BC Ministry of Transportation and Infrastructure

Highway 99

(King George Highway to Oak St. Bridge)

Corridor Assessment

DRAFT V 1.5

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1.0 BACKGROUND

Highway 99 is a major north-south corridor through Metro Vancouver that runs from the south at its connection with Interstate 5 at the Canada-US border, to the Highway 97 junction near Cache Creek (a total length of 409 km). The 40 kilometres of Highway 99 between the US border and the City of Vancouver is configured as a four lane freeway, with interchanges, tunnels, and overpasses that were constructed between the mid 1950's and 1986. Only structures built since 1986 (Highway 91 interchanges) meet current seismic design standards.

The South of Fraser portion of Highway, depicted in Figure 1.1, is located within the Greater Vancouver Regional District (GVRD) and runs through the City of Surrey, Corporation of Delta and City of Richmond,

Figure 1.1 – The South of Fraser Portion of Highway 99

Highway 99 provides strategic goods movement connections between the US interstate Highway System and the BC Lower Mainland, Vancouver Island, and the Whistler-Pemberton area. Significant goods movement hubs served by this highway include the Tsawwassen Ferry Terminal, Delta Port and Vancouver International Airport.

In addition to goods movement support the highway also connects Surrey, White Rock, Delta, and Richmond with the Lower Mainland highway and municipal roadway systems. In fact the majority of demand served by Highway 99 is commuter shed traffic generated by these and neighbouring municipalities.

2.0 REGIONAL CONTEXT

The South of Fraser municipalities have experienced the greatest rate of growth within the GVRD over the past 10 years. The communities that Highway 99 runs through have experienced the highest rate of growth in the South of Fraser Area. This trend is expected to continue over the next twenty years. Table 2.1 and Figures 2.1 and 2.2 illustrate growth in population and employment for these areas from 2001 to 2031.

Table 2.1
GVRD and South of Fraser Population and Employment (2001 to 2031)

GVRD	**2001**	**2006**	**2021**	**2031**
Population	1,987,000	2,117,000	2,540,400	2,900,000
Employment	1,062,000	1,145,000	1,351,100	1,541,000
South of Fraser				
Population	573,564	628,000	832,764	950,000
Employment	234,000	256,400	378,000	408,000
South Surrey				
Population	58,710	79,500	80,000	175,000
Employment	21,175	25,410	27,800	71,000
White Rock				
Population	18,250	18,755	33,760	43000
Employment	4,745	4,876	9,000	13000
Semihamoo Peninsula South Surrey/White Rock				
Population	76,960	98,255	113,760	218,000
Employment	25,920	30,286	36,800	84,000

Source: South of Fraser Area Transportation Study, TransLink, City of Surrey

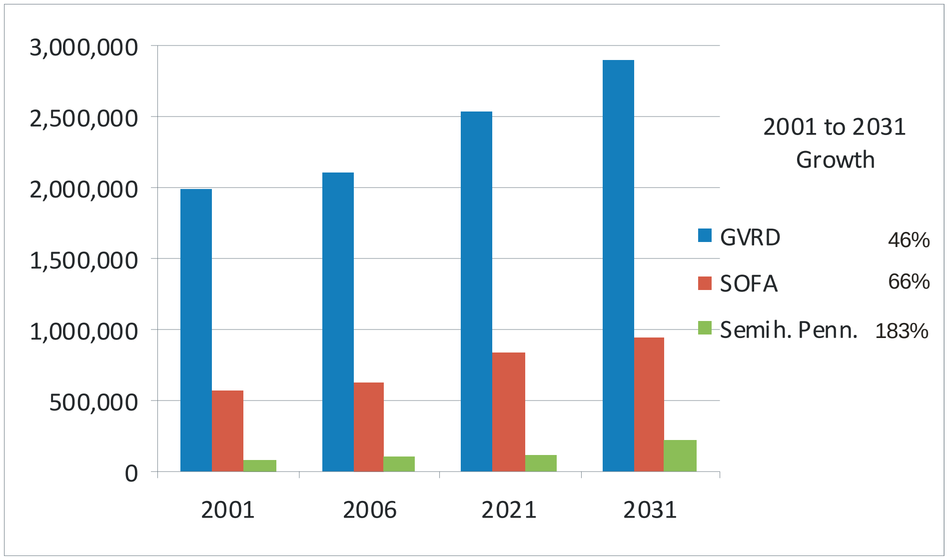


Figure 2.1 – GVRD and South of Fraser Population (2001 to 2031)

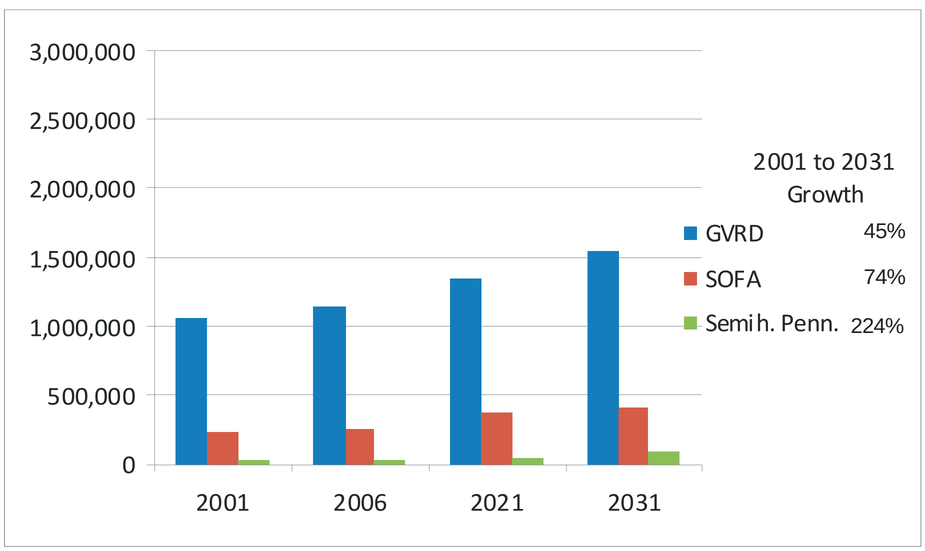


Figure 2.2 – GVRD and South of Fraser Employment (2001 to 2031)

3.0 HIGHWAY 99 CONFIGURATION

The portion of Highway 99 under discussion is configured as an urban freeway with cross sections that range from 4 and 6 lanes. Figure 3.1 describes the corridor laning in detail while Figure 3.2 illustrates the various cross-sections of this portion of the corridor.

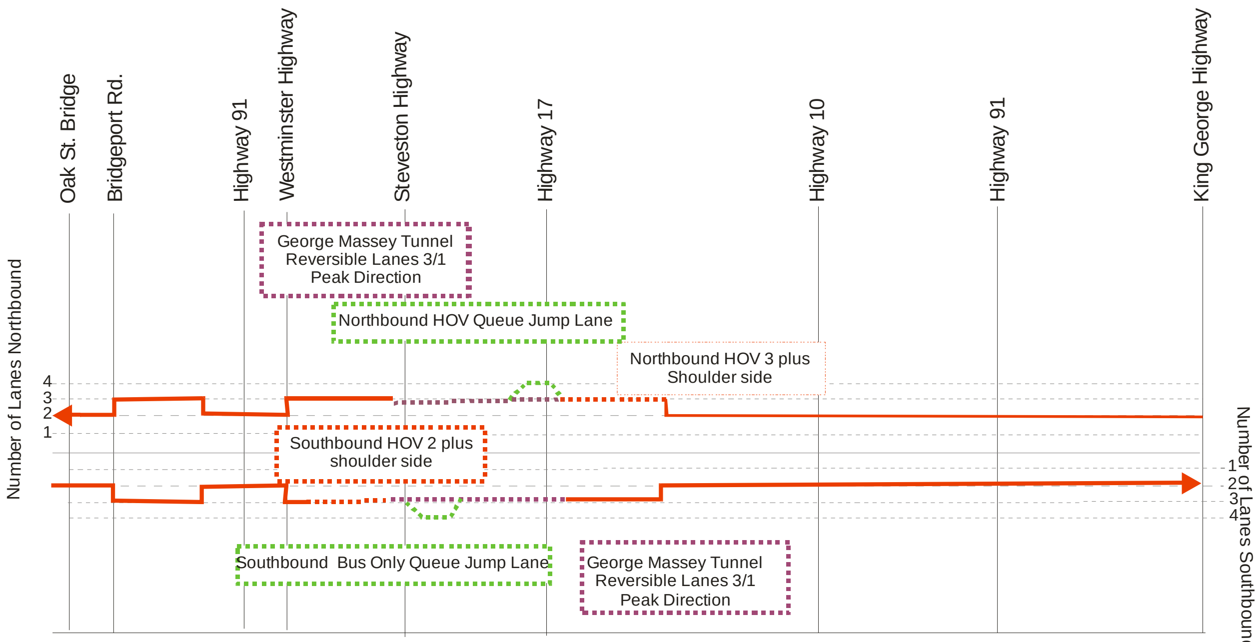


Figure 3.1 - Highway 99 Lane Allocation by Direction

The George Massey Tunnel approaches operate under a signalized lane allocation system which re-organizes the physical two northbound and southbound tunnel lanes such that three peak direction lanes and one off-peak direction lane are made available during peak periods.

As well, there are northbound and southbound HOV lanes at the George Massey Tunnel approaches. Northbound HOV eligibility was originally established as plus 6 persons in 1998 but has been successively reduced to plus 3 since. Similarly, the southbound HOV eligibility was also established at plus 6 and has also been successively reduced to plus 2. A northbound HOV queue jump was also implemented in 1998. This queue jump begins at the signalized intersection of the Highway 99 northbound off-ramp signal and Highway 17 with an HOV only pre-emptive signal phase that allows HOV vehicles priority access to a northbound HOV lane leading to the tunnel. The HOV only lane terminates just prior to the George Massey Tunnel portal where HOV traffic must merge with general purpose (GP) traffic. A southbound transit only queue jump was implemented in 2008. This queue jump begins at the Steveston interchange and proceeds south using a decommissioned Ministry truck inspection area. TransLink buses bypass southbound tunnel queues and re-enter GP travel lanes at the tunnel entrance.

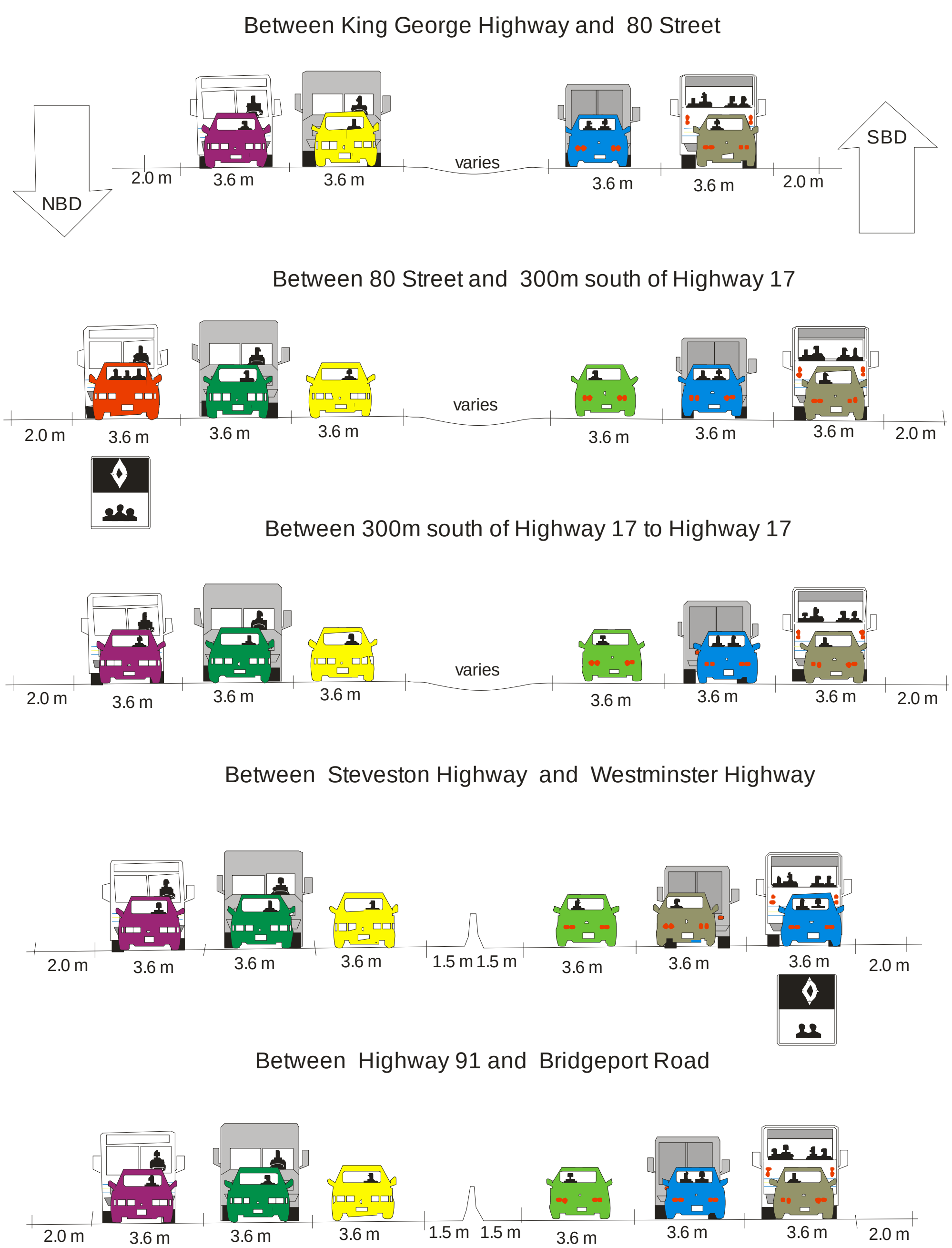
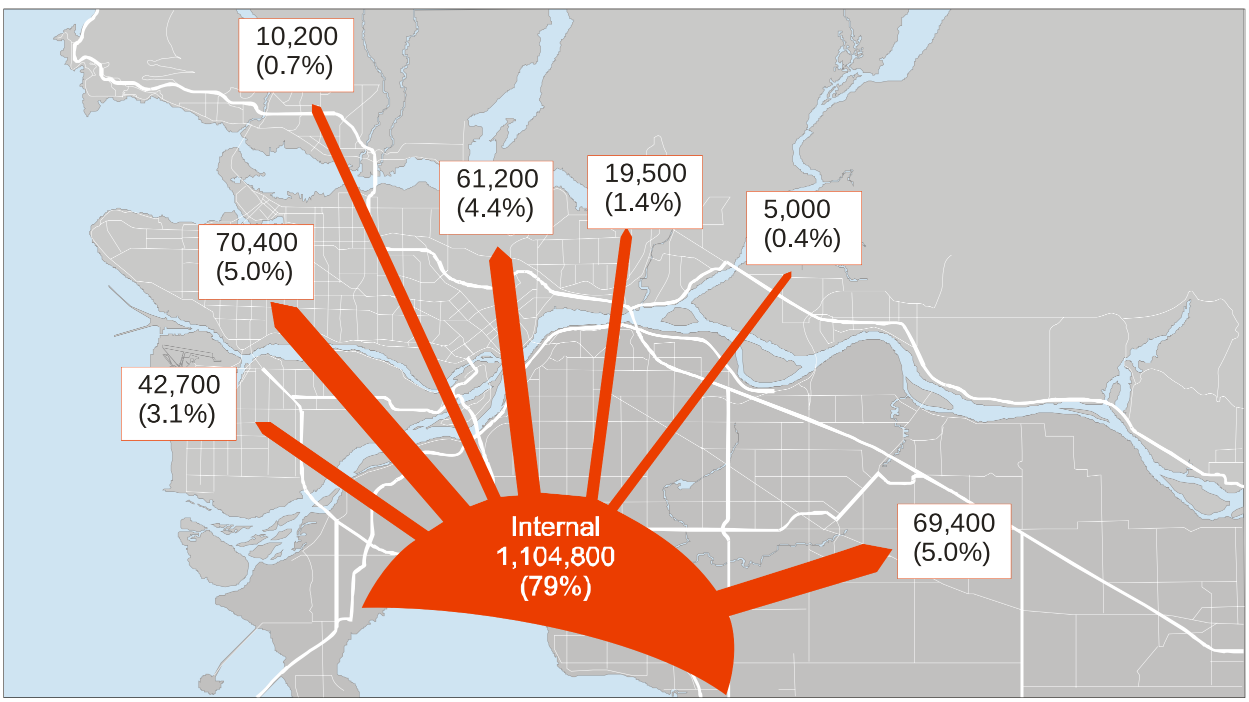


Figure 3.2 – Highway 99 Cross-Sections

The shoulder widths along the corridor narrow to 0.5 meters at most bridge and interchange structures. In locations where there is no median barrier the median width varies from 8 to 12 meters.

4.0 HIGHWAY 99 TRAVEL DEMAND

Figure 4.1 describes the typical weekday 24 hour trip generation from the Surrey, Delta, White Rock Area (including US border traffic). As can be seen approximately 120,000 daily trips are destined to Richmond, Vancouver and the North Shore. Approximately 50% of this demand of this demand is served by Highway 99.



Source: South of Fraser Transit Plan, TransLink

Figure 4.1 – Surrey, Delta, White Rock 24 Hour Trip Destinations

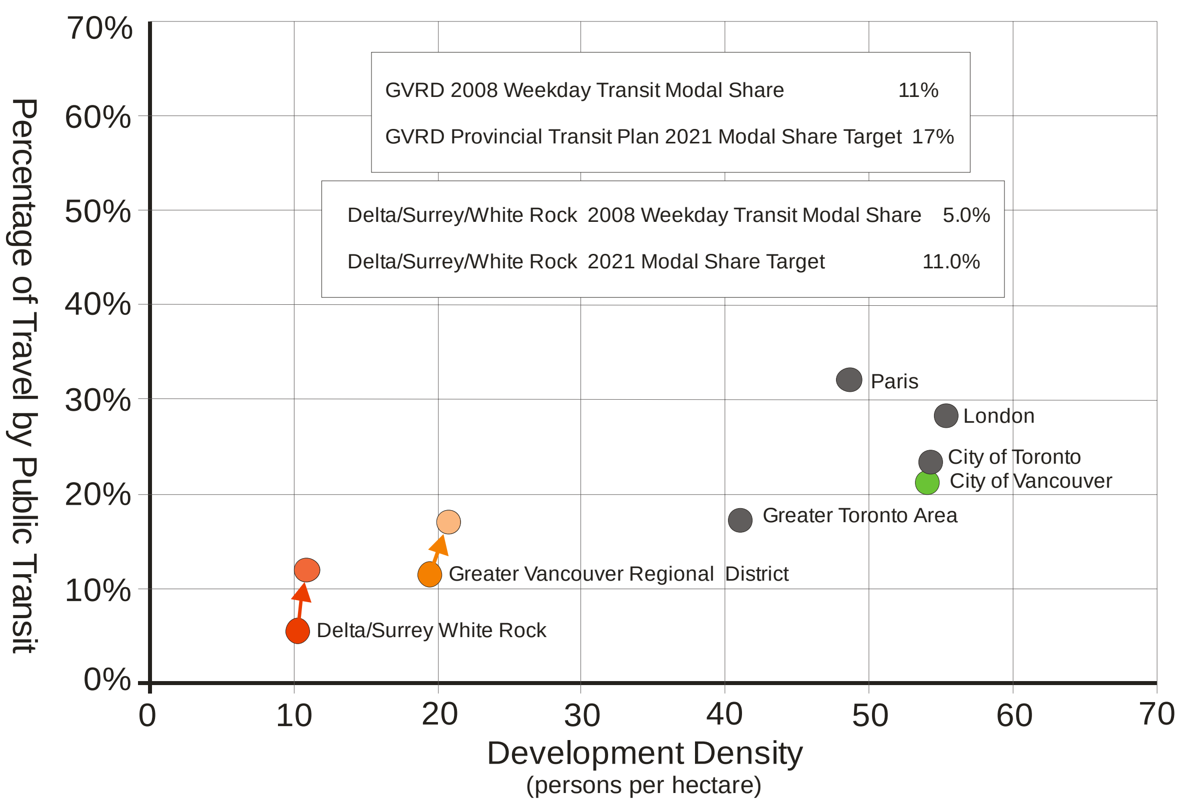
The two way Highway 99 corridor AADT ranges from 8,800 vehicles at the US border and peaks at the George Massey Tunnel with 94,600 vehicles. Table 4.1 provides a summary of total AADT's and SADT's at various corridor locations.

Table 4.1 Highway 99 Total AADT's and SADT's

	2008 AADT	2008 SADT
North of US Border	8,800	11,900
North of 32 Ave	51,000	54,000
North of Highway 91	48,400	51,200
George Massey Tunnel	94,600	99,700
Bridgeport Road	44,000	46,500

Source: BC Ministry of Transportation and Infrastructure

The Delta, Surrey, White Rock portion of the GVRD currently has a transit modal share of approximately 5%. Figure 4.2 describes modal shares for this area, the GVRD, City of Vancouver and other major jurisdictions.

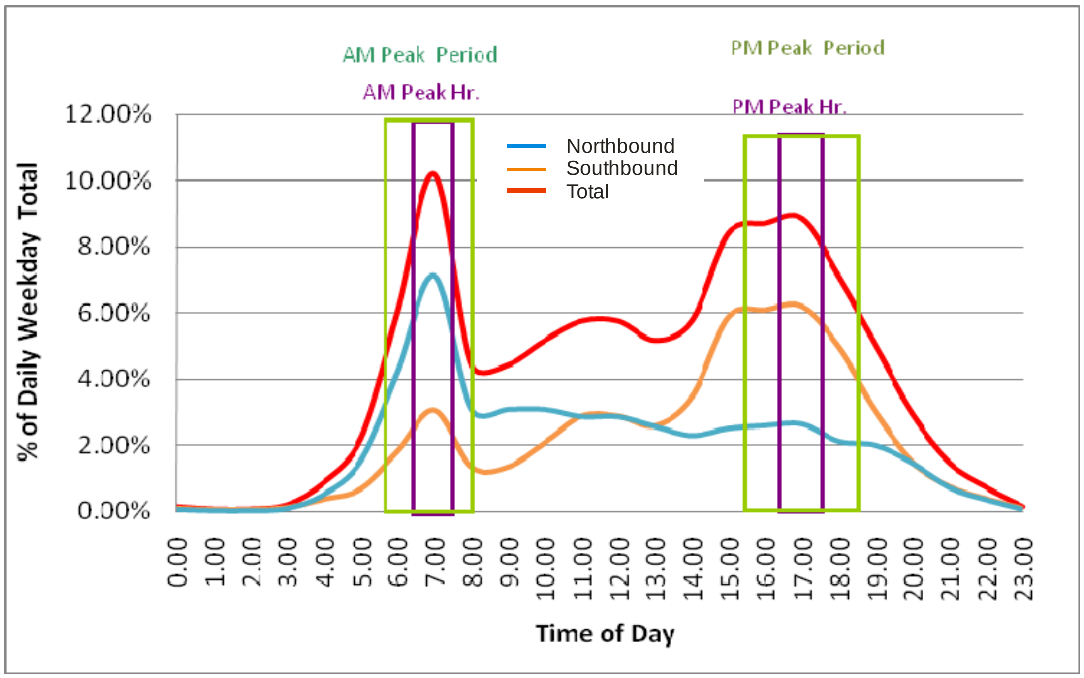


Source: South of Fraser Transit Plan

Figure 4.2 – Percentage of Travel by Transit in the GVRD and other Jurisdictions

The recently completed Provincial Transit Plan (PTP) has set a goal for increasing the modal share target of the GVRD from 11% to 17% by 2021. In order to achieve the regional modal share target the South of Fraser Area will have to increase its modal share form 5% to 11%.

Figure 4.3 describes the weekday hourly distribution of southbound, northbound and total vehicular demand on Highway 99, as well as the weekday AM and PM peak periods and peak hours. The peak periods account for approximately 50% of total daily demand.



Source: TransLink 2006 Travel Diary

Figure 4.3 - Highway 99 Weekday Hourly Vehicle Demand Distribution

The corridor serves auto, truck and transit modes. Truck demand ranges between 7% and 12%. The corridor supports the operation of the 10 TransLink bus routes shown in Figure 4.4. The bus routes generate 40 buses per hour at the peak load point (Bridgeport Road) in the peak direction.

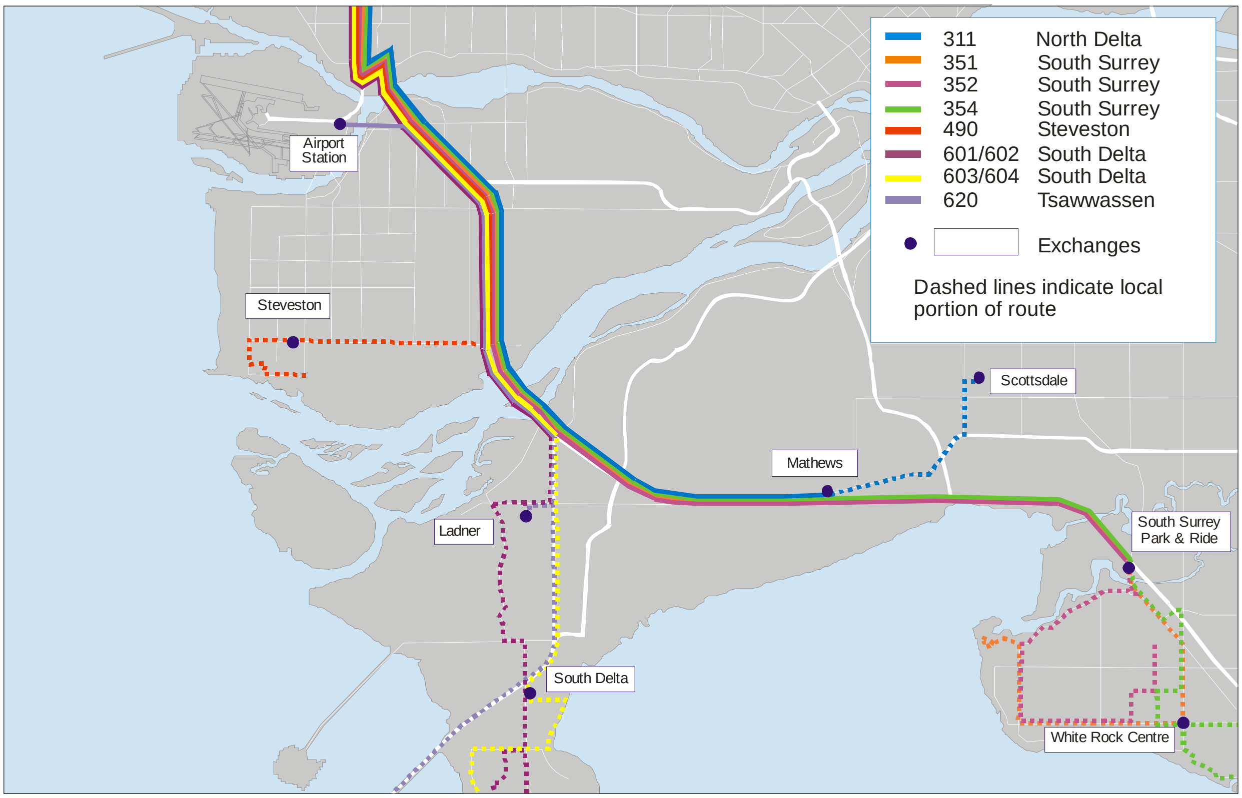


Figure 4.4 – TransLink Bus Routes Using Highway 99

All of the bus routes operating on Highway 99 circulate through their respective service areas as local buses and then operate as express buses on the Highway. There are only two stop locations on the highway in both eastbound and westbound directions; at the Mathews Exchange at Highway 10 and the Steveston Highway. In both instances buses leave and re-enter the highway via interchange ramps.

This portion of Highway 99 does not support cycling. This is primarily because of physical constraints posed by the Massey Tunnel (no shoulders through the tunnel) as well as the complexity induced by the tunnel lane control system. Buses operating on Highway 99 are equipped with bus racks.

Figures 4.5 and 4.6 describe the 2008 AM and PM corridor peak hour vehicular demand by mode in the peak direction of travel.

Figures 4.7 and 4.8 describe the 2008 AM and PM corridor peak hour person demand for auto/truck and transit modes in the peak direction of travel.

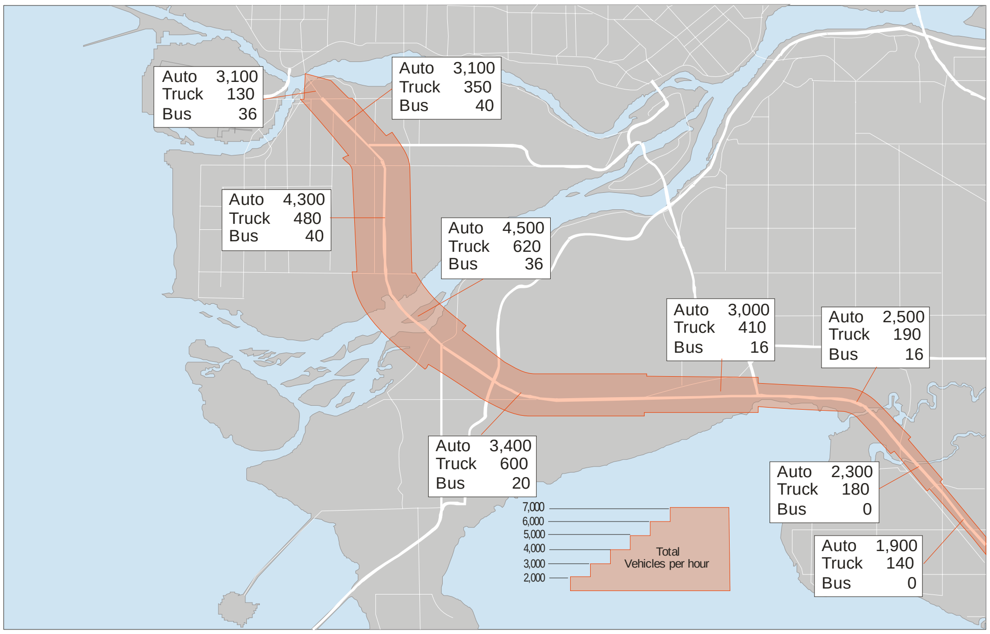


Figure 4.5 – Northbound AM Peak Hour Vehicular Demand on Highway 99

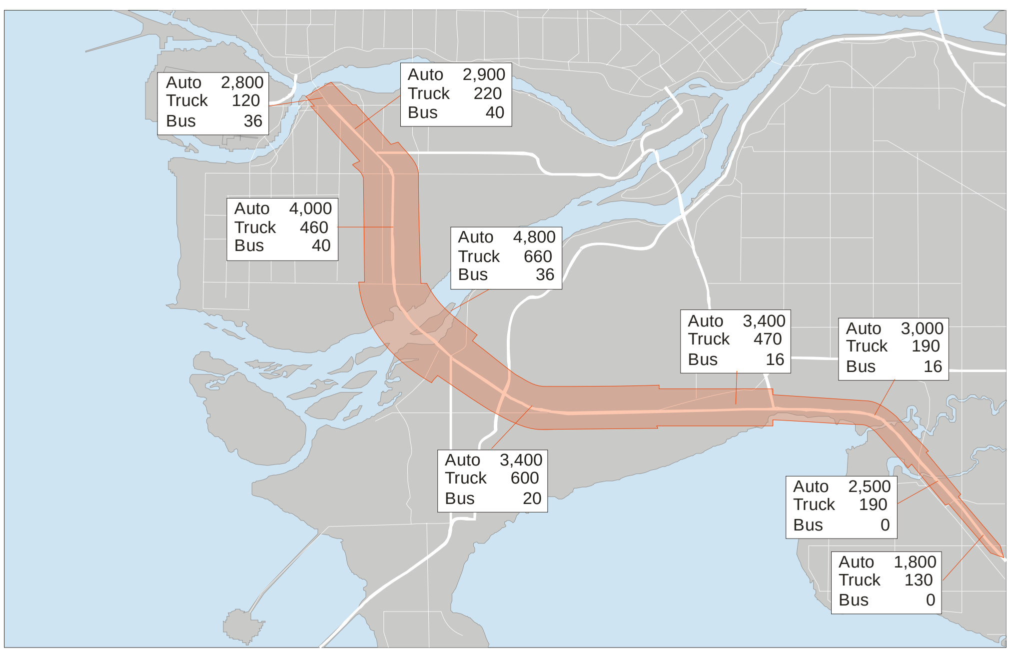


Figure 4.6 – Southbound PM Peak Hour Vehicular Demand on Highway 99

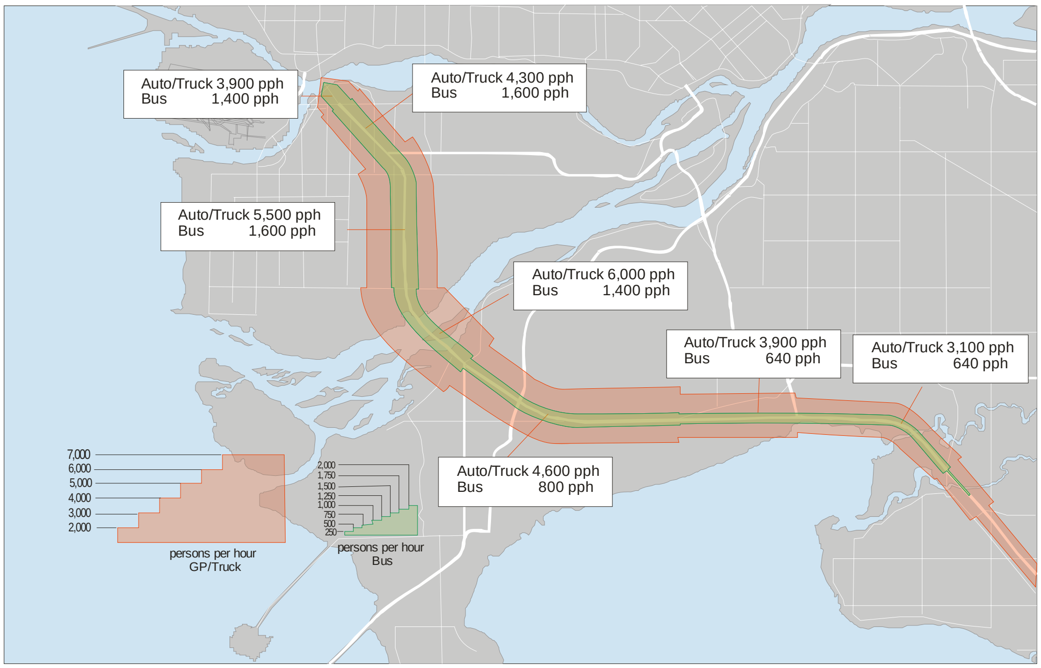


Figure 4.7 – Northbound AM Peak Hour Person Demand on Highway 99

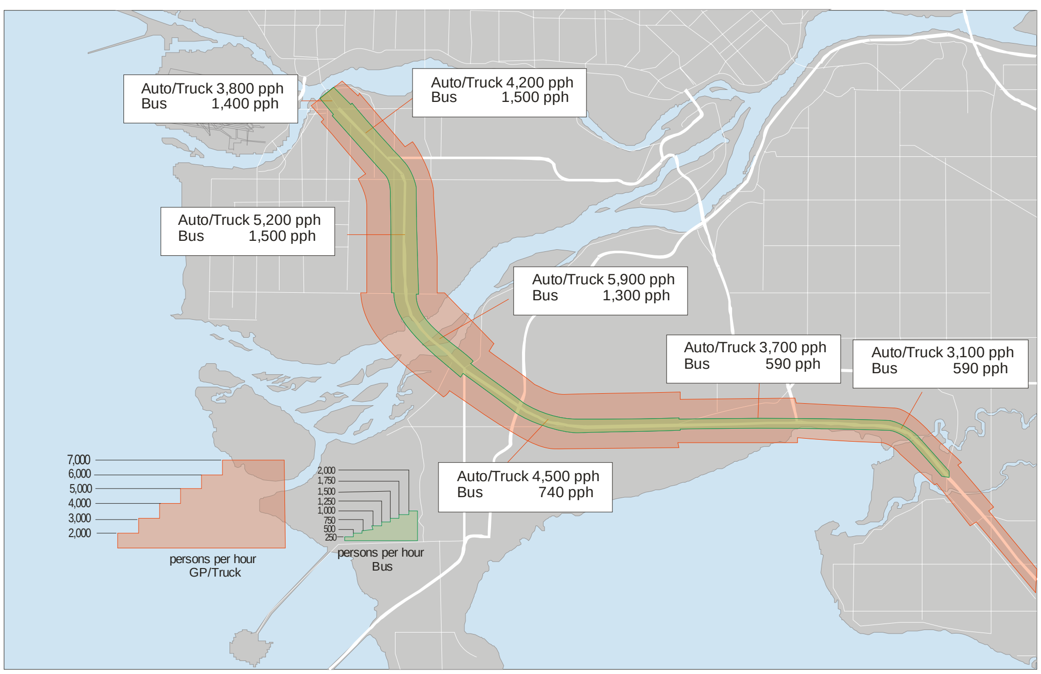


Figure 4.8 – Southbound PM Peak Hour Person Demand on Highway 99

It is interesting to note that although the numbers of buses on the corridor represent less than 1% of the vehicular demand, the person demand accommodated by buses on the highway ranges from 17% to 26%.

5.0 QUALITY OF SERVICE AND SAFETY PERFORMANCE

The quality of service on "free flow" facilities is described by the speed flow relationship that ascribes level of service based on the density of the traffic flow and the resultant speed achievable. Figure 5.1 describes the speed flow curve calibrated to BC Lower Mainland highway conditions.

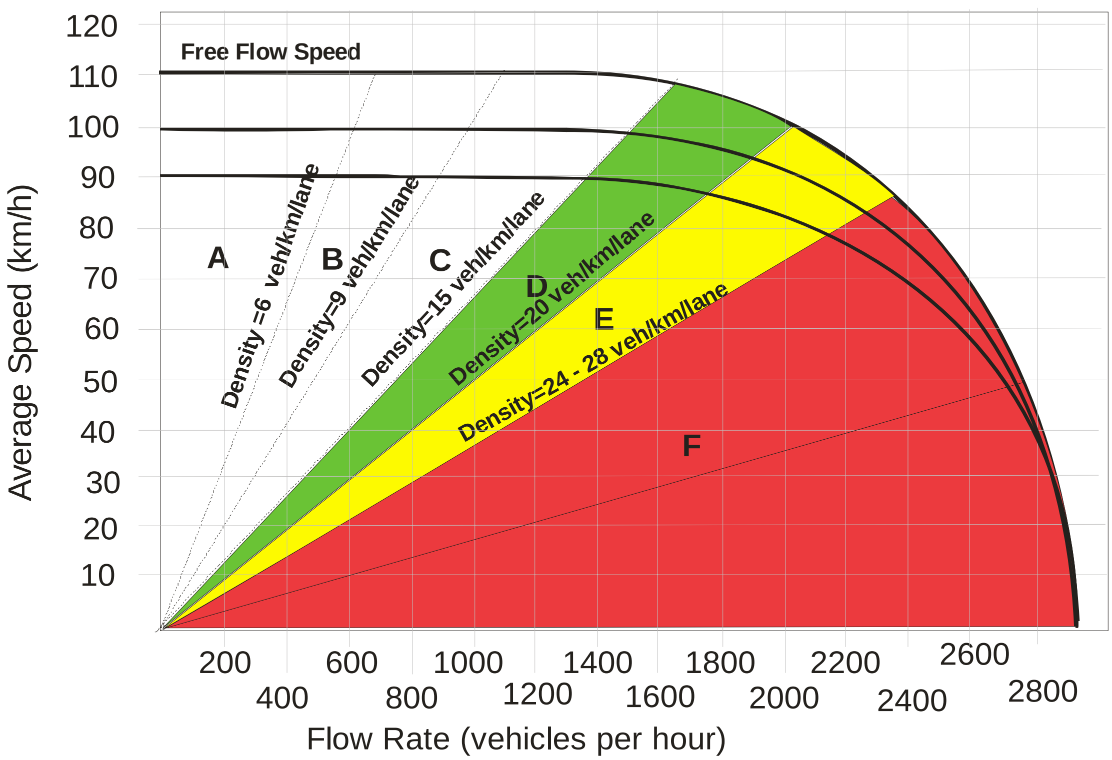


Figure 5.1 – Speed, Flow Rate, and Service Levels

Figures 5.2 and 5.3 describe the range of speeds in the peak direction of travel along Highway 99 from King George Highway to the Oak St. Bridge in the weekday AM and PM peak periods. The Figures also show the average peak hour speeds for GP traffic and transit buses.

The northbound speed variation during the AM peak period, between the King George Highway and Highway 91 is caused by peak demands which result in vehicle densities that can drop speeds to 30 km/h for short intervals. There is a significant "off-load" to Highway 91 which reduces vehicular density and thereby reduces the speed variation to more typical ranges. With the addition of southbound demand from Highways 91, 10, and 17 the peak period demand significantly exceeds the available tunnel capacity. This results in speeds dropping to 10 km/h at the tunnel approaches. These effects rebound as far back as 80th St. Average bus speeds between King George Highway and 80th St. drop below GP speeds because buses must exit for passenger exchange at Highway 10. From this point to the tunnel average transit speeds are faster than GP speeds because of northbound HOV accommodation.

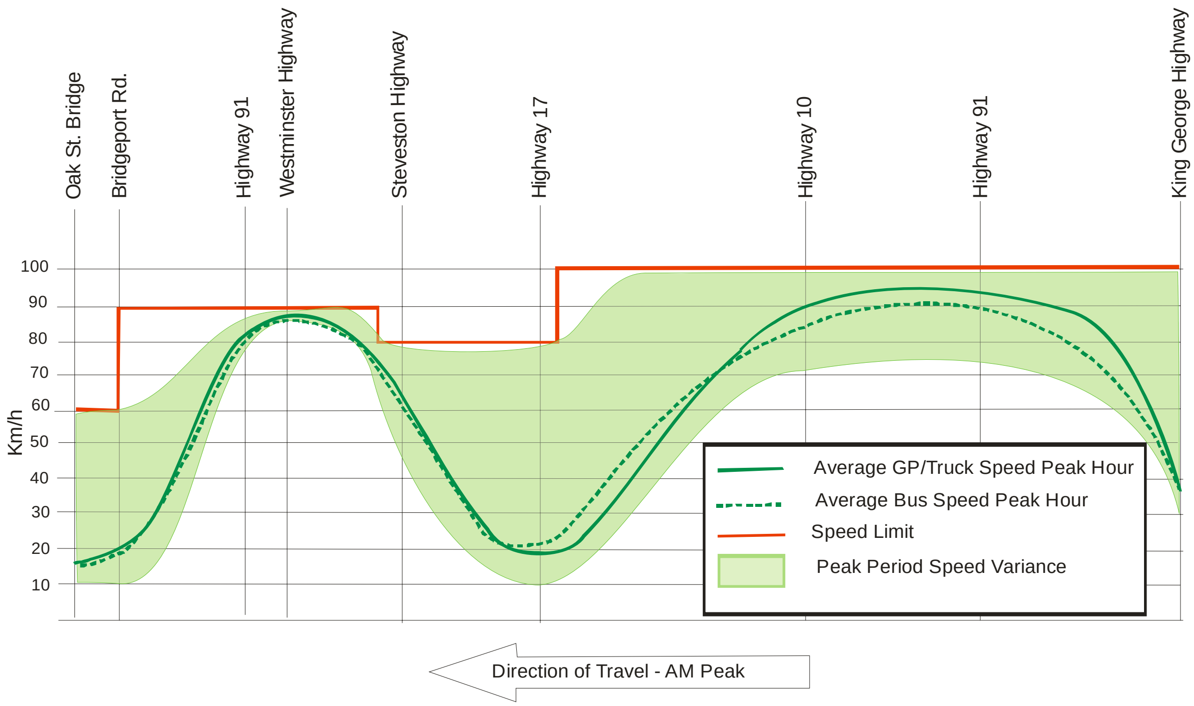


Figure 5.2 – Northbound AM Peak Period Speeds on Highway 99

Northbound through the tunnel transit and GP speeds increase to near posted speeds. Transit average speeds drop slightly because buses must exit and re-enter the Highway for passenger exchange at the Steveston Highway. Northbound buses and GP buses maintain the posted speed (90 km/h) to the Westminster Highway. Capacity constraints north of the Oak St. Bridge result in a significant increase in vehicle density which induce speeds as low as 10 km/h for buses and GP traffic. The impact of this capacity constraint is felt as far back as Westminster highways during the AM peak period.

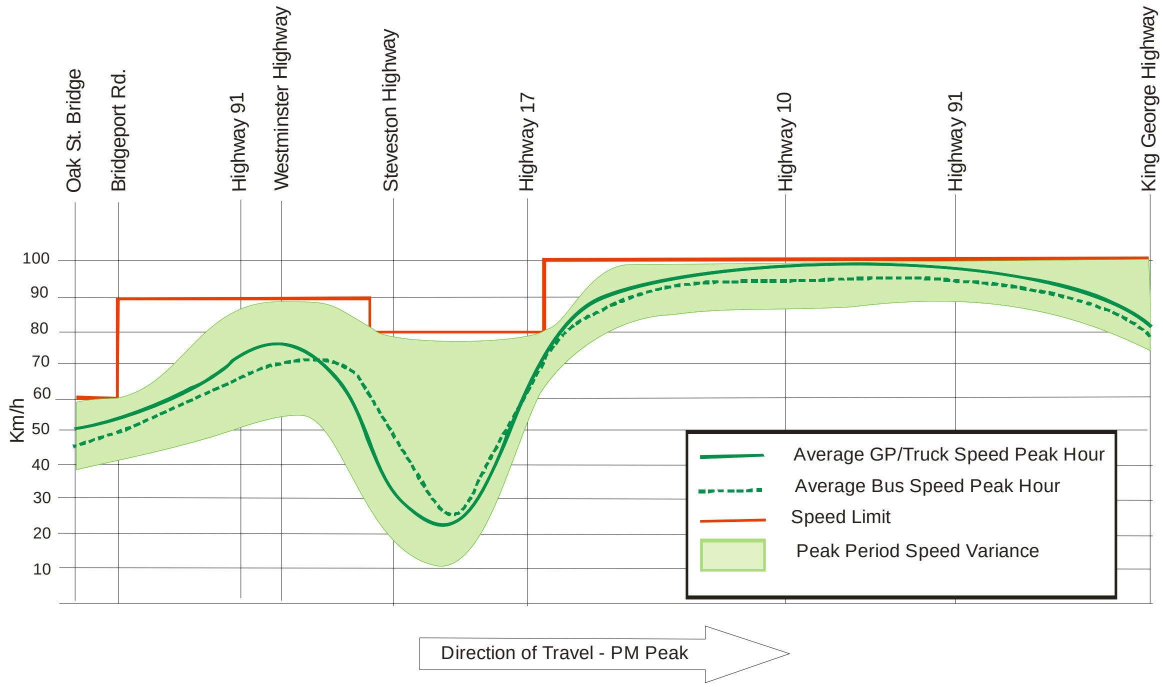
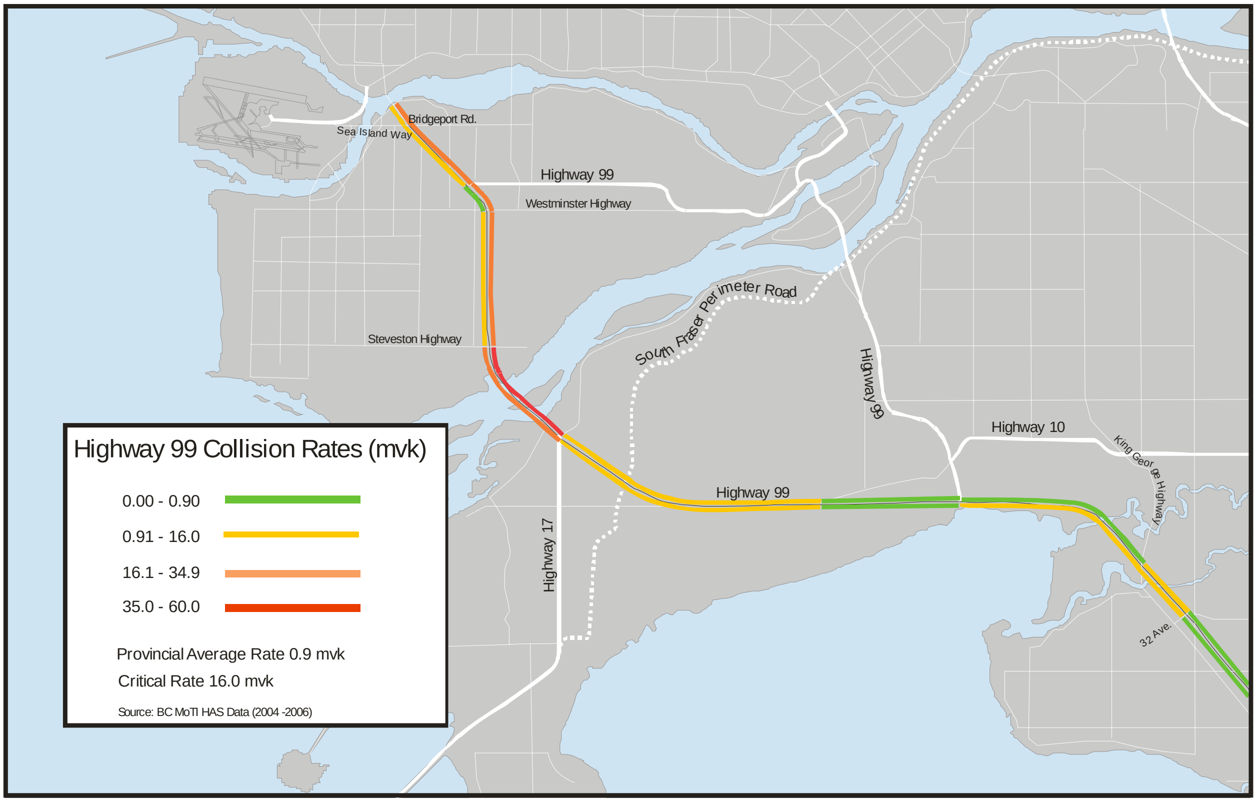


Figure 5.3 – Southbound PM Peak Period Speeds on Highway 99

In the southbound direction during the PM peak period buses and GP traffic experience relatively modest speed variation between the Oak St. Bridge and Westminster Highway. Transit and GP traffic achieve average speeds slightly lower than the posted speeds on this portion of the highway. South of Westminster Highway the effects of congestion at the George Massey Tunnel begin to affect bus and GP average speeds. With the addition of southbound demand from Highway 91 and Westminster Highway the southbound demand significantly exceeds the capacity available at the George Massey Tunnel. This results in similar speed variation to those experienced in the southbound direction in the AM peak period. Southbound buses achieve higher average speeds from Westminster Highway to Highway 17 as a result of the southbound HOV lane and George Massey Tunnel Queue jump lane. From Highway 17 to the Highway 91 speed variation for southbound buses and GP traffic is relatively low with average speeds very near the posted speed limit. Buses have slightly lower average speeds than GP traffic because buses must leave and re-enter the highway for passenger exchange at Highway 10. Between Highway 91 and King George Highway the peak period highway density increases to levels where average speeds for buses and GP traffic can drop 70 km/h for short durations.

Figure 5.4 illustrates the safety performance of the corridor in terms of collision rates (collisions per million vehicle kilometres). Figure 5.5 describes the various causes of these collisions.



Source: BC Ministry of Transportation and Infrastructure HAS System (2006 data)

Figure 5.4 – Highway 99 Collision Rates

Source: BC Ministry of Transportation and Infrastructure HAS System (2006 data)

Figure 5.5– Highway 99 (Oak St. Bridge - King George Highway) Collision Types

Between 32 Ave. and King George Highway in South Surrey the collision rate exceeds the provincial average rate. The majority of collisions are "rear end" and "off road right". This collision profile is typical for vehicle density levels that this portion of the highway experiences. Between the King George Highway and Highway 10 both directions of travel are generally within the average provincial rate. From Highway 10 to Highway 17 both directions of travel exceed the provincial average rate. This is again attributable to peak period vehicle density. Between Highway 17 and the Steveston Highway (George Massey Tunnel section) the collision rates significantly exceeds the provincial average rate. This results from head on collisions in the contra flow lanes of the tunnel as well as very high vehicle densities. Various locations on this segment rank 38th and 56th on the list of provincial critical safety locations. Between Steveston Highway and the Oak St. Bridge virtually the entire section of highway in both directions exceeds the provincial average rate, the northbound direction being more critical. The collision rates in this segment are consistent with the peak period vehicle densities that occur.

6.0 TRANSIT SERVICE LEVELS

From a capacity perspective, the allowed passenger load on a bus (set by policy) constrains the number of people that a given number of buses can carry. From a passenger's perspective, loading reflects the comfort level of the on-board portion of a bus trip—both in terms of being able to find a seat and in overall crowding levels within the bus. From a transit operator's perspective, liability concerns and the desire to provide every customer with a seat for high-speed or long-distance services may cause the operator to set the allowed loading at levels lower than what riders might tolerate.

The *passenger load* is simply the number of passengers on a single transit vehicle. The occupancy of the vehicle relative to the number of seats, defines the load factor. A factor of 1.0 means that all of the seats are occupied. The importance of vehicle loading varies by the type of service. In general, bus transit provides load factors below 1.0 for long-distance commuter trips and high-speed, mixed-traffic operations such as those on Highway 99.

In an effort to manage crowding, while at the same time run an efficient and effective transit service, TransLink worked with area municipalities on the development of service design guidelines. In June 2004, the GVTA approved new *Transit Service Guidelines* that provide objective rationale for the allocation of transit resources. As the title suggests, these guidelines are used as "tools" for evaluating system conditions and making decisions on the provision of new services as well as adjustments to the design of existing services. Although many of the guidelines are set as minimum or maximums to achieve desired "optimum" conditions for the customer and operator, they are not treated as rigid standards. In other words, the guidelines are typically used by transit planners and operators to best manage the system on behalf of all interests. The guidelines are designed with the flexibility to achieve the following:

- Form a consistent basis for service planning;
- Evaluating and monitoring the performance of individual routes and making adjustments as necessary;
- Developing annual budgets to provide service that support the guidelines; and
- Providing transparency to transit customers, the general public and decision makers on the expected levels of service and performance.

Table 6.1 describes Transit Service Design Guidelines with respect to vehicle passenger loads for buses allocated to the South of Fraser Bus routes.

Table 6.1 TransLink Transit Service Guidelines
Passenger Loads

Bus Type	Peak 15 minutes In AM & PM Peak periods	Peak 30 minutes In AM & PM Peak periods	Weekday Midday & Evening, Weekends Peak 60 minutes
Maximum Number of Passengers On-Board (standees in brackets)			
12 m Highway Coach (47 Seats)	50 (3)	47 (0))	47(0)
18 m Low Floor Articulated Coach (54 seats)	85 (31)	75(21)	65(11)
These guidelines are for the highest passenger loads averaged for all bus trips on a route within the busiest 15 minutes and 30 minutes in peak periods and over 60 minutes in off-peak. Passenger loads on some individual bus trips may exceed the guidelines.			

The bus allocation to each South of Fraser route currently results in a spare peak period capacity of 20% for each routes It is assumed that TransLink will continue the provision of bus capacity on the same basis in the future.

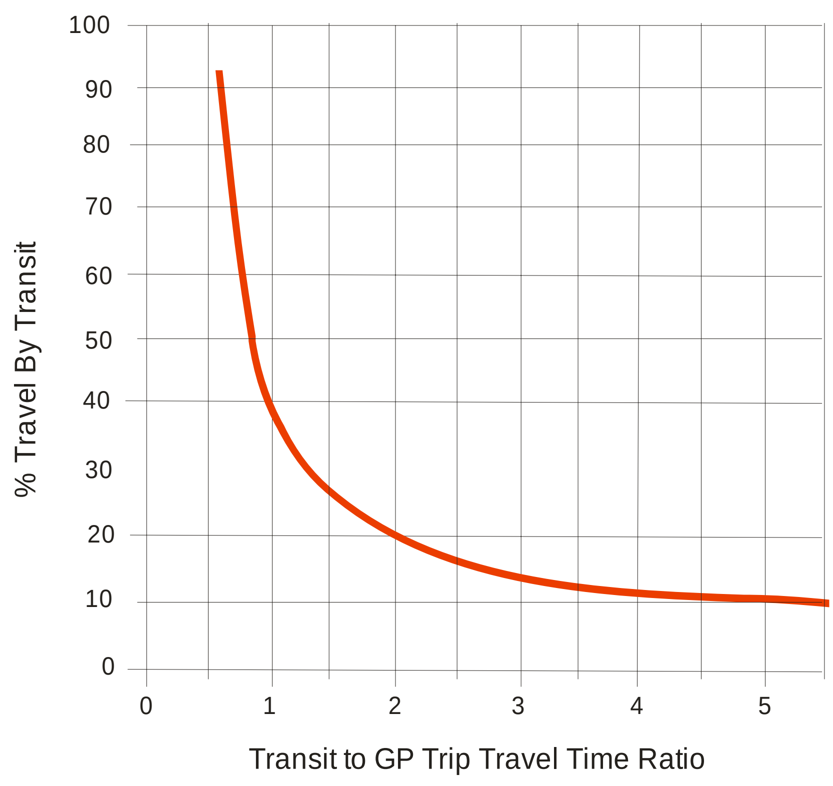
7.0 ISSUES

The congested peak period conditions on the Oak St. Bridge and Massey Tunnel approaches and the resultant safety performance pose the most significant service quality and safety issues along the corridor. Bus services and higher occupancy vehicles on the corridor experience slightly better operating conditions than single occupant GP traffic as a result of HOV and bus accommodations provided. However transit operations in terms of schedule reliability and operating efficiency, are particularly affected by the dramatic variance in average operating speeds along the corridor. The collision and incidence frequency further erodes transit schedule reliability. Goods movement along the corridor experience similar effects. With the Delta Port using a just in time truck reservation system truckers are adjusting to the reliability issue by arriving earlier and then parking on Highway 17.

8.0 FUTURE CONDITIONS

Based on projected land use changes it is expected that travel demand on the Highway 99 corridor will increase 36% by 2021 and another 50% from 2021 to 2031. Given that there are no current plans to expand the capacity of Highway it is unlikely that such growth could occur without a major shift to the transit mode. To effect such a shift transit operations on the corridor would have to be significantly improved in terms of reliability and efficiency and transit would have to perform significantly better than GP based travel.

Figure 8.1 describes the relationship between transit and auto based travel times and resultant mode splits for work trips (includes school trips). Travel times are total times from trip origin to trip destination for each mode.



Source: Metropolitan Transportation Planning (John W. Hickey, Robert C. Stewart, Richard D. Walker)

Figure 8.1– Modal Shares Associated with Transit to GP Travel Time Ratios

Given that the majority of travel in the AM peak hour is work related the applicability of the curve shown in Figure 8.1 can be confirmed. The current total travel time averages by bus and car (derived from 2008 AM Peak travel surveys) from White Rock/South Surrey to the Vancouver CBD are estimated to be: 83 minutes and 125 minutes respectively. This produces a transit to GP travel time ratio of 1.51. Figure 8.1 predicts a transit/GP mode split outcome of 25% with such a travel time differential. The current peak hour mode split at the peak load point is measures at 24% indicating that the relationship is valid for this highway corridor.

Based on this relationship it is estimated that the Transit to GP ratio needed to effect a doubling in mode split is 0.80. This implies a significant increase in transit travel time as well as a significant deterioration in GP travel times.

8.1 Canada Line Integration

In Augustl of 2009 the new Canada Line Rapid Transit Line will initiate services between Richmond, the Vancouver International Airport, and Downtown Vancouver. The Bridgeport Canada Line Station intercepts the Highway 99 Corridor near the Oak St. Bridge. Given the limited opportunity for transit accommodation on Vancouver north-south arterial roadways including those that are utilized by South of Fraser buses, TransLink determined that the most effective transit delay mitigation for South of Fraser routes was to terminate the routes at the Bridgeport Canada Line Station and transfer passengers to the Canada Line to complete Vancouver portions of their trip. This would provide significant delay reductions for passengers continuing their trip to Vancouver destinations. Table 8.1 provides a comparison of travel times associated with this a strategy. Figure 8.1 describes the proposed re-routing of South of Fraser Bus routes.

Table 8.1 Travel Time Comparisons For Terminated South of Fraser Bus Routes

Weekday AM Peak Period		
	Former Bus Only	Bus/Canada Line
Southbound Average Run Time (min)	66	58
run time variation (min)	13	3
Weekday PM Peak Period		
	Former Bus Only	Bus/Canada Line
Southbound Average Run Time (min)	78	64
run time variation (min)	21	16

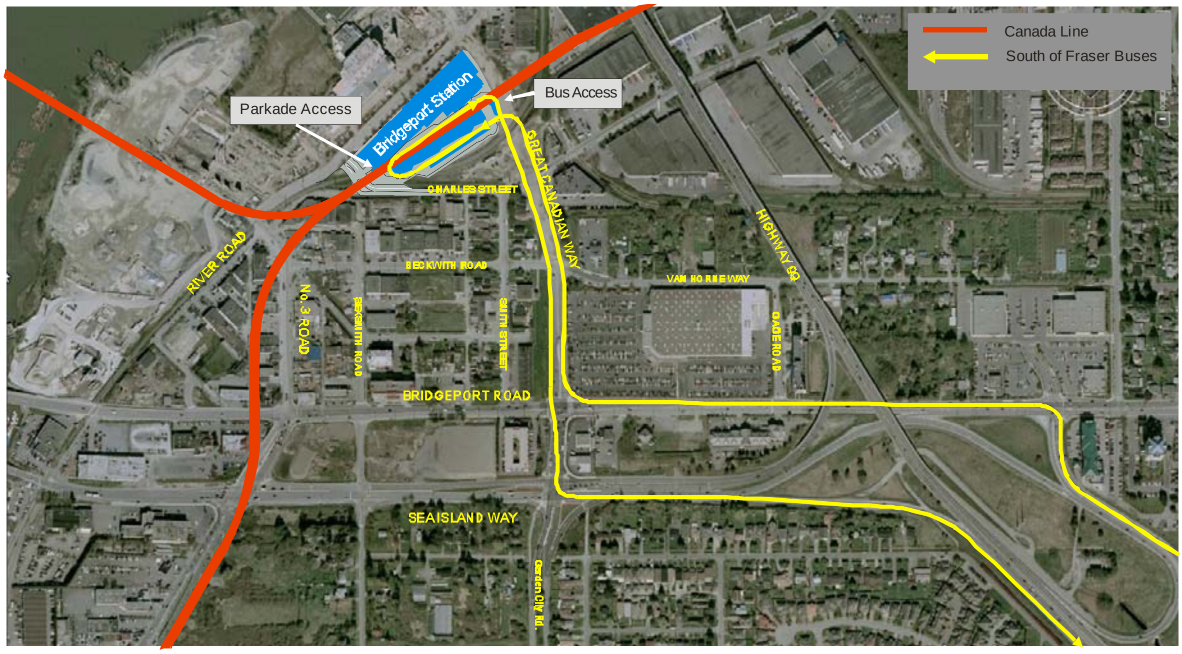


Figure 8.1 South of Fraser / Canada Line Transit Service Integration

Times are in minutes and reflective of buses travelling between Burrard Station in the Vancouver CBD and the South Surrey Park& Ride. The Bus/Canada Line Trip Assumes a 5 minute transfer time once buses reach the Canada Line Station. This strategy by itself will reduce peak direction transit travel times from South Surrey and the Vancouver CBD by 8 and 14 minutes in the AM and PM peak periods. Bus run time variance is reduced by 77% and 25% in the AM and PM peak periods.

The northbound AM peak period bus delay is affected by congestion on Highway 99 approaching Bridgeport Road and traffic signal delays along Bridgeport Road. In order to further reduce AM peak period delay the Ministry of Transportation and Infrastructure is constructing a northbound shoulder bus lane from Highway 91 to Bridgeport Rd. The construction of a NBD transit only lane between Westminster Highway and Bridgeport Rd. off-Ramp will save an additional 4 minutes in AM peak direction transit delay.

The signal delay along Bridgeport Road and Seas Island Way will be mitigated by provision of transit signal priority (TSP) on Bridgeport Road and Sea Island Way. Figure 8.2 describes the signalized intersections that will provide transit signal priority. Table 8.2 describes the time savings achievable with the implementation of the Bridgeport Rd./Sea Island Way TSP.

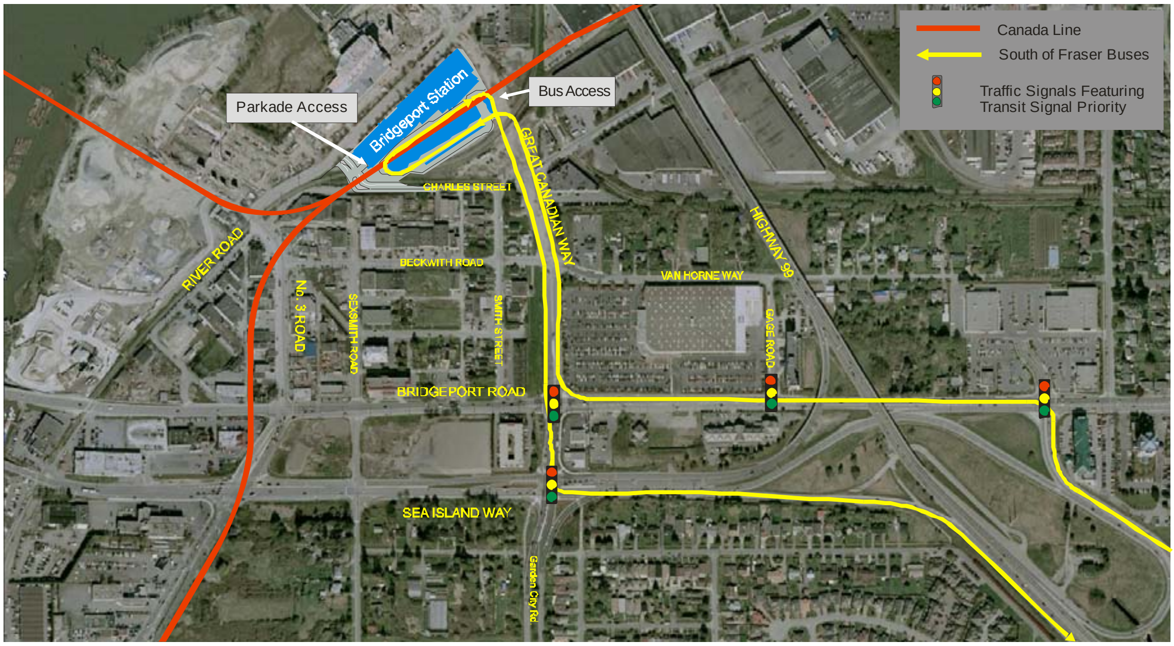


Figure 8.2 – Bridgeport Rd. /Sea Island Way Transit Signal Priority Intersections

Table 8.2
2009 Bridgeport Station Access Times

Scenario	AM Peak		PM Peak	
	Inbound	*Outbound*	*Inbound*	*Outbound*
Canada Line Open No TSP	2:25	2:35	3:00	3:45
Canada Line With TSP	1:50	2:00	2:05	2:25

Times represent minutes and seconds

As can be seen the TSP will reduce peak period station access times by South of Fraser buses by about a minute in the peak direction of travel.

Table 8.3 provides comparisons of bus only and bus/Canada Line transit travel times with northbound transit shoulder bus lane and Bridgeport Rd. /Sea Island Way TSP implemented.

Table 8.3 Travel Time Comparisons For Terminated South of Fraser Bus Routes With 2009 Transit Accommodation

Weekday AM Peak Period		
	Former Bus Only	Bus/Canada Line
Southbound Average Run Time (min)	66	53
run time variation (min)	13	2
Weekday PM Peak Period		
	Former Bus Only	Bus/Canada Line
Southbound Average Run Time (min)	78	64
run time variation (min)	21	16

The AM and PM peak direction travel time differences of 13 minutes and 14 minutes provide travel time reductions of 20% and 18% respectively.

9.0 MAINTAINING THE STATUS QUO

Although the South of Fraser bus route termination strategy resolves delay issues from the Oak Street north, deterioration in bus travel times and reliability remain to be resolved south of the Oak St. Bridge. Figures 9.1 and 9.2 describe AM and PM peak Hour GP and transit travel times for 2008, 2021, and 2031 under a "maintain status quo" scenario. (no change in Highway 99 capacity and no additional transit accommodation).

Maintaining the status quo is predicted to increase the Highway 99 portion of 2021 AM and PM peak direction transit and GP travel times by 11 and 10 minutes, while 2031 AM and PM peak direction travel times are predicted to increase by 22 and 33 minutes. Table 9.1 provides estimates of total AM peak period origin to destination travel times between White Rock/South Surrey and The Vancouver CBD for bus and GP modes.

Table 9.1
AM Peak Periods Bus and GP Total Travel Times
(White Rock/South Surrey to Downtown Vancouver)

	AM Peak Hour		
	NBD		
	BUS	GP	Bus to GP Travel Time Ratio
2008	125	83	1.51
2021	145	103	1.41
2031	180	135	1.34

Travel times are in minutes

The transit accommodations that will be in place by the fall of 2009 will provide some mitigation for travel time delay mitigation under future demand. Figure 9.3 identifies the forecast Highway 99 mode splits that could be expected with these modal travel times. The mode splits are predicted to shift by 5% by 2031. The Provincial Transit Plan and South of Fraser Transit Plan Goals of doubling the South of Fraser modal share would require a shift in Highway 99 mode split to move from the current 25% to 50%.

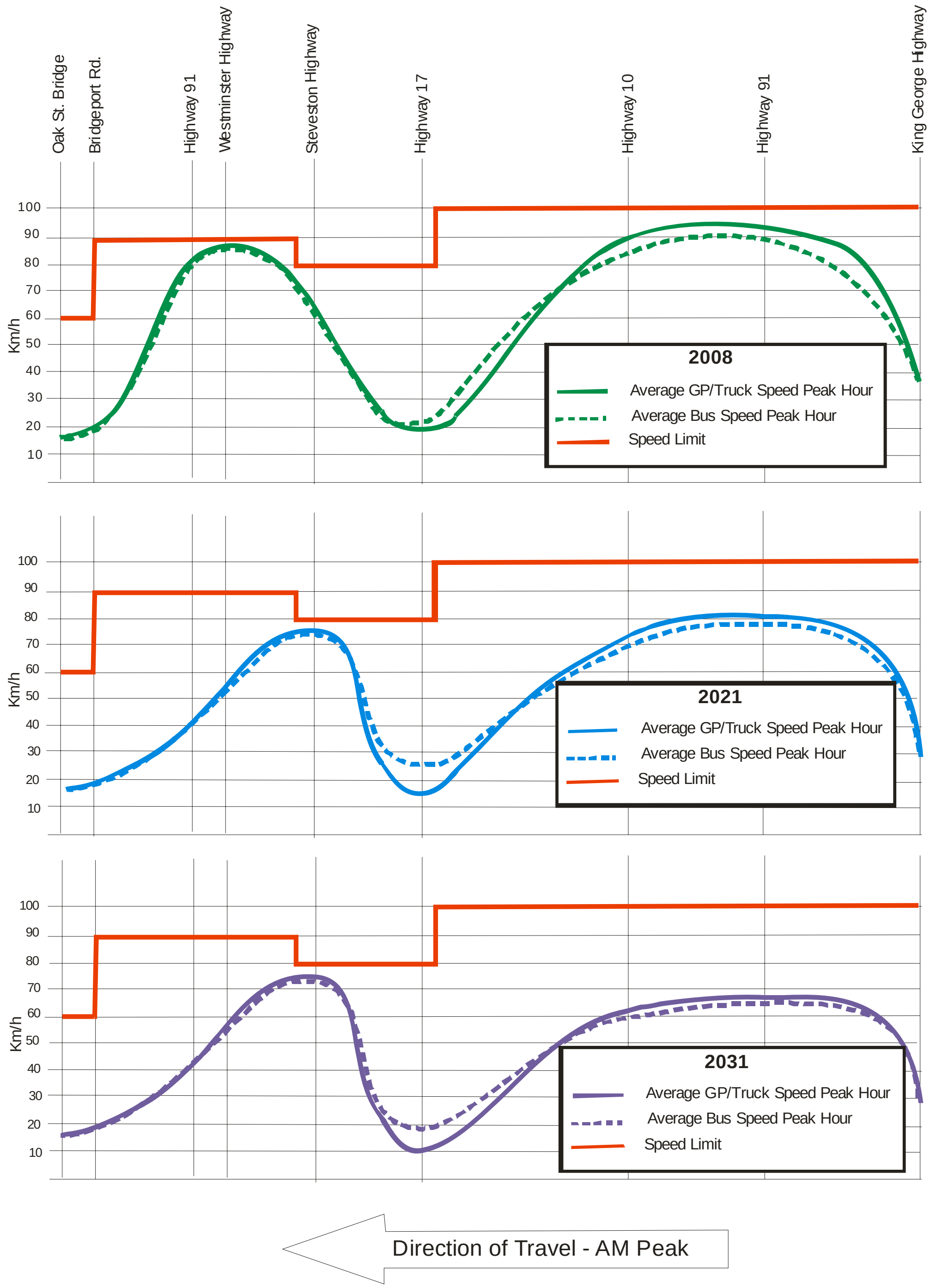


Figure 9.1 – AM Peak Hour Northbound GP & Transit Average Transit Travel Time Changes

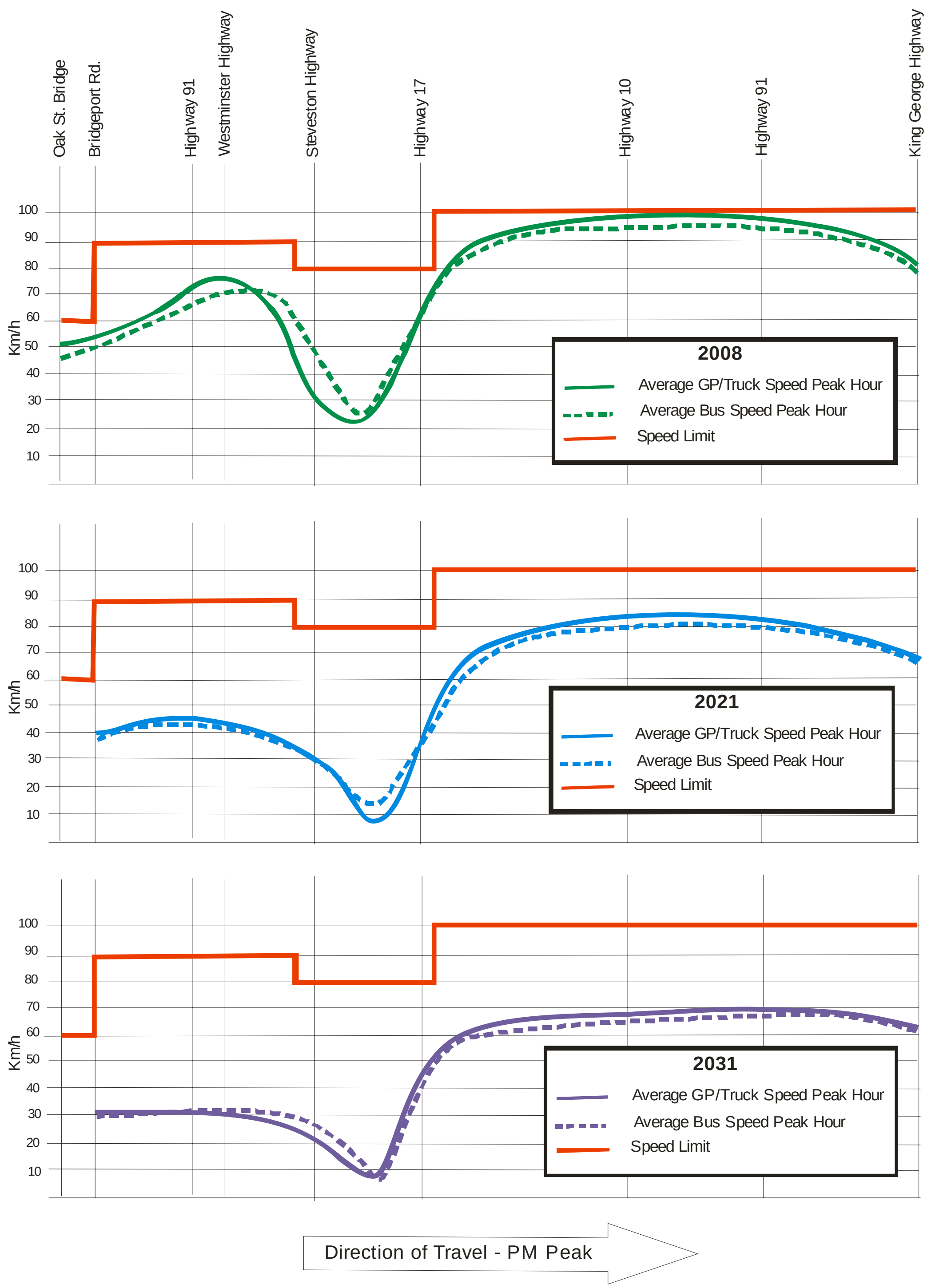


Figure 9.2 – PM Peak Hour Southbound GP & Transit Average Transit Travel Time Changes

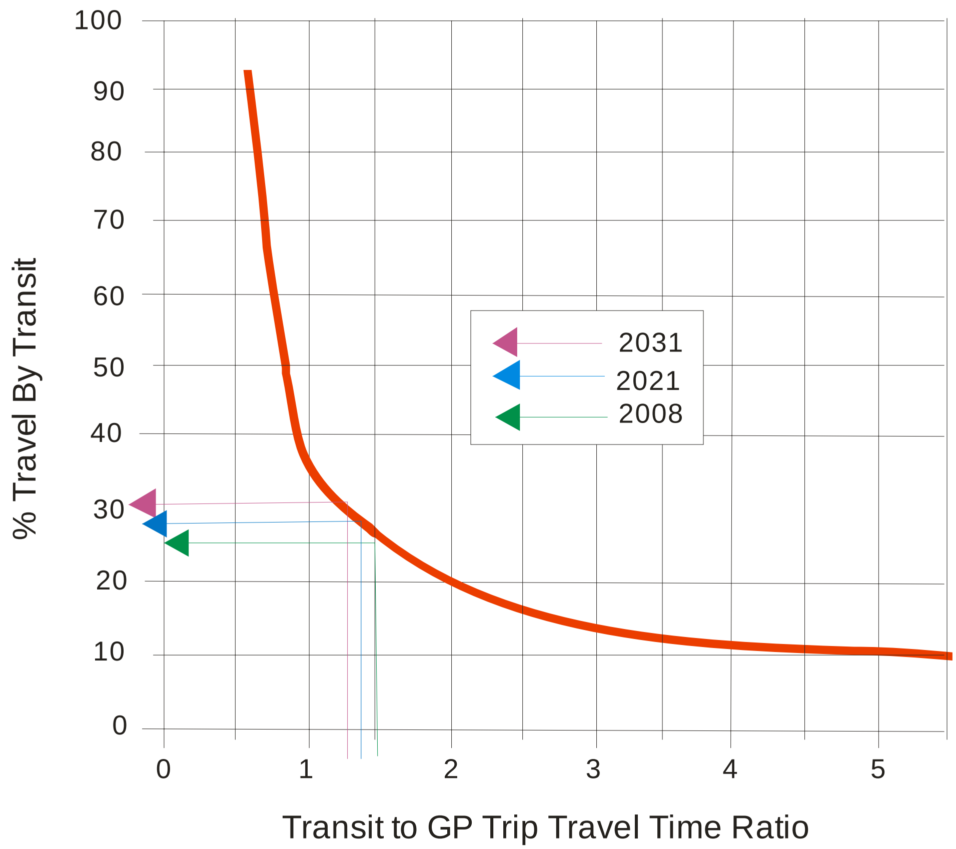


Figure 9.3 – Status Quo Mode Splits on Highway 99 (2021 & 2031)

10.0 DEGREE OF TRANSIT ACCOMODATION REQUIRED

Figures 10.1 and 10.2 describe the AM and PM peak hour travel time savings achievable if buses were accommodated in some form of dedicated lane on sections of Highway 99 that currently have no form of accommodation. Table 10.1 describes the Bus and GP traffic trip times in both the AM and PM peak hour that would result with such additional transit accommodation.

Table 10.1
Predicted Peak Hour Bus And GP Travel Times on Highway 99
(South Surrey Park & Ride to Bridgeport Off-Ramp)

	AM Peak Hour		PM Peak Hour	
	NBD		SBD	
	GP	Bus	GP	Bus
2008	32	44	36	50
2021	34	55	37	60
2031	36	66	39	83

Travel times are in minutes

Table 10.2 provides comparative bus /GP total origin to destination time estimates for AM peak travel from the White Rock /South Surrey Area to downtown Vancouver.

Table 10.2
AM Peak Periods Bus and GP Total Travel Times With Enhanced Transit Accommodation
(White Rock/South Surrey to Downtown Vancouver)

	AM Peak Hour		
	NBD		
	BUS	GP	Bus to GP Travel Time Ratio
2008	125	83	1.51
2021	93	103	0.9
2031	98	135	0.8

Travel times are in minutes

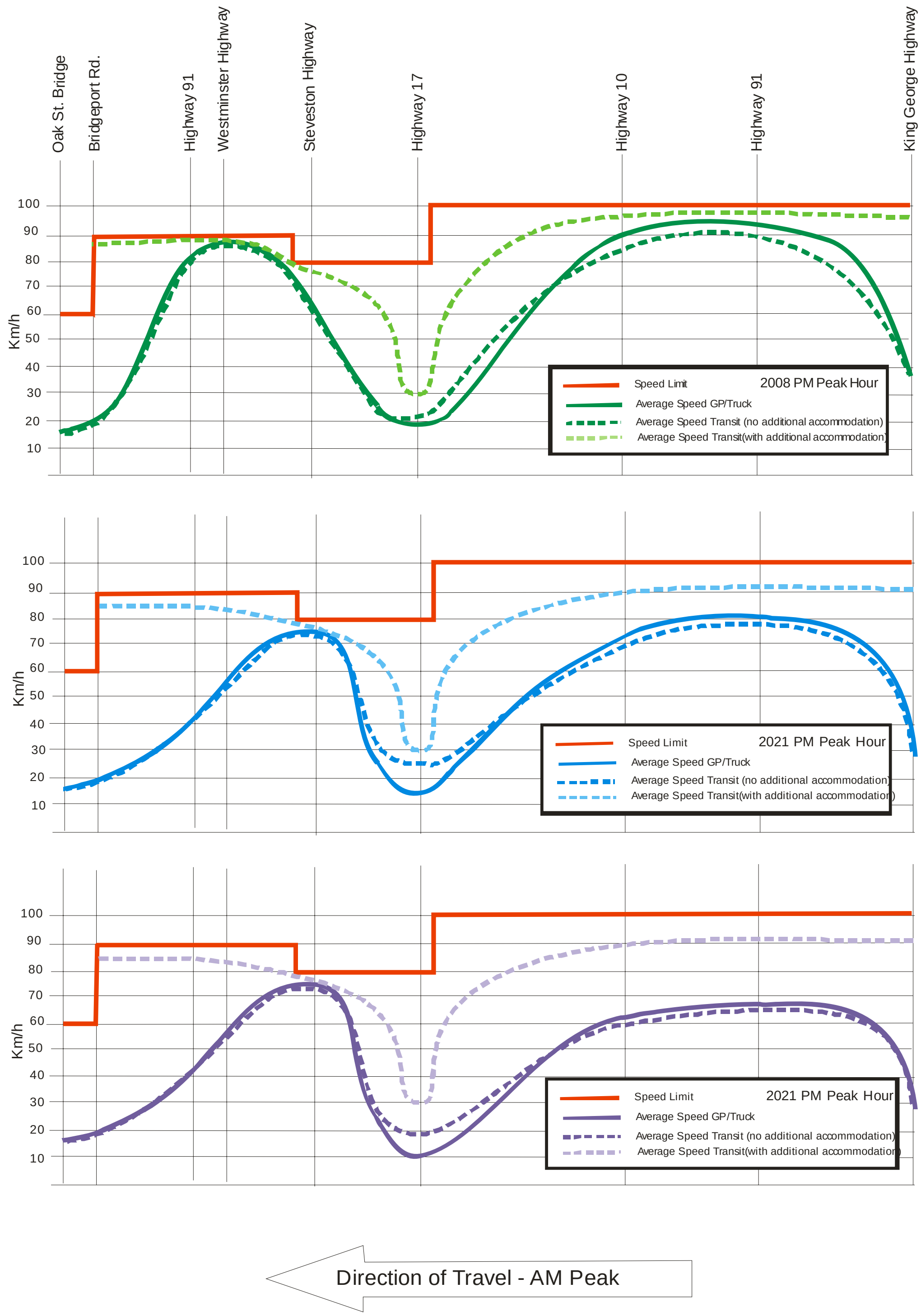


Figure 10.1 – AM Peak Hour Northbound GP & Transit Average Transit Travel Time Changes With Additional Transit Accommodation on Highway 99

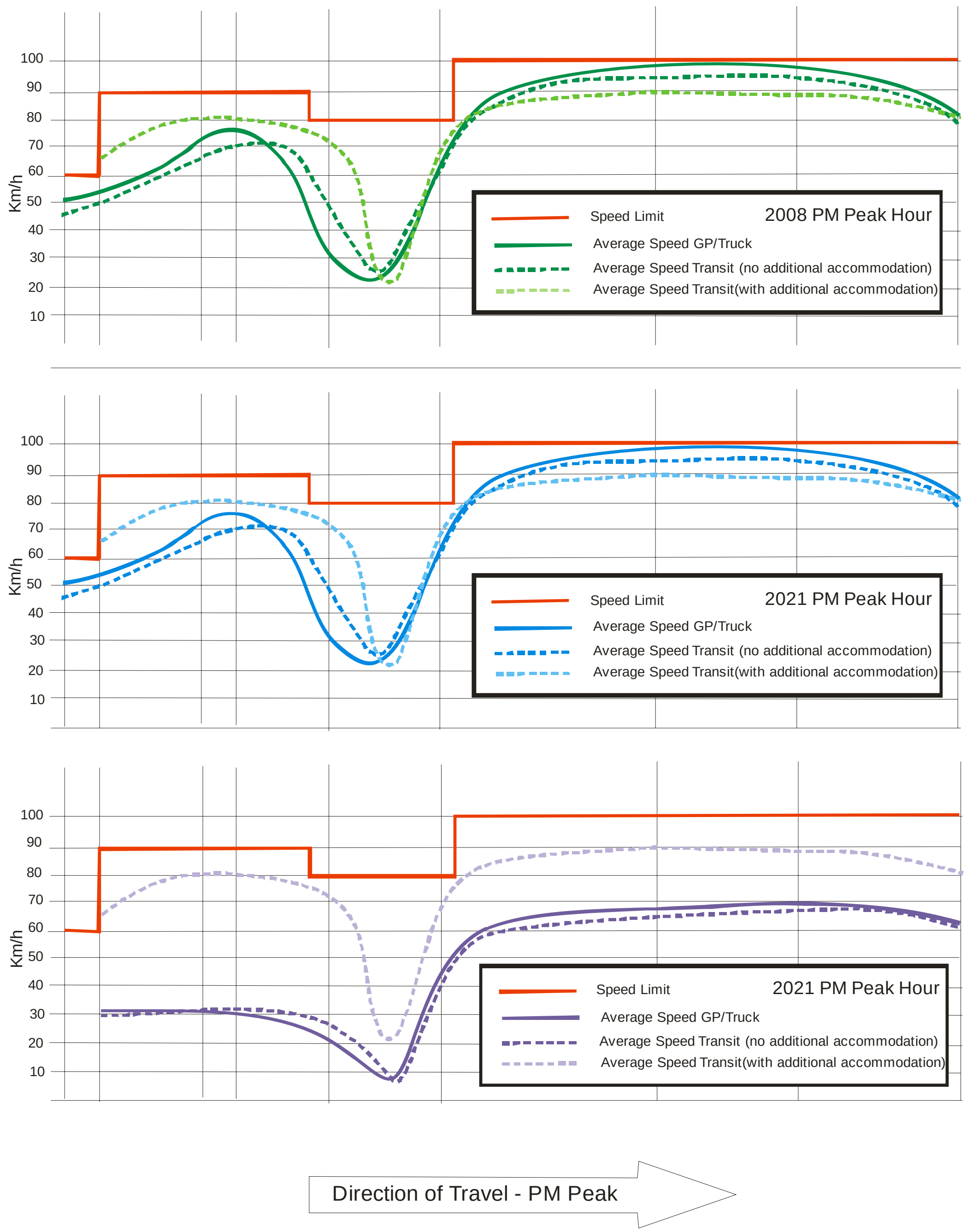


Figure 10.2 – PM Peak Hour Northbound GP & Transit Average Transit Travel Time Changes With Additional Transit Accommodation on Highway 99

Figure 10.3 describes the projected modal splits for Highway 99 assuming the Bus to GP total travel time ratios in Table 10.1.

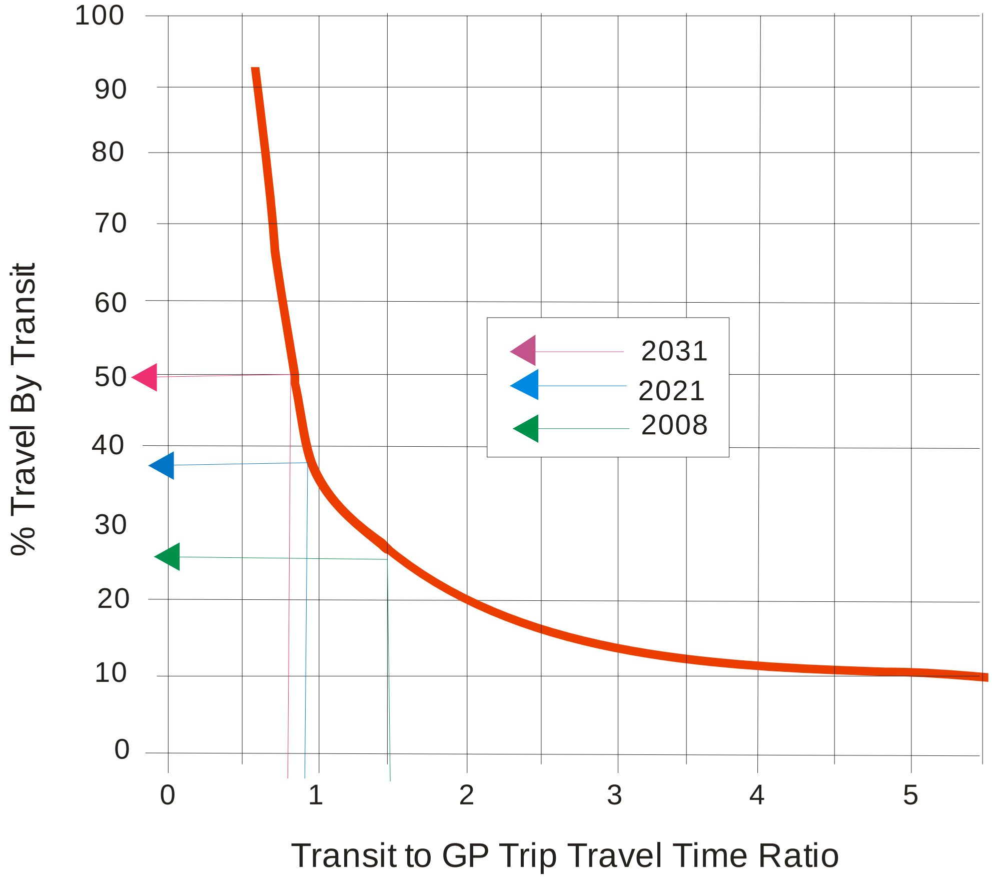


Figure 10.3 – Predicted Mode Splits Assuming Enhanced Transit Accommodation on Highway 99 (2021 & 2031)

The predicted mode splits are consistent with the Goals of the Provincial Transit Plan and South of Fraser Transit Plan.

Figure 10.4 describes the speed ranges and average speeds for GP and Bus vehicles traveling the Highway 99 corridor in the peak direction in the AM and PM peak periods in 2021 assuming the availability of enhanced transit accommodation.

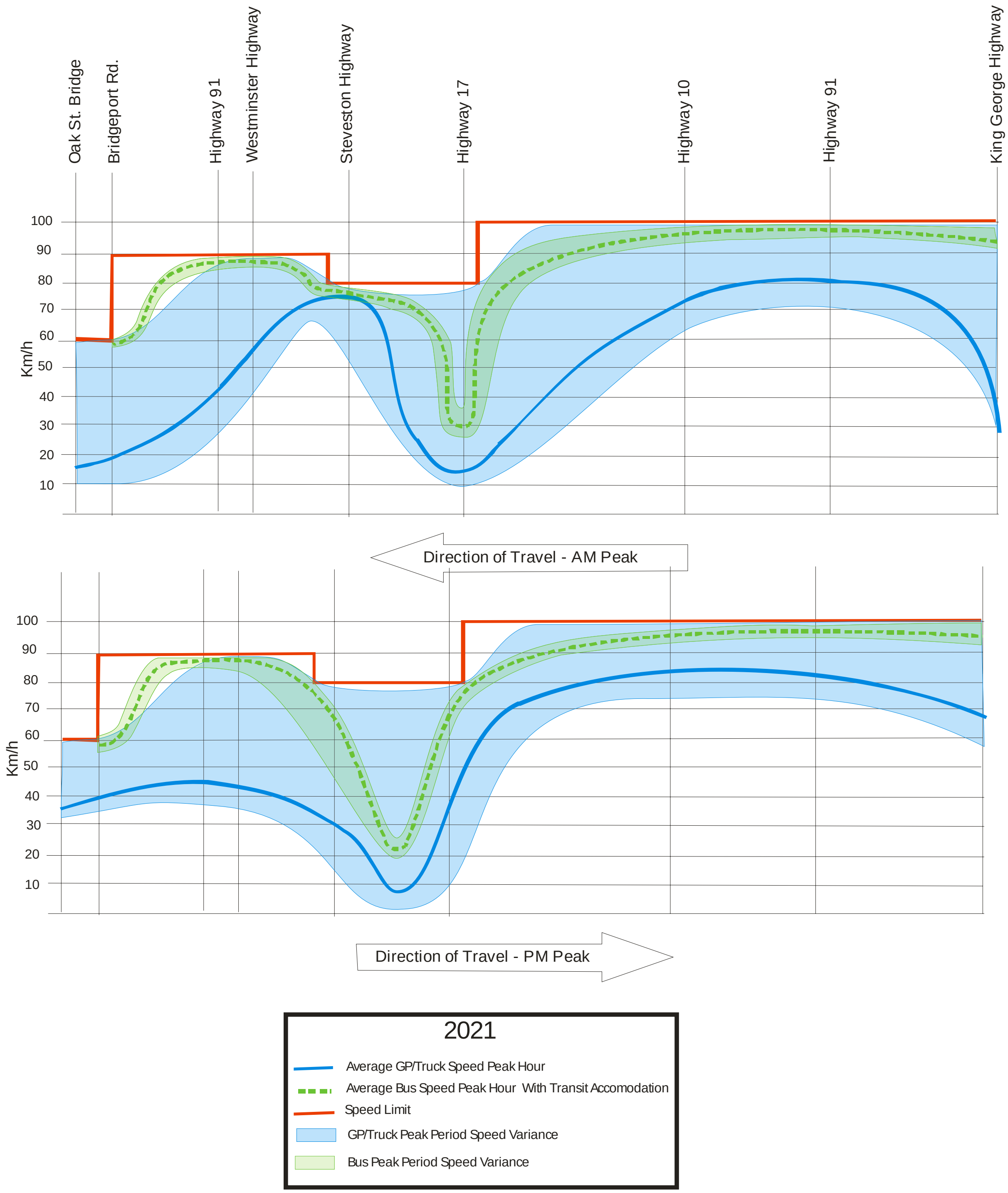


Figure 10.4 – 2021 AM & PM Peak Hour Average GP/Truck & Transit Travel Times and Peak Period Speed Variation Assuming Transit Accommodation on Highway 99

11.0 OPTIONS FOR PROVISION OF ENHANCED TRANSIT ACCOMODATION

Existing HOV Accommodation

It is assumed that the existing Northbound HOV lane will be converted to an occupancy eligibility of plus 2. This will match the southbound HOV eligibility that was recently amended. The current northbound HOV lane has a low utilization and there is a continuing public desire to decrease eligibility given the growing northbound delays at the Massey Tunnel approaches. It is expected that the plus 2 eligibility should provide adequate transit accommodation until 2013 to 2015. At this time occupant eligibility can be increased or dedicated transit lanes constructed. The northbound HOV queue jump should also be sustainable until the 2013 to 2015 time period. When additional transit accommodation is necessary occupancy eligibility can be modified or dedicated transit lanes constructed. Between 2013 and 2021) the northbound queue jump will have to revert to transit only usage similar to the current southbound queue jump.

Location of Priority Lanes

Conventional practice for placement of HOV/Bus lanes in highway environments is median side. This works well if buses do not have to move from the lane for the duration of the highway trip. In some cases HOV interchange ramps to facilitate HOV exit and entry from the median side lanes can be considered. This is generally avoided because of costs and complexity of operation. In the Highway 99 environment where buses must move to the curb to leave and re-enter the highway for passenger exchange the median lanes cannot practically be utilized, particularly in the highly congested portions of the corridor such as those approaching the George Massey Tunnel or Oak St. Bridge. The construction of interchange ramps required for median side lanes would exceed the entire cost of constructing shoulder side lanes through the entire corridor. Given that the passenger exchange being accommodated is less than 5 passengers per bus run and given that the existing shoulder side HOV have no operational issues, median side priority lanes were not considered further. Figure 11.1 depicts existing Highway 99 cross sections with shoulder side HOV lanes.

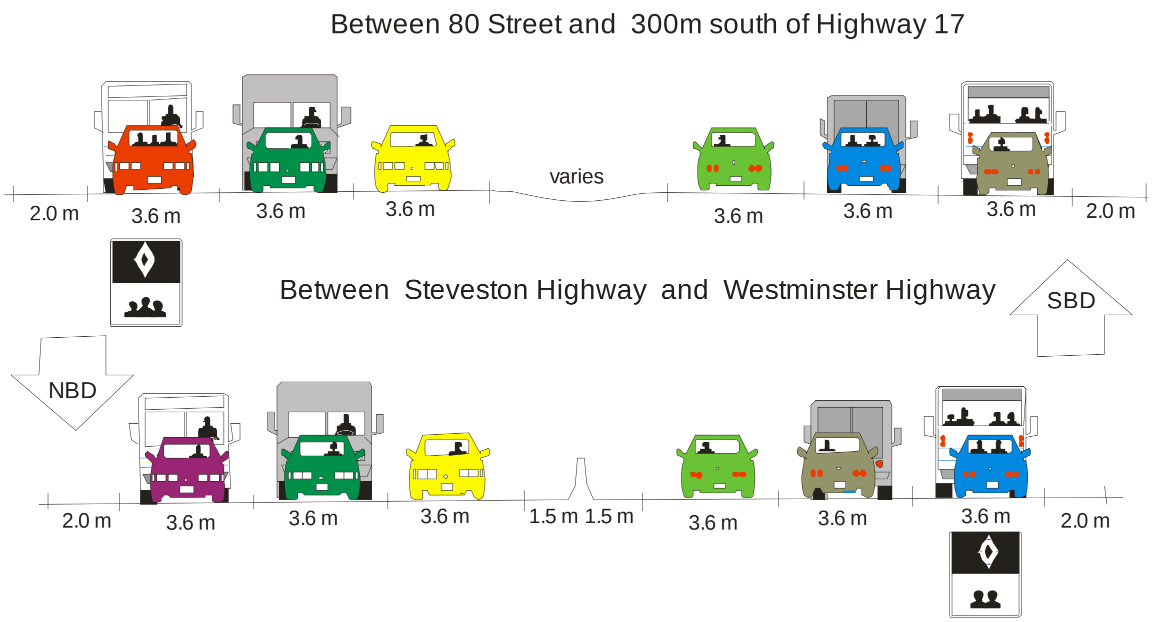


Figure 11.1 – Highway 99 Cross Sections with HOV lanes

Additional Priority lanes

Additional priority lane accommodation (for highway segments that currently have no accommodation is achievable in a number of ways. The determination of which is the most applicable approach for Highway 99 was determined through a comparisons of the following evaluation criteria:

- Transit operational feasibility;
- GP traffic effects – Quality of Service and Safety;
- Transit effects – Quality of Service and Safety;
- Acceptability and Enforcement support required;
- Capital costs; and
- Resultant Mode Split Shift.

Option 1 – Convert Existing GP Lanes to Bus Only Use

Exclusive bus priority lanes would be created by converting existing GP lanes to bus only usage (Figure 11.2). The effects of this option would be as follows.

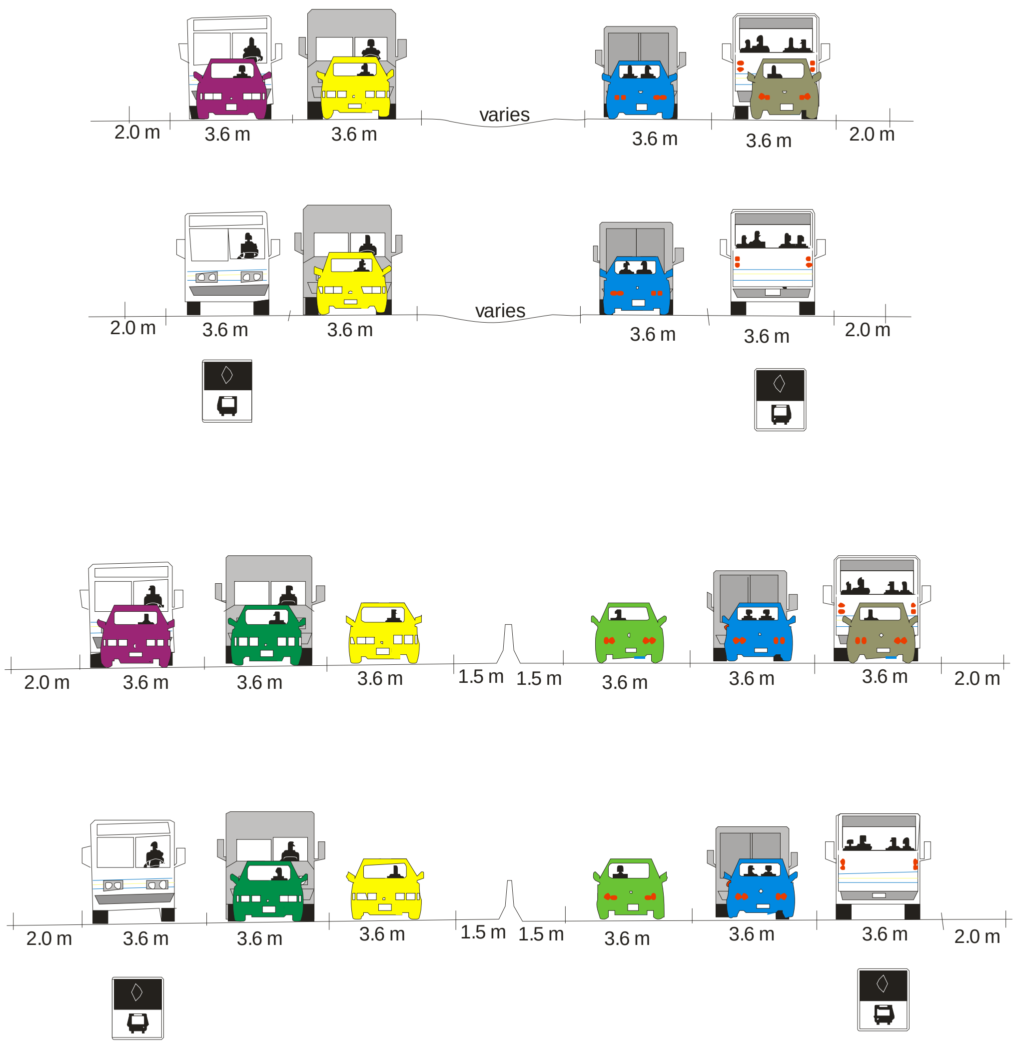


Figure 11.2 – Highway 99 Cross Sections with GP lanes Converted to Exclusive Bus lanes

Transit operational feasibility – Assuming that GP traffic utilization of the converted lane could be kept to a minimum this option would present no feasibility issues form a transit perspective.

GP traffic effects - Peak period GP lane demand would be increased to more than 3000 vph. This would drop GP average speeds to less than 30 km/h or less along the entire corridor. The corridor would experience a dramatic increase in rear end collisions at these vehicle density levels.

Transit effects – Transit speeds would theoretically be maintained at speeds close to the posted speed. The bus/GP speed differential would pose significant safety issues as GP traffic would continually intrude into the bus only lane.

Acceptability and enforcement support required – This strategy would required full time dedicated enforcement along the entire corridor as GP traffic users would not accept the resultant operating environment when the bus only lane would appear relatively empty. This phenomena has seen the reduction of existing HOV eligibility gradually reduced from plus 6 to plus 2 over a 10 year period.

Capital costs – The lane conversion would require pavement marking modifications and additional regulatory signage. This is estimated to cost $15,000 per km for each direction.

Resultant Mode Split – This strategy would result in a Bus to GP total peak hour travel time ratio of 0. 5 or less. This would result in modal splits on Highway 99 that significantly exceed 50%.

Given the significant impacts to GP traffic, the hourly bus demand (between 75 to 100 buses per Hour), and the level of enforcement required keep GP vehicles out of the bus lane this option is not considered feasible.

Option 2 – Construct New Bus Only Lanes

Exclusive bus lanes would be constructed on the shoulder side of Highway 99 (Figure 11.3).

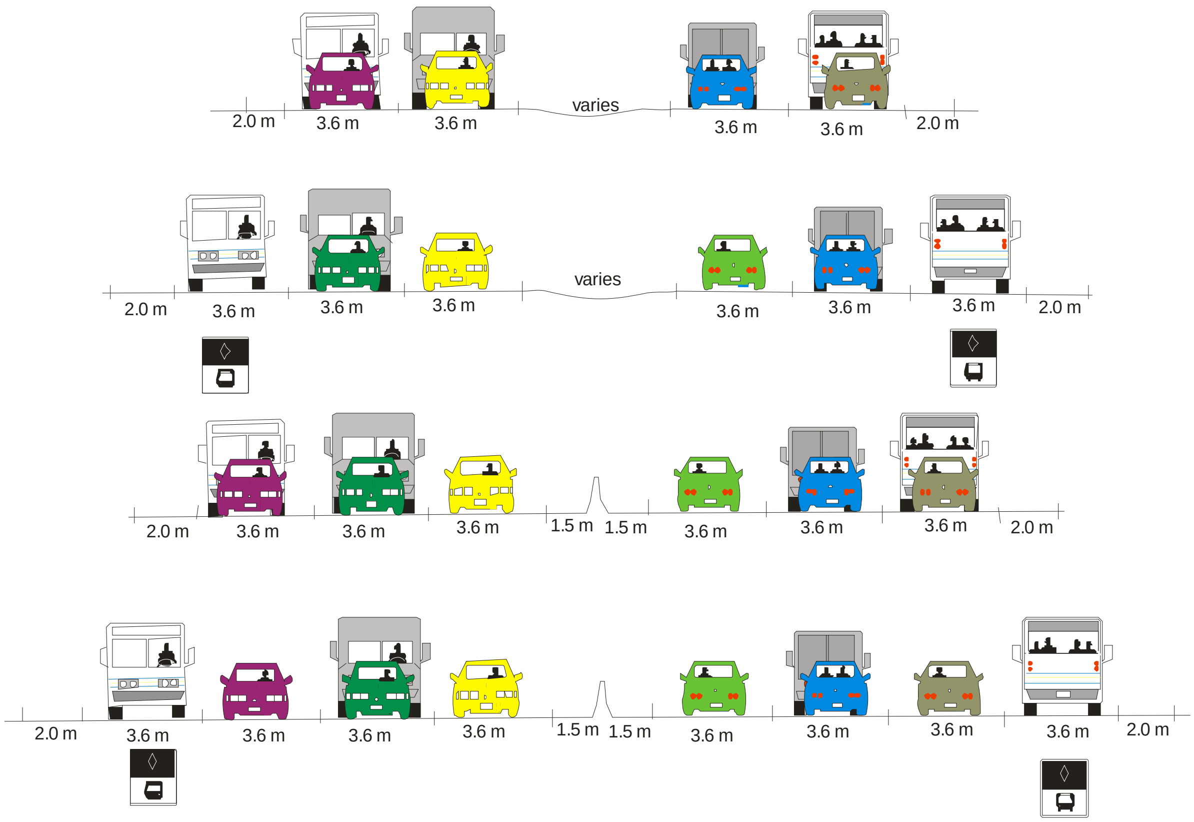


Figure 11.3 – Highway 99 Cross Sections with New Exclusive Bus lanes

The effects of this option would be as follows.

<u>Transit operational feasibility</u> – This option is not expected to have any transit operation issues as the bus lane configuration is identical to the current HOV lanes that buses operate in on Highway 99.

<u>GP traffic effects</u> - Peak period GP lane demand would remain unchanged and therefore quality of service and safety performance for GP vehicles would be unaltered

Transit effects – Transit speeds would theoretically be maintained at speeds close to the posted speed other than at the George Massey Tunnel. Bus safety would be enhanced given that much lower vehicle density of the bus lane.

Acceptability and enforcement support required – This strategy would require dedicated enforcement as GP traffic users would view the bus only lane as being relatively under-utilized in relation to GP vehicular lane demand. (Approximately of 75 buses per hour). The Canadian experience is that it is virtually impossible to maintain exclusive bus lanes on congested corridors when bus demands fall below 90 to 100 buses per hour.

Capital costs – The construction of dedicated bus lanes could be done within existing highway rights of way. The highway widening required to provide exclusive bus lanes would require extensive bridge and overpass modifications (including seismic upgrades of virtually all structures). This is estimated to cost $7.5 million per km for each direction.

Resultant Mode Split – This strategy would result in a Bus to GP total peak hour travel time ratio of 0.8. This would result in doubling the current modal splits on Highway 99 from 25% to 50%.

This option is considered feasible.

Option 3 – Construct New HOV Lanes

In response to the “empty lane syndrome’ associated with exclusive bus lanes that have an hourly demand that is less than 90 to 100 buses, most North American highway jurisdictions have developed HOV lanes that accommodate vehicles with occupancy levels higher than 1. In the South Coast Region it has not been possible to maintain occupancy eligibility levels higher than plus 2 without constant calls for eligibility reductions. Figure 11.4 describes newly constructed HOV lane cross sections appropriate to Highway 99.

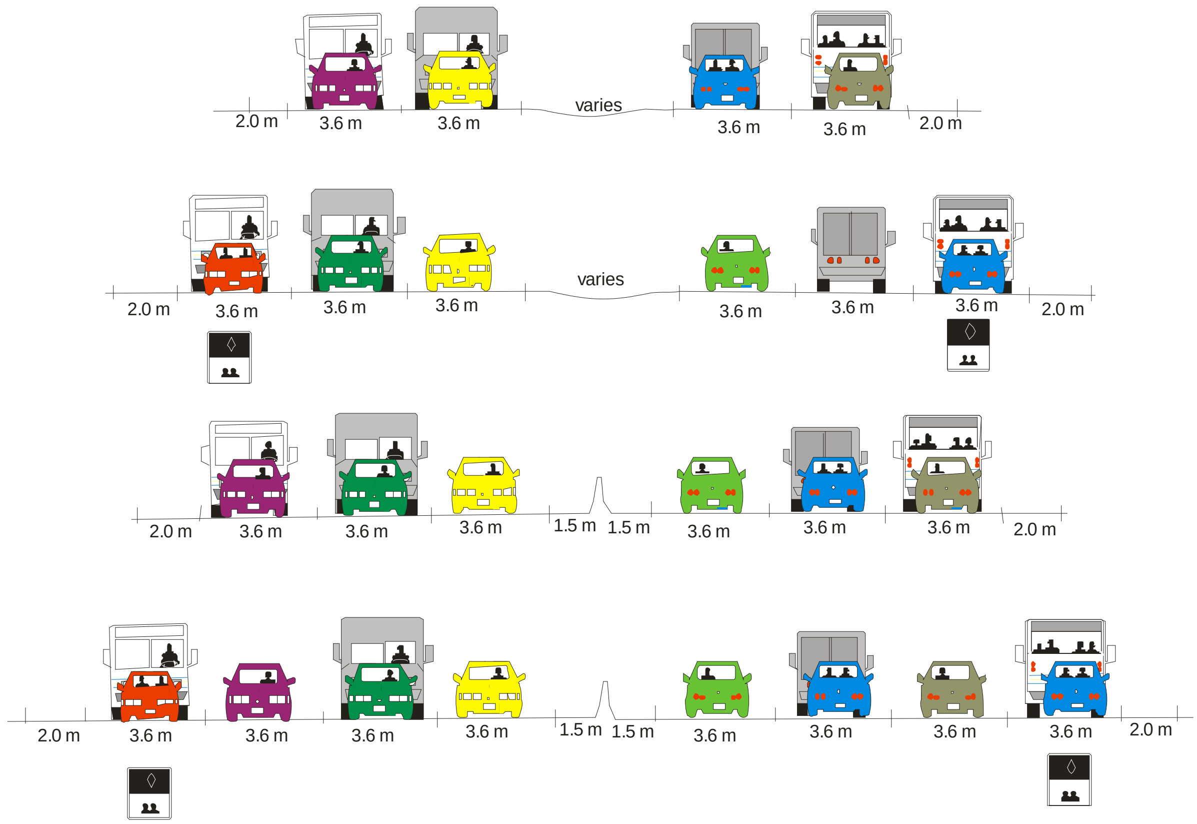


Figure 11.4 – Newly Constructed HOV lanes on Highway 99 (plus 2 eligibility)

The effects of this option would be as follows.

Transit operational feasibility – This option is not expected to have any transit operation issues as the new HOV lanes would be identical to the current HOV lanes that buses operate in on Highway 99.

GP traffic effects - In the South Coast Region HOV lanes with plus 2 eligibility generally accommodate between 600 to 800 vehicles per hour in peak periods. This reduces GP Peak period lane demand slightly and therefore GP quality of service and safety performance would be slightly enhanced.

Transit effects – In the South Coast Region HOV lane demand is usually 50% to 60% of GP lane demand in peak periods. This provides HOV traffic with modest travel time advantages over GP traffic. Transit speeds would improve slightly but would still be maintained at speeds that are within 10 km/h of GP vehicle speeds. Bus safety performance would improve slightly because buses are operating in traffic densities that are lower than those on GP lanes.

Acceptability and enforcement support required – This strategy would require a greater level of enforcement than is provided on existing HOV lanes on the corridor as current enforcement efforts result in high violation rates which reduce the effectiveness of the HOV lanes.

Capital costs – The construction of the new HOV lanes is the same as the cost of constructing new dedicated bus lanes ($7.5 million per km for each direction).

Resultant Mode Split – This strategy would result in a Bus to GP total peak hour travel time ratio greater than one which means the model split could not increase beyond 30%

This option is considered feasible.

Option 4 – Construct New Bus and Truck Only Lanes

In order to reduce the number of vehicles using the HOV facility while still increasing the utilization of eh lane (combat “empty lane syndrome”) an option whereby only Trucks and Buses are permitted use of the HOV lane was also considered. (Figure 11.5)

The effects of this option would be as follows.

Transit operational feasibility – For two thirds of the corridor buses in the HOV lane would be operating in lane densities similar to GP traffic as the passenger car equivalent for trucks is 2.5. Because truckers are also professional drivers this would result in fewer operational issues than would be expected while operating in GP lanes. The portion of the corridor between Highway 91 and King George Highway would experience an improved operating environment (slightly better than on existing HOV lanes.

GP traffic effects – With the removal of 200 to 600 trucks per hour from existing GP lanes both quality of service and safety performance would be improved.

Transit effects – The number of buses operating in the peak direction during peak periods ranges from 200 to 600 trucks per hour. This is the equivalent of 500 to 1500 passenger car vehicles per hour. This level of truck activity would result in no improvements to transit service levels or safety performance on two thirds of the corridor. Between Highway 91 and King George Highway HOV lane densities would be similar to current HOV service quality and safety. (Improves service quality and safety performance over GP lane operation).

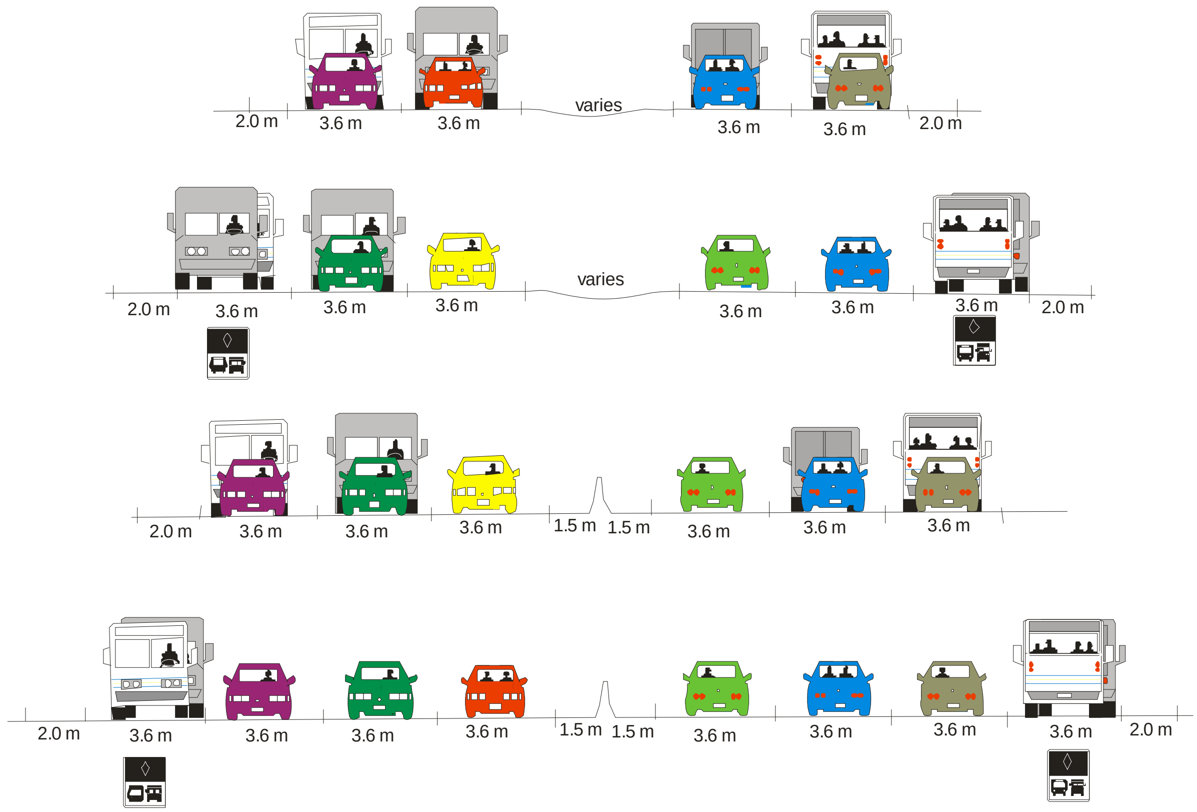


Figure 11.5 – HOV Lanes with Bus and Truck Eligibility Only

Acceptability and enforcement support required – This strategy would require a greater level of enforcement than is provided on existing HOV lanes on the corridors this would be a new form of HOV lane operation in the lower mainland.

Capital costs – The construction of the new HOV lanes is the same as the cost of constructing new dedicated bus lanes ($7.5 million per km for each direction).

Resultant Mode Split – This strategy would result in a Bus to GP total peak hour travel time ratio greater than one which means the model split could not increase beyond 30%

This option is considered feasible.

Option 5 – Reconstruct Highway Shoulder to Accommodate Bus Usage

In response to the issue of "empty lane syndrome" the Ministry of Transportation in Ontario introduced the concept of shoulder bus lanes in the Ottawa area some 20 years ago. OC Transpo buses were given permission to use widened shoulders of Highway 17. Only buses and emergency vehicles were extended this privilege (the rationale was that the operating environment was difficult therefore only trained supervised bus operators could be granted usage permission). This implementation was much more favourable received than traditional bus only lane provision as shoulder bus lanes did not result in "empty lane syndrome" as most drivers are conditioned to view the shoulder with virtually no vehicle activity. Based on these findings Ontario expanded the OC Transpo shoulder lanes and other North American jurisdictions have successfully implemented shoulder bus lanes in their jurisdictions as well. The BC Ministry of Transportation and Infrastructure is constructing a pilot shoulder bus lane northbound on Highway 99 between Westminster Highway and Bridgeport Road. Figure 11.6 describes the cross sections appropriate for operation of shoulder bus lanes on Highway 99.

The effects of this option would be as follows.

Transit operational feasibility – Based on the successful operation of this type of transit accommodation no transit operational issues are anticipated..

GP traffic effects - Peak period GP lane demand would remain unchanged and therefore quality of service and safety performance for GP vehicles would be unaltered

Transit effects – Transit speeds would theoretically be maintained at speeds close to the posted speed other than at the George Massey Tunnel. Bus safety would be enhanced given that much lower vehicle density of the shoulder bus lane.

Acceptability and enforcement support required – Canadian and US highway and transit agencies experience report that shoulder bus lanes have a high degree of public acceptance even ion very congested corridors. Enforcement agencies indicate that only minimal enforcement efforts are required to keep GP traffic form operating on the shoulder bus lanes. It is expected that the BC experience will be similar to that of other jurisdictions.

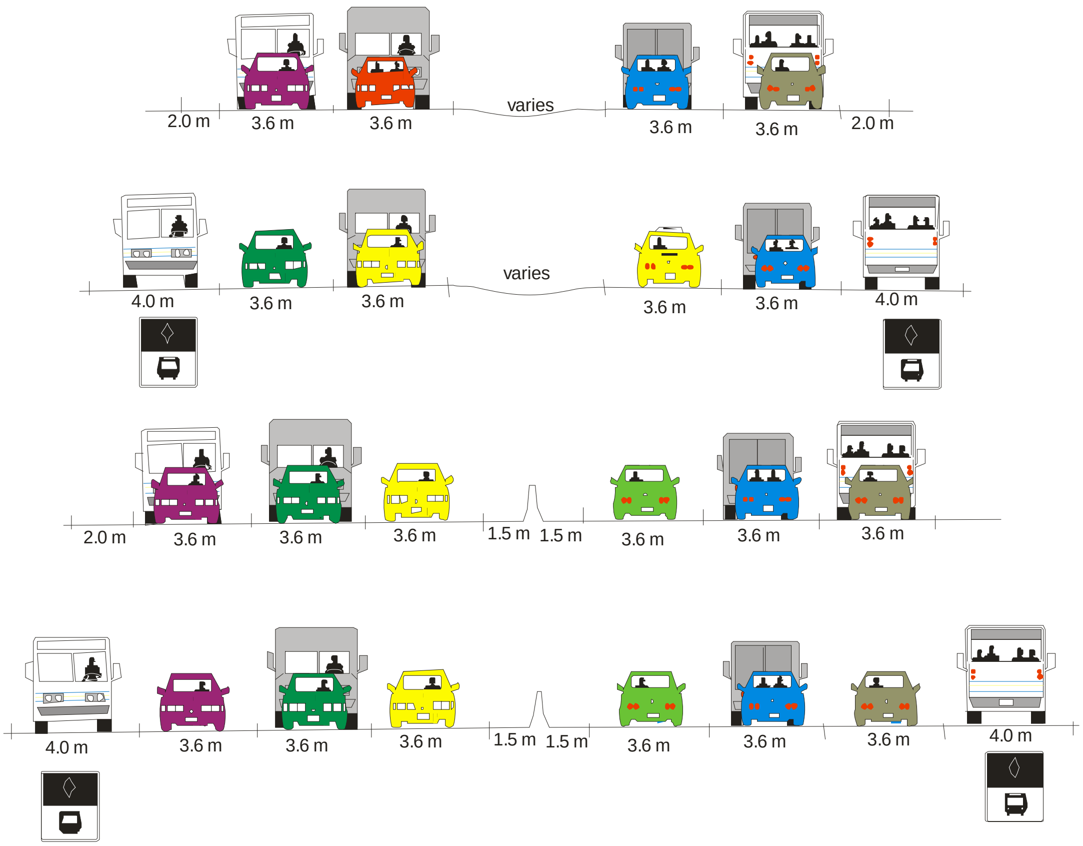


Figure 11.6 – Shoulder Bus Lane Cross Sections Appropriate To Highway 99

Capital costs – The construction of dedicated bus lanes can be done within existing highway rights of way. The highway widening required to provide shoulder bus lanes will require bridge and overpass modifications. This is estimated to cost $2.5 million per km for each direction.

Resultant Mode Split – This strategy would result in a Bus to GP total peak hour travel time ratio of 0.8 by 2031. This would result in doubling the current modal splits on Highway 99 from 25% to 50%.

This option is considered feasible.

12.0 PREFERRED HIGHWAY 99 TRANSIT ACCOMODATION

Tabl1 12.1 summarizes the evaluation criteria adherence associate with maintaining the status quo (no additional accommodation of highway modifications) and the five following priority lane accommodation strategies:

- Convert existing GP lanes to bus only lanes;
- Construct new bus only lanes;
- Construct new HOV lanes;
- Construct new Bus and Truck only lanes; and
- Reconstruct shoulders to accommodate bus usage.

Table 12.1 Option Evaluation Summary

	Transit Accommodation Options					
Evaluation Criteria	Status Quo	GP lanes to Bus Only Lanes	New Bus Only Lanes	New HOV Lanes	New Bus And Truck Lanes	New Shoulder Bus Lanes
Transit Operational Feasibility	Low Preference	Medium Preference	High Preference	High Preference	Low Preference	High Preference
GP Traffic Effects	Low Preference	Low Preference	No Effect	Medium Preference	High Preference	No Effect
Transit Effects	Low Preference	High Preference	High Preference	Medium Preference	Low Preference	High Preference
Acceptability & Enforcement Required	Low Preference	Low Preference	Medium Preference	No Effect	Medium Preference	High Preference
Capital Costs	High Preference	High Preference	Low Preference	Low Preference	Low Preference	Medium Preference
Resultant Modal Shift	Low Preference	High Preference	High Preference	Medium Preference	Low Preference	High Preference

High Preference **Medium Preference** **Low Preference**

No Effect

Based on this assessment the preferred form of lane priority for buses on Highway 99 between King George Highway and Bridgeport Road is 4.0 m shoulder bus lanes. Disable vehicles, emergency response vehicles, and qualified inter-city buses are the only other vehicles that would be permitted use of the shoulder bus lanes. Usage protocols that detail permitted and prohibited behaviours appropriate to Highway 99 will have to be developed jointly between Ministry staff and Transit Operating agencies.

A more detailed assessment of costs and benefits associated with the preferred options was undertaken to ascertain preliminary investment feasibility. Table 12.2 provides a summary of the financial performance of the preferred option. The benefit-cost (B/Cs) ratios for the cumulative development of bus shoulder lanes goes is over 1.45 for all scenarios, and is at a high of 7.0 for the segment between the tunnel and Sea Island Way. Further, the net present values for the project range from between approximately $17.9 million for the entire project through to over $30 million for the segment north of the tunnel. These results indicate that although the northern section of the shoulder bus lane project certainly generates the highest benefit relative to the project costs, the complete project between King George Highway and Sea Island Way/Highway 91 would be effective investments.

Table 12.2
Financial Performance Assessment
(Highway 99 Northbound Bus Priority Lane)

Account	Criteria	Measurement	Corridor Segment		
			Tunnel to Sea Island / Hwy91	**Hwy 10 to Sea Island / Hwy91**	**KGH to Sea Island / Hwy91**
Financial	Capital Cost	($mil)	$5.350	$14.200	$49.010
	Capital Cost	Present Value ($mil)	$4.761	$12.638	$43.619
	Maintenance Cost	Present Value ($mil)	$1.184	$2.368	$4.736
	Salvage Value	Present Value ($mil)	$0.952	$2.528	$8.724
	Total Incremental Cost	Present Value ($mil)	**$4.993**	**$12.478**	**$39.631**
Customer Service	Travel Time Savings	Value of Travel Time ($mil)	$29.378	$35.113	$47.930
	Vehicle Operating Costs	Value of Operating Costs ($mil)	$5.863	$7.023	$9.577
	Total Incremental Benefits	Value of Operating Costs ($mil)	**$35.241**	**$42.136**	**$57.507**
Economic Summary	NPV	Present Value ($mil)	**$30.248**	**$29.658**	**$17.876**
	B/C Ratio	Ratio	**7.058**	**3.377**	**1.451**

Note: In 2008 dollars based on discount rate of 6 percent over a 25 year planning period.

The preferred options ability to effect significant modal shift in this corridor also implies that GHG reduction benefits can be expected.

Annual vehicle emission reductions have been calculated based on the decline in operating speeds with increasing congestion without any changes to the corridor. One of the key greenhouse gases produced is vehicular carbon dioxide (CO_2) (approximately 99.9 percent). The more fuel that is burned, the more CO_2 emissions are produced. The project is expected to reduce greenhouse gas or CO_2 emissions by approximately 290 tonnes per year over the 25 year planning period, and significantly more through the southern sections of the corridor. This reduction accounts for steady state bus travel of the bus priority lane as it would consume less fuel when compared to a stop-and-go scenario and potential modal shift from auto mode to transit.

Highway Segment	***Average Annual Reduction CO2 Emissions***
Tunnel to Sea Island/Hwy 91	290 tonnes
Hwy 10 to Sea Island/Hwy 91	575 tonnes
KGH to Sea Island/Hwy 91	765 tonnes

13.0 IMPLEMENTATION

As illustrated in Table 12.2 the project can be implemented in ten individual stages in order of highest rate of return.

Table 12.2
Project Cost Estimate By Stage (Year of Construction $)
(Assumes Annual Inflation of 6%)

Elements	Budget (Year of Construction $)	Completion
Construct NBD shoulder bus lane from Westminster Highway to Bridgeport Rd. Implement transit signal priority along Bridgeport Rd., Great Canada Way, & Sea Island Way	$7.0M	August 2009
Construct SBD shoulder bus lane from Sea Island Way to Westminster Highway.	$10.6M	2009-2010
Construct NBD shoulder bus lane from Steveston Highway to Westminster Highway	$1.7M	2010-2011
Construct NBD shoulder bus lane from South Surrey Park & Ride to Highway 91.	$16.4M	2011-2013
Construct SBD shoulder bus lane from River Road to 80th Street.	$21.0M	2013-2015
Construct NBD shoulder bus lane from Highway 91 to Highway 10.	$6.2M	2015-2016
Construct NBD shoulder bus lane from Highway 1 to 80th St.	$4.0M	2016-2017
Construct SBD shoulder bus lane from 80th Street to Highway 10 to Westminster Highway	$6.0M	2017-2018
Construct SBD shoulder bus lane from Highway 10 to Highway 91.	$6.8M	2018-2019
Construct SBD shoulder bus lane from Highway 91 to South Surrey Park & Ride.	$26.6.0M	2019-2020

Critical TransLink and Municipal Support Measures

The accommodation of transit on Highway 99 is only one of a number of critical success factors in converting the existing limited stop express services into Rapid Bus conformance and ensuring the necessary modal shift from auto to transit by 2021. Additional actions by both TransLink and the municipalities served by transit routes operating on Highway 99 will be needed.

<u>TransLink</u>

It is assumed that TransLink will continue to monitor the need for additional buses and add additional rolling stock as growth and modal shifts occur over the next 12 year period. As utilization exceeds the transit service guideline thresholds it also assumed that TransLink will add rolling stock to restore bus occupancies to confirm with the service design guidelines. From 2008 to 2021 it is estimated that as many as 25 additional vehicles per hour will be required.

The growth in demand as well as conversion of existing services service to RapidBus BC may also require modification to stops and terminal infrastructure. This could require modifications to allow all door loading, automated fare equipment, enhanced shelters, and schedule status display equipment. It is assumed that TransLink would assume responsibility for this.

Given that the Bridgeport Station is brand new it is not anticipated that this terminal will require any modifications for servicing South of Fraser services. The South Surrey Park & Ride Facility although less than five years old is nearing capacity. TransLink will have to assess expansion options as soon as possible in order to expand capacity within the next three years.

Most to the buses that operate on Highway 99 also operate on roadways that form part of the major road network on the municipal portions of their respective routes. Given the importance of Bus to GP travel time from Origin to destination in effecting modal shift, TransLink in cooperation with municipalities will have to ensure that adequate transit accommodation is also made available on MRN roadways.

<u>Municipalities</u>

The degree of modal share shift required to meet the PTP targets (doubling of modal shares in South Surrey by 2021) will also require land use intensification. It is assumed that municipalities and TransLink will ensure that municipal OCP's will focus on ensuring the transit supportive land use policies and zoning are incorporated.

Portions of bus routes that operate on municipal roadways that are not part of the TransLink MRN may also require the implementation of transit accommodation measures. These could include such things as parking restrictions, control signage, or transit signal priority. It is assumed that such accommodation will take place on an as need basis. The identification and development of measures would take place through existing processes established between Coast Mountain Bus Company, TransLink and TransLink member communities.