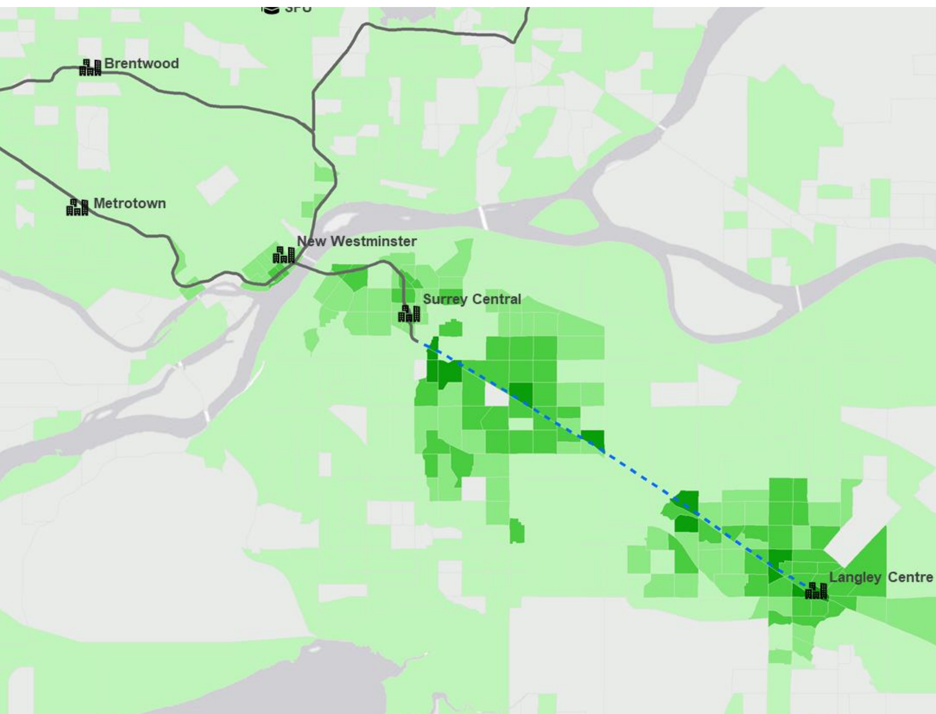

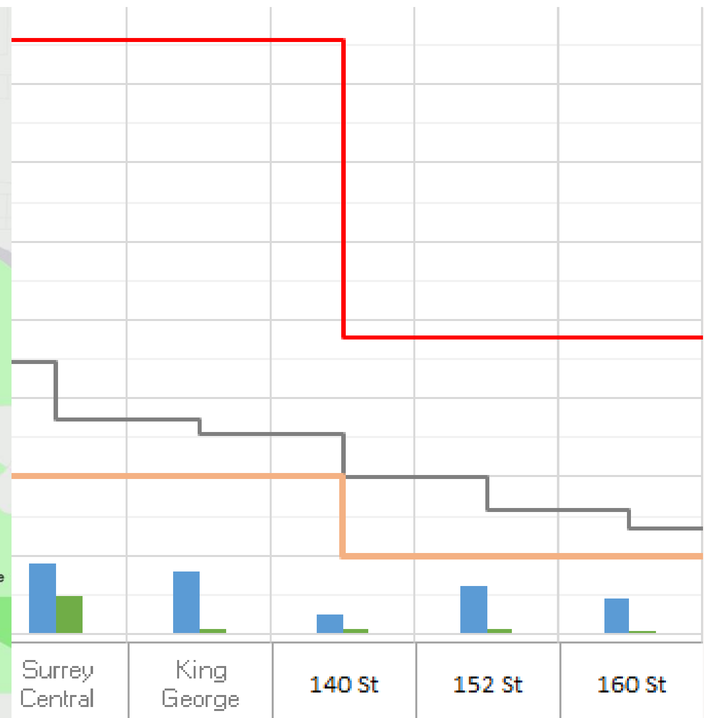

Surrey Langley SkyTrain Business Case Update – Ridership Report – Revision #2

March 15, 2022

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Our file: 2121-00846-00

Your Challenge.
Our Passion.

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1 Introduction

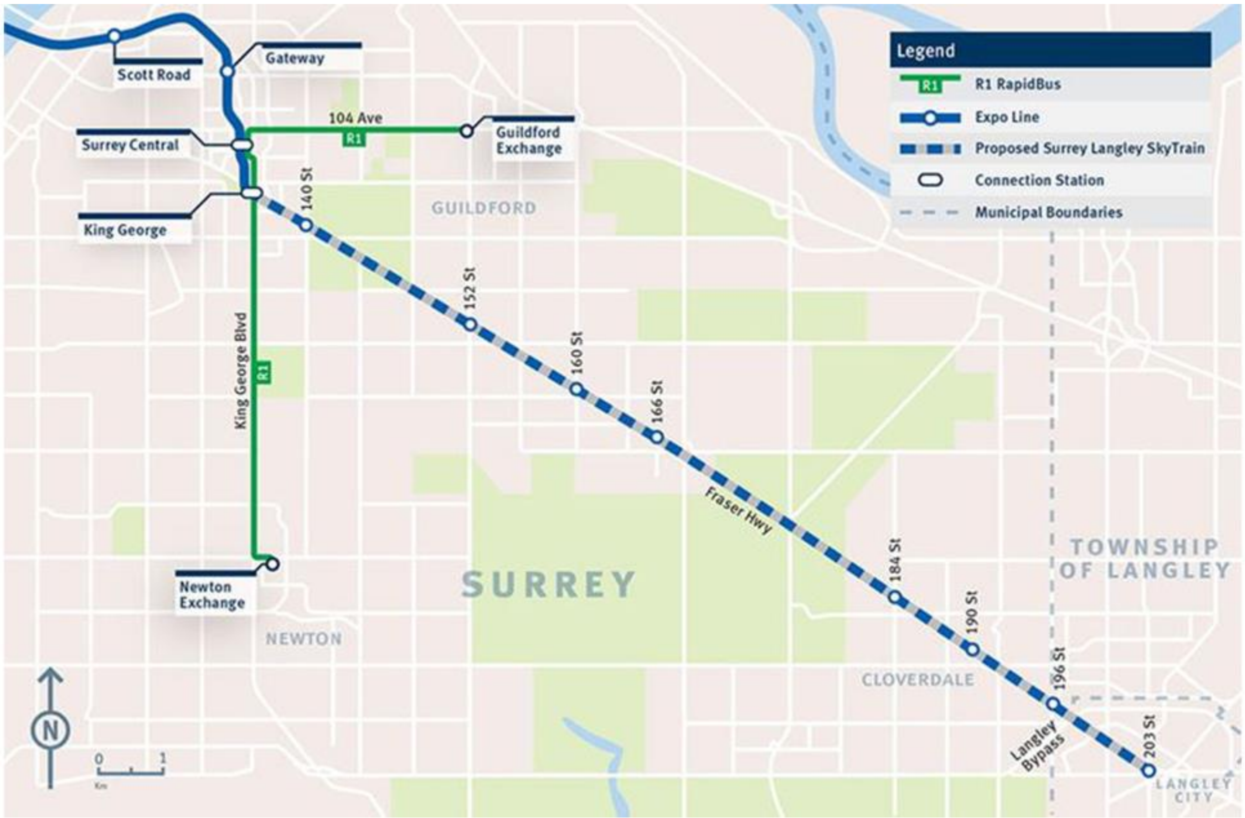
Transportation Investment Corporation (TI Corp) required updated ridership and user benefits forecasts to support the latest Surrey Langley SkyTrain (SLS) business case; the Project. TransLink's latest regional transportation model, RTM 3.5, was the main tool used to develop ridership forecasts and estimates of user benefits for this project.

This technical report presents updated ridership results for the Project prepared by McElhanney for the Expo Line extension from King George Station to Langley City Centre as shown in *Figure 1-1*.

In addition to outputs related to the Project's ridership, this report summarizes other key transportation outcomes, such as mode shares, incremental transit trips and improved accessibility to job opportunities.

The Project's economic outcomes, specifically user benefits and associated benefits-cost-ratio and net-present-value, are summarized in a separate technical report.

Figure 1-1: SLS Project Alignment and Stations



Source: https: / / www2.gov.bc.ca / assets / gov / transportation-infrastructure-projects / surrey-langley-skytrain / translink-assets / sls-map_stages.jpg

1.1 BACKGROUND

In December 2018, the Mayor's Council directed TransLink to start planning work for a SkyTrain extension along Fraser Highway. In 2019, TransLink embarked on an extensive study of potential SLS alignments and rapid transit technology, culminating in a comprehensive business case that was approved by the Mayors Council in early 2020. McElhanney was part of the consulting team that supported TransLink in delivering the original business case, specifically providing ridership and benefits forecasts. In July 2021, the Federal government pledged $1.3 Billion for building the complete extension to Langley City Centre.

TI Corp is responsible for delivering the updated business case. As such, TI Corp requires updated ridership and lifecycle economic forecasts based on the latest version of the Regional Transportation Model (RTM 3.5) including updated land use and revised capital and operating costs.

2 The Regional Transportation Model (RTM)

The RTM is Metro Vancouver's official travel demand forecasting tool. It is developed and maintained by TransLink and is comprised of inter-connected sub models that are estimated from travel surveys, specifically the trip diary and screenline surveys that provide information on observed travel behaviour, patterns and volumes. The RTM has historically been the main tool used by the region to forecast the impact of major transportation investments and policies such as: Port Mann / Highway 1 Upgrade, Broadway Subway Project (BSP), Transport 2050 and the Mobility Pricing Independent Commission (MPIC) study. Recently, the RTM was used to support the George Massey Tunnel Replacement business case, which supported the selection of an eight-lane immersed tube tunnel option.

The RTM models typical fall weekday travel conditions for three distinct years: 2017 (base conditions) and the forecast horizons of 2035 and 2050. The fall period, when students are back to school and workers are back from summer holidays, provides the most stable commuting patterns. Demographic inputs into the RTM, population and employment projections are provided for each of the study years directly by Metro Vancouver based on their latest Regional Growth Strategy, which pivots from the most recent Census survey (2016). The model's transportation network provides a detailed representation of the region's current road and transit networks. Future road and transit upgrades assumed in the model for horizon years 2035 and 2050 are based on a list of major committed future projects as provided by the BC Ministry of Transportation and Infrastructure (BCMOTI), TransLink, and the region's municipalities.

As previously highlighted, forecasts for this study were developed using the latest version of the model, RTM 3.5. The previous business case used an earlier release: RTM 3.2. Both versions are structurally similar and generate comparable forecasts. Below are some of the key differences:

- RTM 3.5 includes more recent demographic forecasts and is better aligned with the latest regional growth strategy, Metro 2050, and municipal Official Community Plans (OCPs).
- RTM 3.5 includes up-to-date road and transit network assumptions; for example, the eight-lane immersed tube George Massey Crossing and the comprehensive RapidBus program.
- RTM 3.5 includes upgraded forecasting capabilities that model trip-chaining[1] behaviour more realistically.
- RTM 3.5 includes several fixes to coding errors uncovered over the course of other transportation studies in the last two years.

[1] An example of trip chaining is stopping for shopping on the way back home from work.

- RTM 3.5 is programmatically more optimized and integrates seamlessly with TransLink's exploratory modelling analysis tool (EMAT) which is used to model uncertainty in travel forecasts.

It is important to note that RTM 3.5 is based on pre-COVID-19 pandemic travel patterns. These base model assumptions do not account for potential long-term changes in post-pandemic travel behaviour (COVID-19 legacy) such as increase in tele-working and staggered work / school shifts. The potential impact of the COVID-19 legacy on the Project's ridership is covered in more detail in *Section 6*.

2.1 MODEL VALIDATION

Prior to undertaking any forecasting analysis, it is important to confirm that the RTM's base year model (2017) validates well with observed travel behaviour, specifically transit ridership, traffic volumes and congestion in the study area. A well-validated model provides confidence in its ability to generate robust and reliable forecasts.

The model used for this study benefited from extensive validation and calibration efforts undertaken for the previous business case as well as coding fixes to the RTM in the last two years. As such, no additional model validation or adjustment was required.

2.2 KEY MODELLING ASSUMPTIONS

The RTM produces weekday daily travel demand forecasts by mode: auto, transit and active (walk and bike). Further, the model generates network-level forecasts for traffic volumes and transit ridership by route for three distinct hours:

1. AM peak: 07:30 – 08:30
2. Mid-day: 12:00 – 13:00
3. PM peak: 16:30 – 17:30

To produce daily and annual forecasts for various metrics such as ridership or reduction in vehicle-kilometers travelled, peak hour outputs were multiplied by mode-specific expansion factors shown in *Table 2-1*. Those factors were developed by TransLink using observed Compass Card ridership data and traffic counts from the screenline survey and BCMOTI's permanent traffic count database.

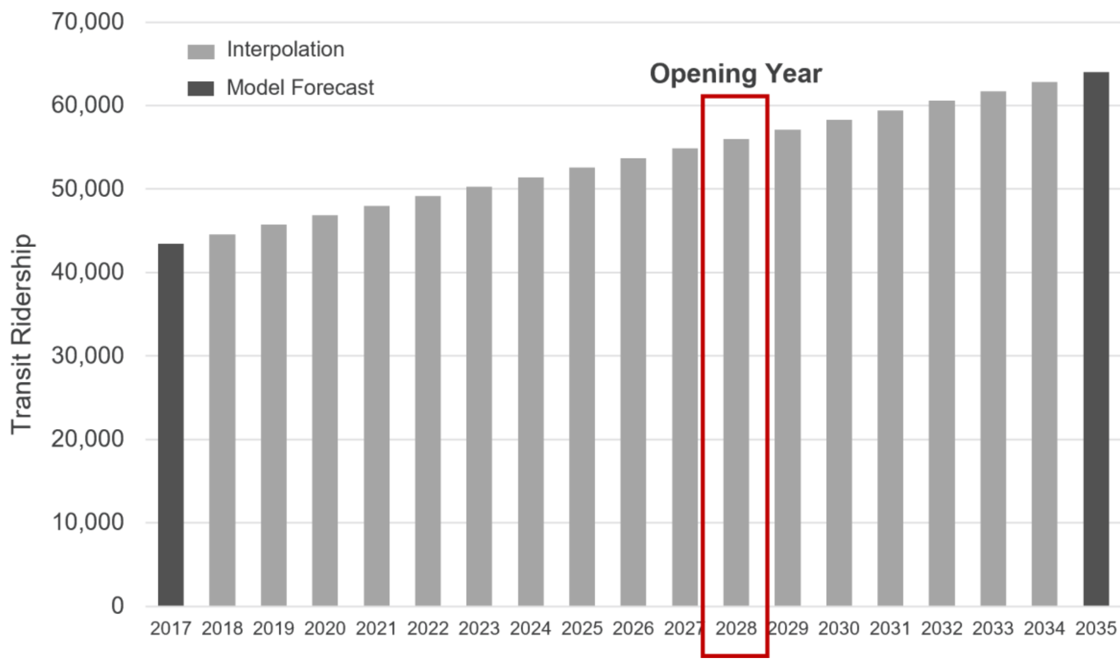
Table 2-1: Project Assumptions Including Expansion Factors

ASSUMPTIONS / INPUTS:	
Expansion Factors (AM, MD, PM to Daily)	
Single Occupancy Vehicles (SOV)	AM: 3.44, MD: 8.41, PM: 3.95
High Occupancy Vehicle (HOV)	AM: 1.51, MD: 8.58, PM: 5.32
Light Truck	AM: 3.59, MD: 5.63, PM: 6.17
Heavy Truck	AM: 4.88, MD: 5.43, PM: 6.36
Transit (Bus)	AM: 2.54, MD: 9.44, PM: 2.57
Transit (Rail)	AM: 2.53, MD: 9.54, PM: 2.92
Expansion Factors (Daily to Annual)	
Auto Vehicle	335
Light Truck	313
Heavy Truck	276
Transit (Bus and Rail)	300

2.3 INTERPOLATION

Ridership and other outputs from the RTM were generated for two horizon years: 2035 and 2050. McElhanney also modelled a hybrid scenario using 2017 demographics and 2035 networks. Outputs from the hybrid scenario and the 2035 model run were used to interpolate opening year, 2028, metrics[2]. An illustration of the interpolation for hypothetical model outputs is shown in *Figure 2-1* below.

Figure 2-1: Interpolation Example



2.4 TERMINOLOGY

Before presenting the results, it is important to define some of the technical terms used in this report that are typically associated with travel demand forecast outputs.

Boardings versus trips: Boardings is the number of times a person physically 'enters' a transit vehicle. For example, if a person lives in Surrey and commutes daily to downtown, their morning trip itinerary for getting to work in the morning can consist of:

1. Walking from home to the closest bus stop.
2. Boarding and riding the bus.
3. Transferring to the Expo Line and boarding the train at King George Station.
4. Alighting at Burrard station and walking to their final destination.

The total boarding count for this itinerary is two boardings. The total number of trips, however, is one.

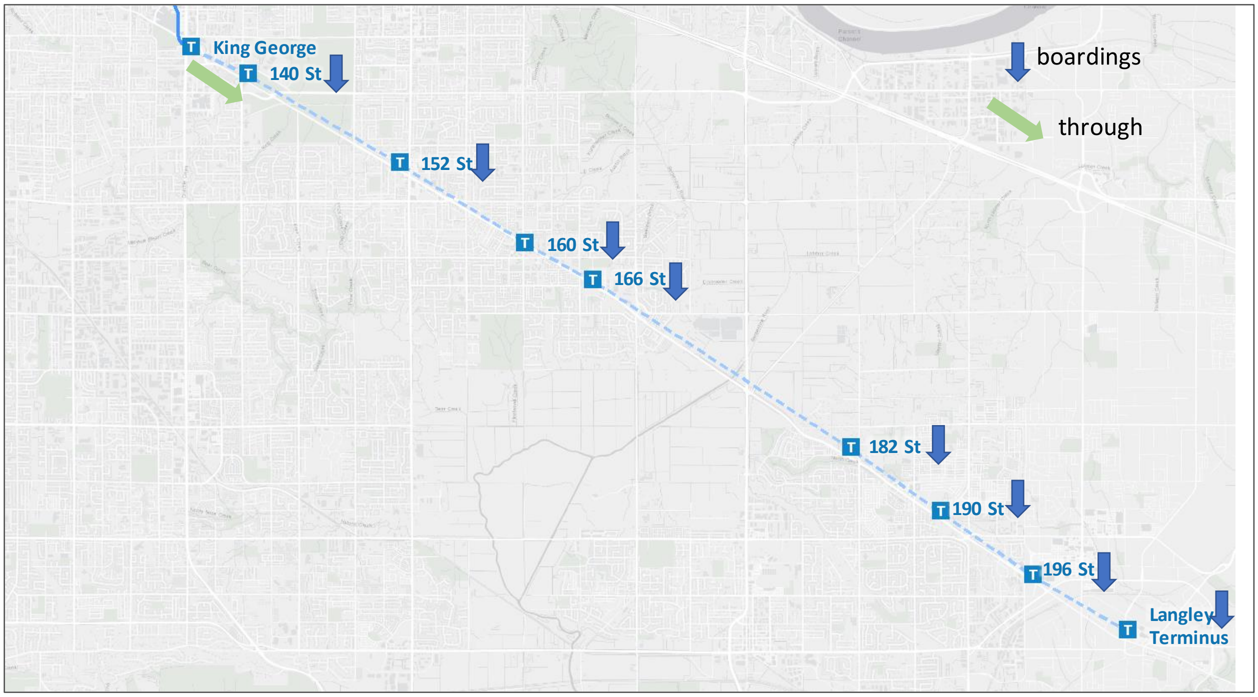
Line ridership: Typically, this statistic is calculated by tallying up total boardings at all stations for a given bus or rail line. However, since this project is an extension of the existing Expo Line, ridership is

[2] The assumption is that the 2028 and 2035 transportation networks will be similar. An alternative approach is to develop an explicit 2028 model. This, however, adds little value in terms of improved forecasting accuracy and requires significant effort to obtain demographic forecasts and network details for year 2028.

calculated differently, using a method developed by TransLink to calculate ridership on the Evergreen Line.

As shown in *Figure 2-2*, the total Project daily ridership is calculated by adding the total boardings at the eight new stations (blue downward arrow) with the volume of riders on trains that continue eastbound from King George (green arrow). In other words, line ridership represents the number of people that 'interact' with the extension as part of their journey.

Figure 2-2: Definition of Line Ridership



3 Business As Usual (BAU) Scenario

The BAU scenario represents expected transportation conditions in the study area if the Project is not built and is used to calculate the transportation benefits of the Project. Apart from that, both the Project and BAU scenarios assume the same demographic and regional transportation network information. This section summarizes the key assumptions included in the BAU scenario, specifically:

1. Demographic Inputs.
2. Transit Network.
3. Auto Network.

3.1 DEMOGRAPHICS

The three key municipalities influenced by the Project – City of Surrey, City and Township of Langley – are expected to grow at a significantly faster pace relative to the regional average, as shown in *Figure 3-1* and *Figure 3-2*. This is consistent with the RGS's forecast trend of increased development in the City of Surrey, Township and City of Langley, the Three Municipalities. Further, employment increases at a similar rate to population, implying balanced demographic growth and improved access to jobs in the Three Municipalities.

Figure 3-1: Population Growth Forecast

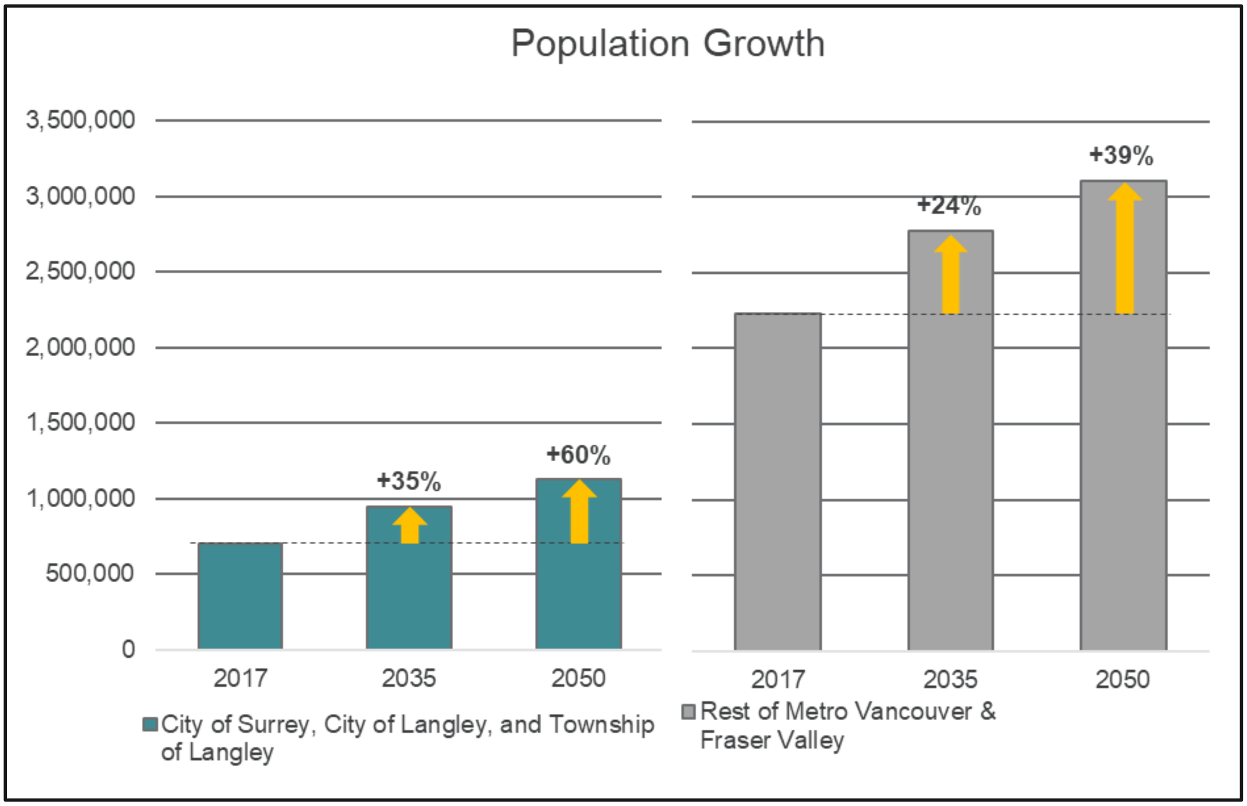


Figure 3-2: Employment Growth Forecast

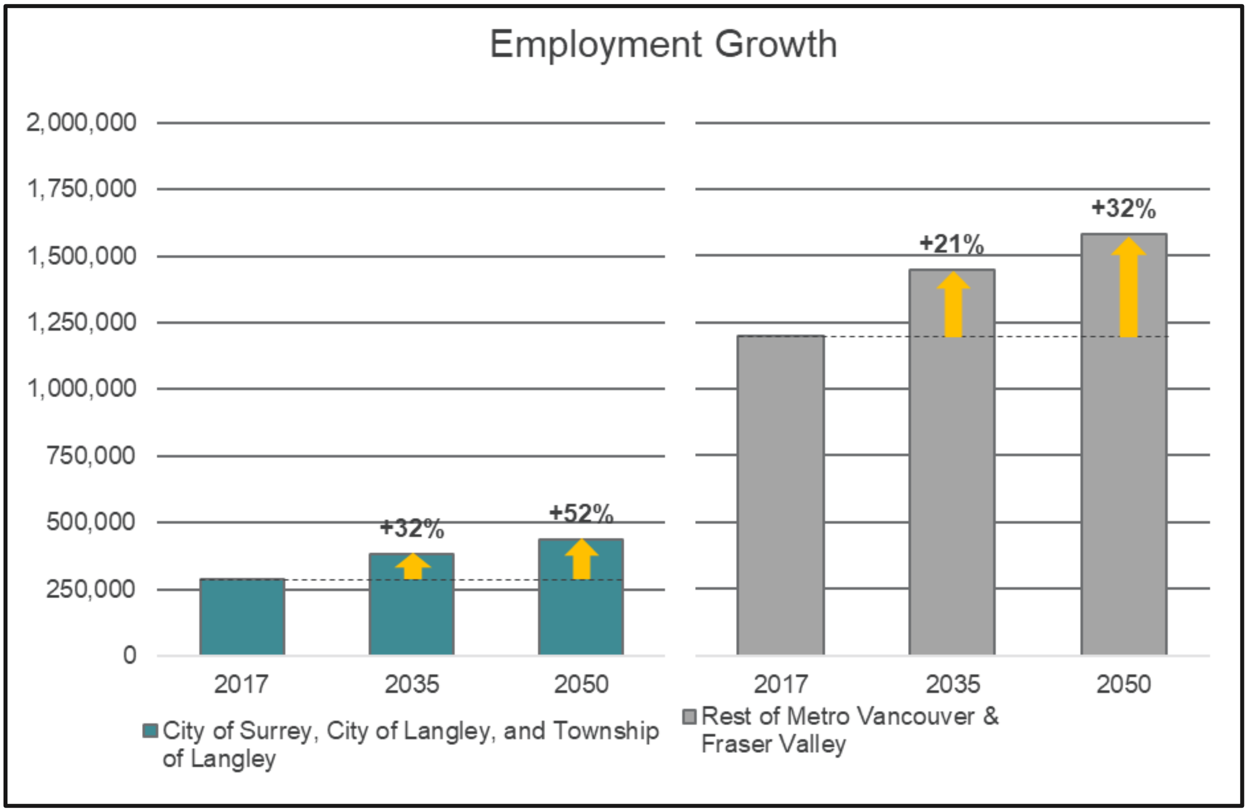


Figure 3-3 and *Figure 3-4* show the population and employment growth in the study area between 2017 and 2050. The largest increase in population is forecast around the proposed Project stations which is consistent with Metro Vancouver's target of concentrating growth in compact, transit-oriented developments. Employment growth clusters will be concentrated along the existing Expo Line in Central Surrey, Newton / King George Boulevard and Langley City.

Figure 3-3: Population Growth 2017 – 2050

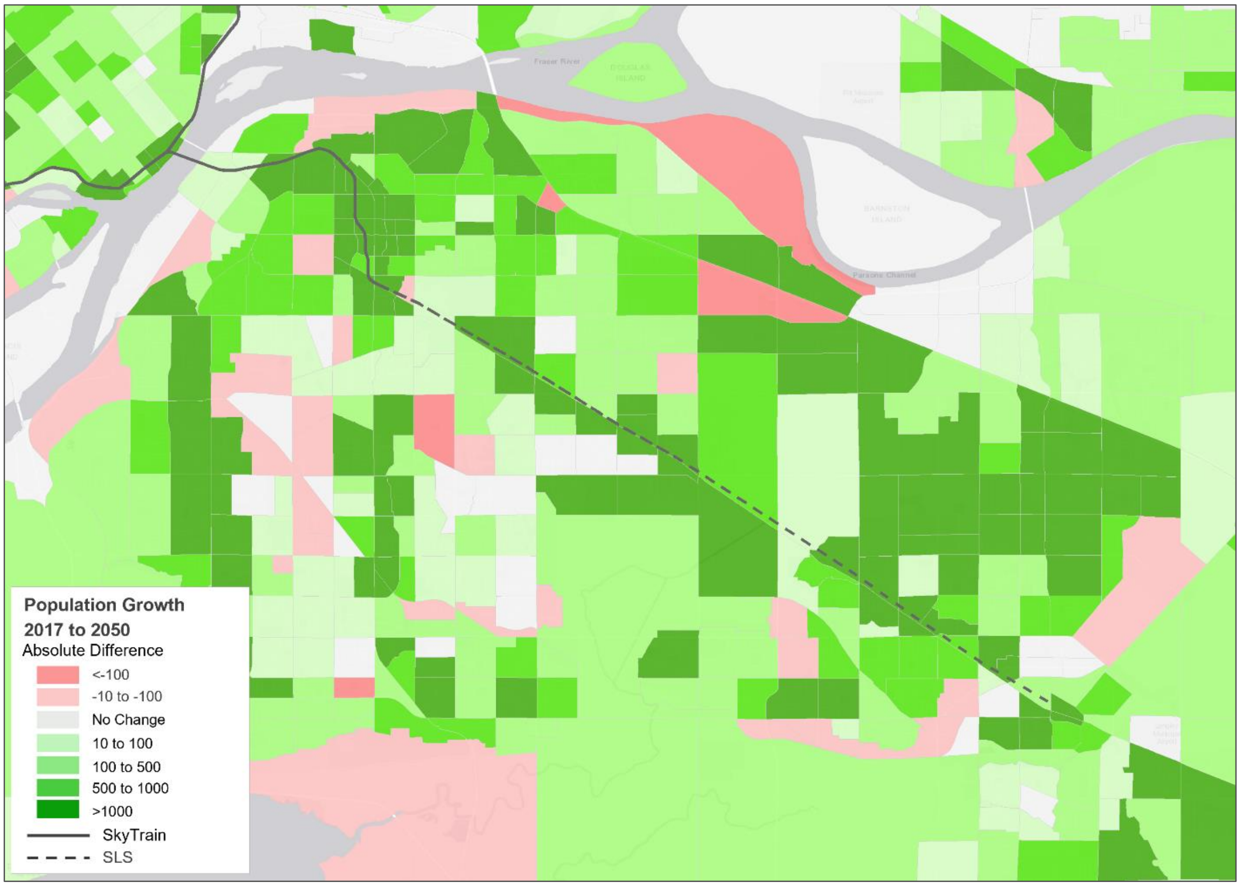
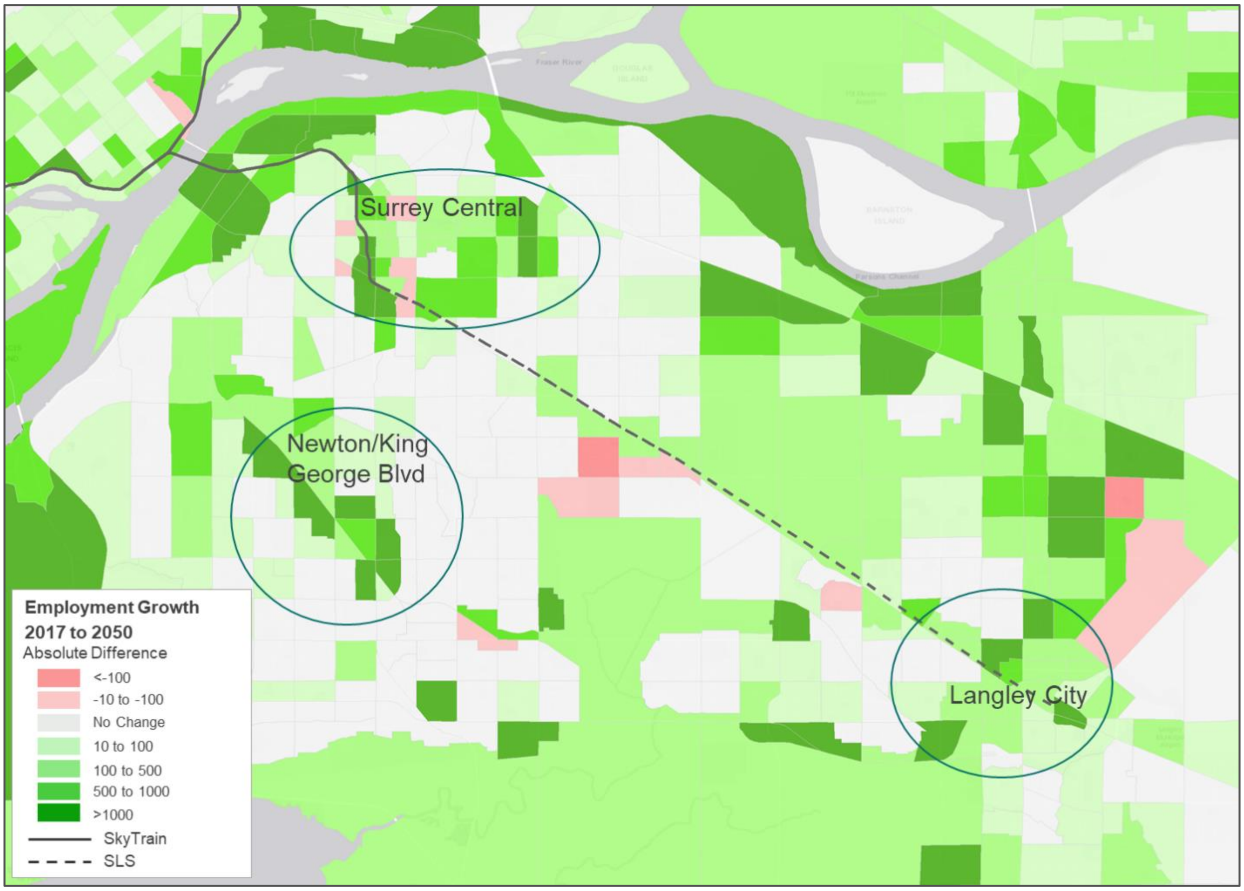


Figure 3-4: Employment Growth 2017 - 2050

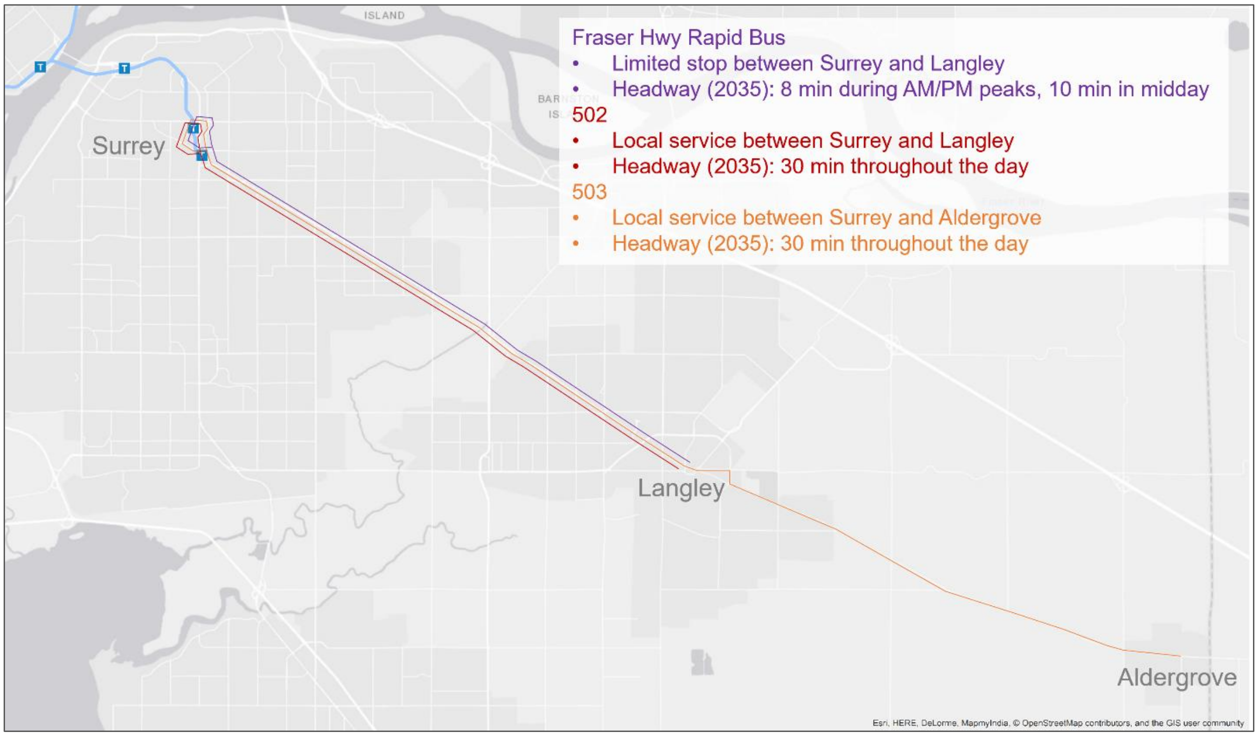


3.2 TRANSIT NETWORK

The BAU scenario assumes limited stop bus service between Surrey and Langley (see *Figure 3-5*) as well as TransLink's Phase 1 and 2 investment plan projects, specifically:

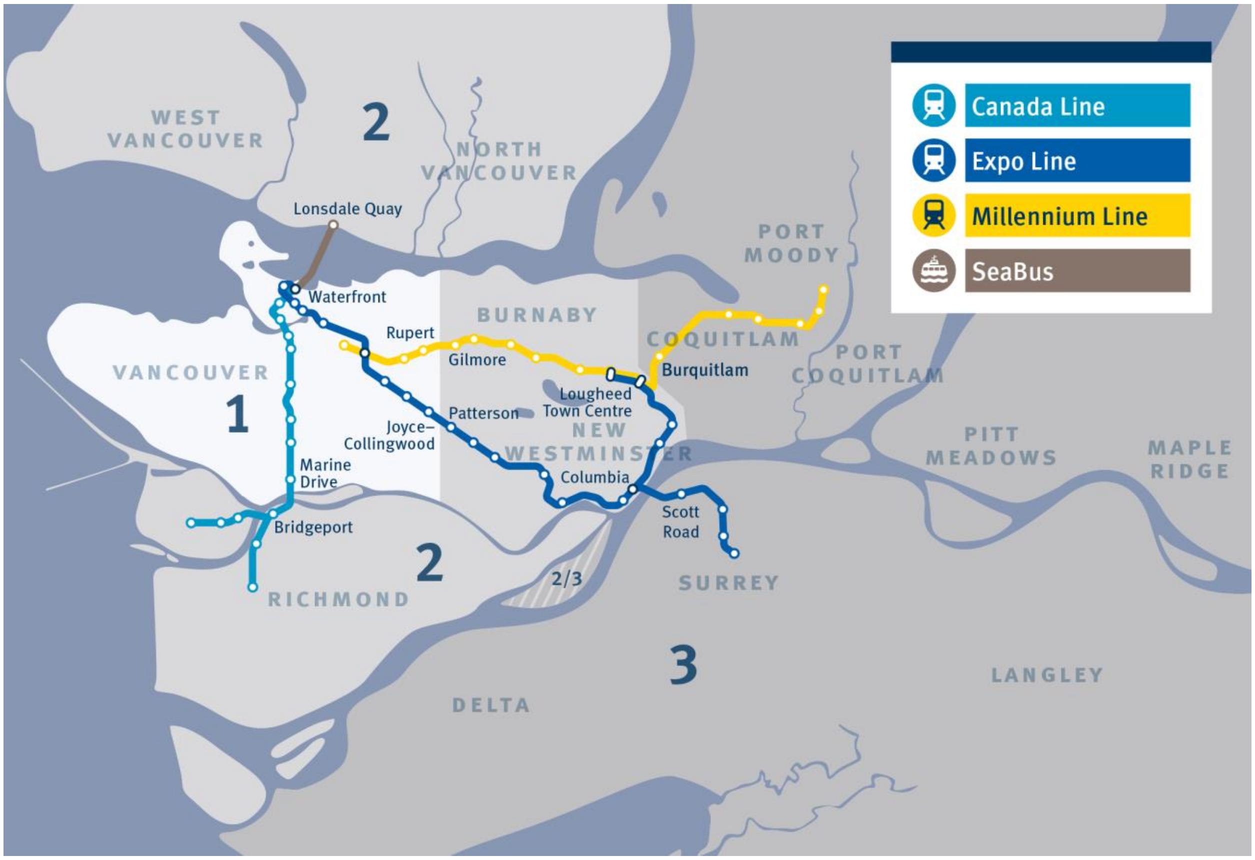
- Broadway Subway Project.
- TransLink RapidBus Program.
- 10-minute SeaBus headway during the morning and afternoon peak periods.
- 20-minute West Coast Express headway.

Figure 3-5: BAU Transit Network



Also, the RTM assumes improved bus frequencies between now and 2050 that are indexed to population growth in the region. The RTM uses TransLink's current fare zone system; three zones for SkyTrain and SeaBus and a single fare zone for buses as shown in *Figure 3-6*.

Figure 3-6: TransLink Fare Zone Boundaries



Source: https://www.translink.ca/transit-fares

SkyTrain Assumptions

Based on information provided by TransLink and British Columbia Rapid Transit Company (BCRTC), the following SkyTrain lines and patterns will be operational in 2028 (*Figure 3-7*) and 2035 / 2050 (*Figure 3-8*):

- 2028 SkyTrain Patterns:
  - Canada Line: Same pattern as today.
  - Expo Line: Same patterns as today, i.e. King George to Waterfront and Production Way to Waterfront.
  - Millennium Line: Lafarge Lake-Douglas to Arbutus (i.e. BSP is operational).
- 2035 / 2050 SkyTrain Patterns:
  - Canada Line: Same pattern as today
  - Expo Line:
    - King George to Waterfront.
    - Arbutus to Waterfront (similar to previous Millennium Line alignment) during peaks.
    - Production Way to Waterfront during off-peaks.
  - Millennium Line: Lafarge Lake-Douglas to Arbutus (i.e. BSP is operational).

Figure 3-7: 2028 BAU SkyTrain Network Assumptions

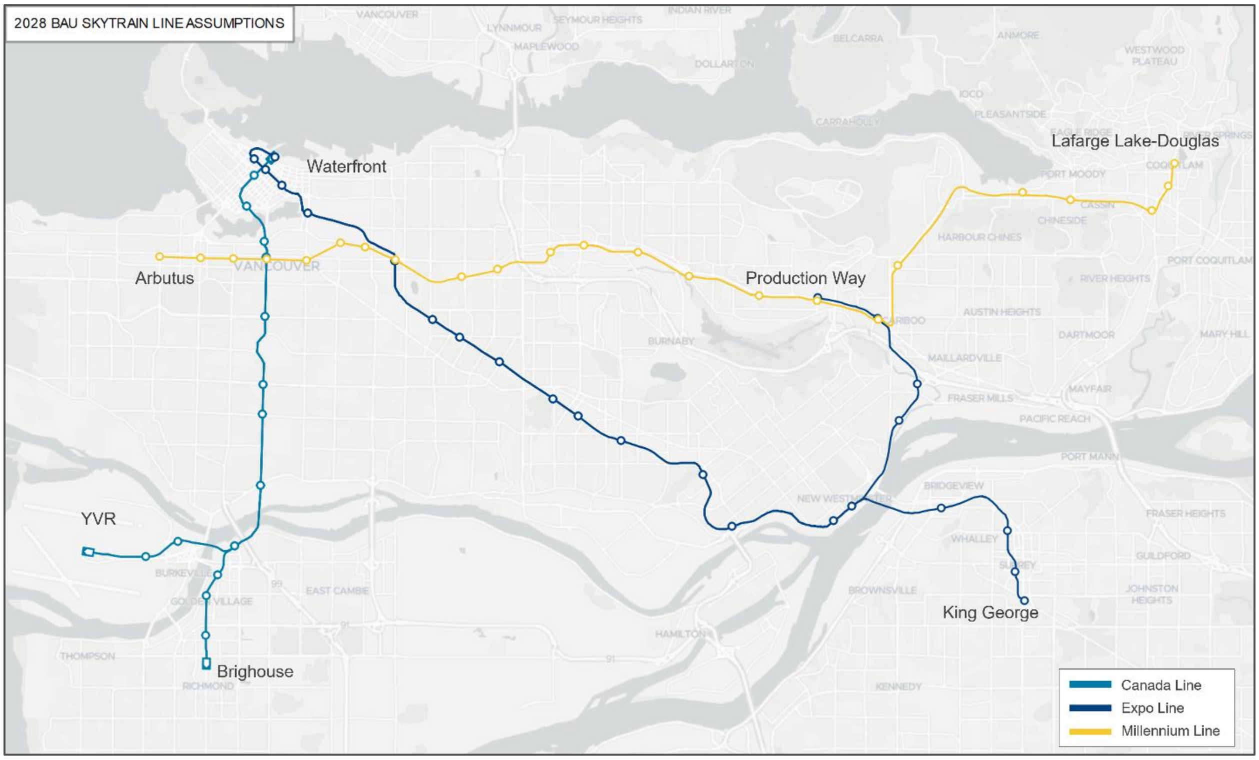


Figure 3-8: 2035 / 2050 BAU SkyTrain Network Assumptions

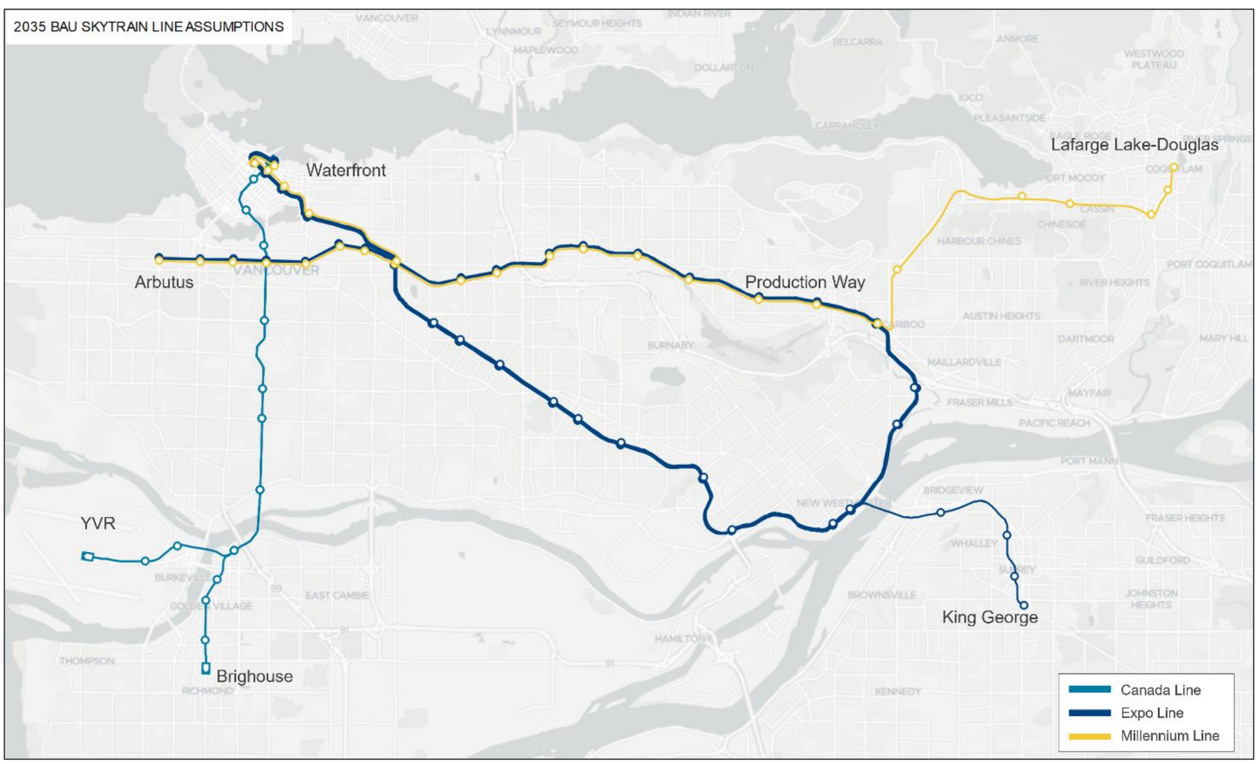
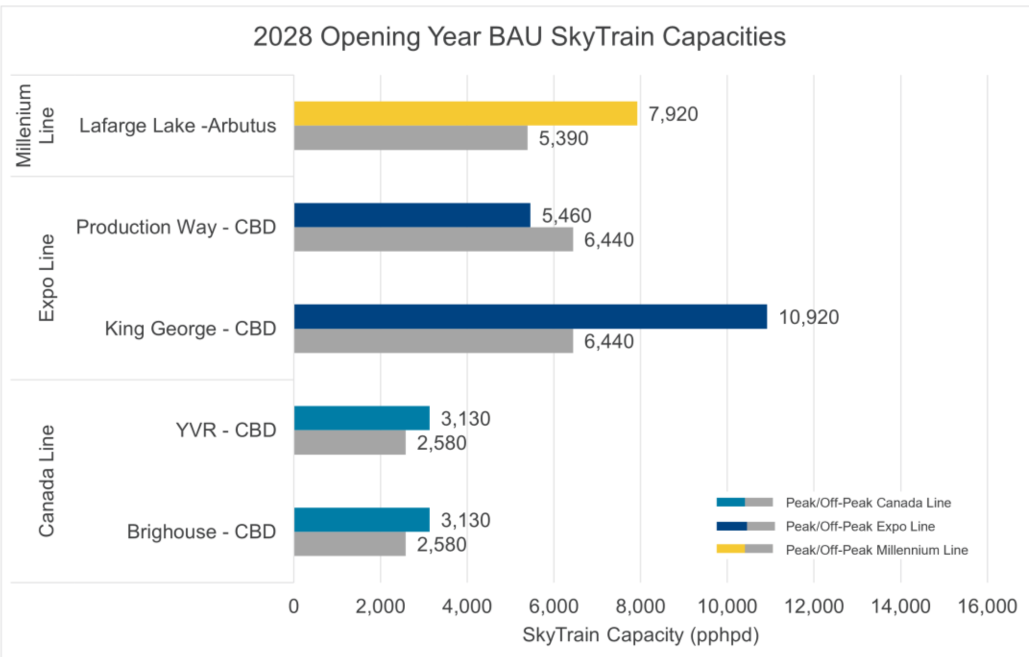


Table 3-1 summarizes the peak hour headways while Figure 3-9, Figure 3-10 and Figure 3-11 show peak / off peak practical capacity[3] by line.

Table 3-1: BAU SkyTrain Network Headway Assumptions (Minutes)

Line	Pattern	2028 BAU		2035 BAU		2050 BAU	
		AM / PM	MD	AM / PM	MD	AM / PM	MD
Canada Line	Brighouse - CBD	05:30	06:40	04:00	06:40	04:00	06:40
	YVR - CBD	05:30	06:40	04:00	06:40	04:00	06:40
Expo Line	King George - CBD	03:00	05:00	02:30	05:00	02:18	05:00
	Production Way - CBD	05:54	05:00	N / A	05:00	N / A	05:00
	Arbutus - CBD	N / A	N / A	05:00	N / A	04:30	N / A
Millennium Line	Lafarge Lake -Arbutus	03:24	05:00	N / A	N / A	N / A	N / A
	Lafarge Lake - CBD	N / A	N / A	05:00	05:00	04:30	04:30

Figure 3-9: BAU SkyTrain Network Capacity Assumptions - 2028



[3] Transit practical capacity is defined as 85% of absolute capacity (i.e. crush load). It is the point at which passenger comfort levels deteriorate substantially.

Figure 3-10: BAU SkyTrain Network Capacity Assumptions - 2035

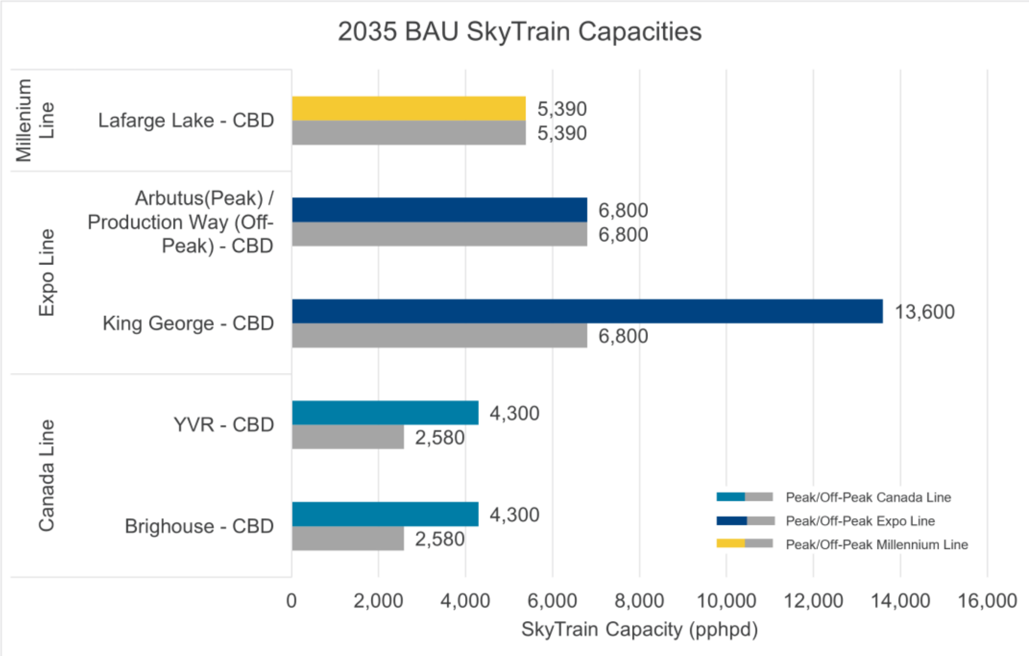
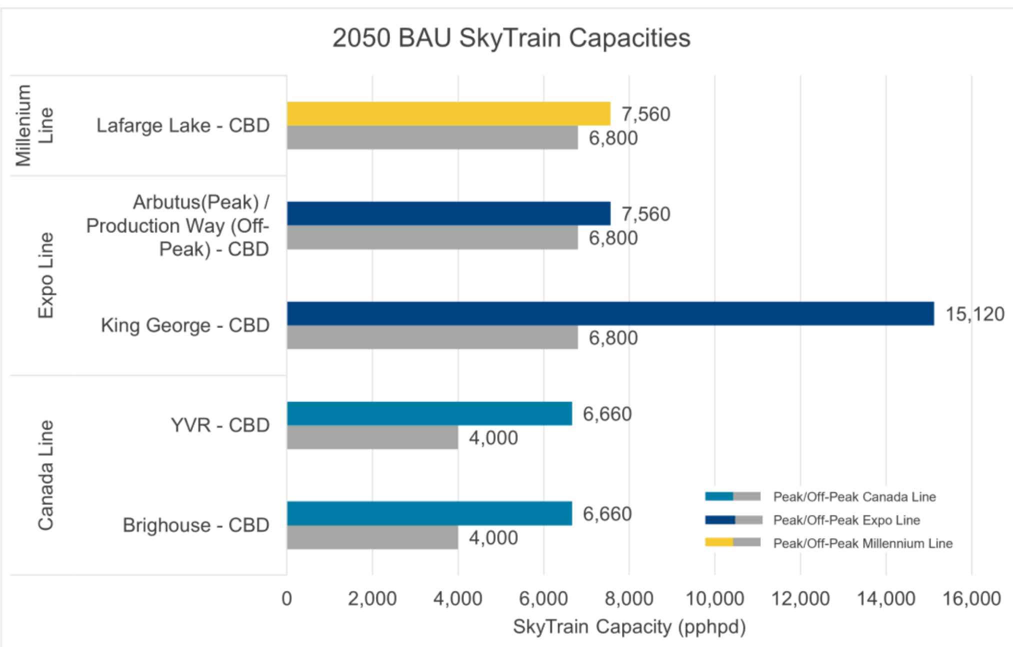


Figure 3-11: BAU SkyTrain Network Capacity Assumptions - 2050



3.3 REGIONAL ROAD NETWORK

The RTM includes the following major road infrastructure upgrades for the future:

- New four-lane Pattullo Bridge with upgraded connectivity in Surrey and New Westminster.
- Eight lane immersed tube tunnel George Massey Crossing with Highway 99 improvements.
- Highway 1 Lower Lynn Improvements.

- Highway 1 Widening from 264 St interchange to Whatcom Rd interchange.

In addition, the RTM includes major road projects in the study area based on Surrey and Langley's latest transportation plans such as:

- Widening of Fraser Highway through the Green Timbers Urban Forest.
- Whalley Boulevard extension between Fraser Highway and 96 Ave.

The RTM does not consider any form of road pricing in the medium and long term.

4 SLS Project Scenario

As previously noted, the Project and BAU scenarios are largely similar in terms of land use and networks. Both scenarios assume the same demographic inputs and underlying road network. This section summarizes the Project characteristics, such as alignment, station locations and running time, and includes changes made to the underlying bus network in the study area to better connect with the Project.

4.1 SLS PROJECT DESCRIPTION

The Project extends along Fraser Highway from King George station to the Langley Terminus station at 203 Street as shown in *Figure 4-1*. Upon opening, the Project will provide a fast and reliable single boarding transit service that connects Langley Centre with major activity centres in the region including Surrey Central, Downtown New Westminster, Metrotown, Broadway and Downtown Vancouver. Eight new stations will be built along the alignment as shown in *Figure 5-1* which also includes travel times between stations.

Figure 4-1: Project Alignment

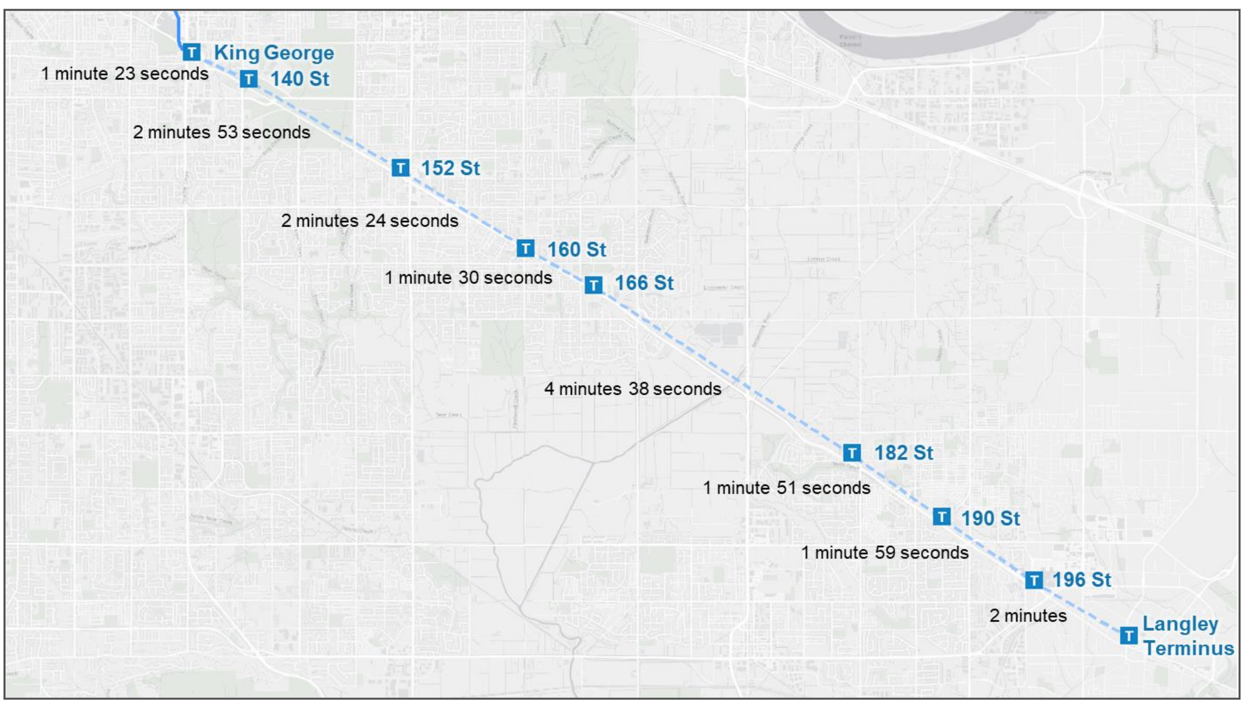


Table 4-1 summarizes the overall attributes of the extension. The end-to-end travel time is approximately 21.5 minutes. In comparison, today it takes more than 30 minutes by car (Google Maps) and 35 minutes

by bus (route 503 schedule, excluding waiting and walking times) to travel from Langley Centre to King George during the AM peak hour.

Table 4-1: SLS Project Alignment Characteristics

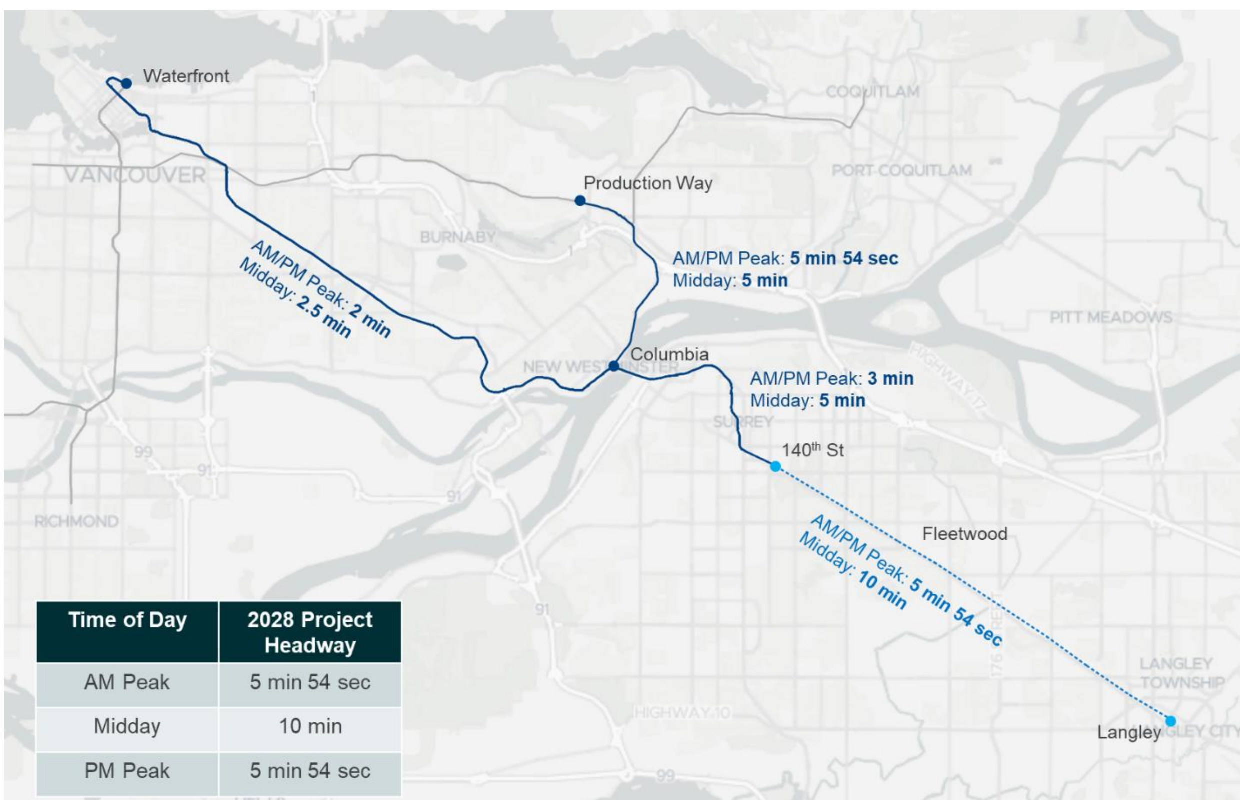
Operating Characteristic	The Project
End to end travel time (min)	21.5
Line Length (km)	16
Number of new stations	8
Average speed excluding dwell (kph)	52
Dwell time at stations (sec)	25
Dwell time at terminus (sec)	40

Figure 4-2 maps the headways by time of day for the three Expo Line operating patterns in 2028, the opening year of the Project:

1. Waterfront Station to 140th St Station.
2. Waterfront Station to Production Way Station.
3. Waterfront Station to 203rd Station.

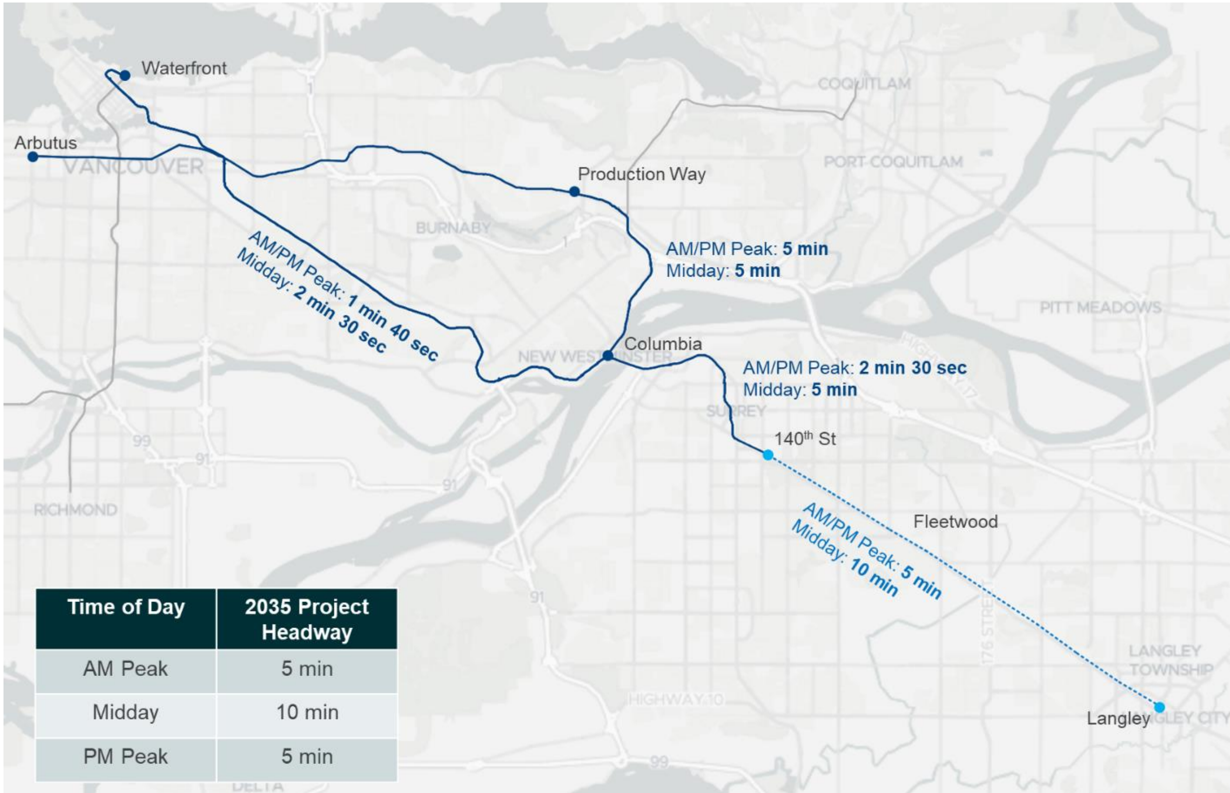
The three Expo Line branches combine to produce an effective peak headway of about 2 minutes (30 trains per hour) during the peaks along the main trunk between Columbia and Waterfront stations.

Figure 4-2: 2028 Expo Line and Project Headways



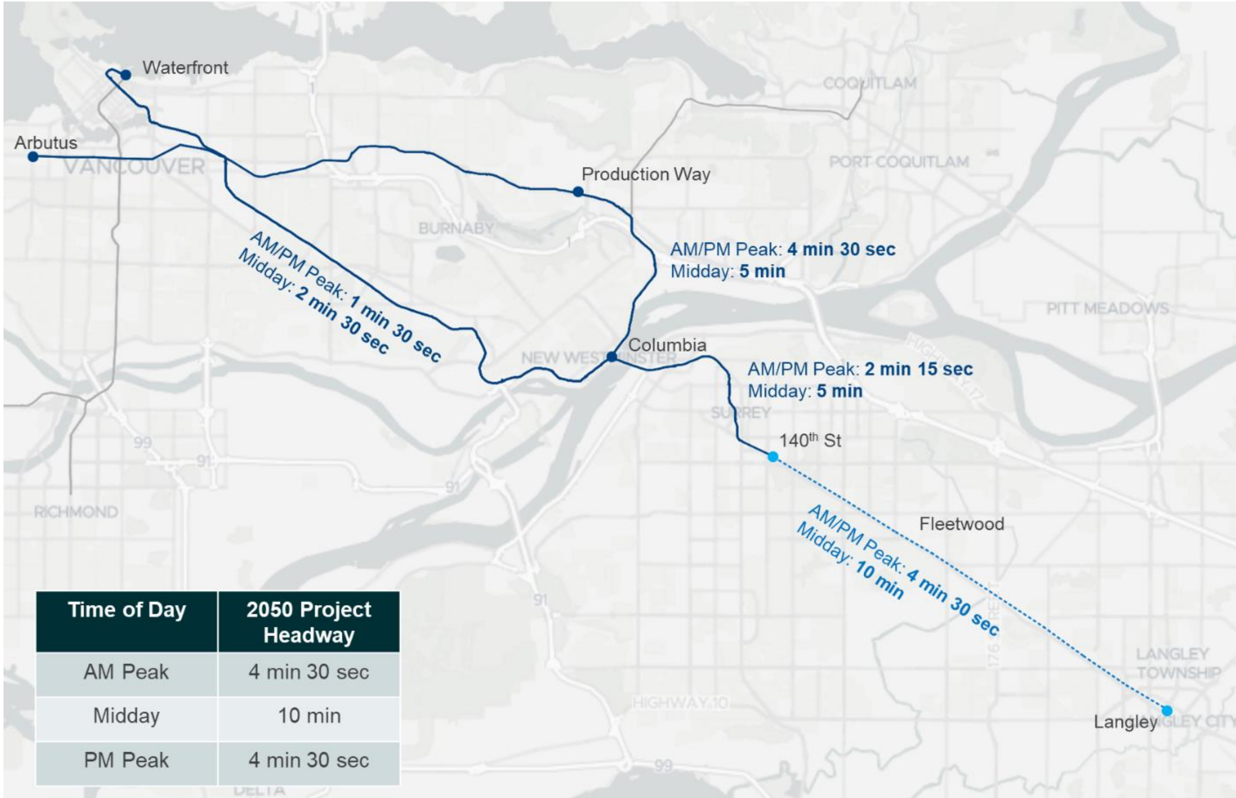
By 2035 and 2050, peak frequency on each of the three Expo branches increase as shown in *Figure 4-3* and *Figure 4-4*. By 2050, the combined peak headway along the main trunk is approximately 90 seconds, or 40 trains per hour. It is important to note that the 2035 and 2050 Project scenario networks also assume the modified Arbutus to Waterfront pattern as previously highlighted in *Section 3.2*.

Figure 4-3: 2035 Expo Line and Project Headways



Time of Day	2035 Project Headway
AM Peak	5 min
Midday	10 min
PM Peak	5 min

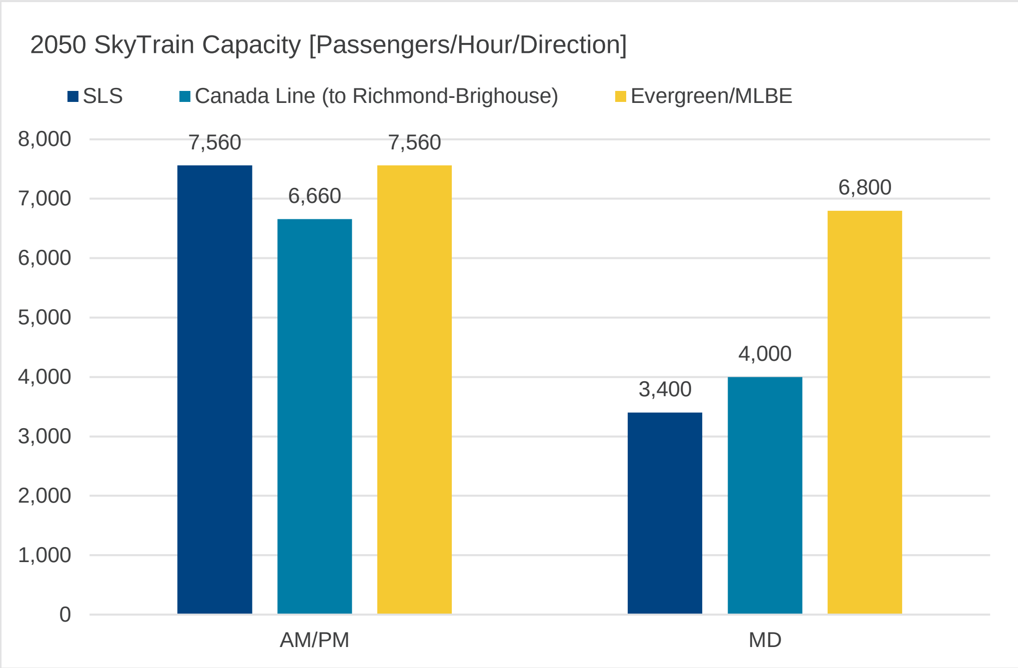
Figure 4-4: 2050 Expo Line and Project Headways



Time of Day	2050 Project Headway
AM Peak	4 min 30 sec
Midday	10 min
PM Peak	4 min 30 sec

Figure 4-5 compares the Project extension's practical capacity in passengers per hour per direction (pphpd) to the Canada Line and Evergreen Line. By 2050 the Project will be able to carry approximately 7,560 passengers per hour per direction (pphpd) during the AM / PM peak, and 3,400 pphpd during off-peak hours.

Figure 4-5: Project Capacity



4.2 BUS NETWORK CHANGES

A high-level bus integration plan was incorporated into the RTM to ensure bus routes connect logically and efficiently to the Project stations. For example, the RTM reflects the plan of having the bus routes shown in *Figure 4-6* (provided by TI Corp) terminate / stop at Langley Station.

Figure 4-6: Bus Integration at 166th St, Willowbrook and Langley Terminus

Option A (Do minimum)

Future transit assumptions (including 10 -yr vision phase 2 improvements) TBC by TransLink

Terminus	166 St Stn		Willowbrook		Langley		
	Routes	Trips/Hr	Routes	Trips/Hr	Routes	Trips/Hr	
			370	2	320 B	2	
			531	2	342	3	
			564	1	364	3	
					372	2	
					395	3	
					501	6	
					502	5	
					503 B	3	
					560	1	
					561	1	
					562	3	
					563	2	
					564	1	
					595	2	
					New C	6	(TBC)
					BC Transit	2	(TBC)
	0	0	3	5	16	45	

Through	166 St Stn		Willowbrook		Langley	
	Routes	Trips/Hr	Routes	Trips/Hr	Routes	Trips/Hr
	320 B	2	320 B	2	531	2
	395	3	364	3		
	502	5	501	6		
			502	5		
	3	10	4	16	1	2

Total	166 St Stn		Willowbrook		Langley	
	Routes	Trips/Hr	Routes	Trips/Hr	Routes	Trips/Hr
	3	10	7	21	17	47

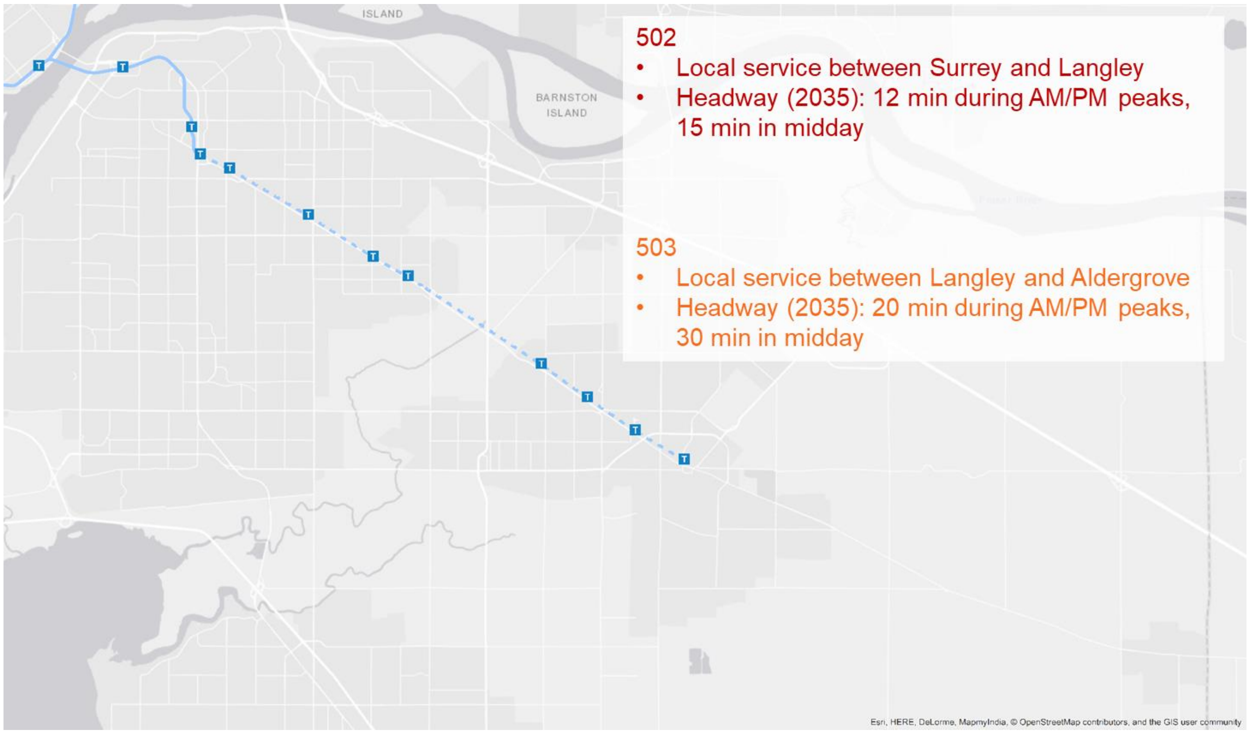
Service Change Log (relative to existing conditions)

364	Re-routed to provide through-service at Willowbrook
370	Terminus shifted to new Willowbrook Exchange
503 A	Surrey Central - Langley overlay service eliminated
503 B	503 serves Langley - Aldergrove only
595	Service potentially converted to B-Line (vehicle change to Articulated)
New C	Potential new B-Line service connecting Langley to Carvolth + Pitt Meadows
BC Transit	Potential new BC Transit service connection to SkyTrain

Source: 'Transit Integration Aug 30 2019', Steer Group and Hatch Ltd.

The key changes made were to future bus routes along Fraser Highway as shown in *Figure 4-7*. Specifically, the limited stop service between Surrey and Langley Centre will be eliminated.

Figure 4-7: SLS Project Scenario Bus Service Network Changes



The Project scenario also assumes changes to other key routes along Fraser Highway. The Northern pattern of the #320 will be extended along Fraser Highway to Fleetwood. The main pattern today, which runs from Surrey to Langley, will be truncated to a Southern segment as shown in *Figure 4-8*. Similarly, the peak-only #395 route will be truncated to a Southern segment as shown in *Figure 4-9*.

Figure 4-8: #320 – SLS Project Scenario Bus Service Network Changes

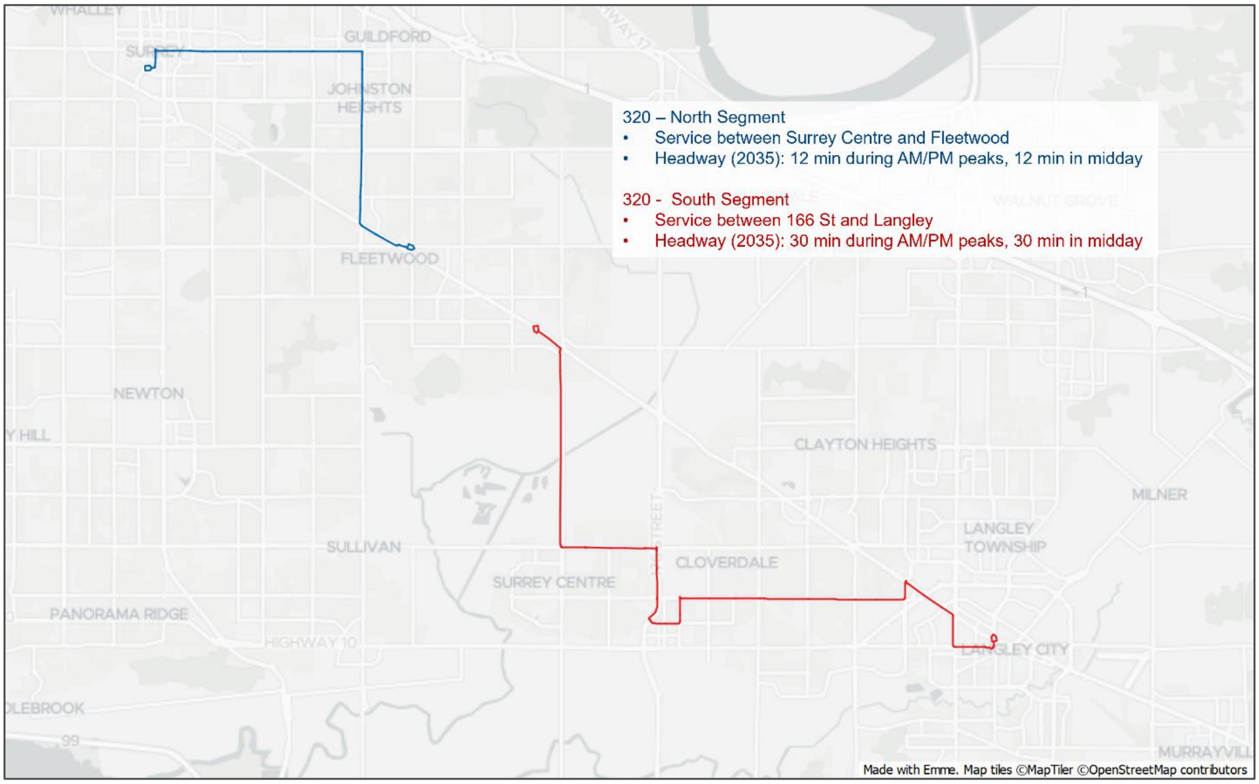
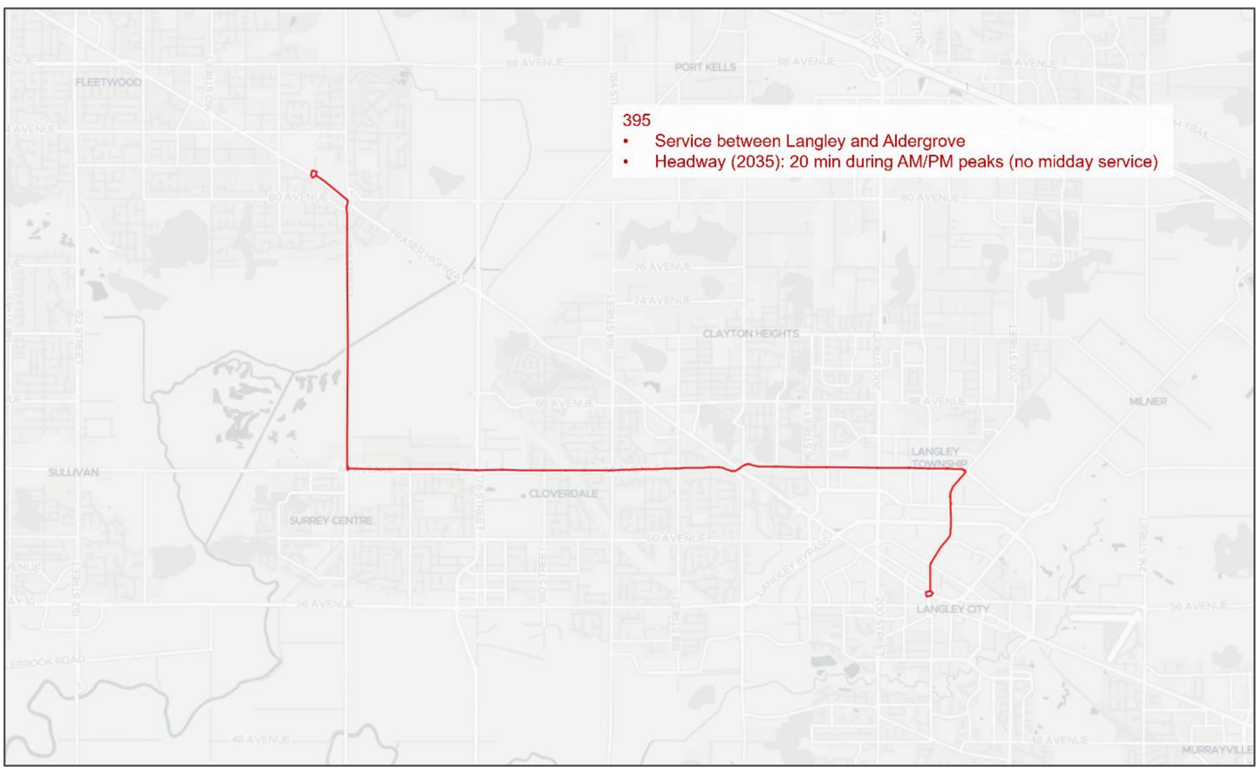


Figure 4-9: #395 – SLS Project Bus Service Network Changes



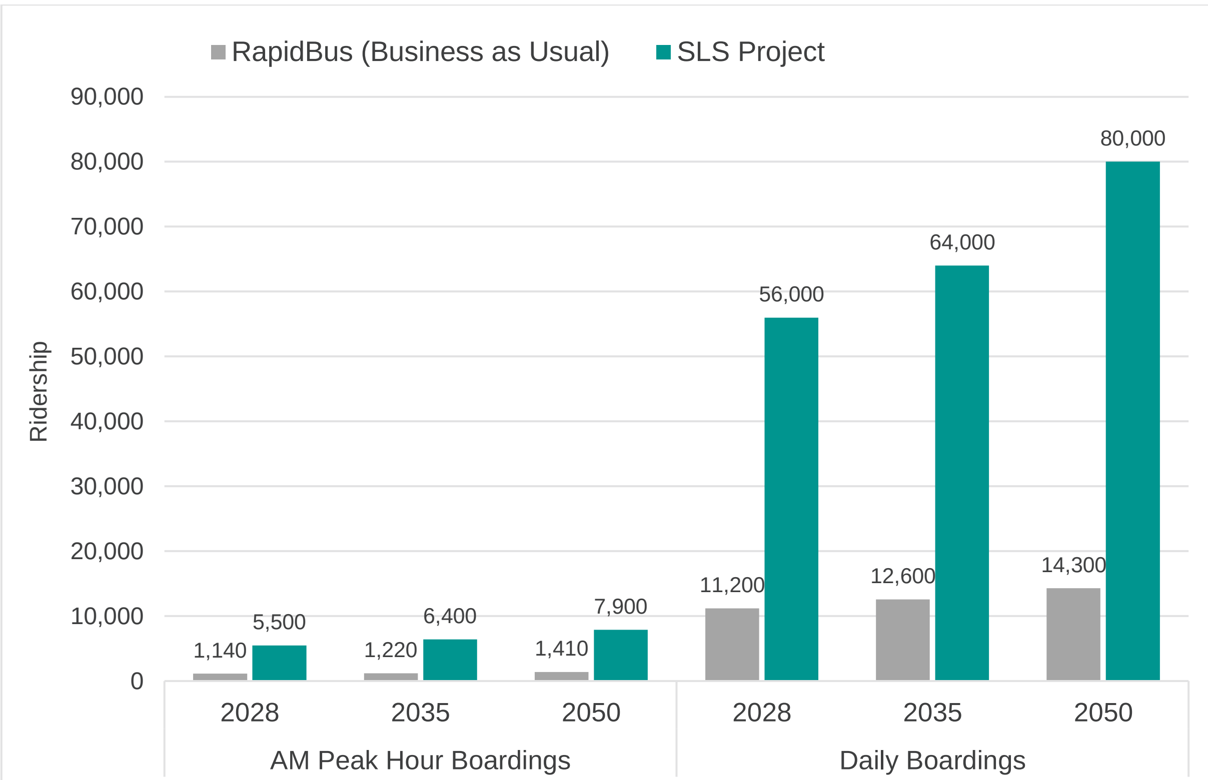
5 Outputs

This section summarizes travel demand-related outputs of the Project. The assumptions described in the previous sections were coded into the RTM, which was run to generate ridership outputs. These specifically focus on important metrics such as line ridership, shift in mode share, line utilisation and improved accessibility to job opportunities.

5.1 RIDERSHIP

Figure 5-1 summarizes the peak hour and daily ridership (weekday) for the Project compared to the BAU limited-stop bus service. Overall, Project ridership is forecast to be **five to six times greater than the limited-stop bus service**, which reflects the speed, reliability and attractiveness of the proposed rapid transit extension. It also points to the fact that **SLS draws ridership from parallel and alternative bus routes, not just the main limited-stop (RapidBus) route** which would no longer be operational when the Project is built.

Figure 5-1: AM Peak Hour and Daily (Weekday) Project Ridership



5.2 INCREMENTAL TRANSIT TRIPS AND REDUCTION IN AUTO TRIPS

Table 5-1 summarizes the daily and annual incremental system-wide transit trips and reduction in auto trips (compared to BAU). By 2050, approximately **42% of the Project's ridership (34,000 out of 80,000) is comprised of trips that shift from other modes, largely auto. The remainder 56% of the project ridership is due to re-routing from other bus routes.**

Table 5-1: Incremental Transit Trips and Reduction in Auto Trips

Statistic	Horizon		
	2028	2035	2050
Daily Incremental Transit Trips	22,000	26,000	34,000
Daily Reduction in Auto Trips	20,000	24,000	31,000
Annual Incremental Transit Trips	6,500,000	7,790,000	10,320,000
Annual Reduction in Auto Trips	-6,780,000	-8,080,000	-10,350,000

5.3 MODE SHARE

Table 5-2 shows the BAU and the Project's transit mode shares for the Three Municipalities. Between opening year (2028) and 2050, the transit mode share is estimated to increase by 0.6% during the AM Peak and by 0.8% daily, largely due to background growth. By 2050, transit mode share is estimated to increase by 1.6% during the morning peak and 1.3% daily with the introduction of the Project. The incremental impact of the Project increases over time as the road network becomes more and more congested.

Table 5-2: Transit Mode Shares (The Three Municipalities)

Scenario	AM Peak			Daily		
	2028	2035	2050	2028	2035	2050
BAU	9.8%	10.0%	10.4%	7.9%	8.2%	8.7%
SLS Project	11.1%	11.4%	12.0%	9.0%	9.3%	10.0%

5.4 STATION ACTIVITY

Figure 5-2, *Figure 5-3* and *Figure 5-4* compare daily station activity on the Project to current Expo Line stations in Surrey for the opening year (2028) and 2035 and 2050 horizons respectively. Overall, existing stations, in particular Surrey Central, have significantly higher activity compared to the new stations. Out of the eight new stations, Langley terminus and 152 St stations will experience the highest activity. By 2050, those two stations are forecast to generate activity levels similar to Canada Line's **Oakridge 41st St station today as per TransLink's 2019 Transit Service Performance Review**[4]. The lower ridership stations (166 St, 184 St and 190 St) in 2035 would be about as busy as Moody Station is today and the moderate ridership stations (140 St, 160 St and 196 St) in 2050 would be about as busy as Royal Oak Station is today.

5.5 SLS PROJECT UTILISATION

Figure 5-5 and *Figure 5-6* show the Project's load profiles for the peak hour and peak direction: AM Westbound and PM Eastbound by 2050. Overall, ridership on the extension and SkyBridge (Scott Road to Columbia) are well within the line's practical capacity. Seat availability however is limited for sections west of 166th. Thus, a substantial number of riders will have to stand for a portion of their trips.

[4] https: / / public.tableau.com / app / profile / translink / viz / 2019TSPR-RailSummaries / TableofContents

Figure 5-2: Weekday Project Station Activity (2028)

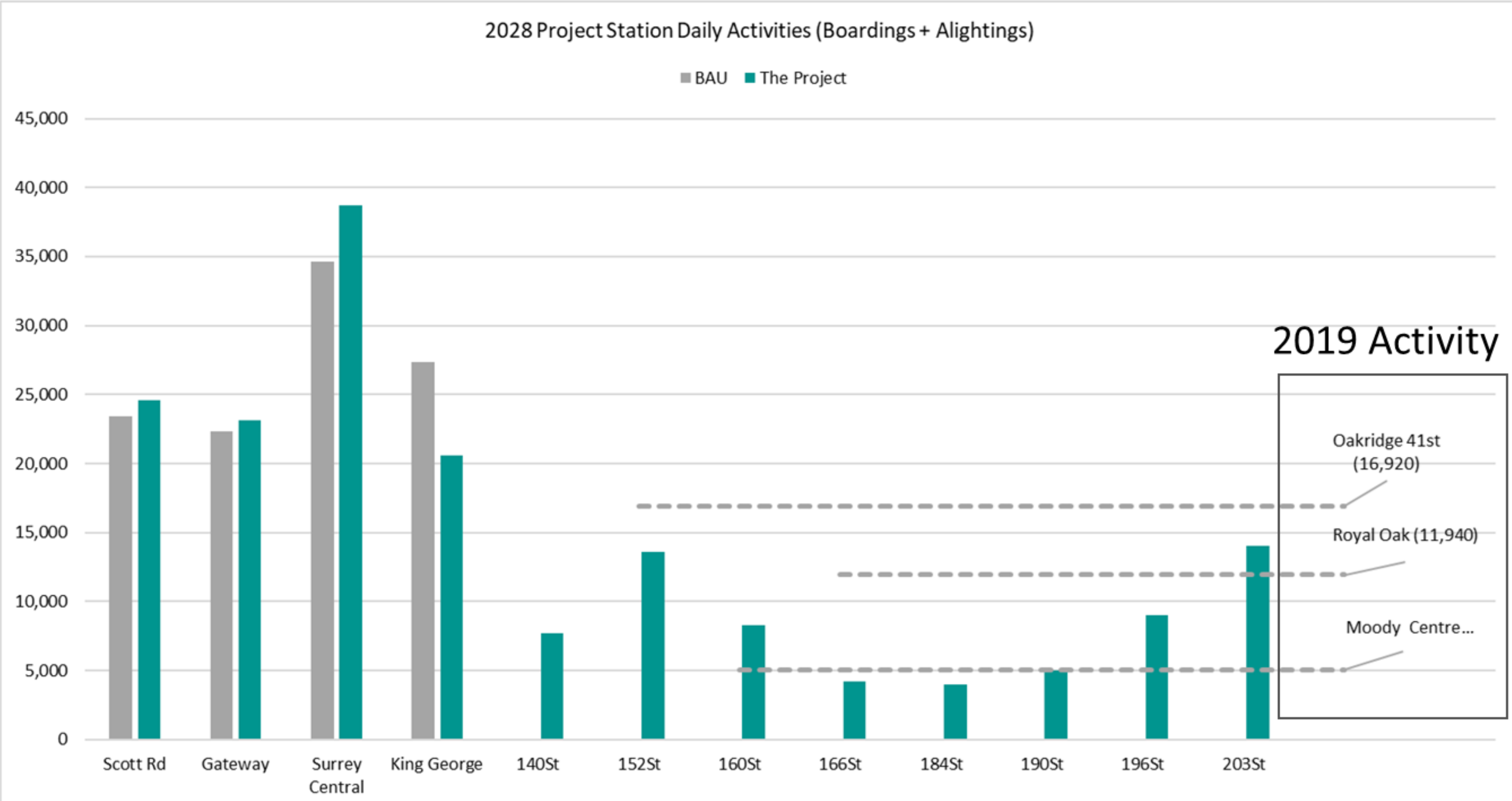


Figure 5-3: Weekday Project Station Activity (2035)

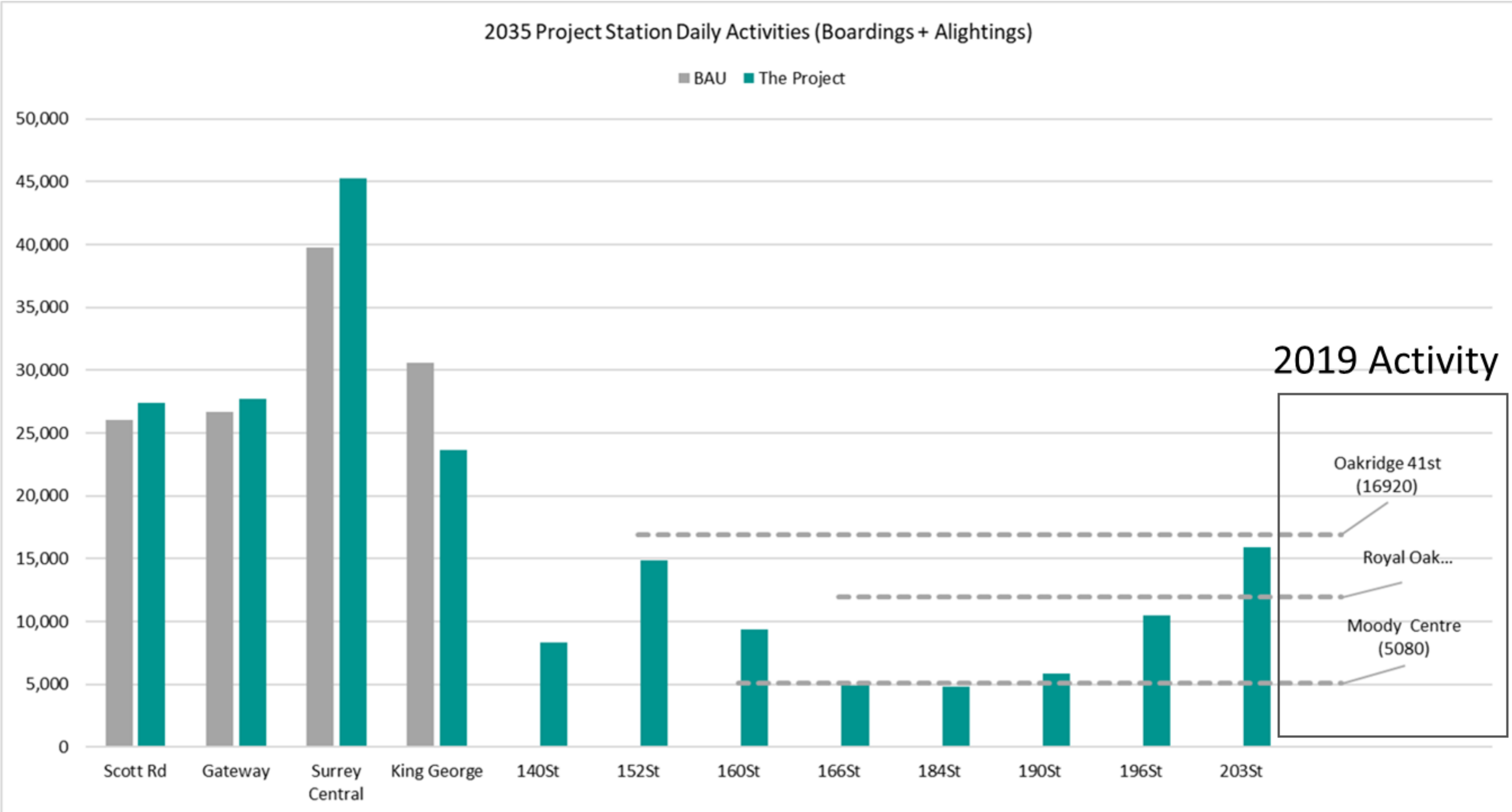


Figure 5-4: Weekday Project Station Activity (2050)

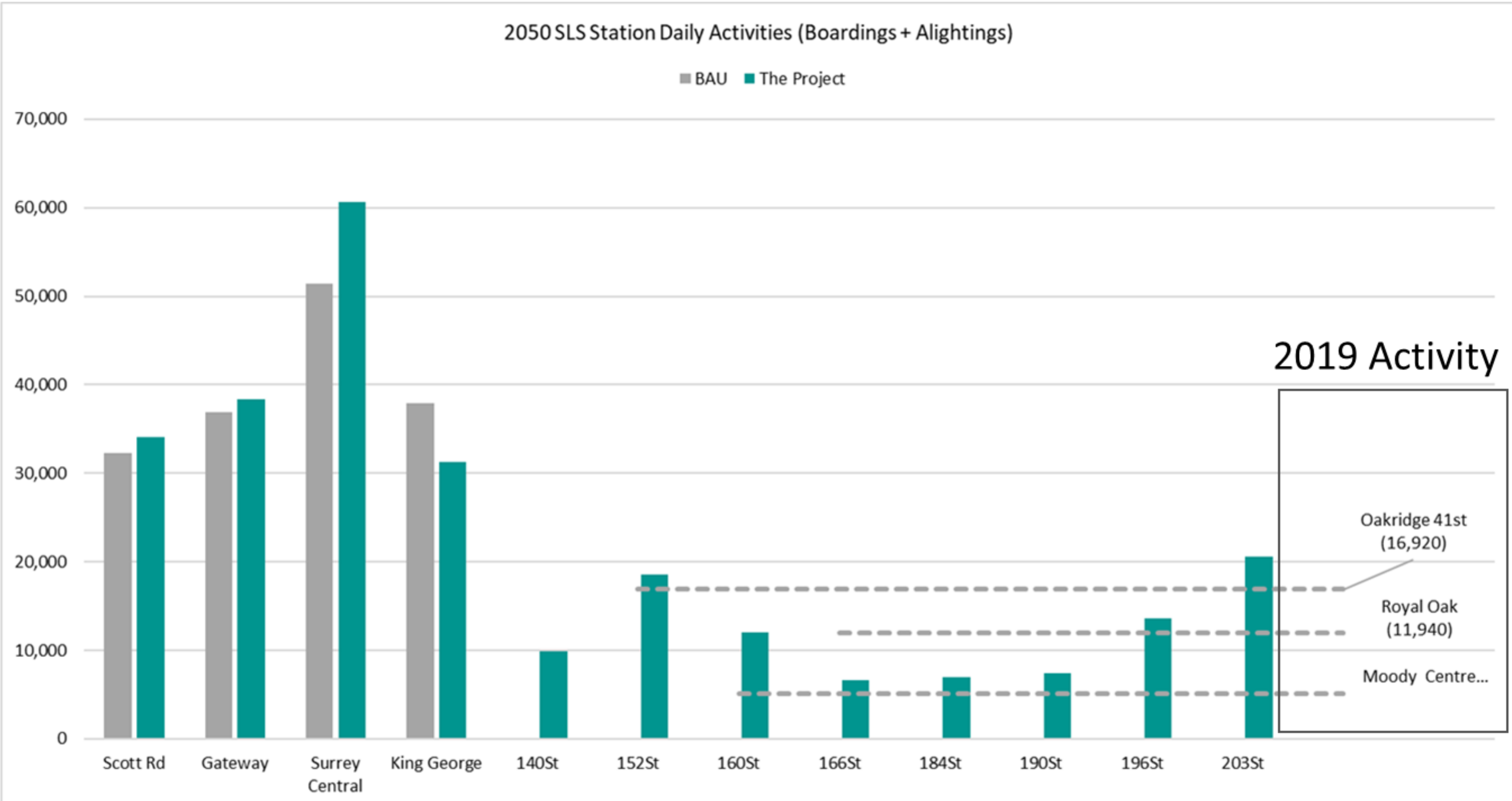
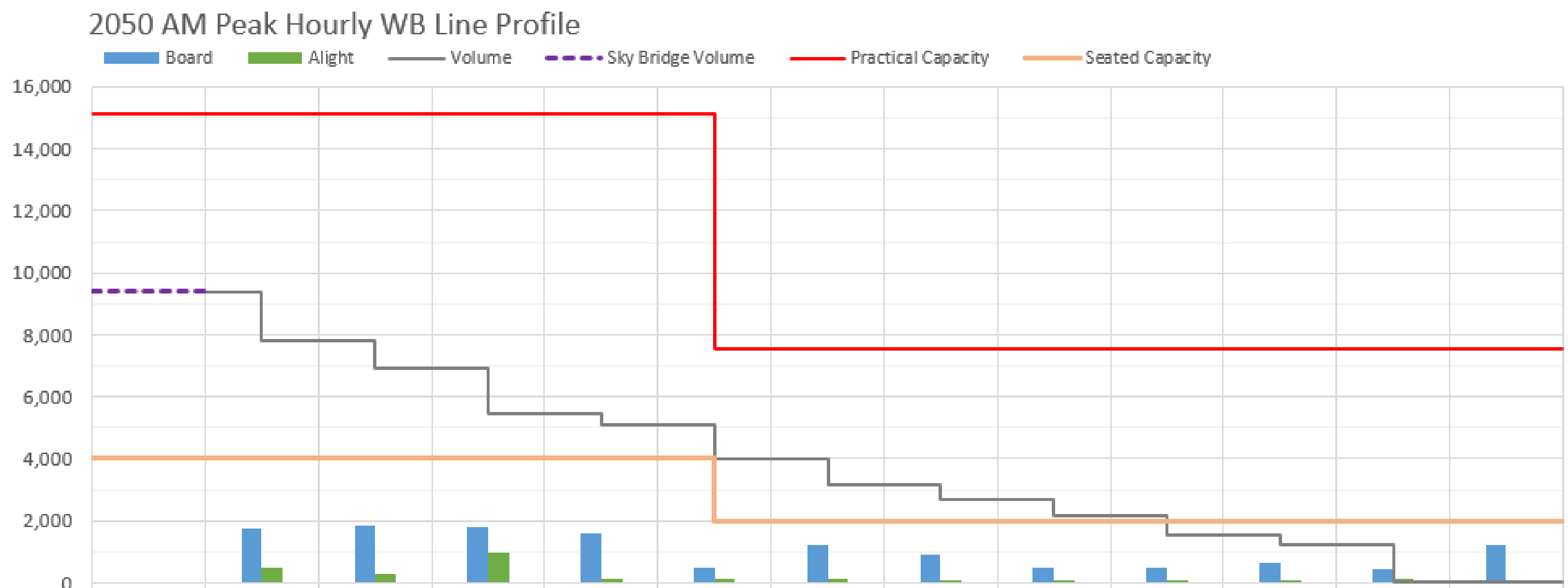
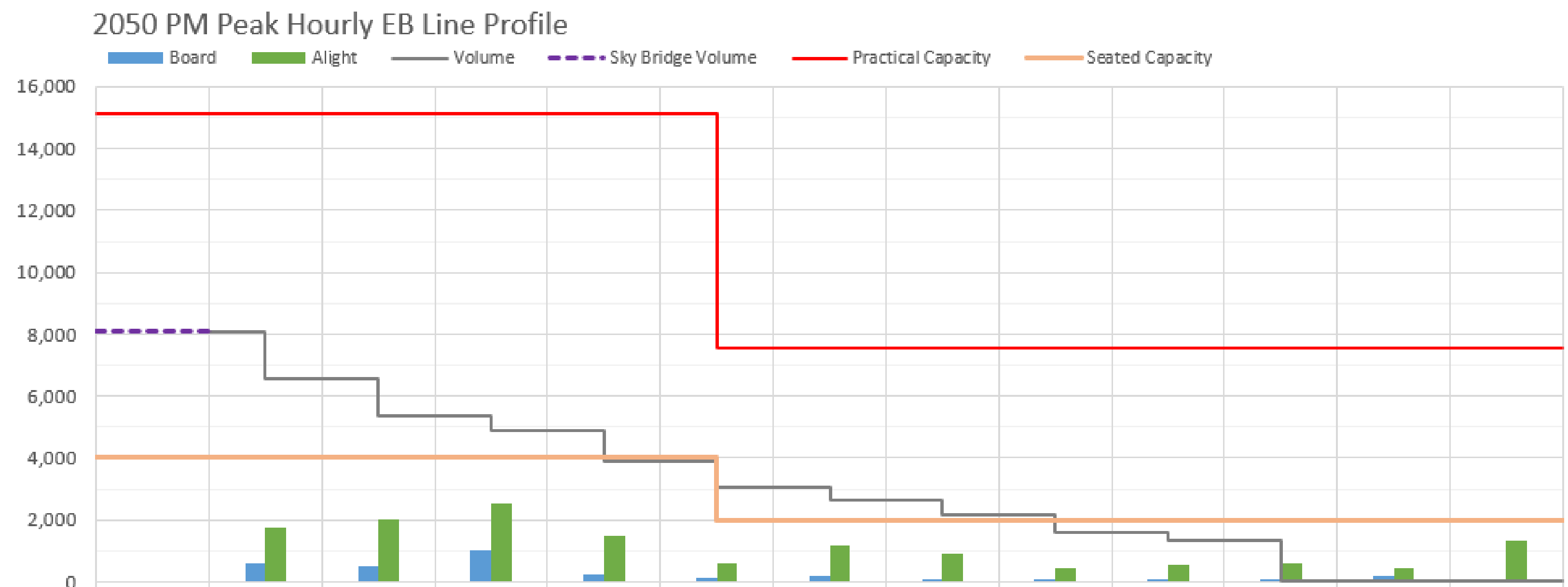


Figure 5-5: AM Westbound Project Load Profile (2050)



	SkyBridge	Scott Rd	Gateway	Surrey Central	King George	140 St	152 St	160 St	166 St	182 St	190 St	196 St	Langley Terminus
Arriving Volume	10,650	9,390	7,810	6,940	5,470	5,090	4,010	3,140	2,670	2,190	1,520	1,220	
Board	-	1,750	1,870	1,810	1,580	490	1,230	900	500	500	680	430	1,220
Alight	-	480	300	940	110	110	150	40	30	20	10	120	

Figure 5-6: PM Eastbound Project Load Profile (2050)



	SkyBridge	Scott Rd	Gateway	Surrey Central	King George	140 St	152 St	160 St	166 St	182 St	190 St	196 St	Langley Terminus
Arriving Volume	9,630	8,090	6,580	5,370	4,880	3,880	3,040	2,660	2,160	1,600	1,350		
Board	-	580	490	1,020	260	120	180	70	40	40	40	190	
Alight	-	1,760	2,030	2,530	1,470	610	1,180	900	430	540	600	440	1,350

At the SkyTrain system-wide peak link, AM westbound between Commercial Drive and Main Street stations, ridership is expected to increase by about 500 riders by 2050. This represents a marginal increase of about 3% during the morning peak hour when compared with the total westbound ridership of over 15,000. **This indicates that only a small number of the extension's riders travel downtown during the morning peak, 500 riders out of 7,900**, as previously shown in *Figure 5-1*.

5.6 ACCESSIBILITY

In general, accessibility reflects the number of opportunities – for example, jobs or recreational activity centres – that a person can reach in a reasonable amount of time, e.g. 60 minutes in the case of commuting. Accessibility is a simple yet powerful transportation performance metric. Accessibility mapping is used extensively to gauge the geographic impact of transportation projects and identify areas poorly served by transit. In the context of South of Fraser Sub-Region[5], the Sub-Region, the Project is a significant transit infrastructure project that can unlock economic and housing potential along the Fraser Highway corridor. The Project can provide access to a larger pool of workers who benefit from improved access to jobs as well as housing options including affordable housing units in the Sub-Region and elsewhere in the Lower Mainland.

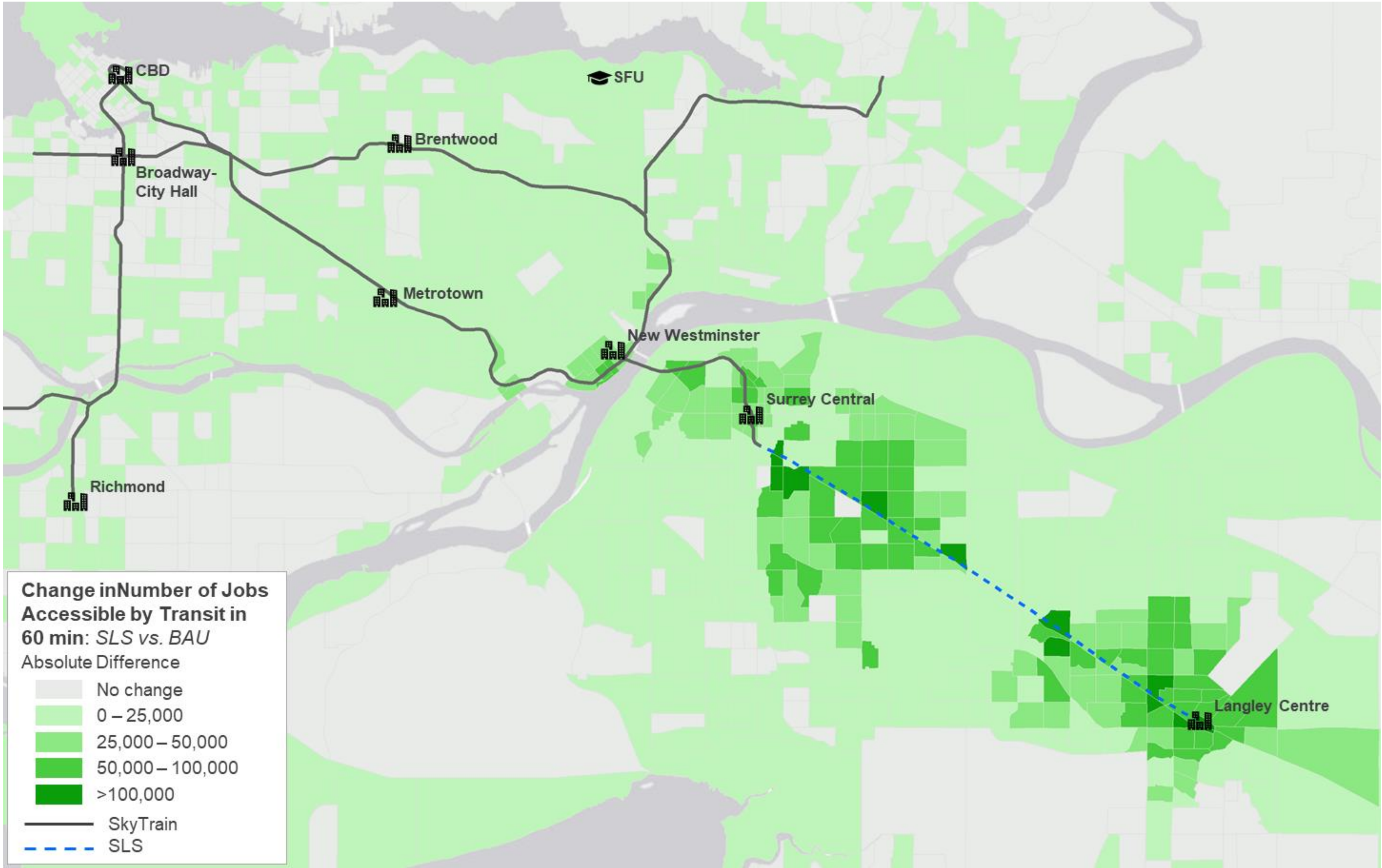
Figure 5-7 maps the change in transit accessibility to jobs in 2050 as a result of building the Project. The SkyTrain extension provides substantial improvement in transit accessibility for communities in the Sub-Region, especially for Fleetwood and Langley neighbourhoods where the number of accessible jobs increases by more than 50,000 in some areas. On average, the Project improves transit accessibility to jobs by about 8% for Surrey residents and 22% for Langley residents, as shown in *Table 5-3*.

Table 5-3: Average Accessibility for Surrey and Langley (City and Township) Residents in 2050

Transit Accessibility to Jobs weighted by Number of Households			
Municipality	**2050 BAU**	**2050 Project Scenario**	**Difference**
City of Surrey	270,000	291,000	21,000 (+8%)
Langley City & Langley Township	31,400	38,600	7,200 (+23%)

5 The South of Fraser Sub-Region encompasses the King George Boulevard, Fraser Highway and 104 Avenue corridors, capturing the communities of Surrey Centre, Newton, Guildford, Fleetwood, Cloverdale/Clayton, South Surrey/White Rock and Langley Centre

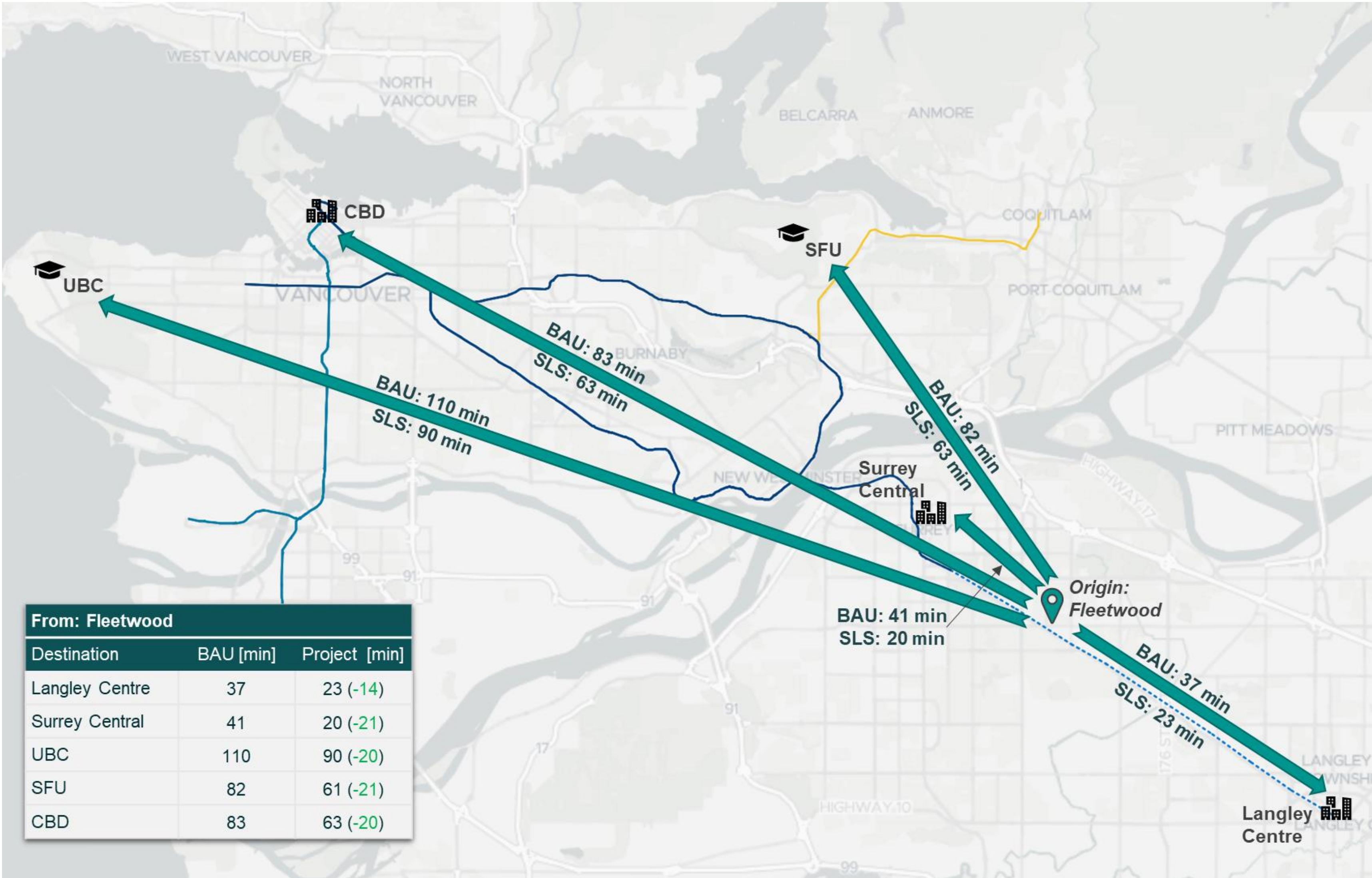
Figure 5-7: Change in Transit Accessibility in 2050 – The Project vs. BAU



5.7 TRAVEL TIME IMPROVEMENT FROM SELECT ORIGIN-DESTINATION PAIRS

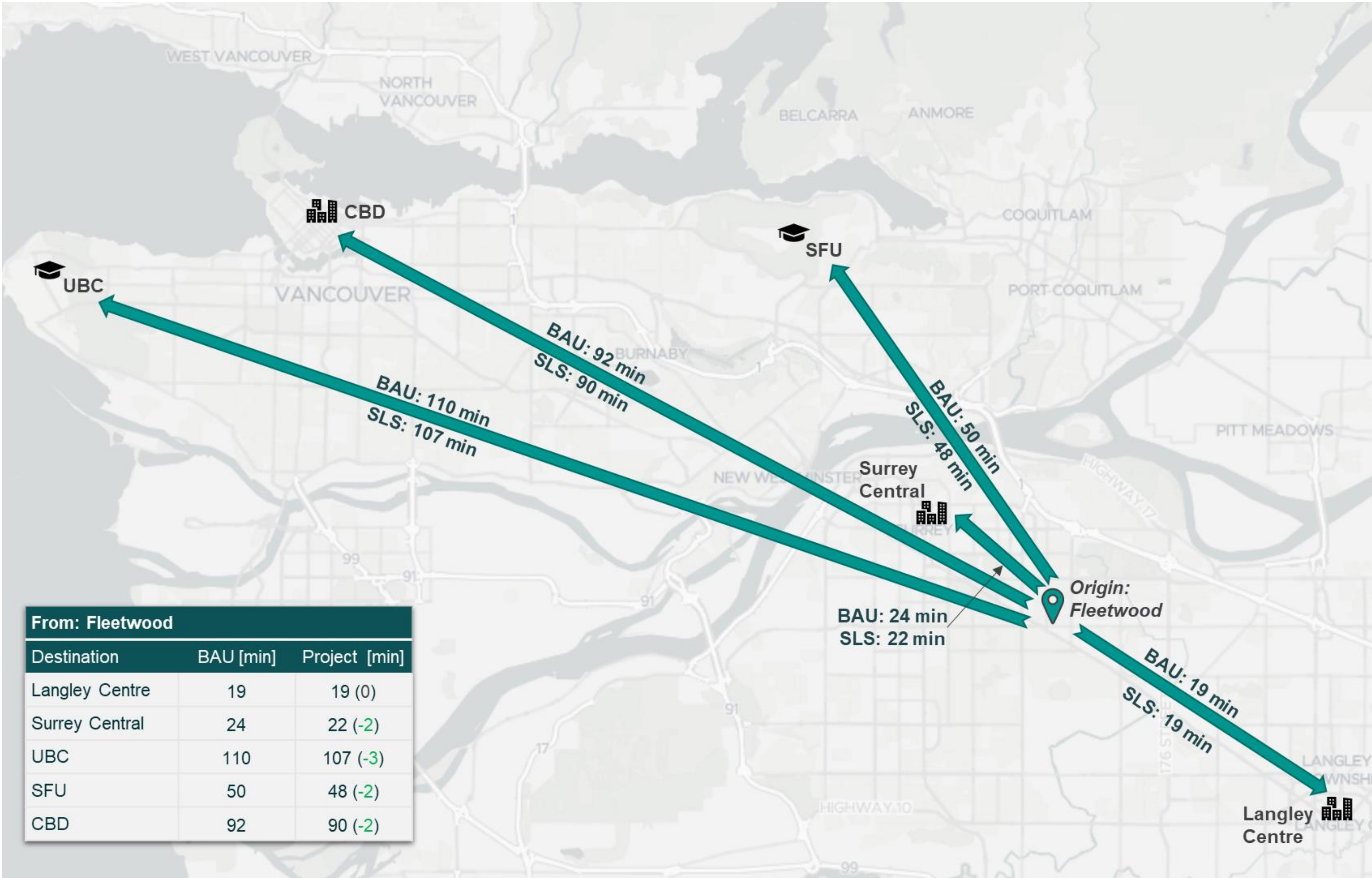
Figure 5-8 and *Figure 5-9* compare forecast BAU and Project scenario travel times from Fleetwood, close to Fraser and 166th St, to key destinations in the region. **It is important to note that the reported transit travel times include out of vehicle trip components, i.e., access to and from station/stop, wait time and boarding time.** Overall, the Project improves transit travel times significantly. For people travelling to Surrey or Langley City Centre, transit travel times become comparable, or even faster, to those made by car. A trip from Fleetwood to downtown Vancouver is forecast to be half an hour shorter on the train (63 minutes) compared to auto (90 minutes). Also note the travel time savings for auto trips with the Project as more people choose to use transit, freeing road capacity.

Figure 5-8: Transit Travel Times (in-vehicle and out-of-vehicle) from Fleetwood to Key Destinations in 2050 (Project vs. BAU)



From: Fleetwood		
Destination	BAU [min]	Project [min]
Langley Centre	37	23 (-14)
Surrey Central	41	20 (-21)
UBC	110	90 (-20)
SFU	82	61 (-21)
CBD	83	63 (-20)

Figure 5-9: Auto Travel Times from Fleetwood to Key Destinations in 2050 (Project vs. BAU)



From: Fleetwood		
Destination	BAU [min]	Project [min]
Langley Centre	19	19 (0)
Surrey Central	24	22 (-2)
UBC	110	107 (-3)
SFU	50	48 (-2)
CBD	92	90 (-2)

6 Forecasting Considerations

Ridership estimates presented in this report represent a central case forecast based on latest baseline assumptions and estimates of future demographic, economic and travel behaviour conditions before the onset of the COVID-19 pandemic. Variations in these assumptions and forecasts are expected and will result in uncertainty in the Project ridership forecasts. In addition to long-term 'COVID-19 legacy' factors, other variations may affect any one of several factors, for example different employment growth, different fuel price forecasts or different economic outcomes.

6.1 RISK AND UNCERTAINTY MODELLING ANALYSIS

The central case provides a vision of the future that is based on today's knowledge, calibrated model parameters and a set of reasonable future assumptions and estimates regarding the direction and magnitude of change in the years to come. If we could predict the future with absolute certainty, it would be possible to define the demand levels for the Surrey-Langley SkyTrain project associated with particular economic conditions at specific points in time. But clearly, this is not the case. Whilst we can develop 'best estimates' of future demand levels, even with the most sophisticated forecasting techniques the future cannot be predicted with absolute certainty.

With this in mind, the SLS project team decided that it would be prudent to undertake a comprehensive uncertainty analysis and generate a range of ridership outcomes based on possible upside and downside factors that could have a material impact on the ridership forecasts. The project team was supported by TransLink's Forecasting Team who undertook the majority of the analytical work using the state-of-the-art Exploratory Modelling Analysis Tool (EMAT)[6]. *Table 6-1* summarizes four identified factors that are anticipated to significantly affect the Project's ridership by 2050. For detailed information on the analysis methodology see *Appendix A*.

Table 6-1: Uncertainty Factors

Uncertainty Factors	Distribution Type	Upside / Downside	Range		
			Min	Max	Peak
Work and learn from home	Continuous (Triangular)	Downside	75% of baseline forecast	100% of baseline forecast	90% of baseline
Commute length	Continuous (Triangular)	Upside	100% of baseline forecast	120% of baseline forecast	107% of baseline forecast
University Employment and Enrolment (Satellite UBC Campus close to King George Station)	Continuous (Triangular)	Upside	Enrollment: 1,500 Full Time Equivalent (FTEs)	Enrollment: 9,000 Full Time Equivalent (FTEs)	Enrollment: 5,500 Full Time Equivalent (FTEs)
			Employment: 250	Employment: 2,250	Employment: 1,375
Corridor Development (i.e. TAZs around SLS stations)	Discrete(Three scenarios: low, medium and high)	Upside and Downside	-20% Population / Employment relative to baseline	+20% Population / Employment relative to baseline	Baseline (RTM RGS) Forecast

The first two factors, work / learn from home and commute length, are COVID-19 legacy variables. The general premise is that, long-term, some employees will continue to work from home for a portion of the work week. At the same time, given the increased adoption of remote work, some employees will be

[6] https: / / tmip-emat.github.io /

willing to travel longer to work given that they only need to commute for part of the week and assuming that people will purchase households in more affordable outlying areas.

The third variable is based on the recent announcement that the University of British Columbia has purchased a parcel of land in Central Surrey with the intention of building a future satellite campus[7].

The last variable accounts for potential uncertainty in the level of development along the corridor. Evidence from the region points to substantial transit-oriented development that exceeded expectations in some town centres. Recent examples include the densification around the Brentwood, Lougheed and Marine Gateway SkyTrain stations. On the other hand, areas around some existing SkyTrain stations remain under-developed, for example Nanaimo and Lake City Way SkyTrain stations.

It is important to note that the ranges and probability distributions assigned to the variables are largely based on a combination of the best available information today and professional judgment. For example, the enrollment ranges for the UBC variable were based on a combination of adjacent Simon Fraser Campus full time equivalent (FTE) forecasts and recent media announcements. The assumed corridor development scenarios can be considered a ‘thought experiment’ as it is difficult to predict growth levels given their dependency on many other factors, such as economic and regulatory factors. Finally, while the COVID-19 experience will likely have a lasting impact on travel behaviour, it is difficult to ascertain what the long-term trend in remote work will be 30 years from now.

Based on the uncertainty factors defined above and taking all the caveats into consideration, the forecast Project weekday ridership is expected to range between 64,000 (5th percentile) and 86,250 (95th percentile) in 2050 as shown in *Table 6-2*. The baseline ridership estimate of 80,000 (see *Section 5*) falls within that range.

Table 6-2: Forecast Weekday Project Ridership Range (2050)

Percentile	Ridership
P05	64,000
P25	69,750
P50	74,100
P75	80,400
P95	86,250

6.2 OTHER CONSIDERATIONS

The estimates shown in *Table 6-2* provide useful insight on the expected range of the Project’s ridership. However, it is important to remember that these outcomes are based on a handful of uncertainty factors. There are other risk factors, known and unknown, that can impact the Project. Some examples of known factors not considered in the analysis include:

- **Network Assumptions** – Other transportation projects within the Surrey-Langley SkyTrain project area could have a complementing or competing effect on ridership. Several assumptions regarding future transportation projects have been made based on planned, committed or funded projects such as the Highway 1 and 216 St Interchange project which has been recently

[7] https: / / news.ubc.ca / 2021 / 11 / 02 / ubc-expanding-presence-in-surrey-with-70m-land-acquisition /

completed. There are other projects, however, where there is uncertainty in terms of timing and project definition that could have an effect on the Project's ridership. The Pattullo Bridge replacement is currently being developed as a four-lane crossing that can be expanded to six lanes but the timing of six laning has not been determined. Highway 1 widening from 216 St to 264 St and further east to Whatcom Rd has been announced but some of the project details have not been confirmed including timing. Widening of 16 Ave from Highway 99 to Abbotsford has been discussed but no firm commitments have been made to date. Finally, the bus integration strategy that would see bus routes realigned to tie into the SLS extension has been assumed, but further expansion of feeder routes, or increase in existing service, has not been considered.

- **Growth Assumptions** – There are several variables related to growth, each of which has a level of uncertainty. Explanatory variables that drive travel demand growth include future population and employment growth outside the Project corridor, which are subject to uncertainty given a dynamic housing and labour force market. Socio-economic factors such as fuel prices, economic activity as measured by British Columbia Gross Domestic Product (BC GDP), and the Canada-US exchange rate have all been shown to have a significant impact on travel behaviour in the Metro Vancouver region.
- **Behavioural Response** – Understanding how people respond to new transportation services, infrastructure and policy is based on collection of travel survey and traffic count information. There have been recent changes to the transportation system that have allowed for the collection of data to better understand travel behaviour response such as rehabilitation activities on the Pattullo Bridge, transit fare changes and toll removal on the Port Mann and Golden Ears bridges. TransLink has been studying the impacts of various pricing policies such as mobility pricing and distance-based transit fares. Both of these could have a significant impact on ridership forecasts for the Project.
- **Technology** – Vehicle and ridesharing technologies have progressed significantly over the last decade. The BC government introduced legislation to allow ridesharing companies such as Uber and Lyft to operate in the province. These companies began providing services in early 2020 and their impact will become more evident as emergent travel patterns stabilize post COVID-19. Connected and autonomous vehicle technology has progressed to a level where several vehicle manufacturers have introduced low-level driver automation features such as lane keeping assistance and adaptive cruise control. Higher level automation technologies will eventually be brought into Canada's road transportation network when they meet safety requirements. The impact of these technologies on travel behaviour could be significant and should be considered in future ridership forecasts.

Appendix A: Surrey Langley SkyTrain Forecasting Uncertainty Analysis Memo (TransLink)

Date: March 3, 2022

TO: Sarah Sweeting, Senior Project Manager, TI Corp

FROM: Reid Keller, Lead Modeler, TransLink

SUBJECT: **Surrey Langley SkyTrain Forecasting Uncertainty Analysis**

This memo summarizes the uncertainty analysis conducted for the forecasts of the Surrey to Langley extension of the SkyTrain Expo Line (SLS). The forecasting study used TransLink's Regional Travel Model (RTM) and a tool for simulating uncertainty in modeling[1].

PURPOSE

Evaluation of infrastructure projects typically uses point forecasts for decision making, usually with a single value (or point forecast) for ridership, the benefit cost ratio (BCR), and other outcomes of interest. These forecasts are profoundly influenced by the input assumptions for many of the predictive variables, such as the level of future development around the stations, or the preference for private vehicles for future populations.

There is uncertainty around the value of those predictive variables, and this uncertainty increases for longer range forecasts. COVID19 provided strong evidence of the uncertainty of forecasts; for example, it has shown that the level of work from home (WFH) and learn from home (LFH) can change rapidly for a variety of organizations, many of which are currently contemplating continuing full or part time WFH policies.

This change has the potential to alter the long-term nature of commuting as full or part time WFH would lead to less frequent commute trips. An increase in WFH could have especially large impact on SkyTrain usage since these commute trips constitute a large portion of their ridership. SkyTrain also tends to serve longer distance trips and it is possible that less frequent commuting could allow some people to live further from their work thereby providing a dampening effect on the reduction in ridership due to increase WFH.

The COVID19 legacy is not the only uncertain aspects that could impact project forecasts. There is further uncertainty around many other factors, such as future land use changes and development potential along the project corridor, which could also impact usage of this facility.

Over the last two years, the TransLink forecasting team developed analytical capabilities to conduct exploratory modeling – a methodology designed to give an idea of the range of outcomes that are possible for projects and policies given the uncertainty of the input variables. This memo summarizes the findings of such an exploratory modeling analysis for the SLS project.

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[1] The United States Federal Highway Administration (FHWA) Transportation Model Improvement Program (TMIP) Exploratory Modeling and Analysis Tool (EMAT)

METHODOLOGICAL APPROACH

For this project the TransLink forecasting team has used the United States Federal Highway Administration (FHWA) Transportation Model Improvement Program (TMIP) Exploratory Modeling and Analysis Tool (EMAT) to investigate the uncertainty around the point forecasts provided for the SLS extension of the Expo line. Uncertainty is analyzed with EMAT by the following process (illustrated in Figure 1):

- Study design
    - Identify the outcomes of interest, including the baseline value (in this case the project point forecast)
    - Identify the uncertainty factors, including the range and distribution of possible input values
    - Design a set of model runs by varying the uncertainty factors, which become inputs to the Regional Transportation Model. Each model run is called an *experiment*.
- Regional Transportation model runs
    - Run the RTM once for each of the experiments from the previous step. There are typically 10 experiments for each uncertainty factor. However, for this analysis we used 15 experiments to capture more of the variability. Thus, this analysis with four uncertainty factors required 60 RTM runs.
    - Record the different levels for the outcomes of interest for each experiment.
- Uncertainty analysis
    - Estimate meta-models for each outcome of interest based on RTM outputs from the experiments from the previous stage.
    - Simulate thousands of possible outcomes from the meta-models. This analysis is used to determine the distribution of values for the outcomes of interest.

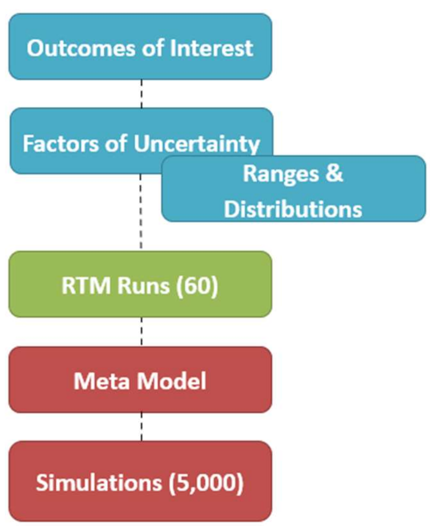

Figure 1: EMAT Uncertainty Analysis Process

Outputs from this analysis include the range of estimated values for each of the outcomes of interest - given the different combinations of uncertainty factors - and the relative importance of each of the uncertainty factors on the outcomes of interest.

<u>APPROACH TO THE SLS EXTENSION UNCERTAINTY ANALYSIS</u>

This analysis used the full SLS alignment which includes eight stations at 140 St, 152 St, 160 St, 166 St, 184 St, 190 St, 196 St, and 203 St, as shown in Figure 2.

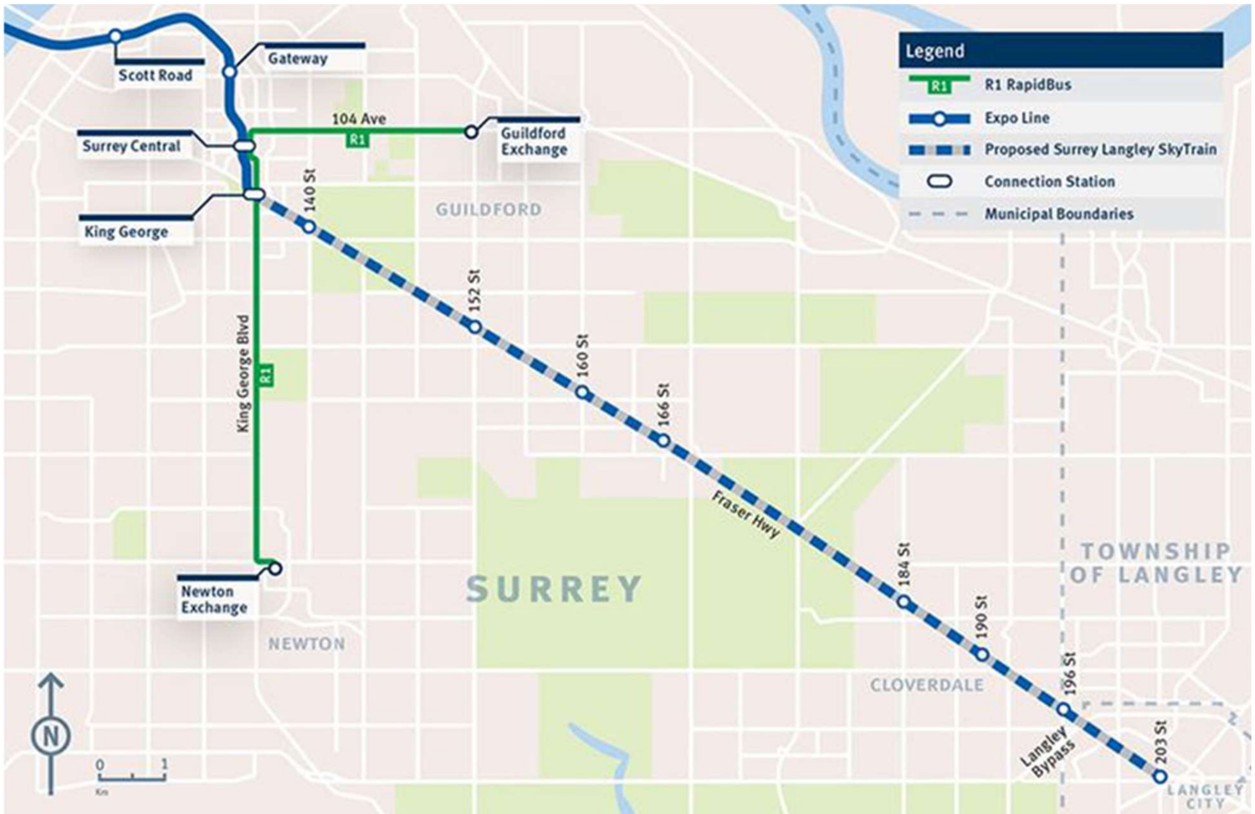

Figure 2: Alignment

Outcomes of Interest

The following outcomes of interest were included as part of this analysis:

- Daily line ridership for the extension
- Peak load westbound (WB) during the morning (AM) peak hour
- Surrey and Langley transit mode share

Uncertainty Factors

The following uncertainty factors were included as part of this analysis:

- Amount of Work from Home (WFH) and Learn from Home (LFH) (university)
- Commute length (how far/long people are willing to travel for work)
- Level of development along the project corridor
- Level of enrollment at the proposed University of British Columbia (UBC) Surrey campus

First it is important to note that these uncertainty factors have different scopes and scales with regards to travel behavior. Variables such as WFH/LFH and commute distance apply to travel across the entire region, while the other variables are local to the project area.

In many cases for this type of analysis, the range and distribution of the uncertainty factors are assumed to be symmetrical around baseline assumptions used in the business case analysis (point forecast), implying that the input assumptions are equally likely to be greater or less than the baseline assumption used in the point forecast.

However, some variables can only move in one direction. The RTM was estimated and calibrated to conditions with almost no WFH or LFH, so these variables can only remain at the baseline forecast level or increase in the future. As such, this variable ranges from commuting as it was pre-Covid, to a 15% reduction in commute trips.

It is possible that people are willing to spend more time commuting because they commute less frequently, in other words it was assumed that increased commute length would be positively correlated with increased work from home. As such, commute distances are assumed to remain at the baseline level or increase in the future.

Additionally, some variables are categorical in nature. These variables use a fixed set of 'levels' as opposed to a continuous range of values. The amount of future corridor development is this kind of factor, with low, medium, and high levels of corridor development. The medium scenario is the current forecast from Metro Vancouver based on the Regional Growth Strategy (RGS), and was the scenario used for the point forecasts. The high and low represent a 20% increase or decrease (respectively) of the projected growth along the project corridor from the medium (baseline) forecast.

UBC recently announced plans for a satellite campus adjacent to King George station in Surrey, which is just outside this project and would be well-served by SLS adjacent residential areas. The original announcement included estimates of up to 10,000 students enrolled. The RTM uses full-time equivalent enrolment (FTE), and a continuous FTE range was assumed for this effort, ranging from 1,500 to 9,000 students.

It should be noted that considerable testing of the work from home ranges was done in previous uncertainty analysis, including for COVID19 recovery, the SFU gondola, and the UBC Millennium Line Extension. The ranges for each uncertainty variable are shown in Appendix A.

Background Statistics

It is useful to consider a few numbers from the regional 2017 trip diary when considering the findings in this document:

- Commute trips, which include travel to work or university, comprise more than half of all transit trips
- Commute trips are roughly a third of all trips made in the region

As such, commute patterns are particularly important for transit facility usage.

<u>FINDINGS</u>

The following figures show the range and distribution for the outcomes of interest based on the results of the exploratory modeling analysis. On the charts, the blue vertical line indicates the point forecast value from the business case analysis.

Daily Line Ridership

Figure 3 shows the frequency of the estimated daily ridership outcomes based on the simulations. As shown in the chart, ridership could range between 64,000 daily riders at the 5th percentile (P5) and 86,500 at the 95th percentile (P95). The difference between P25 at 70,000 daily riders and P75 at 80,000 gives an interquartile range of about 10,000 daily riders. The point forecast of 79,500 daily riders falls at P73, which means that 73% of the simulated outcomes were lower than the point forecast.

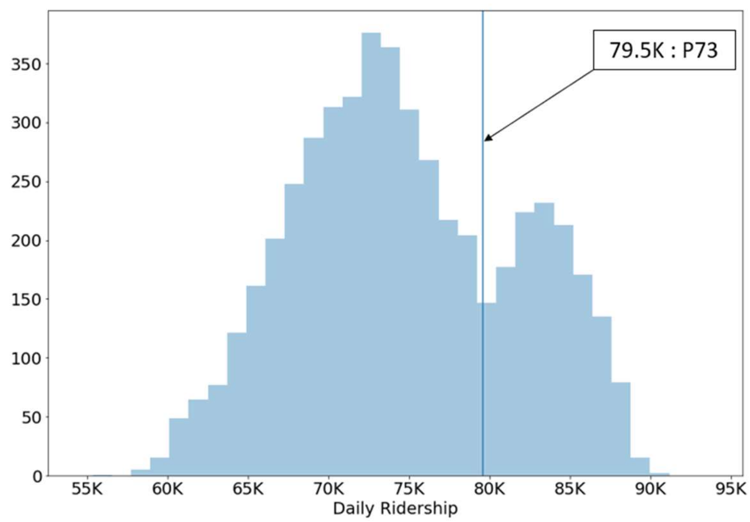

Figure 3: Daily Line Ridership Distribution

According to the analysis, the level of corridor development has the greatest impact on daily line ridership, and a significant impact on peak hour ridership. This suggests that residential and commercial development along the corridor could be as important as the Covid 19 work and learn from home legacy for use of this facility.

As noted above, the amount of WFH/LFH can only increase over baseline conditions as well as commute trips form a greater share of transit trips than overall trip-making, so reduced commuting has an outsized impact on transit results.

However, willingness to commute longer distances or travel times could allow people to travel further for their commute trips. The SLS would connect communities along the alignment to numerous distant regional job centers such as Metrotown, the Broadway Corridor, and the Vancouver central business district. Increased willingness to travel further suggests that more people living in these areas could be willing to use the SLS to connect to these destinations providing they need to do it less frequently.

The simulation outcomes shown in Figure 3 appear “lumpy” because corridor growth was implemented as a categorical variable (three distinct scenarios). Most of the simulations exceeding the point forecast included the high corridor growth scenario. Different mixtures of the low or medium growth with the other variables blended to form a continuous distribution, while simulations with the high corridor growth resulted in distinctly greater forecast values. The combined effect resulted in the bi-modal distribution seen in Figure 3.

Peak Link Volume

Figure 4 shows the frequency of the estimated peak link outcomes based on the simulations. As shown in the chart, peak link ridership could range between 4,000 peak hour riders at P5 and 5,600 at P95. The difference between P25 at 4,400 peak hour riders and P75 at 5,100 gives an interquartile range of about 700 peak hour riders. The point forecast of 5,500 peak hour riders falls at P91, which means that 91% of the simulated outcomes were lower than the point forecast.

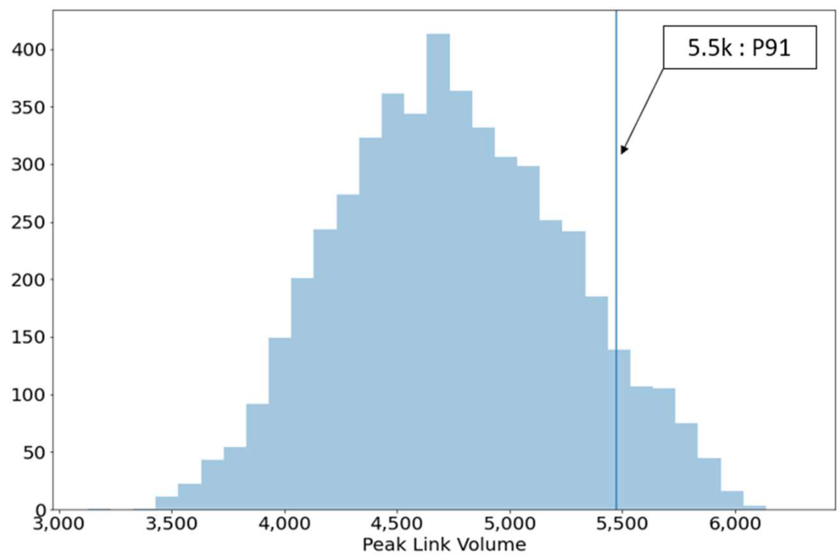

Figure 4: Peak Link

Commute trips form a greater percentage of peak hour ridership than daily ridership, and so the effect of WFH/LFH is greater for the peak link volume, where the point forecast falls at the 91st percentile (Figure 4), than for daily ridership, where the point forecast falls at the 73rd percentile (Figure 3). People living around the corridor and traveling for non-commute reasons could bolster ridership, while locating increased employment along the corridor provides additional destinations for areas both served by the project and the existing SkyTrain. The combined outcome of these is that WFH and corridor development have similar magnitude of impact on peak usage of the facility.

Surrey/Langley Transit Mode Share

Figure 5 shows the frequency of the estimated Surrey/Langley sub-region transit mode share outcomes based on the simulations. As shown in the chart, transit mode share could range between 9.3% at P5 and 9.9% at P95. The difference between P25 at 9.5% and P75 at 9.7% gives an interquartile range of about 0.2%. The point forecast of 10% transit mode share falls at P99, which means that 99% of the simulated outcomes were lower than the point forecast.

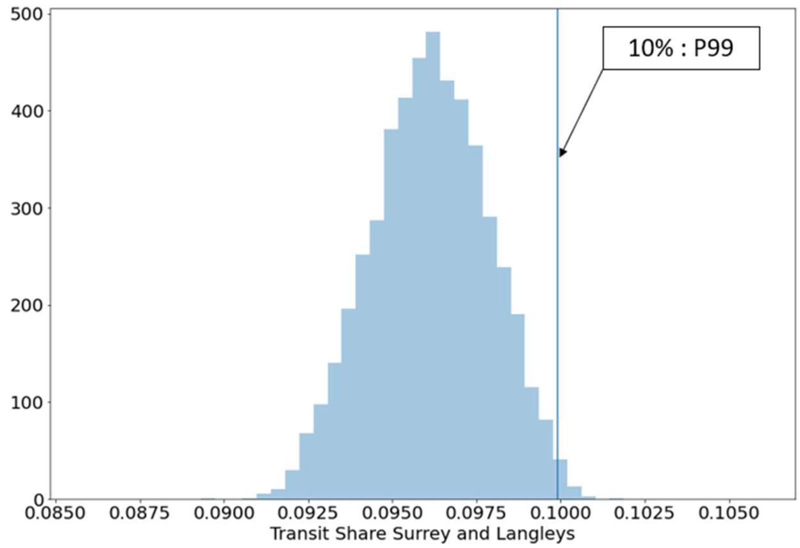

Figure 5: Surrey and Langley Transit Share

The project corridor is only part of the Surrey/Langley region, with approximately 30% of Surrey/Langley transit riders estimated to use the facility for some, or all, of their journey in 2050. As such, the variables local to the project area, including the corridor development and UBC Surry campus enrollment, are not as important to Surrey/Langley transit mode share as the variables that effect the whole region. Since most of the upside for the SLS ridership comes from the corridor development variables, the estimated transit mode share falls near the top of the distribution, as shown in Figure 5. This outcome is most effected by the uncertainty of WFH/LFH.

Outcome Ranges

Figure 6 provides a reference table of the range of possible values for the outcomes given the uncertainty inputs that were discussed above.

Measure	5th Percentile	25th Percentile	Median	75th Percentile	95th Percentile	Point Forecast Value	Point Forecast Percentile
Daily Ridership	64,000	70,000	74,000	80,500	86,500	79,500	73rd
Peak link	4,000	4,400	4,700	5,100	5,600	5,500	91st
Surrey and Langley Transit Mode Share	9.3%	9.5%	9.6%	9.7%	9.9%	10%	99th

Figure 6: Outcomes of Interest Ranges

Analysis of the importance of each uncertainty factor for the outcomes of interest is shown in Appendix B.

Conclusion

Development along the project corridor, including a new UBC Surrey campus near King George station, has a significant impact on projected ridership for this line, particularly at the daily level.

As noted, previously there was little WFH and LFH in the region, and this low level of WFH and LFH is calibrated into the RTM. As such, because this variable can only increase, and it has a major impact on commute trips, the point forecasts provided in the business case analysis typically fall between the median and the upper end of the distribution. It remains to be seen where the long-run equilibrium for WFH and LFH lies.

Longer commute lengths increase SLS ridership (and transit ridership in general). Note that the entire SLS alignment could reach major employment centers in downtown Vancouver and the Broadway Corridor in roughly 60 minutes.

APPENDIX A: UNCERTAINTY FACTORS

Uncertainty Factors	Range			Variable Type	Notes
	Min	Max	Peak		
Work and learn from home	85% of baseline forecast	100% of baseline forecast	90% of baseline	Continuous	Baseline model had almost no work from home. Most likely scenario assumed to be greater than baseline model. The minimum value is associated with all workers who are eligible working one day a week from home on average. In practice this could mean some workers working 2-3 days/week from home and some working fulltime at their worksite
Commute length	100% of baseline forecast	120% of baseline forecast	107% of baseline forecast	Continuous	Strong positive correlation with WFH/LFH
University Employment and Enrolment	1,500	9,000	5,500	Continuous	Potential UBC campus at King George and expansion of SFU at Surrey Central
Corridor Development	Low Scenario	High Scenario	Baseline Forecast	Categorical	Three levels: low, medium, and high. Medium is the current forecast. High and low are +/- 20% from medium.

Appendix B: Feature Scoring

	Work and Learn From Home	Commute Length	UBC Surrey Enrollment	Corridor Development
Daily Line Ridership	0.21	0.12	0.11	0.56
Peak Link Volume	0.35	0.18	0.11	0.35
Transit Share for Surrey and Langleys	0.43	0.16	0.13	0.29

The table above shows the relative impacts of the different uncertainty factors on each of the outcomes of interest. The outcomes of interest are on the horizontal axis, while the uncertainty factors are on the vertical axis. The values in the cells depict the share of impact the different factors have on each outcome of interest, so that the higher the value in the cell, the larger relative impact the uncertainty factor has on the outcome of interest.