (2011$ millions)	Total Benefit (2011$ millions)
User Benefits	Travel Time Savings	355	455
	Auto Operating Cost Savings	55	
	Collision Reductions	41	
	Parking Cost Savings	2	
	Vehicle Emissions Reductions	2	
Producer Benefits	Transit Operating Cost Savings	92	109
	Transit Replacement Cost Savings	17	
		Total	**564**

Exhibit 2-24b – Present Value of Project Benefits (without Evergreen Line)

Category	Benefit Type	Benefit Estimate (2011$ millions)	Total Benefit (2011$ millions)
User Benefits	Travel Time Savings	322	440
	Auto Operating Cost Savings	65	
	Collision Reductions	49	
	Parking Cost Savings	2	
	Vehicle Emissions Reductions	2	
Producer Benefits	Transit Operating Cost Savings	59	71
	Transit Replacement Cost Savings	12	
		Total	**511**

2.12 Cost and Benefit Summary

Using the above project costs and benefits, a benefit cost analysis was conducted using the discounted cash flow over the life–cycle of the project. The analysis assumed a real discount rate of 6%, 18 months of construction, and 25 years of operation. For simplicity, no residual value was assumed at the end of the 25-year operating period, though the system would still have significant value at that time. The purpose of the benefit cost analysis is to compare the costs and benefits of the project and estimate the BCR of the project. Exhibit 2-25 presents the results of the analysis:

Exhibit 2-25 – Present Value (PV) of Benefits and Costs

Category	Estimate (2011$ millions)	
	With Evergreen	Without Evergreen
PV Benefits	564	511
PV Capital and O&M Costs	157	157
Benefit Cost Ratio	3.59	3.25

A BCR greater than 1.0 indicates that the project benefits surpass the project costs. A BCR of 3.59 indicates that significant benefits result from implementing the project when considering a 6% real discount rate. Without the Evergreen Line, the BCR of 3.25 is still positive and significant.

2.12.1 Sensitivity Tests

In order to test the robustness of the project a number of sensitivity tests were conducted involving different discount rates and capital costs. The sensitivity tests were done assuming the scenario with Evergreen Line. Exhibits 2-26 through 2-28 summarize the various tests conducted. The sensitivities were analyzed on the variables most likely to fluctuate.

The results indicate the soundness of the project at a broad range of discount rates and capital costs. In extreme conditions, with a discount rate of 12% and capital project costs 25% above the original estimate, the BCR still displays a strong value of 1.98.

Exhibit 2-26 – Discount Rate and Capital Cost Sensitivities

Discount Rate Sensitivity	Capital Cost Increase (+)/Decrease (-) Sensitivity				
	-10%	**(Base)**	+10%	+20%	+25%
4%	4.49	4.19	3.92	3.69	3.59
6% (Base)	3.86	**3.59**	3.35	3.14	3.05
8%	3.35	3.10	2.88	2.70	2.61
10%	2.93	2.70	2.51	2.34	2.26
12%	2.38	2.58	2.20	2.05	1.98

Exhibit 2-27 – Discount Rate and Value of Time Sensitivities

Discount Rate Sensitivity	Lower Value of Time at			
	25% $3.25/hr	50% $6.50/hr	75% $9.75/hr	**(Base) 100%=$13/hr**
4%	2.19	2.85	3.52	4.19
6% (Base)	1.89	2.46	3.02	**3.59**
8%	1.65	2.13	2.62	3.10
10%	1.45	1.87	2.29	2.70
12%	1.29	1.65	2.02	2.38

Exhibit 2-28 – Discount Rate and Carbon Tonne Price Sensitivities

Discount Rate Sensitivity	Carbon Tonne Price ($2011)				
	$15	**Base ($25)**	$50	$100	$200
4%	4.18	4.19	4.20	4.22	4.27
6% (Base)	3.58	**3.59**	3.60	3.62	3.66
8%	3.09	3.10	3.11	3.13	3.17
10%	2.70	2.70	2.71	2.73	2.76
12%	2.37	2.38	2.39	2.40	2.43

2.13 Investment Recommendation

Investment recommendations around benefit cost analysis usually require the BCR be higher than 1.0. The preceding analysis indicates that the project would achieve economic benefits well in excess of costs and so represents a beneficial investment. This result holds true under all sensitivities tested. Consequently, there is a strong economic justification for proceeding with the project.

3. REGULATORY APPROVALS PROCESS

To proceed with project implementation, regulatory approvals are required, including the following:

- City of Burnaby approval for any relaxations to the bylaws that created the Burnaby Mountain and Burnaby 200 Conservation Areas
- An EA certificate
- An installation permit from the BC Safety Authority
- An operating permit from the BC Safety Authority
- An emergency response plan as a component of other approvals
- Roads and utilities crossing, proximity, and access agreements

A conditional approval from municipal and provincial authorities may be granted pending successful completion of an EA, based on the terms of reference set out by the authority at the time of application (Application Terms of Reference [ATOR]). The design is required to comply not only with the ATOR, but also with conditions of approval from other agencies, applicable legislation, and regulation, as well as any commitments made by the Project during the public consultation phase.

Details on the expected EA requirements are presented in Section 3.1.

3.1 Environmental Assessment

3.1.1 Overview

The Canadian Environmental Assessment Agency (CEAA) conducts EAs when there is a federal authority involved, while the British Columbia Environmental Assessment Office (BCEAO) is responsible for the EA process at the provincial level in BC.

The two main purposes of an EA are to:

- Minimize or avoid adverse environmental effects before they occur
- Incorporate environmental factors into decision-making

The EA process requires an applicant to:

- Identify possible environmental effects
- Propose measures to mitigate adverse effects
- Predict whether there will be significant adverse environmental effects, even after the mitigation is implemented

Delivery of a clear, concise initial Project Description will serve to allow the regulators to scope the Project issues, identify the regulatory authorities, and prepare an ATOR. It will also serve to engage the public through the consultation process. Cost and schedule savings can be realized if initiatives for the purpose of gathering and understanding public perceptions and concerns commence in advance of the next phase of planning and design.

BCEAO Process

As required by the *Environmental Assessment Act*, the BCEAO manages all provincial EAs of proposed major projects and initiatives in BC. There are three ways in which projects in BC become reviewable by the BCEAO:

- If the project meets certain thresholds as indicated in the Reviewable Projects Regulation (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/13_370_2002),
- If the project is not reviewable under the Reviewable Projects Regulation but the Minister of the Environment directs the project to be reviewed, or
- Through proponent "opt-in" where the project proponent requests that the project be designated as a reviewable project.

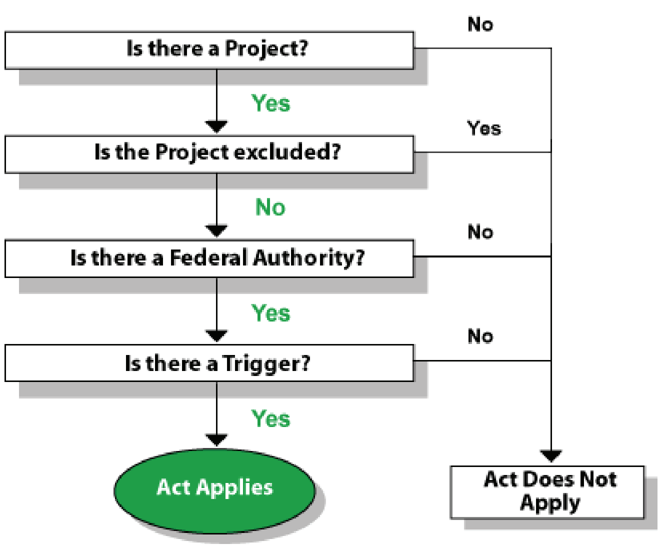
CEAA Process

At the federal level, the CEAA administers the *Canadian Environmental Assessment Act*, and the EA process. The *Act* describes different types of EA that may be required: screenings, comprehensive studies, mediations, and review panels. Details can be found at: http://www.ceaa.gc.ca/default.asp?lang=En&n=4F451DCA-0. It is anticipated that a screening level assessment will be required for BMGT.

Triggers

There are four questions to answer when determining whether an EA is required under the *Act*, as shown in Exhibit 3-3.

Exhibit 3-1 – CEAA Process Flowchart



The federal EA process is applied whenever a federal authority has a specified decision-making responsibility in relation to a project, also known as a trigger for an EA.

Specifically, it is triggered when a federal authority:

1. Proposes a project,
2. Provides financial assistance to a proponent to enable a project to be carried out,
3. Sells, leases, or otherwise transfers control or administration of federal land to enable a project to be carried out, or
4. Provides a licence, permit, or an approval that is listed in the *Law List Regulations* that enables a project to be carried out.

Project funding through a federal body such as P3 Canada would trigger a CEAA review since there is federal authority involved. Aspects of the Project that fall under the jurisdiction of federal acts and regulations, such as the *Fisheries Act* or *Migratory Bird Act*, would also trigger CEAA.

Both BCEAO and the CEAA are triggered by the inclusion/exclusion/law list regulations.

Harmonization

Under the Canada-BC Environmental Assessment Cooperation Agreement (2004), the BCEAO and CEAA have entered into a detailed implementation agreement dealing with a range of matters, including joint work planning, joint staff training, and piloting the delegation of federal EA functions to the BCEAO. This would feature BCEAO in a coordinating role to streamline the two processes. Final decisions and authorizations would still need to be made by federal and provincial EA entities, but BCEAO could function as a single point of contact for environmental permits and approvals from all reviewing parties, including local government, First Nations, and community groups.

A decision on harmonization would be made by the respective BC and Canadian environment assessment offices. It is critical that the Project address the opportunity for a harmonized approach early in the planning process to avoid confusion, and to ensure that the terms of reference, roles, responsibilities, expectations, and timelines are clearly understood from the outset.

3.1.2 Environmental Assessment Task Requirements

The following is an indication of what assessments will likely be required as part of an EA of BMGT. Ultimately, it is the regulatory authority that will define the EA requirements, in the definition of the ATOR. The plans mentioned in this section will form a component of the EA but the inventory, determination of significance of adverse effects, and methodology to determine significance will also be deliverables.

The following table provides an overview of the tasks that the BMGT project will have to undertake to fulfill the requirements of the EA and other regulatory approval processes, and to help ensure that approvals to construct and operate are granted in a timely manner.

Tasks	Comments
Issues Scoping	This phase will involve consultation with stakeholders familiar with the Burnaby Mountain area and specifically have been involved with other projects in the area, such as: regulatory agencies, First Nations, affected landowners, stakeholders, other industry, and the public. The issues scoping exercise will also draw upon the professional judgment and experience of the project team.
Regulatory Jurisdiction Assessment and Plan	It is critical that the Project address the opportunity for a harmonized approach for the EA early in the planning process to avoid confusion and to ensure that the terms-of-reference, roles, responsibilities, expectations, and timelines are clearly understood from the outset. A component of this activity, as noted below, will be the timely identification of all approvals, permits, authorizations, codes, and standards that the Project will be subject to and the development of a Regulatory Approvals Concordance Table so responsibilities are clearly understood. This task will be an iterative process and will require coordination with TransLink and the engineering teams for efficient phasing of the project approval, design, and construction processes. On the other hand, with upfront planning and if the field and project development is designed with understanding of the regulatory jurisdiction and approvals processes, the approvals processes can be relatively routine and time-efficient.
Regulatory Approvals Compliance Strategy	In conjunction with the Jurisdictional Assessment Task, and to provide regulatory compliance and timely project approvals, a strategy for approvals will be developed and a Regulatory Approvals Concordance Table will be developed. The table will identify and assign responsibility for all regulatory items required for project approval and start-up. A description and illustration of all environmental protection measures will be included on site survey sketches and in construction contract documents (scopes of work, specifications, instructions) to ensure that the contractor is aware of measures to be implemented for each aspect of construction and clean-up.
Project Audit Requirements	Maps/plans, needs assessment, construction plans, water course crossing plans/schedules, consultation documentation, land status sheets, technical support information, and emergency response plans must generally be available to the Regulatory Agencies if requested.
First Nations Consultation	The government retains legal responsibility for completing consultation with First Nations regarding potential infringements of Aboriginal or Treaty Rights; however, to assist the Crown, the Project must develop and provide its own consultation materials. The regulatory authorities will monitor and evaluate the consultations to make sure that First Nations issues and concerns have been identified and adequately addressed. An introductory meeting will be held with the regulatory authorities to clarify their expectations.
Public Consultation	It is critical to demonstrate that the local public has been consulted and that their input has been considered in planning decisions. An introductory meeting with the Regulator will clarify their expectations. The affected municipality and other stakeholders should be officially approached for their input.
Land Agent Coordination	Since the Project's Land Agent will be communicating with those directly or indirectly affected by the project, coordination of this function will be key to ensuring consistency and continuity of information.

Tasks	Comments
Route and Terminus Selection and Alternatives	It is critical to demonstrate an understanding of the major environmental, engineering, and economic factors that affected the selection of the route and terminus site locations. It is expected that there will be documentation of the process used to select the preferred route and terminus sites based on the environmental, engineering, constructability, and cost factors as well as the considerations for the stakeholders, landowners, First Nations, and public issues. This aspect of the project is key and will be approached with the understanding that any social or environmental issues will have to be avoided or mitigated within the design and construction planning process. Demonstration of an understanding of the major environmental, engineering, and economic factors that affected the selection of alternate routes and sites is critical.
Geotechnical Investigation	Watercourse crossing, access, footing location and design, construction and contingency plans will be required for the Project. Therefore, geotechnical testing will likely be required to provide design information.
Archaeological, and Land Use	For heritage resources, a file search of heritage resource site data will need to be completed. Once the data search is completed, it will be determined if further fieldwork is required to obtain a field permit. The Project may require field studies, as a condition of the field permit, in the time between application approval and prior to the start of construction. To ensure compliance with the Heritage Conservation Act, an Archaeological Assessment Information Form will need to be completed and submitted for the Project.
Environmental Impact Assessment will include: fisheries; wildlife and birds; vegetation; soils and geotechnology; arboriculture/timber; air; noise; groundwater; visual/aesthetics; cumulative effects; socio-economic	An Environmental Impact Assessment (EIA) will be required. Some of the specific components are mentioned as tasks below. The EA will evaluate how the Project's environmental components will interact with the activities, cost, engineering, and constructability considerations. A mitigation strategy will be developed to reduce adverse effects. Environmental Protection Plans (EPPs) and Emergency Response Plans (ERPs) will be developed as required as part of the mitigation strategy. Plans that may form part of the mitigation and execution program include: • Regulatory Approvals/Permits Concordance Table • Regulatory and Commitment Compliance Management Plan • Environmental Management Plan • Sediment and Erosion Control Plan • Access Plan (Construction and Operations) • Vegetation Management/Landscape Design and Restoration Plan • Spill Contingency Plan • Communications Plan • Environmental Protection Plan • Emergency Response Plan • Traffic Accommodation Plan (includes noise, dust, proliferation controls) • Archaeological Monitoring and Mitigation Plan • Noise and Vibration Management Plan • Contaminated Sites and Soils Management Plan

Tasks	Comments
Environmental Protection Plans	The EPPs will require development of appropriate mitigation techniques for soils, fisheries, wildlife, vegetation, visual, security and historic resources. They will also include a description and illustration of all environmental protection measures on construction drawings to make the contractor aware of the measures to implement for each aspect of construction and clean-up.
Emergency Response Plans	The construction and operations may be scrutinized. Thus, operations should be in a form that instils public confidence in the TransLink's ability to deal credibly with any emergency event. Existing TransLink system ERPs will be studied and amended to be specific to this project and its affect on local landowners/ occupants.
Concurrent Permitting and Approval	All authorities' permits and approvals must be in place to receive an approval to construct. Statements-of-concern must be resolved to the satisfaction of the appropriate regulatory bodies. Other permits and approvals that the Project may need to acquire could include: advice or authorization from Department of Fisheries and Oceans (DFO), Transport Canada (plus the access, land use, cutting, and transportation permits). Other provincial, federal, and municipal approvals may be required. Processes in place to make sure that design and construction procedures are in compliance with Codes of Practice, Safety Act and the Forest Practices Code etc. As well as processes in place to make sure that design and construction are in compliance with local building and development codes/requirements and/or approvals. A key tool is the Regulatory and Commitment Compliance Management Plan which includes the Commitment Compliance Matrix used to track project issues, requirements, and commitments through design to construction and operations.

3.2 Consultation with Stakeholders and the Public

3.2.1 Institutional Stakeholders

Consultation with institutional stakeholders has been continuous during development of the business case with a Project Advisory Committee (PAC) meeting regularly to review progress. The PAC is chaired by TransLink and includes representatives of the following groups: BC Ministry of Transportation and Infrastructure, City of Burnaby (as the Local Approving Authority), SFU, and SFU Community Trust. The project team provides regular updates to PAC, and receives feedback reflecting the interests of PAC members.

3.2.2 Stakeholder Groups and the Public

Known stakeholder groups were contacted early in the project as part of a pre-consultation. These meetings are listed in Exhibit 3-2.

Exhibit 3-2 – BMGT Pre-consultation Stakeholder Meetings

Group	Date
SFU Undergrad Society	November 17, 2010
Burnaby Mountain Biking Association	November 17, 2010
SFU Community Association	November 23, 2010
Stoney Creek Environment Committee	November 24, 2010
Forest Grove Community Strata Representatives	December 8, 2010
Burnaby Board of Trade	December 15, 2010

The nature of these meetings has been to provide general information on the project status, and to garner initial feedback from stakeholders. TransLink conducted an additional round of stakeholder meetings followed by public open houses in May 2011 to provide an update on the findings of the business case.

Exhibit 3-3 – BMGT May 2011 Stakeholder Meetings

Group	Date
SFU Undergrad Society	May 20, 2011
SFU Graduate Students Society	May 20, 2011
Burnaby Mountain Biking Association	May 18, 2011
SFU Community Association	May 16, 2011
Stoney Creek Environment Committee	May 18, 2011
Forest Grove Community Strata Representatives	May 17, 2011
Mountainside Village Strata Corporation	May 10, 2011 May 19, 2011
Pine Ridge Housing Co-operative	May 11, 2011

Two open houses were held to raise awareness about the proposed project, provide information, and solicit participation and feedback from the community. These events took place:

- May 25, 2011: Cameron Elementary School (5-8 pm)
- May 26, 2011: Saywell Hall, SFU (1-4 pm and 5-8 pm)

Both open houses included 11 display boards explaining the project, staff on-hand to answer questions, scheduled presentations to provide an overview, and large-scale orthophotos to support discussions of the alignment. At the request of some participants, a “town hall” style Q&A was added in the last half-hour of each day.

Overall, 504 people attended the May 2011 stakeholder meetings and open houses.

In addition, the public was encouraged to view the project information and submit a feedback form on-line. Input was accepted until June 30 with 561 feedback forms and 110 e-mails and letters received. The Burnaby Mountain Gondola Transit Phase Two

Consultation Summary Report, available on TransLink's website, sums up the key themes heard during the consultation period, including:

- Resident concerns regarding privacy, safety, noise, and neighbourhood character;
- Environmental concerns regarding impacts to the conservation areas and the need to minimize impacts on trees and wildlife;
- Support for the ability of the project to deliver faster and more reliable transit service with reduced GHG emissions;
- Safety and security concerns for riders; and,
- The cost of the project and its relationship to the Evergreen Line in TransLink's plans and priorities.

While there was modest majority support for the project expressed for the project in meetings, feedback forms received outside meetings, and in particular 341 submitted via Citizens Opposing the Gondola, indicated a higher level of disagreement. More detail on the responses and the reasons for them can be found in the consultation summary report.

3.2.3 Follow-up Activities

Additional property owner/resident sessions took place in July and August to provide additional opportunities for the most affected residents to access project information and provide comments.

As the content discussed becomes more material to the project design, a log shall be created to document the issues raised during consultation, and measures undertaken to mitigate concerns.

As the EA process gets under way, there is an opportunity to coordinate these sessions with the EA public comment periods during the pre-application and application review phases of the project.

During construction on projects with significant impact to specific groups or special interest, it is customary to form committees to provide more direct engagement with affected parties. These could take the form of liaison committees created to engage with local business, residents, and/or environmental groups.

Due to the nature of the gondola system, the project will also be expected to consult with local first responders. An Emergency Responders Committee would develop safety training and response protocols in coordination with systems operators.

4. PROCUREMENT OPTIONS ANALYSIS

The following section summarizes the analysis undertaken to determine feasible means of procuring the Project. The details of this work cannot be released publicly in order to protect information of a commercial nature that could limit TransLink's ability to run a competitive procurement process.

Three procurement methods have been considered and modelled for the project:

- The Traditional Model or Public Sector Comparator (PSC)
- The Design Build, Plus Operate and Maintain (DB+OM)
- The Design Build, Finance, Operate, and Maintain (DBFOM)

For the purposes of assessing the procurement options, it has been assumed that under a DBFOM or a DB+OM option the stations, towers, and ropeway technology would be procured as a single package under a competitive selection process. Under these two procurement options all project costs except for land acquisition, initial environmental approvals and mitigation, owner's project management, and security personnel costs would be the responsibility of the contractor.

4.1 Quantitative Analysis

Financial modelling of the Project under each procurement method was undertaken using a methodology consistent with Partnerships BC's Methodology for Quantitative Procurement Options Analysis available at http://www.partnershipsbc.ca/files/guidance.html.

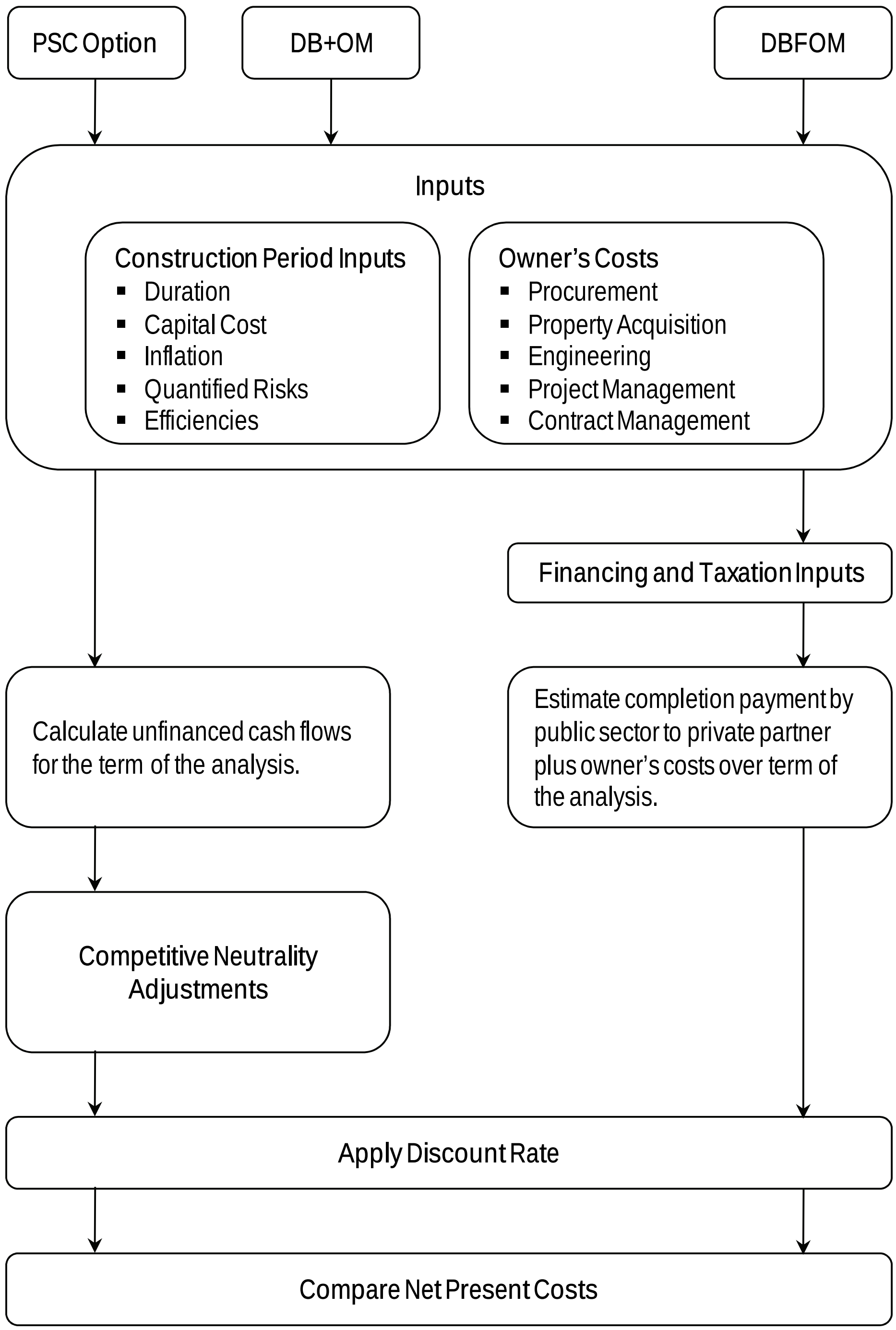
The Traditional Model or PSC is based on a theoretical, publicly procured project which has been risk adjusted for comparison purposes and is based on three separate Design Build packages, one for the stations, one for the towers and one for the ropeway technology.

The DB+OM option is based upon two separate contracts which are procured together. One contract is for the design and construction of the system and the second contract is for operations, maintenance, and rehabilitation over a 25-year period. Under this option TransLink would be required to fund the construction costs and reimburse the O&M costs as they occur over the period of the O&M contract.

The DBFOM option is based upon a concessionaire designing, building, financing, operating, and maintaining the project for a 25-year operating period. This model also assumes TransLink will make milestone payments during the construction period for 25% of the capital costs with the Concessionaire receiving regular availability payments during the operating period to cover remaining capital, operating, maintenance, and rehabilitation costs.

For consistency between the options, the financial analysis for all models has been prepared using the same 18-month construction period and 25-year operating period. The infrastructure, with renewals, would have a longer life than the contract. It is assumed that the output specifications would be the same under the different procurement options (i.e., that the Project would be delivered to the same construction and operational performance standards). The methodology applied is summarized in Exhibit 4-1 below.

Exhibit 4-1 – Overview of Financial Modelling Approach



4.1.1 Timing Assumptions

For the purposes of the financial analysis, the key timing assumptions approximate a notional schedule for the project. This schedule was developed solely to estimate costs and cash flows. An accurate schedule would be developed if and when the project is approved. Testing and commissioning are assumed to occur during the construction phase. These assumptions are consistent across all models and are summarized in the following table.

Exhibit 4-2 – Notional Timing Assumptions

Key Milestones	
Start of construction	January 1, 2013
Construction length (months)	18
End of construction	June 30, 2014
Start of operations	July 1, 2014
Operation period (years)	25
End of operating contract	June 30, 2039

4.1.2 Capital Costs

The total capital cost of the project is estimated at $114 million (2011$) and encompasses the three potential procurement options. This is a comprehensive figure that includes all TransLink and contractor costs including:

- Project management
- Preliminary investigations/engineering
- Environmental mitigation costs
- Private land purchases
- 3S Gondola costs
- Terminal, tower, and alignment costs
- Transit integration costs
- Permits
- System start-up costs
- Interest during construction
- Premiums for project risks and contingencies

There is some variation in total capital costs among the three procurement options but it is not sufficient to preclude any of them from consideration.

4.1.3 Operations and Maintenance Costs

Under all three procurement options the operations period is assumed to be 25 years. The total annual O&M costs, including direct TransLink costs such as policing and risk adjustments, are approximately $3 to $3.5 million per year. Again there is some variation among the three procurement options but it is not sufficient to preclude any of them from consideration.

4.1.4 Asset Renewal Costs

The asset renewal/life-cycle profile and costs were developed by CH2M HILL in consultation with Gmuender Engineering and the project manager of the Portland Aerial Tram. All procurement options assumed identical life-cycle profiles for the analysis. The expected life of the track ropes and the cabins is in the range of 20-40 years and 30 years has been assumed as the mid-point. For the purposes of the analysis, neither the track ropes nor the cabins are assumed to be replaced during the Project term. All other components are assumed to require rehabilitation during the 25-year term of the Project. The following table shows the expected life of the major components of the ropeway technology.

Exhibit 4-3 – Expected Life of Ropeway Components

Asset Rehabilitation Profile (2011$ millions)	Cost	Lifetime
Track ropes	$2.00	30
Haul rope	$0.40	5
Track rope slipping	$0.15	6
Cabins/hangers	$4.00	30
Saddle profiles	$0.20	20
Bullwheel bearings	$0.30	15
AC motors	$0.30	20
Gearbox	$0.50	20
Control systems/hydraulics	$0.50	20

4.2 Risk Analysis and Quantification

In accordance with Partnerships BC's best practice and the Province's Risk Management Guidelines, the Project Team undertook a detailed risk analysis of the Project. A series of risk workshops involving members of the Project Team and external experts were held. At the workshops, 80 risks were identified, described, rated (as low, medium, or high), and 23 key risks were quantified (15 from the design and construction period and 8 from the operations period). The risks were analyzed from both a public sector delivery perspective and from DBFOM and DB+OM perspectives. The analysis is based on the initial estimates for risk and would be reviewed throughout the procurement period and updated on a regular basis.

4.2.1 Quantified Risks

The Project Team identified and evaluated 23 key transferred and retained risks that may have a net impact on the risk adjusted cost of the Project depending on the procurement delivery method used. These key risks were quantified by the Project Team comprising of representatives of CH2M HILL, the project manager of the Portland Aerial Tram, Gmuender Engineering, TransLink, Partnerships BC, and PricewaterhouseCoopers LLP. Low, medium, and high outcomes for each of the key risks, including both cost and probability, were quantified. These outcomes took into account the cost of expected delay to the Project and other cost impacts associated with the occurrence of risk events. These inputs were then used to calculate an expected value for each risk under each procurement delivery method.

PricewaterhouseCoopers LLP used the expected values and range of potential outcomes for each risk as inputs in an industry standard probabilistic risk analysis. The risk valuations were then included in the design and construction and O&M costs as provided above.

4.3 Market Sounding

To determine the appetite for the range of procurement methods under consideration, a market sounding exercise consisting of interviews with the ropeway suppliers and a range of potential construction and financial partners was conducted. While a range of opinions were expressed by the parties contacted as to their interest in participating under each procurement method, the project was found to be of interest to potential contractors under all procurement methods considered.

4.4 Procurement Objectives

TransLink's decision on which procurement model to use for the project will be guided by our goals to:

- Support the long-term safety and reliability of the system
- Achieve best value
- Encourage competition
- Ensure schedule and cost certainty
- Allocate risks to the parties best able to respond to them

To support these goals, a number of objectives will inform selection of a procurement strategy. A fundamental objective is that the strategy be consistent with the project's financial goals and constraints. A competitive and marketable procurement process is needed to ensure best value, particularly given the limited number of ropeway suppliers in the marketplace. The procurement strategy will support a fair, open, and transparent bidding and selection process.

Given the unique nature of the project, special emphasis will be needed to ensure responsiveness to municipal and stakeholder issues by ensuring that these issues are reflected in preliminary designs and specifications and in final negotiations with the preferred proponent(s).

Lastly, there are not anticipated to be many additional candidate installations of high-capacity transit ropeways in the region. The effectiveness of developing in-house ropeway O&M expertise will be assessed against contracting for an experienced operator.

4.5 Conclusions

The preliminary procurement options analysis concluded that the project could be successfully delivered under any of the three procurement models analyzed (traditional DB/DBB, DB+OM and DBFOM) and that capital and operating cost estimates of $120 million and $3.5 million are appropriate for each model. The DB+OM strategy appears preferable under current conditions, but should the project proceed to procurement, a more detailed analysis of the effectiveness of contractual structures will be required to determine the most effective procurement model for the project.

5. AFFORDABILITY ANALYSIS

The section considers TransLink's ability to construct the Project and to assume the long-term operational costs within its approved transportation and financial plan. This analysis is independent of the procurement analysis described in previous sections.

The inputs used for the affordability analysis are summarized in Exhibit 5-1. The capital and operating costs used are indicative and based on representative figures from the financial analysis. The affordability analysis is performed using TransLink's standard 6% discount rate and takes into account the organization's cash flow requirements through the life of the project.

Exhibit 5-1 – Summary of Inputs to Affordability Analysis

Item	Assumption
Capital cost (2011$ millions)	$114
Annual O&M (2011$ millions)	$3.4
Annual Bus Savings (2011$ millions)	$6.3
Discount Rate	6%
Life of the project	25 years

The annual bus savings are derived by comparing the hours of operation and the peak bus fleet for the business as usual (BAU) scenario with that required for implementation of the Project. The comparison, shown in Exhibit 5-2, summarizes projections for 2014 (notional opening year for planning purposes) and 2041 (long-term horizon).

Exhibit 5-2 – Bus Operations and Peak Fleet Savings

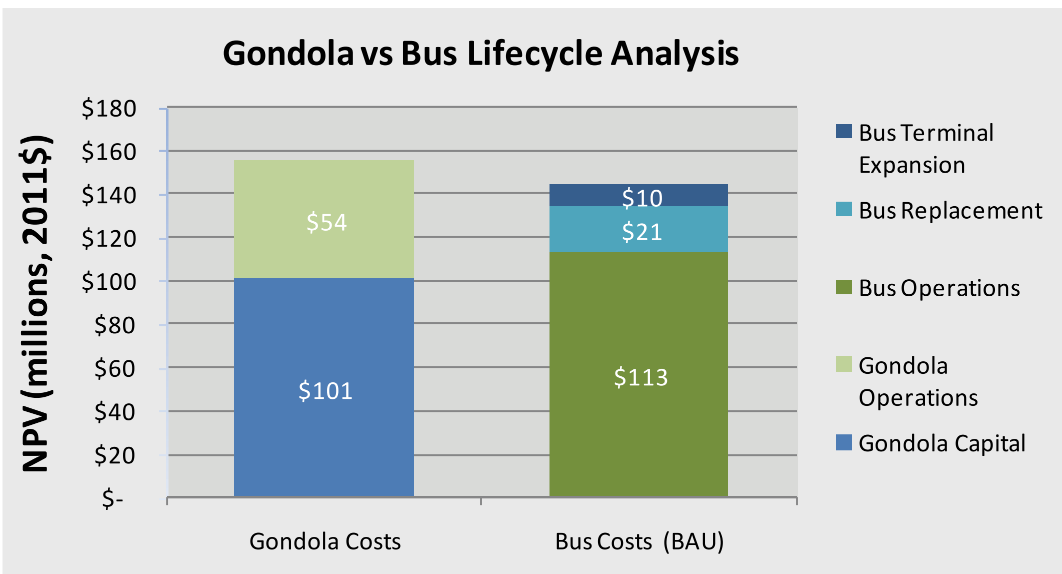
	Annual Bus Service Hours			Peak Bus Fleet		
Year	Base Case	BMGT (with Evergreen Line)	Service Savings	Base Case	BMGT (with Evergreen Line)	Bus Fleet Savings
2014 – Standard Bus				13	16	3
2014 – Articulated Bus				49	27	22
2014 – Total	**190,485**	**153,083**	**37,402**	**62**	**43**	**25**
2041 – Standard Bus				24	19	5
2041 – Articulated Bus				60	32	28
2041 – Total	**226,166**	**160,798**	**65,368**	**84**	**51**	**33**

Implementation of the Project results in operating 25 fewer buses on opening day. These savings serve a dual purpose: buses can be reallocated to other areas of the network, and purchase of replacement buses can be delayed. Over the 25-year evaluation period of the Project, and based on a 17-year replacement cycle, this amounts to avoiding the purchase of 70 buses, including spares.

It is important to note that the bus fleet projects assume implementation of the Evergreen Line. With the Evergreen Line in place, savings are significantly larger since anticipated additional bus service hours and facility upgrades can be excluded, including expansion of the bus terminal facilities on Burnaby Mountain to meet long-term demand as identified in the SFU Hub Study.

The results of the affordability analysis are presented in Exhibit 5-3, which shows that the NPV cost of the Project over 25 years is $155 million while the BAU cost is $144 million. The Project is approximately $11 million (8%) more expensive than the BAU on a purely financial basis. This financial analysis of the impacts to TransLink's budget that does not account for other societal benefits identified in Section 2.12. The analysis has also not assumed any third-party or senior government funding that would make the project more affordable to TransLink. This analysis reflects expenditures over a 25-year horizon to match the quantitative analysis performed in Section 4. The sensitivity analysis shows that the project would break even relative to business as usual at year 28.

Exhibit 5-3 – BMGT Life-cycle Financial Analysis



Note: $101 million is NPV of $114 million capital cost used in the affordability analysis.

6. CONCLUSIONS

The business case work has concluded that 3S and Funitel gondolas emerge as the preferred technologies from amongst the various ground-based and aerial transit technologies assessed, with 3S being most advantageous. The direct route between Production Way – University Station and the SFU Bus Exchange is the preferred alignment as it maximizes travel benefits, is deliverable, and has manageable surface impacts.

Capital and operating costs based on an indicative pricing process conducted with the two key ropeway suppliers, and more conventional estimating practices for civil works, produce a project capital cost of up to $114 million, with annual operating costs of $3 to $3.5 million (all 2011$). Key project benefits are transit operating cost savings, travel time savings, and reductions in automobile operations and consequent savings such as reductions in collisions, parking costs, GHG/CAC emissions, etc.

The resulting BCR of BMGT is calculated to be approximately 3.6 with the Evergreen Line in place, and 3.25 without it.

A Market Sounding was conducted with potential builders and operators and concluded that at least two procurement strategies (DB+OM [design-build and operate-maintain in a joint procurement] and DBFOM [design, build, finance, operate, maintain]) are viable for the project. The DB+OM strategy appears preferable under current conditions but the review of procurement approaches will be refreshed if and when the project is approved for implementation.

A life-cycle affordability analysis indicates a gap between the savings from reduced bus operations and the cost of building and operating a gondola of approximately $12 million NPV.