TECHNICAL MEMO

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Re
Vissim Microsimulation Analysis

Date
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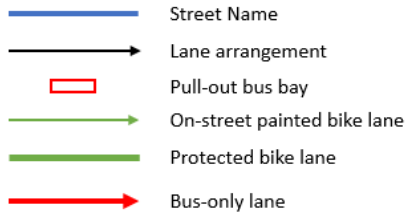
BACKGROUND

A traffic micro-simulation model was developed for the McKenzie Avenue corridor between Finnerty Road and Douglas Street to evaluate three long-term scenarios to support with the selection of a long-term vision in support of the RapidBus project. The base conditions assessment had identified congestion delays to transit that might be reduced by converting existing lanes at select locations.

The Vissim traffic micro-simulation software was used to develop the corridor model. Vissim is generally better suited for corridor-level evaluation than other software packages such as Synchro or Vistro, especially if transit priority options and complex intersection configurations are being considered. Vissim can also evaluate transit operations in more detail and takes into account transit stops, dwell times, passenger flow, and transit schedules. It also provides better measures of operations, especially queue spillback and provides additional value in the long term when improvement concepts move to the detailed design stage.

Ten simulations were run for each modelled scenario. This helps to ensure model consistency and to estimate the level of variability that emerges from the random nature of traffic behaviour and vehicle arrival rate. It is important to note that other sources of variability, such as day-to-day travel demand variation, incidents and inclement weather are not considered for this study.

In total, six scenarios were modelled, a base year scenario representing current conditions (2019) a future business-as-usual (BAU) scenario which largely assumes a similar network configuration as today and four alternatives that are briefly described below.



The line diagrams below illustrate the number of general-purpose lanes and where dedicated turns are provided, along with the extent of dedicated cycling facilities and pull-in bus bays.

- Scenario 1, shown in ***Figure 1***, retains the width of the four-lane cross-section with the curb lanes dedicated to transit and left-turn lanes at major intersections. By converting a general-purpose lane into a dedicated bus lane, the existing pull-out bus bays can be removed and remaining Right of Way (ROW) can be given over to active mode facilities.

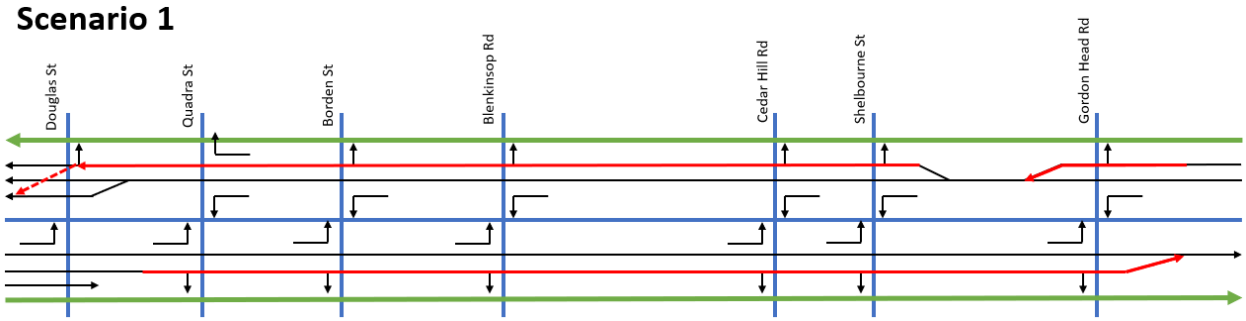


Figure 1: Scenario 1 Line Diagram

Scenario 2, shown in ***Figure 2***, essentially retains the existing roadway arrangement for all lanes, but with widening to allow for addition of transit queue jump lane to address the intersection-related delay that was identified during the base conditions assessment. Note that this option necessarily increases the cross-section of the roadway through the intersections. Primarily, transit infrastructure has been provided in the westbound direction as that is where the greatest instances of delay and travel time variability were detected.

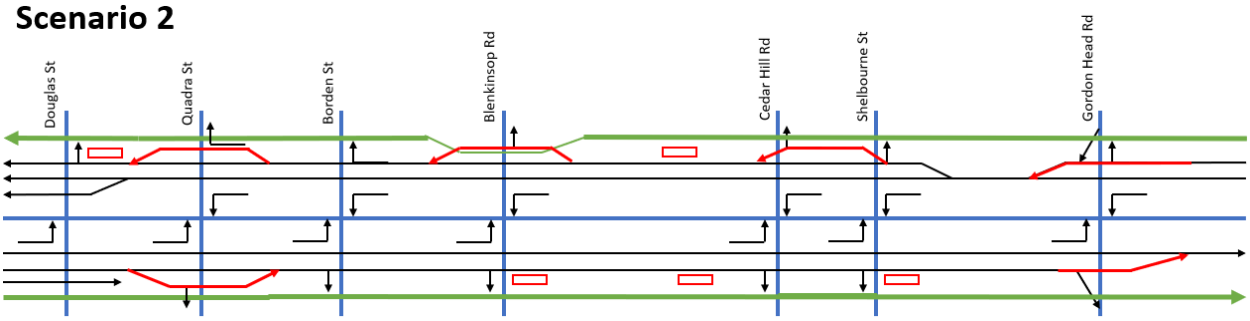


Figure 2: Scenario 2 Line Diagram

- Scenario 3: Based on the findings from the first two scenarios, Scenario 3, shown in ***Figure 3***, aims to address specific concerns at intersections and improve overall operation. A roundabout was developed for the Gordon Head Road intersection to try and resolve the need for the channelized right turn lanes and alleviate the congestion caused by the lane merging that occurs both up and downstream. The westbound bus lane at Borden Street was extended through to west of Quadra Street for ease of navigation.

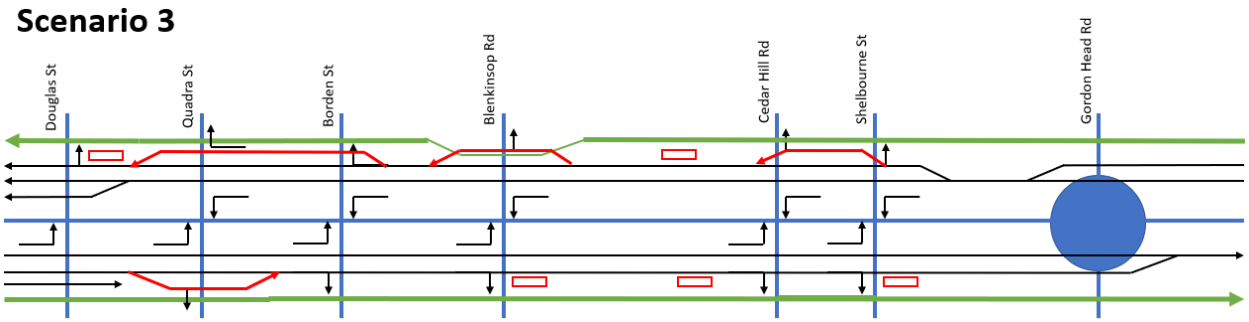


Figure 3: Scenario 3 Line Diagram

Preferred Long-term Vision Scenario ('The Vision')

Based on consultations with the working group, and findings from modelling the scenarios described above, a preferred long-term vision scenario was developed. The Vision is generally a hybrid of scenarios 1 and 2. The four-lane McKenzie cross-section is generally retained. At intersections, curb lanes are re-purposed for bus and right-turning vehicles. Further, a signal is introduced at McGill to improve east-west traffic flow and reduce merge conflicts in the westbound direction. In addition, exclusive right turn lanes at Shelbourne St and right-turn channels at Gordon Head Rd were eliminated. For detailed plots of the preferred long-term vision scenario, see Appendix C.

The traffic modelling focusses on infrastructure and geometric changes to the road network. Transit signal priority[1] (TSP) can achieve further travel time savings as a companion to infrastructure improvements however it wasn't included in this scope of work. The additional benefits of TSP in congested conditions are significantly less than physical measures. TSP, however, can achieve further travel time savings as a companion strategy to infrastructure improvements under a preferred long-term corridor vision.

1. Base Year Model

A base year 2019 McKenzie Avenue corridor Vissim model was developed using pre-Covid turn movement counts, signal timing plans and transit service information provided by the District of Saanich and BC Transit as shown in ***Figure 4***. The base year model provides the foundation for developing future scenarios. The model is typically validated and calibrated to existing observed travel patterns. The calibration fixes are then applied to the future scenarios. A well-calibrated model provides confidence in its ability to generate defensible forecasts that can reliably inform a study's key conclusions.

Model validation and calibration is an iterative process. The newly developed model is validated to observed conditions which usually uncovers locations where the model significantly deviates from observed patterns. The underlying reasons for the deviations are then diagnosed and calibration fixes are

[1] Transit signal priority (TSP) is an upgrade to an existing traffic signal that can extend the green time slightly thus allowing an approaching bus to clear the intersection.

introduced to reduce them. This process is repeated until the model achieves an acceptable validation level.

The following section summarizes the main model calibration updates made to improve model validation:

- Coded bus dwell times by route and direction based on Automated Vehicle Location GPS data provided by BC Transit.
- Added limited traffic volume pulses that are usually not captured by turn movement counts such as access to and from activity generators (e.g., shopping centres and strip malls).
- Added a 15-minute traffic pulse to the westbound-left and eastbound-right movements at Borden Street to simulate student pick-up activity at Reynolds Secondary School.

Four bus routes that partially or fully run along McKenzie Avenue were included in the base year model as summarized in ***Table 1***. The future RapidBus service is expected to be similar to the #16 which was discontinued at the onset of the Covid-19 pandemic.

Table 1: McKenzie Bus Service (2019)

Route Number	Description	Headway (PM)	Type	McKenzie Section (Study Area)
16	Uptown - UVic	15 min	Limited Stop	Hwy 17 - UVic
26	Dockyard - UVic	15 min	Frequent Stop	Saanich Rd - UVic
39	Westhills - UVic	15 min	Frequent Stop	Shelbourne St - UVic
51	Langford - UVic	60 min	Limited Stop	Hwy 17 - UVic

The model does not explicitly consider walking or cycling infrastructure. The model does, however, account for pedestrian and cycling intersection crossing volumes and related signal timing parameters.

Given that travel times in the afternoon are worse in both eastbound and westbound directions, as highlighted in ***Table 2*** and ***Figure 5***, only the PM peak was modelled. This is a common practice to use modelling resources efficiently and assumes benefits to travel times from each scenario would be similar in the AM peak period.

A common practice in traffic modelling is to focus efforts on the period of the day with the worst travel times and congestion. On McKenzie Avenue, as can be seen in ***Table 2*** and ***Figure 5*** , the afternoon period has the highest volume and has the longer travel time. For this reason, only the PM peak was modelled.

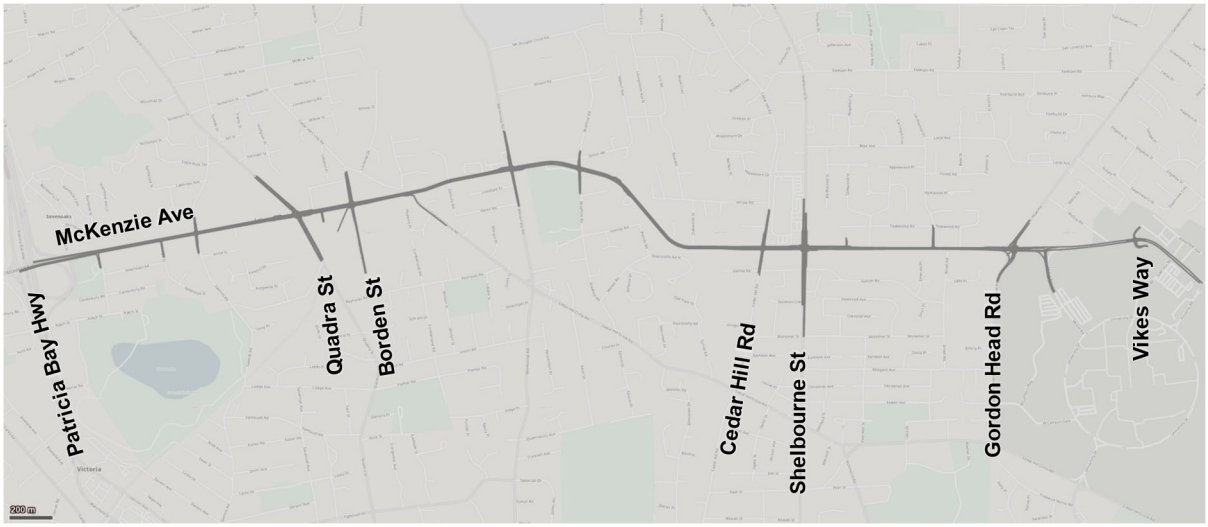


Figure 4: Vissim Model Extents

Table 2: Peak Hour Intersection Volumes (2019)

Total Volumes		
Intersection	**AM**	**PM**
Rainbow Rd	2180	2370
Nelthorpe St	2170	2360
Saanich Rd	2320	2690
Quadra St	3680	4150
Borden St	3100	3380
Blenkinsop Rd	3240	3440
Braefoot Rd	2410	2470
Cedar Hill Rd	3010	3170
Shelbourne St	3600	3900
Larchwood Dr	1800	2090
Gordon Head Rd	2700	2930
McGill Rd	1300	1800
Vikes Way	1160	1390

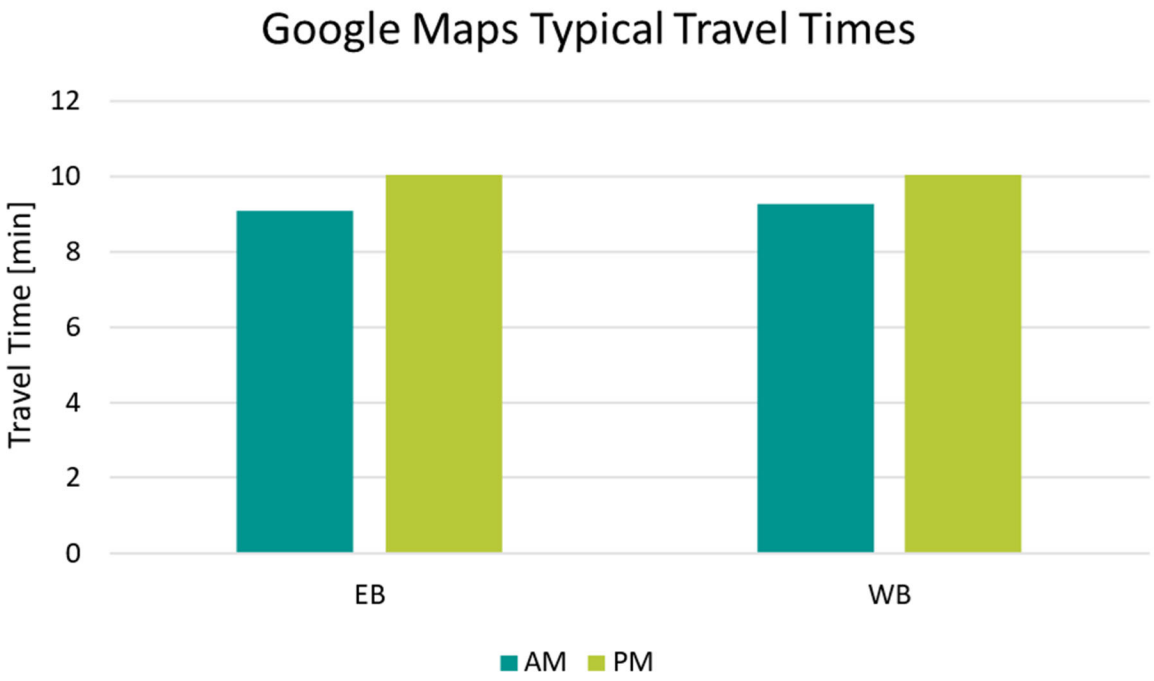


Figure 5: Google Maps Typical Travel Times for McKenzie

1.1. MODEL VALIDATION RESULTS

Figure 6 and ***Figure 7*** compare modelled east-bound and west-bound time space diagrams with observed ones obtained from Google. In general, the model closely replicates typical afternoon travel times, 10 to 11 minutes end-to-end between Rainbow Street and Finnerty Road, and captures the main delay segment along the corridor, between Cedar Hill and Finnerty Road.

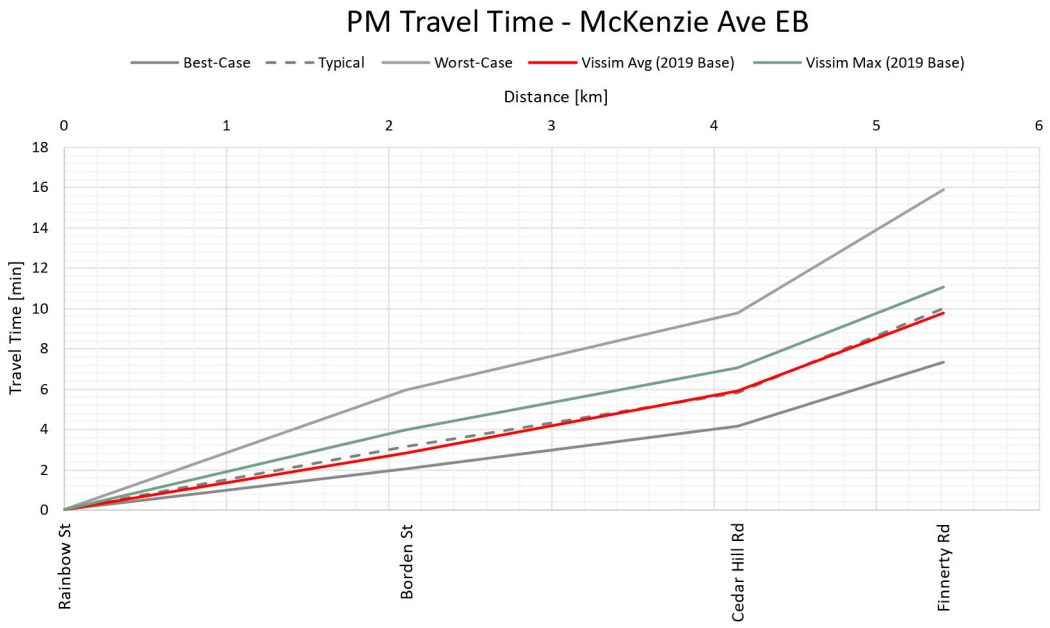


Figure 6: Model Validation – Eastbound PM Time-Space Diagram

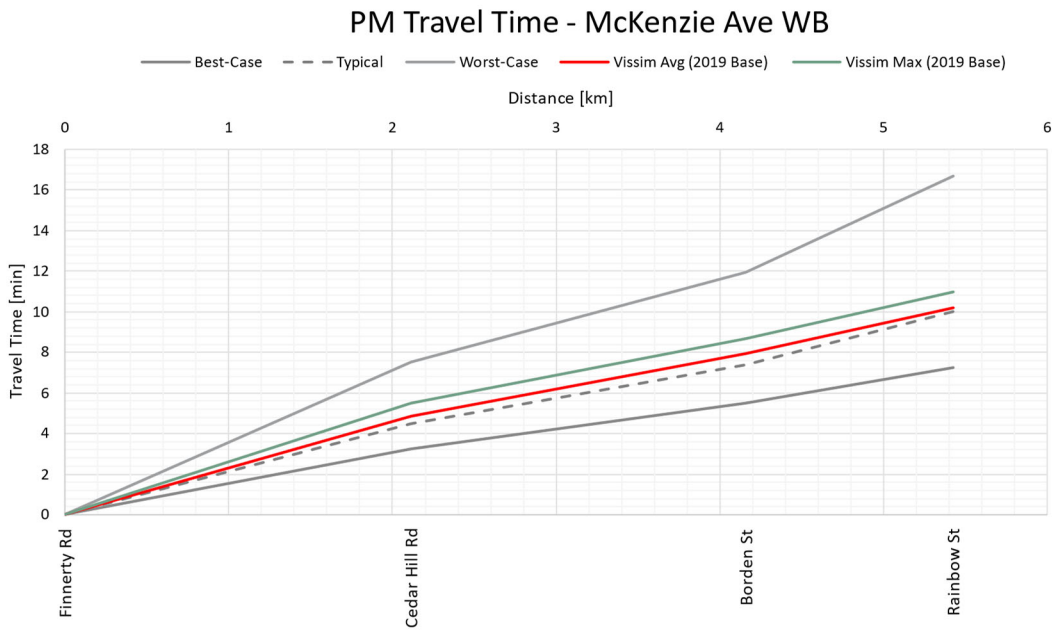


Figure 7: Model Validation – Westbound PM Time-Space Diagram

Maximum travel times from Google, which represent worst case conditions are generally higher than maximum modelled times generated by the Vissim simulations. This is likely because observed travel

times from Google capture a wider range of factors that contribute to travel time variability. The model, however, does capture some variability observed between Finnerty Road and Cedar Hill Road in the westbound direction.

Modelled bus travel times also validate reasonably with observed bus run times information for typical afternoon weekday conditions as shown in ***Figure 8*** and ***Figure 9***. Overall, all modelled times are within two minutes of observed run times. Note that only bus route sections running on McKenzie were included in the validation.

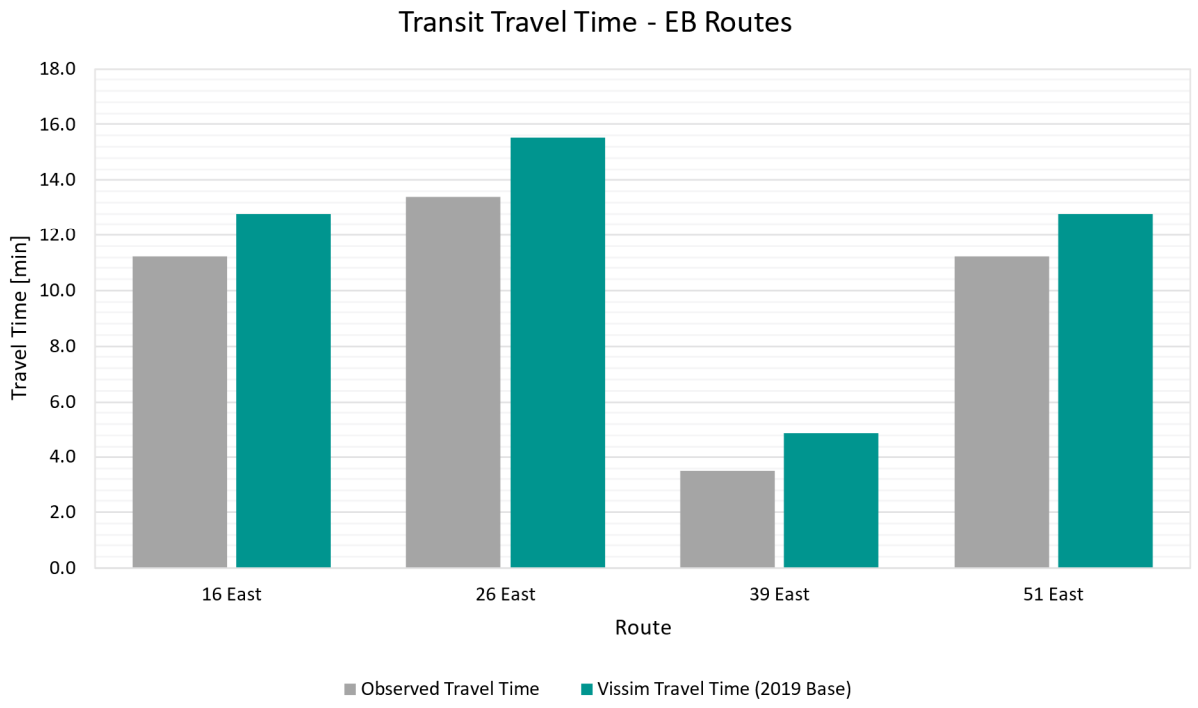


Figure 8: Model Validation – Modelled vs Observed Eastbound Bus Routes (on McKenzie)

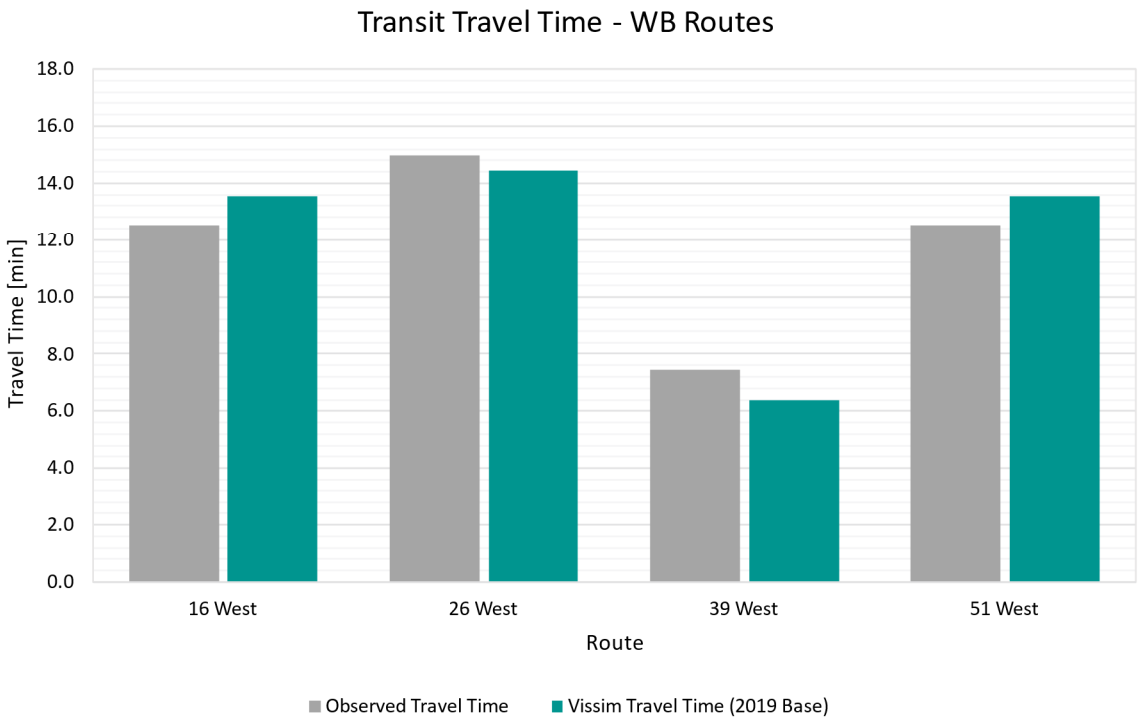


Figure 9: Model Validation – Modelled vs Observed Westbound Bus Routes (on McKenzie)

1.2. TRAFFIC OPERATIONS ANALYSIS

Having validated the modelled results with both Google Maps data and BC Transit data the model was used to investigate the locations and sources of delay on the corridor which can inform candidate locations for future improvements.

Table 3 summarizes modelled intersection performance at the five busiest intersections along the McKenzie Avenue corridor. Below are the main observations:

- Intermediate delay and queues of up to 200 meters is observed at Quadra Street in the eastbound direction, which can block buses trying to clear the intersection to reach the far-side stop. The model results are consistent with observation made during the site visit which identified eastbound Quadra as a major hot spot.

- The model shows Borden Street operating well in the westbound direction. In reality, queues can sometimes back up to Cedar Hill Cross Road, however, given that the model replicates typical corridor travel times well, the observed queues are likely related to sources of variability not captured by the model, such as queues occasionally spilling back from Quadra.

- Intermittent delay and queuing occur at Shelbourne Street in the westbound direction, blocking access to the strip mall located adjacent to McKenzie Avenue.

- Intermittent delay and queuing occur at Gordon Head Road in the westbound direction which can significantly impact buses beginning their journey from the UVic campus. This is largely due to the intersection configuration which currently forces westbound traffic from McKenzie Avenue to merge into the center lane either:
    - Upstream, where it competes for space with northbound left traffic from McGill Road, or
    - Downstream, which creates a conflict with the southbound-right movement.
- Some north-south left turn movements experience significant delays at Quadra Street and Shelbourne Street. This validates well with observed afternoon traffic operations at those locations and is expected given the large left-turning volumes at those two busy intersections.
- Buses occasionally get stuck behind right turning vehicles specially at intersections where maximum queues exceed 100 meters.

Table 3: 2019 Traffic Operations Analysis (PM)

Intersection	Base	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Quadra St	Volume	290	680	90	300	430	30	70	900	70	60	970	260	4150
	AVG Queue	50	40	50	60	40	40	40	60	60	5	40	10	40
	Max Queue	160	160	160	170	160	170	190	200	200	30	180	70	230
	Average Delay	80	50	40	110	50	40	90	40	40	50	30	20	50
	LOS	F	D	D	F	D	D	F	D	D	D	C	B	D
McKenzie and Borden St	Volume	80	150	90	200	100	100	80	1210	110	70	1130	100	3420
	AVG Queue	5	10	20	10	10	10	0	30	30	5	20	20	10
	Max Queue	50	100	100	80	70	70	30	130	130	30	160	160	170
	Average Delay	40	40	30	30	40	40	40	20	30	50	20	10	20
	LOS	D	D	C	C	D	D	D	B	C	D	B	B	B
McKenzie and Cedar Hill Rd	Volume	130	330	90	40	200	150	230	750	90	130	960	70	3170
	AVG Queue	10	30	30	0	10	5	10	20	20	5	30	40	20
	Max Queue	70	120	120	20	70	40	70	120	130	40	120	130	140
	Average Delay	40	40	30	40	30	10	20	30	20	30	30	30	30
	LOS	D	D	C	D	C	A	B	C	B	C	C	C	C
McKenzie and Shelbourne St	Volume	230	680	200	160	530	120	170	630	80	200	800	90	3890
	AVG Queue	30	30	5	10	20	0	20	20	20	20	30	60	20
	Max Queue	110	110	40	70	80	30	80	130	140	90	190	190	190
	Average Delay	80	40	10	50	40	10	70	30	20	60	40	50	40
	LOS	E	D	B	D	D	B	E	C	B	E	D	D	D
McKenzie and Gordon Head Rd	Volume	160	350	70	120	230	130	170	570	130	100	720	170	2920
	AVG Queue	10	30	30	10	20	0	10	20	0	5	40	40	20
	Max Queue	110	160	160	40	120	20	70	100	30	30	180	190	200
	Average Delay	40	40	30	30	40	20	40	30	10	30	30	20	30
	LOS	D	D	C	C	D	B	D	C	A	C	C	B	C

2. Future Business As Usual (BAU)

Having completed and validated the base conditions model, the next step was to build a future BAU model that can be used to test the performance of various proposed improvements to the corridor in the long-term.

The future BAU Vissim model was developed for year 2050, which is consistent with the District of Saanich's current long term transportation planning horizon. The BAU model serves as the main comparator against which the three long-term scenarios are evaluated.

2.1. FUTURE MODELLING ASSUMPTIONS

The following summarizes key assumptions used to develop the 2050 BAU corridor model for the afternoon peak.

1) **Corridor growth factors by mode, auto and transit**: We assumed annual growth factors of 0.5% and 1.5% for auto volumes and transit ridership respectively based on benchmark observed data, forecasts from the CRD travel demand model and BC Stats as shown in ***Table 4***. The higher growth rate assumed for transit also aligns with the District's long-term vision of a 50% sustainable trip mode share by 2050. Vehicle growth at segments that are currently capacity constrained, e.g., Quadra Street and Shelbourne Street cross-streets and McKenzie Avenue east of Shelbourne Street, was reduced to 0.3% annually.

Table 4: 2050 Growth Assumptions

Source	Years	Growth Rate (Annual)	Note
Counts provided by UVic from a separate study (UVic Screenline)	2001 - 2018	Transit: **3%** Auto: **-1%**	The bulk of transit growth occurs between 2000 and 2004 (likely due to increased service and changes in parking charges)
BC Stats Population Forecasts for Community Health Service Areas[2] adjacent to McKenzie	2018 - 2041 Forecast	Adult Population (20+): **0.5%** University Age Cohort (20-24): **1%**	Vehicle growth likely aligns more closely with adult population growth. Transit growth aligns more closely with university cohort population growth
CRD Origin Destination Survey[3]	2011 - 2017	Total Trips: **0.68%**	This represents the whole CRD region
CRD Model Outputs (Auto)	2018 - 2038	Quadra/Shelbourne EB/WB: **0.55%** Quadra/Shelbourne NB/SB: **0.30%**	These are PM forecasts
BC Transit Ridership for Routes using McKenzie	2000 - 2015	Average Weekday Ridership: **2.1%**	Post 2015 data was not included due to changes in passenger counting technology

2) **Changes to Signal Timing Plans:** To accommodate future traffic growth, signal timing plans for intersections along the corridor were re-optimized using Synchro. ***Table 5*** summarizes the absolute changes in cycle length which increase by 10 seconds at Vikes Way and 20 seconds at the remaining intersections. Future timing plans maintain east-west signal coordination and green-wave progression which are key for efficient traffic operations.

Table 5: Future Intersection Cycle Lengths

Intersection	Cycle Length (Today)	Cycle Length (Future)
All except Vikes Way	110 sec	130 sec
Vikes Way (Half Cycle)	55 sec	65 sec

3) **Future Bus Service:** Future PM peak bus service (2050) assumptions, including RapidBus, were provided by BC Transit and coded in the Vissim model. These are summarized in ***Table 6*** below.

[2] https://bcstats.shinyapps.io/popApp/
[3] https://www.crd.bc.ca/project/regional-transportation/origin-destination-household-travel

By 2050, the total number of buses operating in the corridor during the peak periods will increase to about 20 to 25 buses per hour per direction.

Table 6: Future Bus Service Assumption on McKenzie

Route Number	Description	Frequency (PM)	Headway (PM)	Type	McKenzie Section (Study Area)
26	Dockyard - UVic	4 buses/hr	15 min	Frequent Stop	Saanich Rd - UVic
39	Westhills - UVic	4 buses/hr	15 min	Frequent Stop	Shelbourne St - UVic
51	TBD	2 buses/hr	30 min	Limited Stop	Hwy 17 - UVic
40	Langford - UVic	4 buses/hr	15 min	Limited Stop	Hwy 17 - UVic
RapidBus	Uptown - UVic	8 buses/hr	7.5 min	Limited Stop	Saanich Rd - UVic

4) **Future Bus Dwell Times:** Dwell time refers to the length of time a bus is stopped to pick up and/or drop off passengers. This time is usually recorded using automated vehicle location (AVL) GPS data equipped on buses. Using data provided by BC Transit for dwell time and boarding/alighting activity, a simple linear regression equation was estimated to adjust future dwell times in Vissim model to account for increase in future ridership as shown below.

$$Dwell\ Time = 13 + 1.97x(Boardings + Alightings)$$

On average, each incremental boarding or alighting adds two seconds to dwell time. Thus, future dwell times, by route and stop, were calculated based on the following:

$$Future\ Dwell = Observed\ Dwell + 1.97x\Delta(Boardings + Alightings)$$

5) **Future Study Area Assumptions Road Network:** The 2050 BAU model does not assume any major changes to the road network or lane configuration in the study area. The model also does not assume transformative land use changes, beyond what is already anticipated in existing plans such as the Shelbourne Valley Action Plan, resulting from the RapidBus or revisions to existing transportation or parking policies.

2.2. FUTURE DAILY TRIPS

Figure 10 shows the forecast daily people movement along McKenzie Avenue across two screenline locations: east of Borden Street and east of Shelbourne Street. Given that Vissim modelling does not explicitly account for active modes, we assumed that pedestrian and cycling volumes will grow at the same rate as transit, 1.5% annually (see ***Table 4***). By 2050, about 24% of all trips east of Shelbourne Street, which are mostly related to UVic activity, are made by transit. Buses, however, would still

comprise a small portion of the overall traffic stream, highlighting transit's ability of moving a larger number of people more efficiently. The forecast transit mode share at the Borden Street screenline is lower, 12%, which is expected given land use characteristics at that western section of the corridor and its proximity to Highway 17. These growth

Figure 10: Future Daily Mode Share Screenline

2.3. TRAFFIC OPERATION ANALYSIS

Traffic operations in the future were compared with those in the present day. Travel times and delays are the primary metric used to describe the scenario's operations ***Figure 11*** and ***Figure 12*** compare modelled 2019 time-space diagrams with the future BAU scenario. End-to-end travel times for general traffic increase from 10 to 12 minutes in the eastbound direction and from 11 to 14 minutes in the westbound direction. In the eastbound direction, most of the additional delay occurs in the western section of the corridor, upstream of Quadra Street. In the westbound direction, additional delay occurs mostly at the Gordon Head Road intersection, given that location's constrained traffic operations that were highlighted in the previous section. Additional delay also accrues at busy intersections (e.g., Shelbourne Street and Quadra Street) downstream of Gordon Head Road.

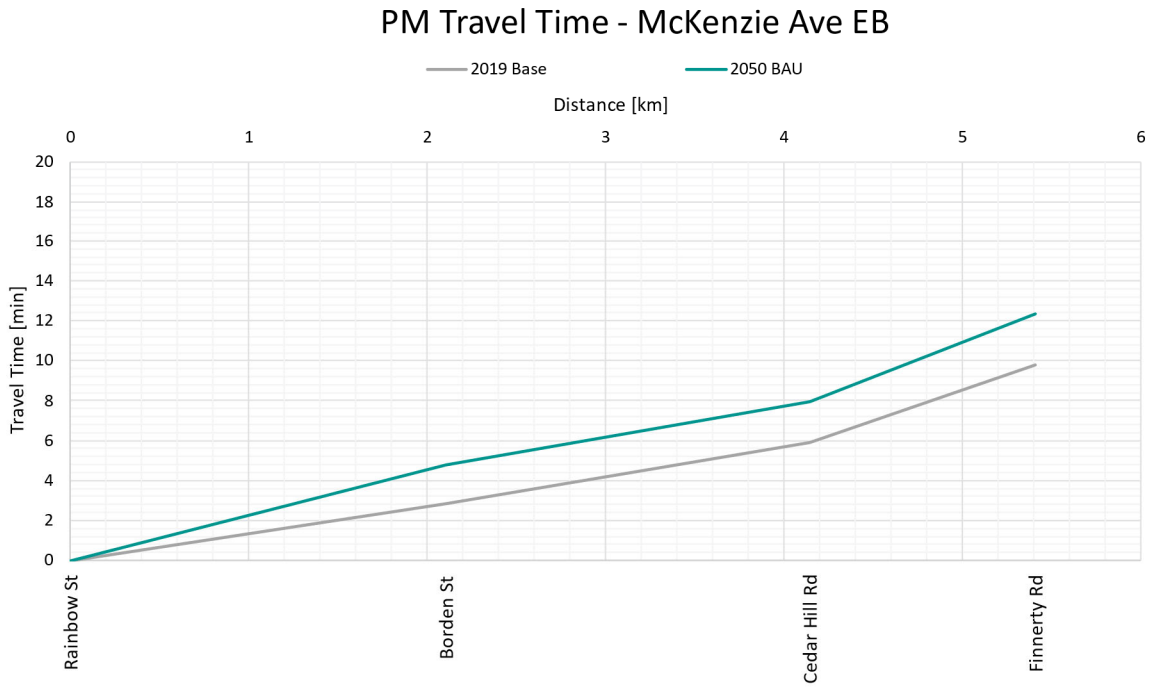


Figure 11: Eastbound Time-Space Diagram, 2050 BAU vs 2019 Base

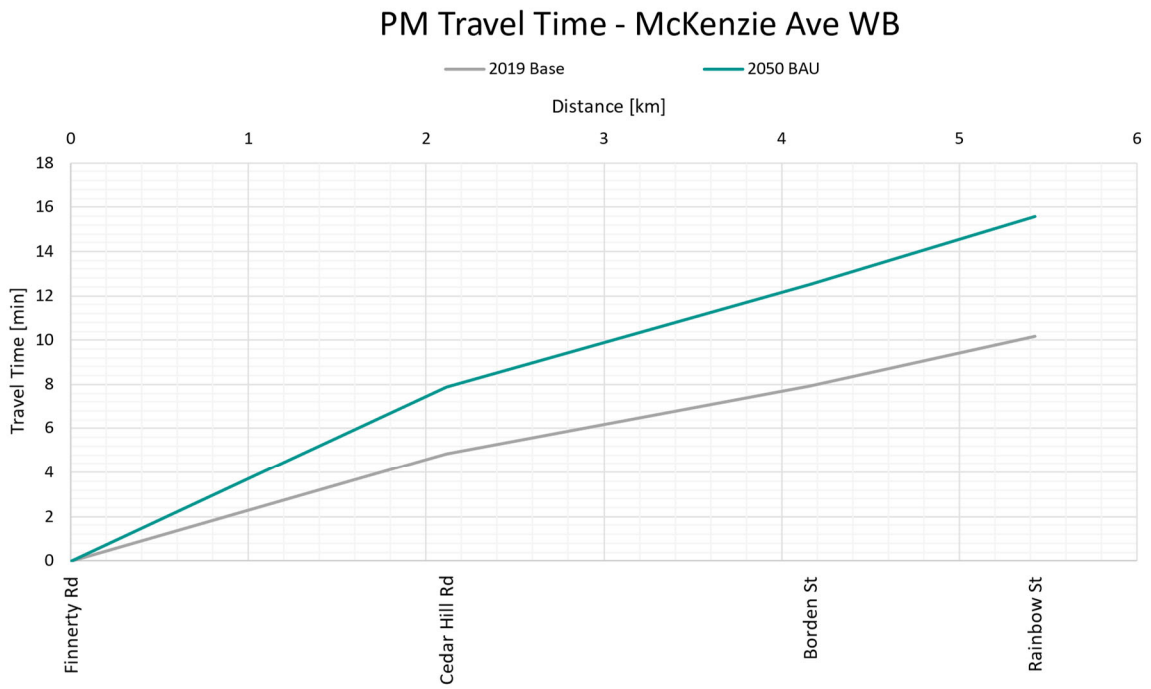


Figure 12: Westbound Time-Space Diagram, 2050 BAU vs 2019 Base

Figure 13 and ***Figure 14*** compare 2019 base and 2050 BAU modelled bus travel times. The RapidBus is not shown since it does not operate today. The results are generally consistent with the auto travel time comparison with westbound routes experiences higher additional delay in the afternoon compared to eastbound routes. ***Figure 15*** is a screenshot output from Vissim showing an example of a bus stuck in the eastbound queue at Quadra. Note that the travel times for the limited stop routes, 16 and 51, are for a portion of the route, between Gordon Head Road and Douglas Street.

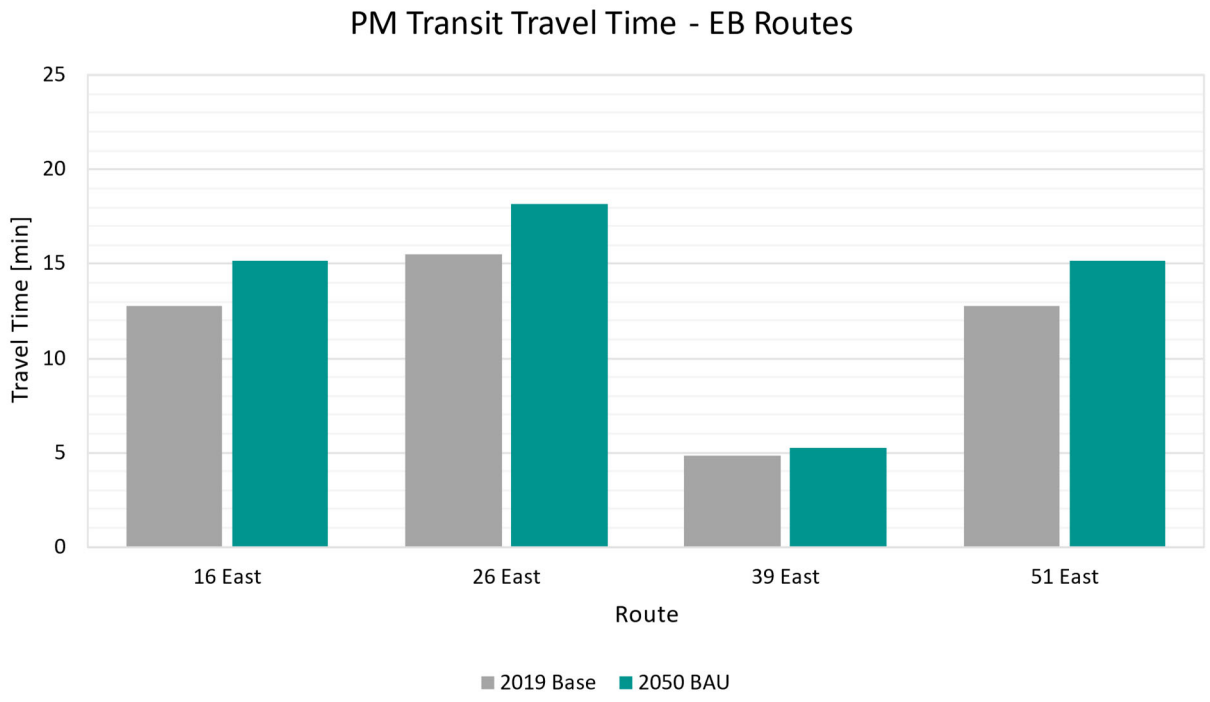


Figure 13: Eastbound Bus Travel Times, 2050 BAU vs 2019 Base

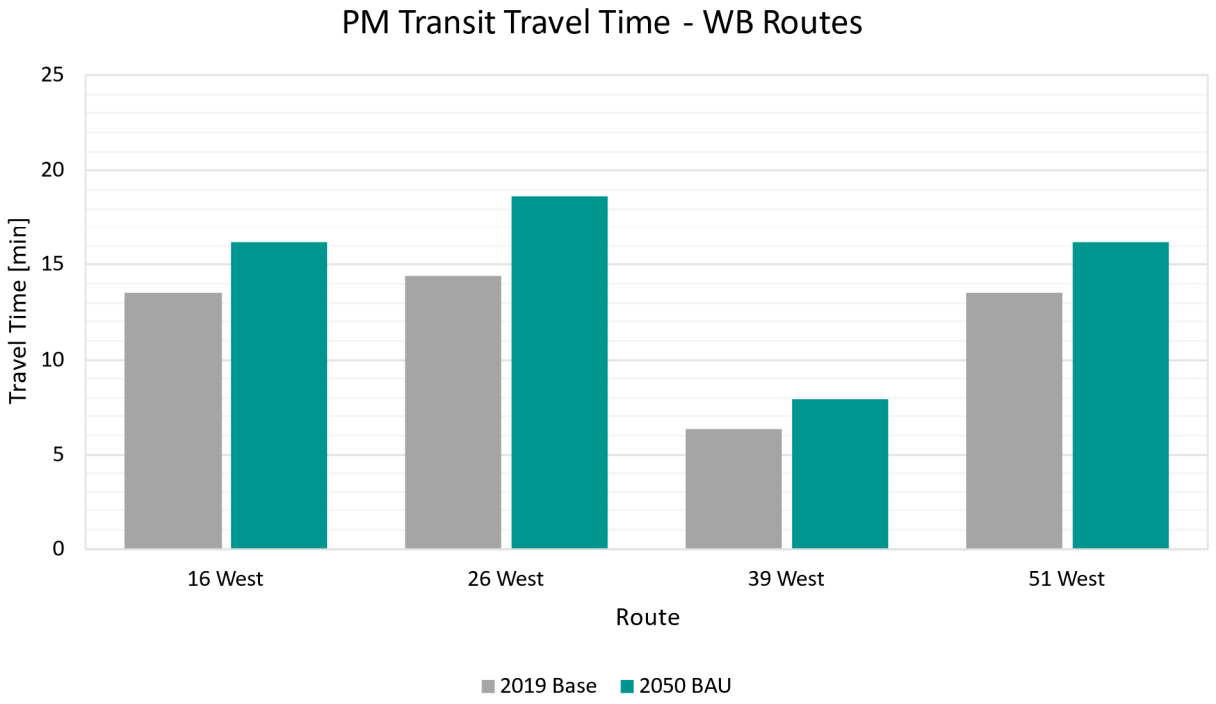


Figure 14: Westbound Bus Travel Times, 2050 BAU vs 2019 Base

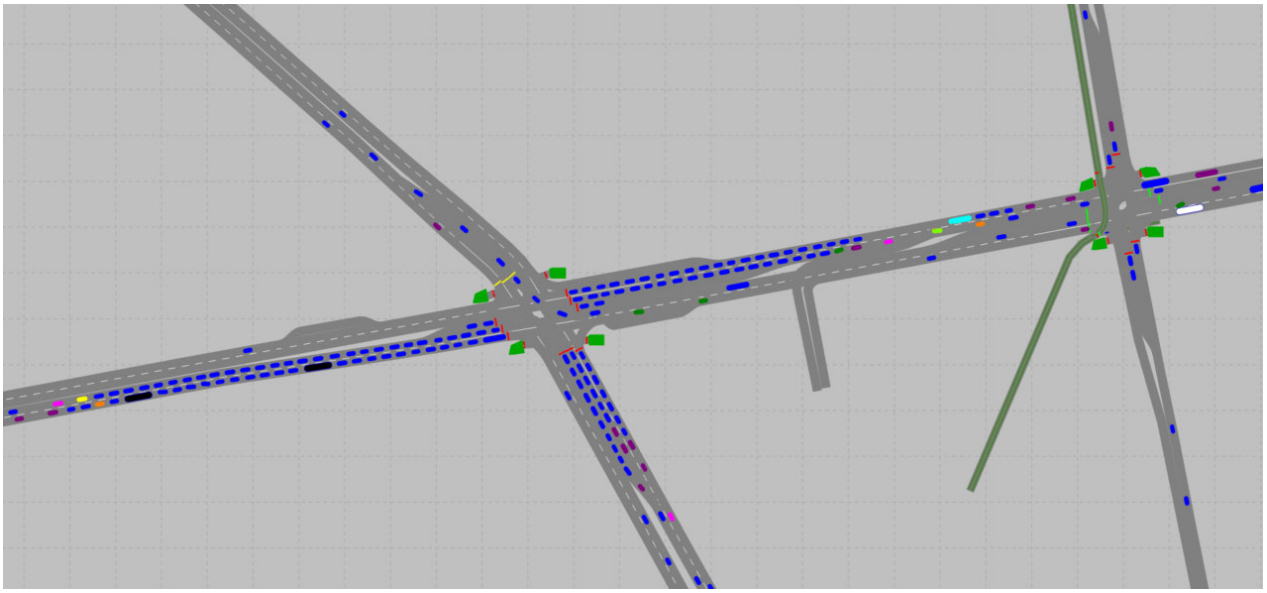


Figure 15: Vissim Screenshot of Quadra Intersection (black vehicles = buses)

Table 7 summarizes the forecast traffic operations at the busiest intersections along the corridor. Below are the main observations:

- In the eastbound and westbound direction, several movements operate at LOS of E or worse.

- The westbound through movement at Gordon Head Road deteriorates to a LOS E with the queue occasionally spilling back to McGill Road and Vikes Way. Further this queue blocks the right-turning volume (approximately 200 vehicles) and buses sharing the same lane with through traffic
- Average queues on McKenzie Avenue exceed 100 meters at several locations including Quadra Street (east and west), Borden Street (west), Shelbourne Street (west) and Gordon Head Road (west). These queues can block bus access through the intersection.
- The average queue length for the east-bound left movement at Quadra Street exceeds 200 meters indicating that the existing left-turn storage bay may not be sufficient.
- Several north-south turn movements are at or exceed capacity, specifically at Quadra Street and Shelbourne Street.

Table 7: 2050 BAU Intersection Analysis

Intersection	2050 BAU	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Quadra St	Volume	310	720	100	330	480	30	80	1040	80	60	1070	280	4580
	AVG Queue	130	160	160	80	60	60	210	240	240	10	100	10	110
	Max Queue	230	220	230	190	180	190	410	420	420	40	190	170	420
	Average Delay	150	130	120	110	60	60	170	80	70	90	50	30	80
	LOS	F	F	F	F	E	E	F	E	E	F	D	C	F
McKenzie and Borden St	Volume	90	180	100	230	110	120	80	1390	120	80	1240	110	3850
	AVG Queue	10	30	30	20	20	20	0	30	30	10	140	140	40
	Max Queue	100	140	140	120	130	130	30	140	140	40	300	310	310
	Average Delay	80	60	50	50	60	60	40	20	30	80	60	50	40
	LOS	E	E	D	D	E	E	D	B	C	F	E	D	D
McKenzie and Blenkinsop Rd	Volume	120	410	120	80	290	150	210	1110	40	110	1220	80	3940
	AVG Queue	10	90	100	10	20	5	20	20	30	10	90	100	40
	Max Queue	150	160	170	40	120	40	160	190	200	50	300	310	310
	Average Delay	90	70	70	60	30	20	70	20	10	50	50	50	40
	LOS	F	E	E	E	C	B	E	B	B	D	D	D	D
McKenzie and Cedar Hill Rd	Volume	140	360	100	40	230	180	260	880	110	140	1100	70	3610
	AVG Queue	10	60	70	5	20	5	10	20	30	10	10	10	20
	Max Queue	110	120	130	20	120	40	90	140	150	50	80	80	160
	Average Delay	60	60	50	50	40	10	40	30	20	30	30	30	30
	LOS	E	E	D	D	D	B	D	C	B	C	C	C	C
McKenzie and Shelbourne St	Volume	240	720	210	180	580	140	190	740	100	220	930	100	4350
	AVG Queue	120	130	40	30	30	5	30	40	40	30	90	100	60
	Max Queue	310	310	160	120	130	40	140	170	180	140	220	230	330
	Average Delay	160	90	40	80	50	20	90	40	40	70	60	70	70
	LOS	F	F	D	F	D	B	F	D	D	E	E	E	E
McKenzie and Gordon Head Rd	Volume	170	370	70	130	250	140	200	660	140	110	800	190	3230
	AVG Queue	30	70	70	10	30	0	20	30	0	5	130	140	40
	Max Queue	160	160	170	50	130	20	140	150	40	50	220	220	220
	Average Delay	110	60	60	40	50	40	50	30	20	40	70	30	50
	LOS	F	E	E	D	D	D	D	C	B	D	E	C	D
McKenzie and McGill Rd	Volume	260	-	30	-	-	-	-	610	250	20	840	-	2010
	AVG Queue	10	-	20	-	-	-	-	0	0	0	160	-	30
	Max Queue	90	-	90	-	-	-	-	70	10	10	360	-	360
	Average Delay	40	-	10	-	-	-	-	5	0	30	50	-	30
	LOS	D	-	A	-	-	-	-	A	A	C	D	-	C
McKenzie and Vikes Way	Volume	100	0	30	10	0	30	10	600	30	10	740	0	1560
	AVG Queue	5	5	0	0	0	0	0	20	10	0	130	140	30
	Max Queue	30	30	20	20	20	30	0	170	180	10	330	340	340
	Average Delay	30	30	10	20		30	20	10	10	30	40	50	30
	LOS	C	C	A	B		C	B	B	B	C	D	D	C

3. Scenario Modelling and Evaluation

This section presents the evaluation of the three proposed long-term vision scenarios that were previously described in Section 5.1 of the main Long-Term Vision Report. All three scenarios build off the 2050 BAU scenario. As a reminder, the three scenarios are briefly described below:

- **Scenario 1**: This scenario retains the four-lane cross-section with the two general purpose curb lanes converted to bus lanes.
- **Scenario 2**: Essentially retains the existing roadway arrangement for all lanes, but with the addition of transit queue jump infrastructure to address the intersection-related delay that was identified during the base conditions assessment.
- **Scenario 3**: Largely builds on Scenario 2 by addressing specific concerns at intersections to improve overall operation. Scenario 3 assumes a roundabout at Gordon Head Road and extends the westbound bus queue jump at Borden Street through to west of Quadra Street for ease of navigation.

Given the loss of a General Purpose (GP) travel lane for the majority of the corridor in Scenario 1, it is expected that some traffic will divert to alternate routes. Traffic diversion rates were estimated from the CRD travel demand macro-model for input into the Vissim model. The CRD model accounts for the following travel behaviour changes: trip distribution, mode shift and route choice travel behaviour changes. The model does not, however, account for other changes such as time of day shift, switching to remote work, or foregoing some discretionary travel. The horizon year for the CRD model is 2038 and likely does not account for longer term growth by 2050. However, it is a useful tool for understanding the diversion effects on the local network and identifying any emerging hot spots.

Figure 16 and ***Figure 17*** show the volume to capacity (v/c) ratios in the study areas for the BAU and Scenario 1. In general, typical capacity for a through lane in an urban setting is approximately 1,600 – 1,800 passenger car units (pcu) per hour per lane[4]. At intersections, capacity depends on the green time allocation for a specific movement and is typically about 700 - 800 vehicles per hour per lane. For example, at Quadra Street, about 40%-45% of the green time is allocated to the east-west movement.

Overall, the regional model suggests that congestion during the peak periods will spread throughout the network on alternate major and collector roads. Importantly, the model suggests the volume to capacity ratio of these alternate routes generally remains below 1 implying that these routes will be able to accommodate the diverted trips. This also implies that with reduced traffic volumes due to re-routing of non-essential trips, 1 GP lane can accommodate the remaining traffic on McKenzie Avenue. As expected, a few localized congestion hot spots emerge along the corridor, due to the reduction in the number of lanes, such as eastbound east of Shelbourne Street (mall access) and in the westbound direction

[4] https://www.tac-atc.ca/sites/tac-atc.ca/files/site/doc/resources/report-capacityguide.pdf (Table 3.7)

upstream of Douglas Street due to lack of any realistic alternatives east-west access for origins/destinations between Quadra Street and Douglas Street.

On the street network north of McKenzie Avenue, congestion levels remain acceptable (v/c < 1). On the southern side, two hotspots emerge at Blenkinsop Road and Cedar Hill Cross Road. While the increase in traffic is generally small, less than 100 vehicles, the capacities on the streets are constrained and measures such as signal retiming or turn restrictions may be needed. The congestion hot spots do not appear to be in areas where transit operates.

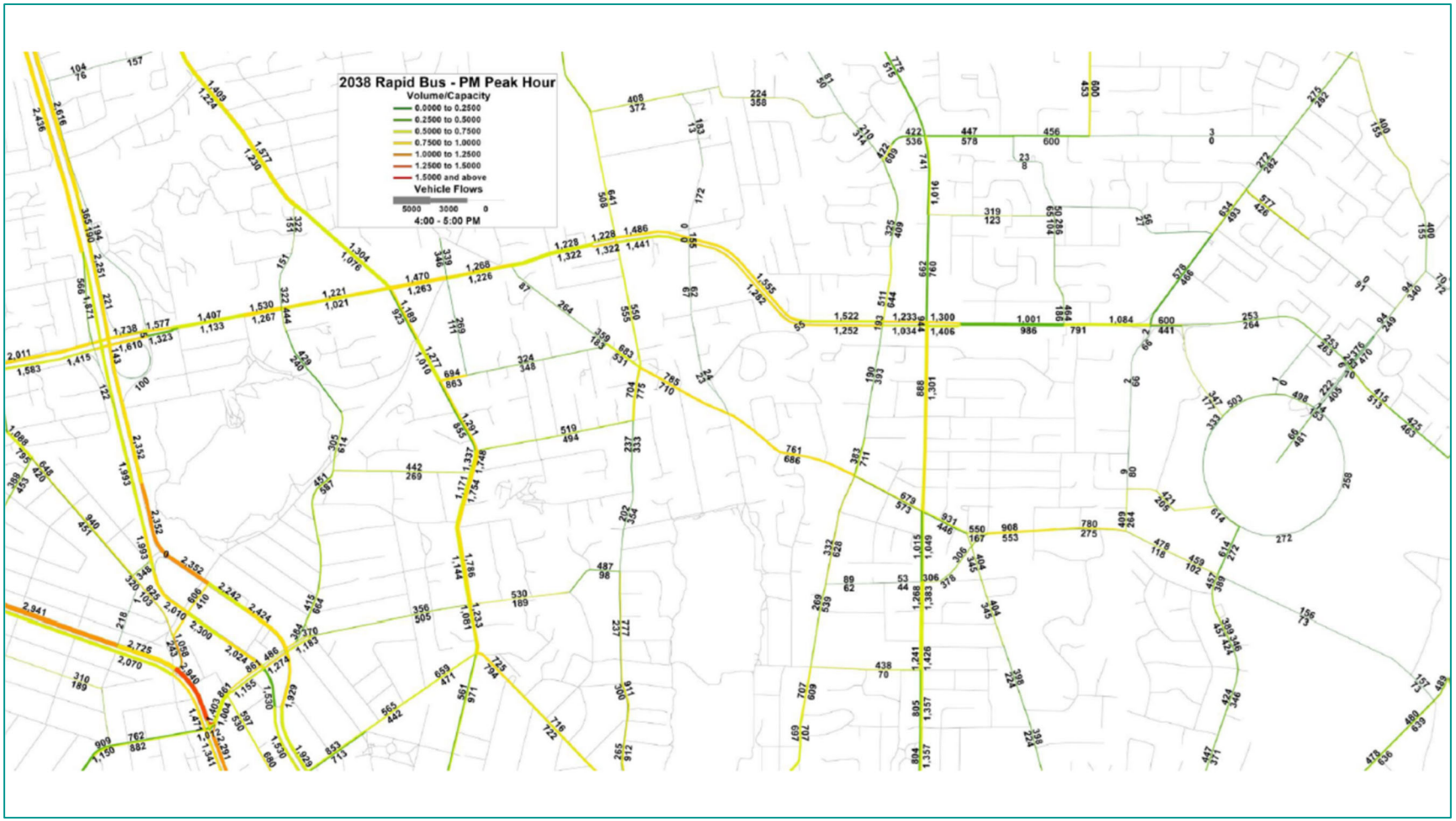


Figure 16: Volume to Capacity Ratio (Business As Usual)

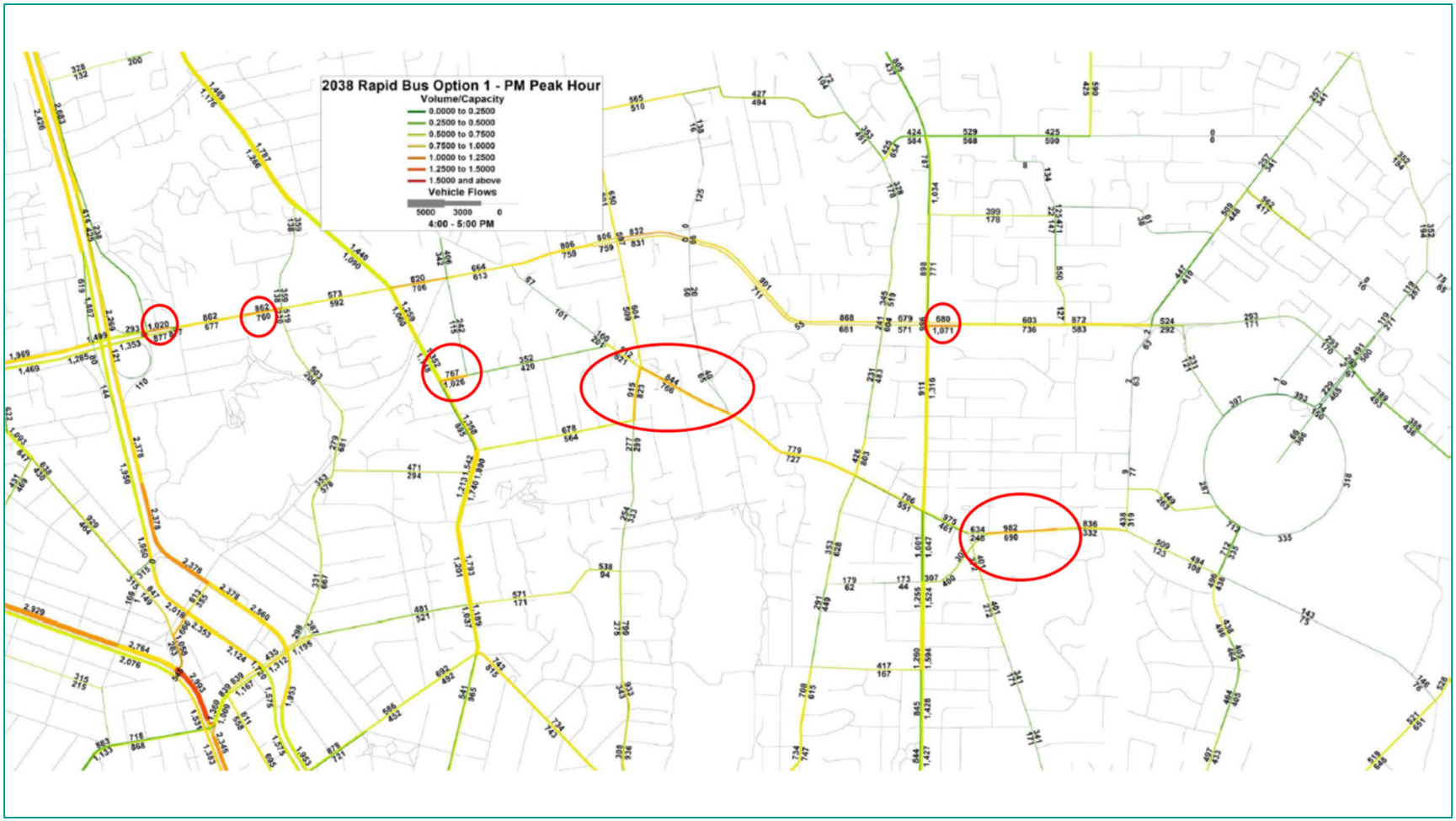


Figure 17: Volume to Capacity Ratio (Scenario 1)

As shown in ***Figure 18***, many vehicles divert away from McKenzie Avenue, especially between Shelbourne Street and Highway 17. In general, since only some vehicles travel the entire length of the corridor, from the University of Victoria all the way to Highway 17, as indicated by the lack of a clear alternative traffic re-routing pattern. Given limited, continuous east-west alternative routes, traffic mostly disperses through the collector road network to access destinations north and south of the corridor. Some alternative routes for bypassing McKenzie Avenue include:

- North side: Mount Douglas Cross Road and local streets that provide access to Douglas Street
- South side: Quadra – Union Road – Blenkinsop Road alternative route

Further, traffic diversion results in increased traffic volume at the busy Shelbourne Street / McKenzie Avenue intersection in the southbound direction as cars choose alternative routings to avoid constrained sections of McKenzie Avenue. The District has a long-term vision for transit priority on Shelbourne Street and they may want to explore this further to mitigate delays.

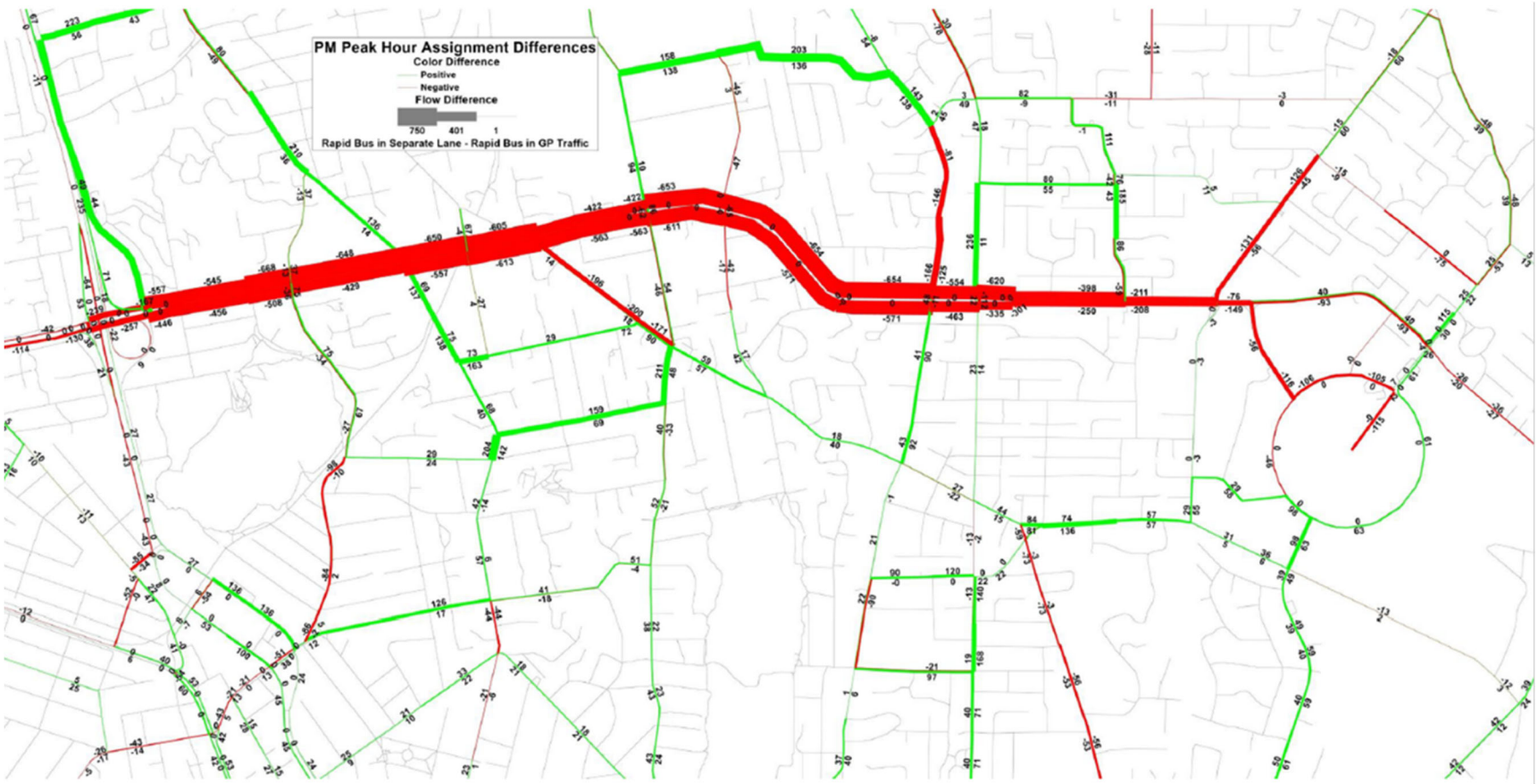


Figure 18: CRD Model Traffic Diversion (Red = Traffic Decrease, Green = Traffic Increase) – 2038 PM Scenario 1 vs BAU

Overall, we conclude that the surrounding network will be able to accommodate the additional traffic and that those streets would still be carrying traffic volumes consistent with their road classification. Although inconvenient, the diversion of people that choose to drive their cars during the peak periods away from major transit routes is necessary to grow the overall people-moving capacity of the network. Existing technology, such as GPS navigation and real-time traffic conditions allow the modern driver comfortable and convenient options, albeit at a slight time disadvantage relative to current conditions. As an example, today, Mt Douglas Cross Rd operates as a collector with an average daily traffic of approximately 3,300 vehicles (see ***Figure 19***). Assuming a 0.5% annual traffic growth, volumes grow to about 3,900 vehicles in 2050. The estimated diversion of about 300 cars translates to about 1,800 additional vehicles on a daily level. Thus, future volumes on this road reaches 5,500 - 6,000 daily vehicles which is well within observed volumes at collectors today in the District. Further, even with the diversion, peak hour volumes at stop signs remain below 400 vehicles which is the typical hourly capacity of a lane at a stop-controlled intersection.

It is important to note that a comprehensive evaluation would be required to assess local impacts of diverted traffic in the study area. While the CRD model points to limited congestion issues, other considerations, such as neighborhood character, noise, pedestrian activity, and safety are equally, if not more, important. Further, comprehensive, traffic operation analysis, beyond the scope of this study, would be necessary to assess detailed traffic operations for specific movements and locations to determine whether the addition of traffic calming would be warranted.

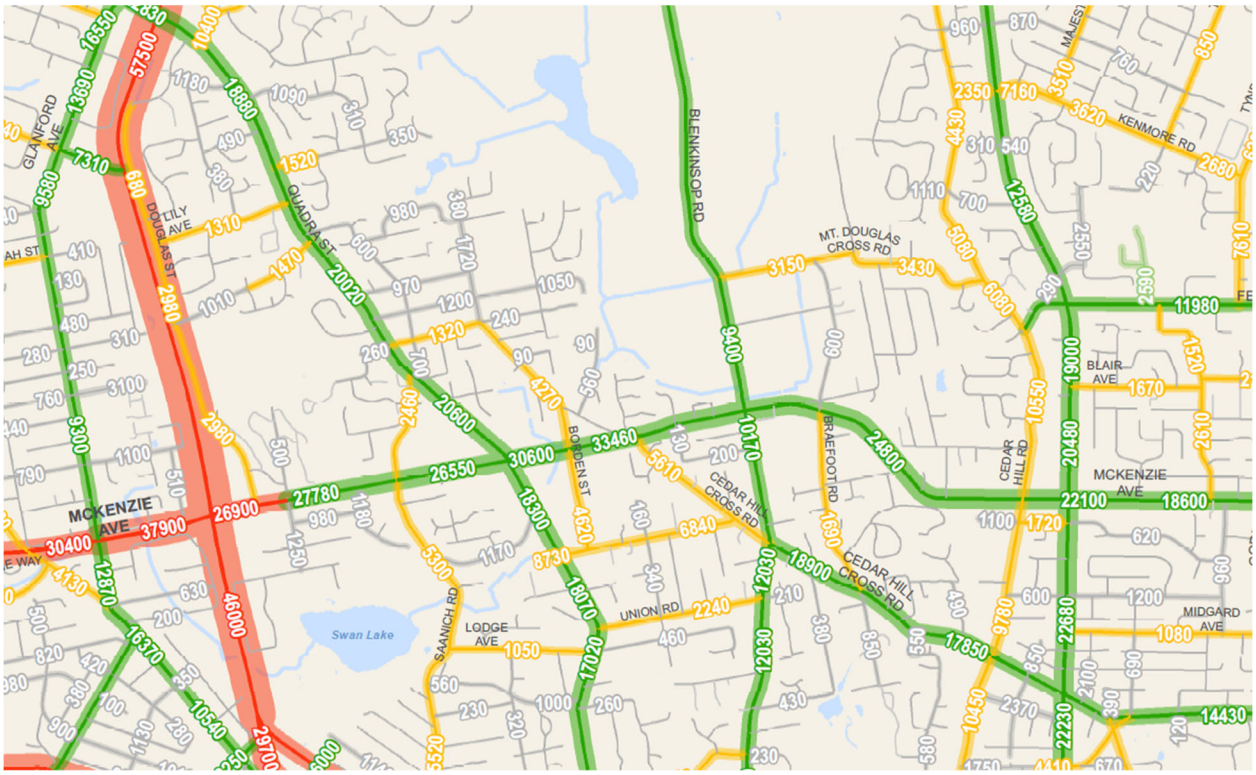


Figure 19: 2020 District of Saanich Daily Volume Traffic Map (Red = Highway, Green = Arterial, Yellow = Collector)

To account for differences in the number of lanes and traffic volumes along the McKenzie corridor, two diversion rates were estimated from the CRD model outputs and applied:

- East of Shelbourne Street: The total number of lanes at this section varies between 2 and 3. The average diversion rate, based on traffic volume forecasts from the CRD model (see ***Figure 16*** and ***Figure 17***) is approximately 28%.

- West of Shelbourne Street: The total number of lanes at this section is 4. The average diversion rate, based on traffic volume forecasts from the CRD model (see ***Figure 16*** and ***Figure 17***) is approximately 45%.

3.1. SCENARIO MODELLING RESULTS

Figure 20 and ***Figure 21*** are time-space diagrams comparing the three scenarios with the 2050 BAU Scenario. Below are some key findings.

- Eastbound Direction

    - All three scenarios operate similarly and reduce travel times by about 2 minutes relative to the BAU. These savings are largely due to the separation of right turning traffic from through traffic at congested locations, Quadra Street specifically.

- Scenario 1 generates slightly more travel time savings for corridor users due to vehicles diverting away from McKenzie Avenue.

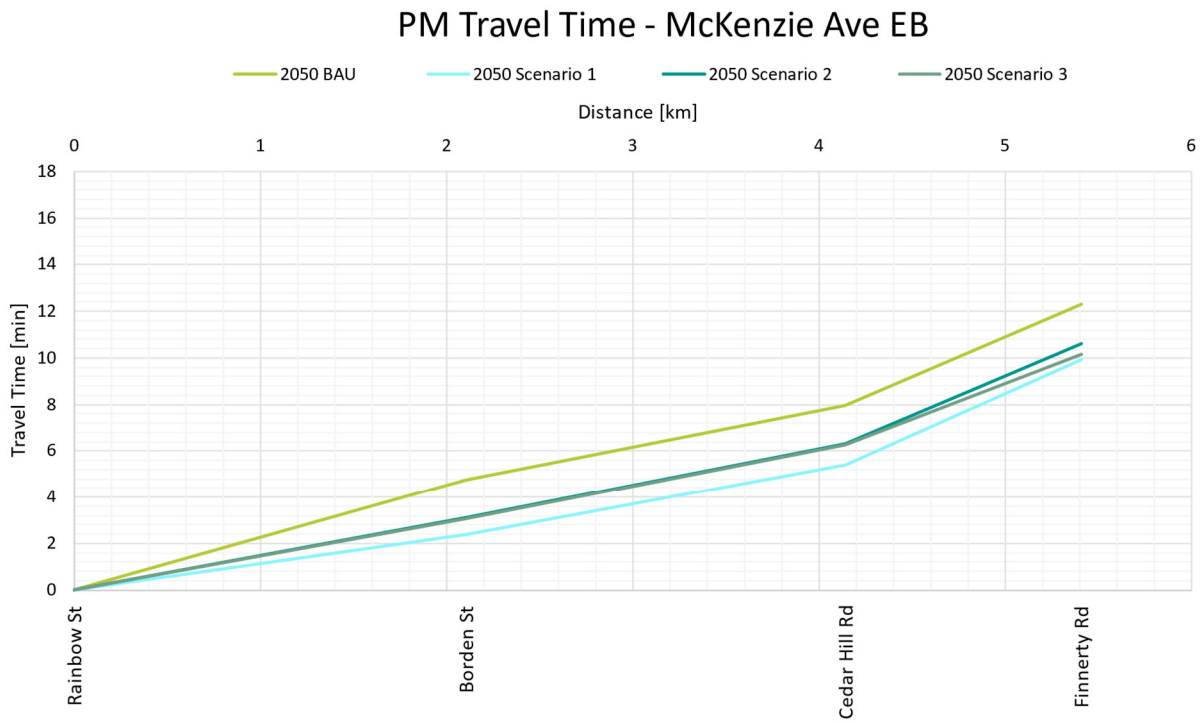


Figure 20: Eastbound Time-Space Diagram, Scenario 1, 2, 3 vs 2050 BAU

- Westbound Direction

  - Scenario 1 end-to-end travel time is significantly lower compared to Scenario 2 and the BAU Scenario. Scenario 1 outputs, however, do not account for additional delay on the wider road network as a result of traffic diverting away from McKenzie Avenue. If the actual diversion from McKenzie is different than what was estimated from the CRD model, Scenario 1 travel times for general traffic will likely be slower (and more similar to BAU travel times along McKenzie), reaching an equilibrium with the alternative routes.

  - In Scenario 2, the introduction of a westbound bus queue-jump upstream of Gordon Head Road westbound moves the bottleneck further back as GP traffic has to merge into the center lane earlier (see ***Figure 22***).

  - The roundabout option in Scenario 3 improves westbound traffic movement relative to Scenario 1.

- Scenarios 1, 2 and 3 operate similarly downstream of Cedar Hill Road for the remainder of the corridor.
- The intersection of McKenzie Avenue at Gordon Head Road becomes a major bottleneck in the future.

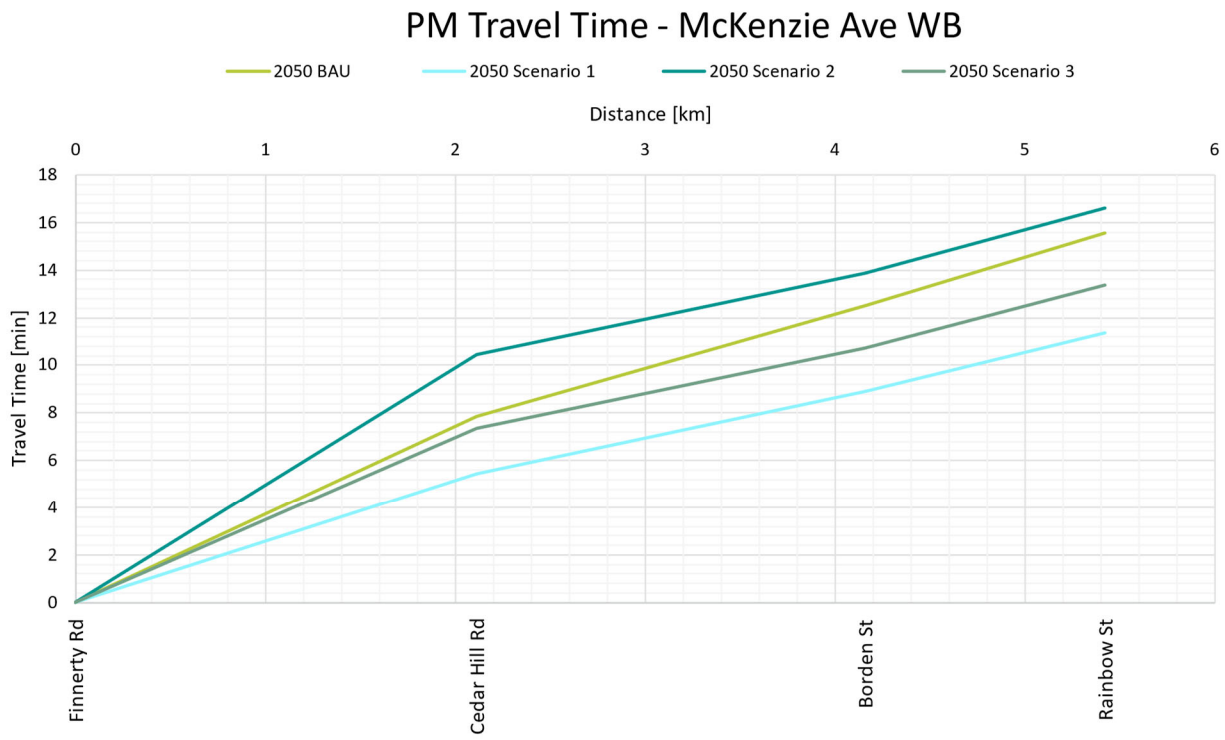


Figure 21: Westbound Time-Space Diagram, Scenario 1, 2, 3 vs 2050 BAU

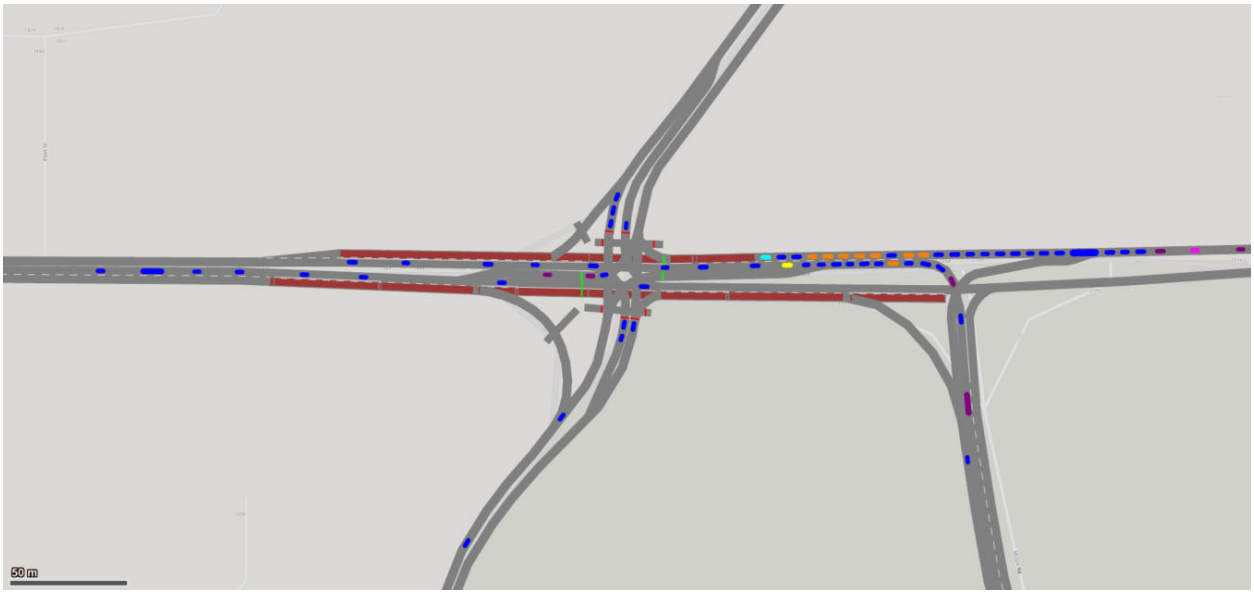


Figure 22: Vissim Screenshot of Gordon Head Road Intersection (Scenario 2)

Table 8 summarizes the forecast traffic operations at the busiest intersections along the corridor for Scenario 1. Below are key observations:

- In general, traffic operations at east-west approaches improve relative to the BAU due to the large number of cars diverted away from the corridor and right turning vehicles utilizing the bus lane to turn right.

- Overall, average delay at cross street approaches increases due to diverted traffic. Northbound approaches operate at LOS E or worse. The intersection of Shelbourne Street at McKenzie Avenue in particular, performs poorly.

- Average left turn queues lengths on McKenzie Avenue are reasonable and do not indicate a need for additional storage length. The only exception is the east-bound-left turn movement at Quadra Street where maximum queues can reach 200 meters indicating a possible need to lengthen the storage bay at that location.

- Average westbound queue length at Shelbourne Street exceeds 100 meters, potentially resulting in some right turning vehicle utilizing longer stretches of the bus lane and potentially blocking bus access.

Table 8: 2050 Scenario 1 Intersection Analysis

Intersection	2050 Scenario 1	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Quadra St	Volume	160	810	80	210	640	30	80	480	90	50	580	180	3390
	AVG Queue	40	190	190	20	30	30	30	40	40	10	60	5	60
	Max Queue	210	220	230	100	130	140	200	190	190	30	190	60	230
	Average Delay	160	150	150	60	40	40	110	40	20	70	30	10	70
	LOS	F	F	F	E	D	D	F	D	B	E	C	B	E
McKenzie and Borden St	Volume	80	200	90	170	210	90	80	680	100	70	660	90	2520
	AVG Queue	20	30	30	10	40	40	0	10	10	0	60	70	20
	Max Queue	120	150	150	110	140	140	30	100	100	30	280	280	280
	Average Delay	110	70	60	50	70	70	30	10	10	40	30	10	40
	LOS	F	E	E	D	E	E	C	A	B	D	C	B	D
McKenzie and Blenkinsop Rd	Volume	90	480	90	80	400	140	150	540	50	110	590	80	2800
	AVG Queue	10	110	120	10	30	0	10	20	20	5	40	50	40
	Max Queue	150	160	170	40	160	30	90	190	200	40	250	260	260
	Average Delay	110	90	80	70	40	10	40	20	10	30	30	10	40
	LOS	F	F	F	E	D	B	D	B	A	C	C	B	D
McKenzie and Cedar Hill Rd	Volume	90	420	100	30	160	110	150	470	60	120	590	80	2380
	AVG Queue	10	80	80	0	10	0	5	10	20	5	20	20	20
	Max Queue	80	120	120	20	70	30	40	110	120	30	100	110	130
	Average Delay	70	70	70	50	40	10	30	20	10	20	20	10	30
	LOS	E	E	E	D	D	A	C	B	A	B	B	B	C
McKenzie and Shelbourne St	Volume	130	840	160	160	830	80	130	410	70	200	570	90	3670
	AVG Queue	110	270	40	60	180	0	10	30	40	20	100	110	80
	Max Queue	340	390	90	220	220	20	60	170	190	120	220	230	390
	Average Delay	180	150	110	180	150	90	70	40	10	70	50	20	110
	LOS	F	F	F	F	F	F	E	D	B	E	D	B	F
McKenzie and Gordon Head Rd	Volume	110	480	60	90	200	100	140	400	100	100	560	150	2490
	AVG Queue	10	110	110	5	10	0	10	10	0	5	40	40	30
	Max Queue	110	170	170	40	100	10	70	120	30	30	170	180	190
	Average Delay	80	80	80	40	30	10	40	30	10	30	30	20	40
	LOS	E	E	E	D	C	A	D	C	A	C	C	B	D
McKenzie and McGill Rd	Volume	170	-	20	-	-	-	-	380	170	10	630	-	1380
	AVG Queue	5	-	5	-	-	-	-	0	0	0	0	-	0
	Max Queue	40	-	40	-	-	-	-	70	5	10	20	-	80
	Average Delay	10	-	5	-	-	-	-	0	0	5	5	-	5
	LOS	A	-	A	-	-	-	-	A	A	A	A	-	A
McKenzie and Vikes Way	Volume	100	0	30	10	0	30	5	380	20	10	500	5	1090
	AVG Queue	5	5	0	0	0	0	0	10	10	0	10	10	5
	Max Queue	30	30	20	20	20	20	0	130	140	10	100	110	150
	Average Delay	30	30	10	20		10	20	10	10	10	10	10	10
	LOS	C	C	A	B		B	B	A	A	A	A	A	B

Table 9 summarizes the forecast traffic operations at the busiest intersections along the corridor for Scenario 2. Below are key observations:

- Approach delays at Northbound and Southbound cross streets are largely similar to BAU results.
- Queues from the bottleneck upstream of Gordon Head Road in the westbound direction spill back to Vikes Way resulting in fewer vehicles being able to make it through Gordon Head Road and blocking bus access through the intersection.

- Compared to the BAU, through and right turning traffic delays are lower at intersections between Gordon Head Road and Quadra Street due to adding shared bus queue jump lanes at Quadra Street, Blenkinsop Road and Cedar Hill Road. Further, lower westbound downstream through volumes from Gordon Head Road, results in lower intersection delays downstream.

- Average left turn queues lengths on McKenzie Avenue are reasonable and do not indicate a need for additional storage length, except eastbound at Quadra Street.

- Average queue lengths at intersections between Gordon Head Road and Quadra Street are largely reasonable except eastbound Quadra Street where the queue can block access to the queue-jump lane.

Table 9: 2050 Scenario 2 Intersection Analysis

Intersection	2050 Scenario 2	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Quadra St	Volume	310	720	100	330	480	30	80	1080	80	60	1,090	290	4650
	AVG Queue	140	170	170	80	60	60	90	110	110	10	70	10	90
	Max Queue	230	230	230	200	180	180	290	290	290	40	190	70	310
	Average Delay	150	130	120	110	60	50	140	50	30	80	40	20	70
	LOS	F	F	F	F	E	D	F	D	C	E	D	B	E
McKenzie and Borden St	Volume	90	180	100	230	110	120	80	1420	120	80	1,270	110	3910
	AVG Queue	10	30	30	20	20	20	5	30	30	10	60	60	20
	Max Queue	100	140	140	120	120	120	30	140	140	40	250	260	260
	Average Delay	80	70	50	50	60	60	40	20	30	80	30	30	30
	LOS	E	E	D	D	E	E	D	B	C	F	C	C	C
McKenzie and Blenkinsop Rd	Volume	130	410	120	80	290	150	210	1130	40	110	1,200	80	3950
	AVG Queue	10	90	100	10	20	0	20	20	30	10	50	50	30
	Max Queue	160	160	170	40	120	30	160	190	200	60	240	240	240
	Average Delay	80	70	70	60	30	10	60	20	20	50	30	20	40
	LOS	F	E	E	E	C	A	E	B	B	D	C	B	D
McKenzie and Cedar Hill Rd	Volume	150	360	100	40	230	180	270	890	110	130	1,050	70	3580
	AVG Queue	10	60	70	5	20	5	10	20	30	5	30	30	20
	Max Queue	110	120	130	20	120	40	90	130	140	40	130	130	160
	Average Delay	60	60	60	50	40	10	40	20	20	30	30	10	30
	LOS	E	E	E	D	D	B	D	B	B	C	C	B	C
McKenzie and Shelbourne St	Volume	240	710	210	170	580	140	200	750	100	210	860	90	4260
	AVG Queue	120	120	40	30	30	0	30	40	40	20	70	80	50
	Max Queue	320	320	140	120	130	30	120	160	180	110	210	220	320
	Average Delay	160	90	40	80	50	10	90	40	40	70	50	70	70
	LOS	F	F	D	F	D	B	F	D	D	E	D	E	E
McKenzie and Gordon Head Rd	Volume	170	370	70	130	250	140	200	670	140	100	710	170	3120
	AVG Queue	20	60	60	10	20	0	20	40	0	5	150	160	50
	Max Queue	160	170	170	50	130	10	230	240	50	30	220	220	260
	Average Delay	60	60	50	40	40	20	60	40	10	40	50	40	50
	LOS	E	E	D	D	D	B	E	D	B	D	D	D	D
McKenzie and McGill Rd	Volume	270	-	30	-	-	-	-	620	250	20	730	-	1920
	AVG Queue	10	-	20	-	-	-	-	0	0	0	260	-	50
	Max Queue	100	-	100	-	-	-	-	100	5	10	360	-	360
	Average Delay	50.0	-	10.0	-	-	-	-	5.0	0.0	40.0	70.0	-	40
	LOS	D	-	A	-	-	-	-	A	A	D	E	-	D
McKenzie and Vikes Way	Volume	100	0	30	10	0	30	5	600	30	5	620	0	1430
	AVG Queue	5	5	0	0	0	0	0	20	20	0	320	340	70
	Max Queue	40	40	20	20	20	30	5	200	210	5	380	390	390
	Average Delay	50	50	10	30		40	20	10	10	70	100	60	50
	LOS	D	D	A	C		D	B	B	B	E	F	E	D

While the introduction of a roundabout in Scenario 3 does improve overall traffic flow east-west, it does increase delay significantly at the Gordon Head Road north and south approaches which operate at a LOS F as shown in ***Table 10***. Roundabouts are usually better suited for intersections with balanced approach traffic volumes. In the case of Gordon Head Road, McKenzie Avenue traffic dominates the traffic stream, reducing opportunities for minor north-south traffic to travel along the roundabout.

Table 10: Scenario 3 Round-about Traffic Operation (McKenzie @ Gordon Head Road)

Intersection	2050 Scenario 3	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Gordon Head Rd	Volume	150	340	60	80	160	90	200	660	140	110	800	190	
	AVG Queue	120	120	120	120	120	120	10	10	10	120	120	120	100
	Max Queue	170	170	170	140	140	140	100	100	100	220	220	220	220
	Average Delay	100	90	90	170	160	160	10	10	10	50	70	60	60
	LOS	F	F	F	F	F	F	A	A	B	D	E	E	E

Figure 23 and ***Figure 24*** compare bus travel times (RapidBus and No. 26) on McKenzie Avenue for the BAU and the three scenarios in the eastbound and westbound directions. Below are some key observations.

- Eastbound Direction:
    - Compared to the BAU, all three scenarios achieve similar travel times savings, approximately 1.5 minutes or 10% in the case of the RapidBus.
    - RapidBus is generally faster than the local route, No. 26, by about 3 minutes despite operating for a longer stretch along McKenzie Avenue.

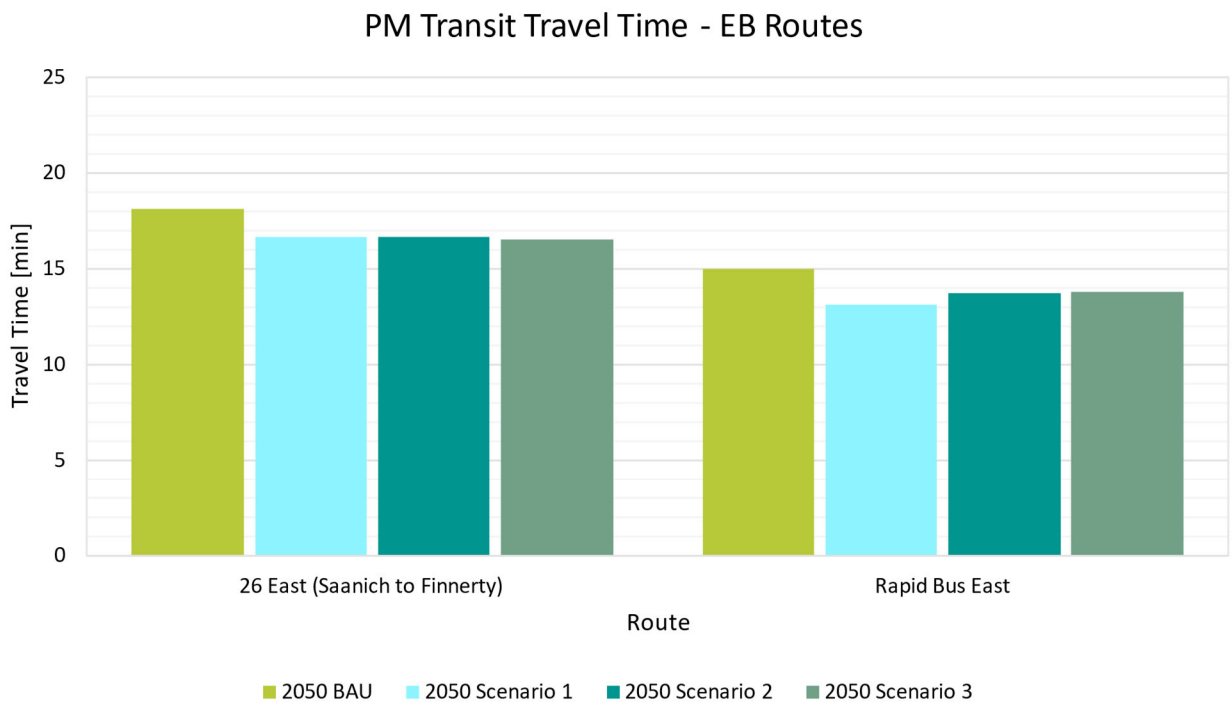


Figure 23: Eastbound Bus Travel Times, Scenario 1, 2,3 vs 2050 BAU

- Westbound Direction:
    - Scenario 2 outputs are highly influenced by constrained traffic operation at Gordon Head Road as previously highlighted in the traffic time-space diagrams. Buses get stuck in the vehicle queue that forms upstream of the bottleneck at beginning of the bus queue jump lane.
    - Scenarios 1 generates the highest travel times savings, approximately five minutes in the case of the RapidBus. This makes sense given the bus operates in its own dedicated lane in the otherwise more congested, westbound, direction.
    - Scenario 3 achieves substantial travel time savings, approximately 3 to 4 minutes in the case of the RapidBus.
    - RapidBus appears to operate slightly slower than the No. 26. That is partly because the travel time for the No.26 was extracted for a shorter segment from Vissim, 4.5 km segment between Finnerty Road and Quadra Street. The RapidBus travel time measurement is for the whole corridor (5.5 k). Further, dwell times on the RapidBus are longer given assumed higher ridership levels.

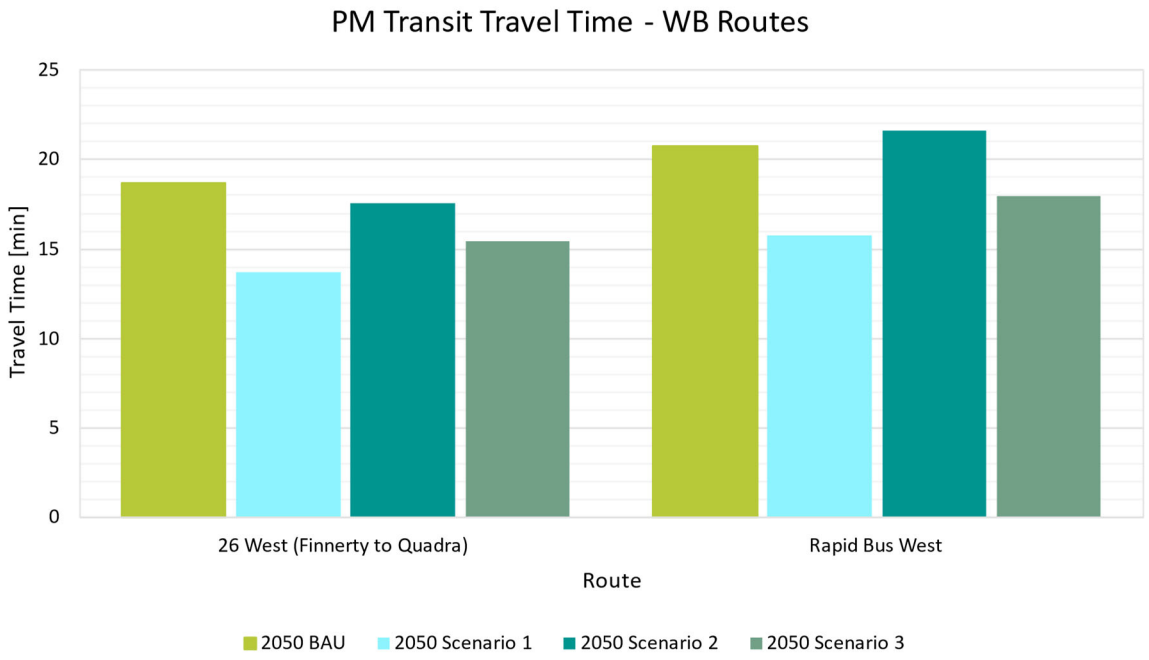


Figure 24: Westbound Bus Travel Times, Scenario 1, 2,3 vs 2050 BAU

Table 11 summarizes changes in average bus delays relative to the BAU scenario at the five busiest intersections in the corridor. In Scenario 3, the extension of the bus queue jump lane in the westbound

direction, from upstream Borden Street to downstream Quadra Street, achieves significant travel time savings. We considered a similar intervention at Shelbourne Street, i.e., extending the bus queue jump lane further back upstream in the westbound direction, however we concluded that this change is unlikely since it encroaches on the property lines of relatively new developments at that location.

Table 11: Bus Delay Compared to 2050 BAU

	Bus Delay Compared to 2050 BAU [sec]					
	Scenario 1		Scenario 2		Scenario 3	
Intersection	EB	WB	EB	WB	EB	WB
Quadra St	-50	-20	-40	-20	-40	-30
Borden St	0	-50	0	-20	0	-40
Cedar Hill Rd	0	-10	0	-10	0	-10
Shelbourne St	0	-40	-10	0	0	-10
Gordon Head Rd	0	-40	0	0	-30	0

Most travellers experience and remember something much different than average travel times throughout a year of travel. Their travel times vary greatly from day to day, and they remember those few bad days when they experienced unexpected delays. Thus, trip makers place a high value on travel reliability as it enables them to use their time more productively.

While travel on McKenzie Avenue will still be faster by car than bus on average by about 3 minutes, as shown in ***Figure 25*** and ***Figure 26***, the proposed RapidBus is more reliable, especially in the peak westbound direction. This frequent service provides customers with predictable journey times, especially in Scenario 1 where the bus runs in its own dedicated lane.

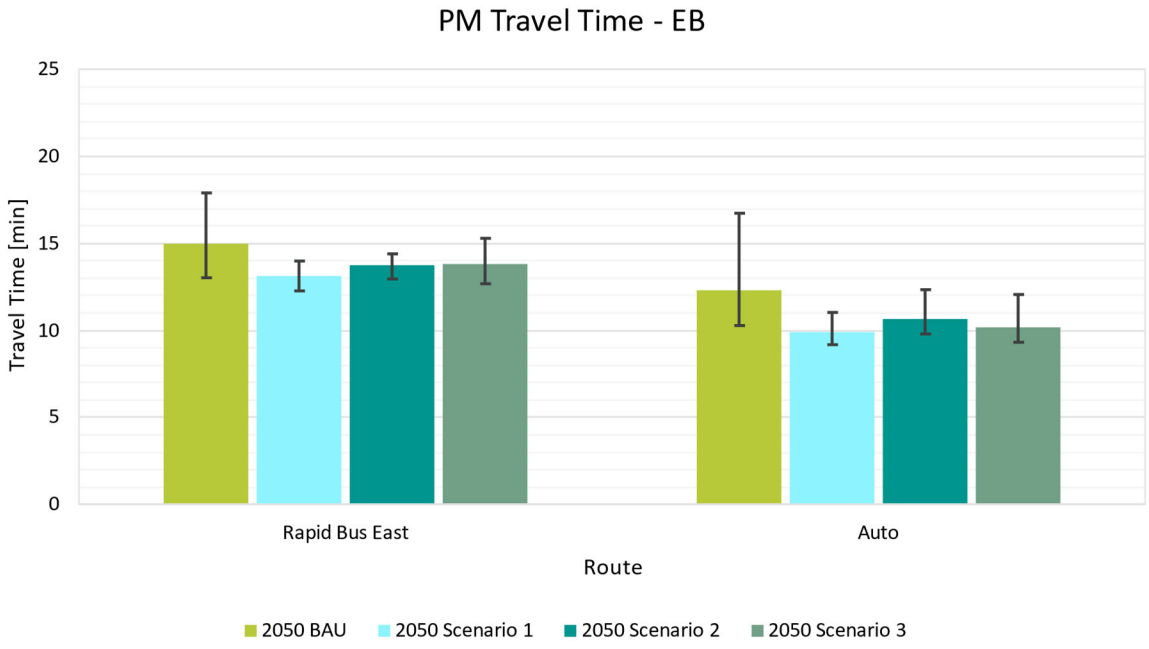


Figure 25: Eastbound Auto and RapidBus End-to-End Travel Times

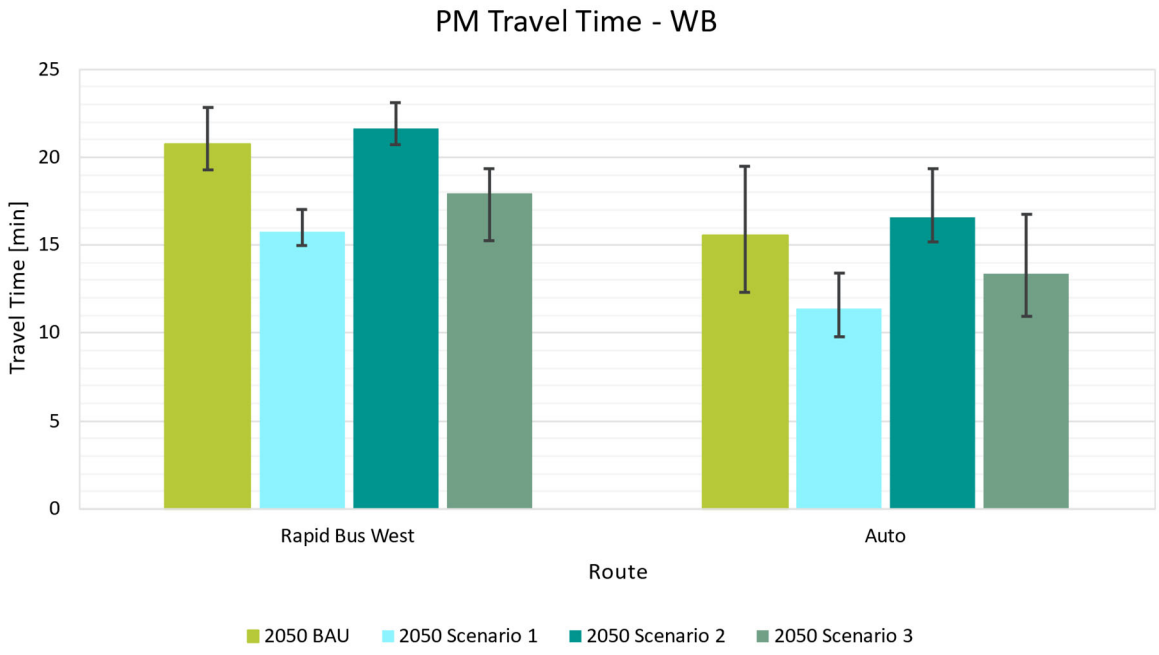


Figure 26: Westbound Auto and RapidBus End-to-End Travel Times

4. Preferred Long-term Vision Scenario

This section presents the evaluation of the preferred long-term Vision scenario. Given the loss of a GP lane at the majority of intersections along McKenzie, diversion rates sourced from the CRD model and applied to Scenario 1 were also used for the 'Vision' Scenario.

4.1. VISION SCENARIO MODELLING RESULTS

Figure 27 and ***Figure 28*** are time-space diagrams comparing the 'Vision' scenario with 2050 BAU and Scenario 1 for general traffic. Below are some key findings.

- The 'Vision' modelled travel times trend close to Scenario 1, likely because both scenarios assumed the same diversion rates.
- The removal of exclusive right-turn lanes at Shelbourne and Gordon Head, which was not considered in 2050 BAU and Scenario 1, meters traffic volumes onto McKenzie, resulting in additional travel time savings, specially in the westbound direction.

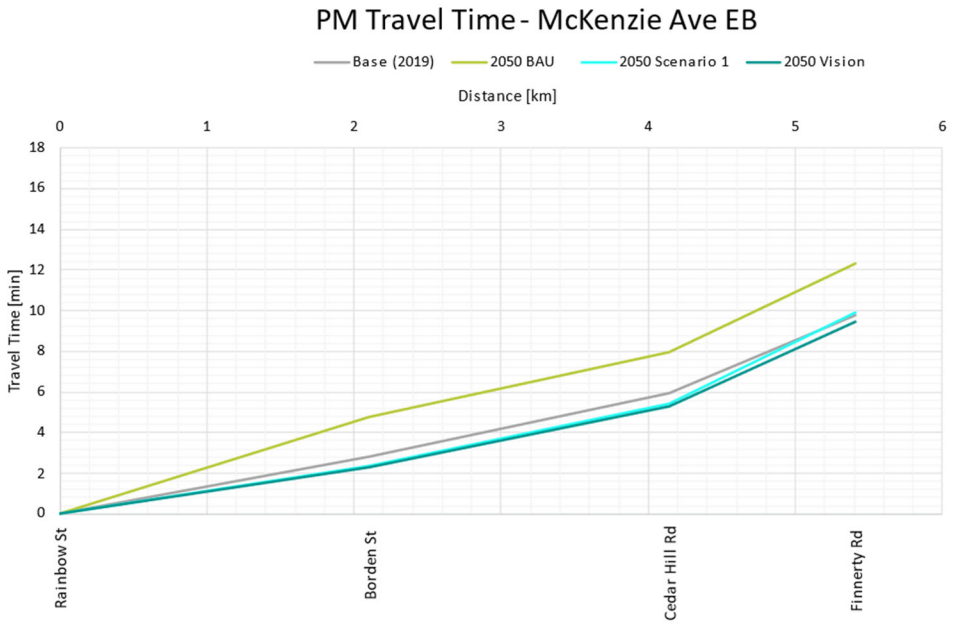


Figure 27: Eastbound Time-Space Diagram, Vision Scenario, Scenario 1 and 2050 BAU

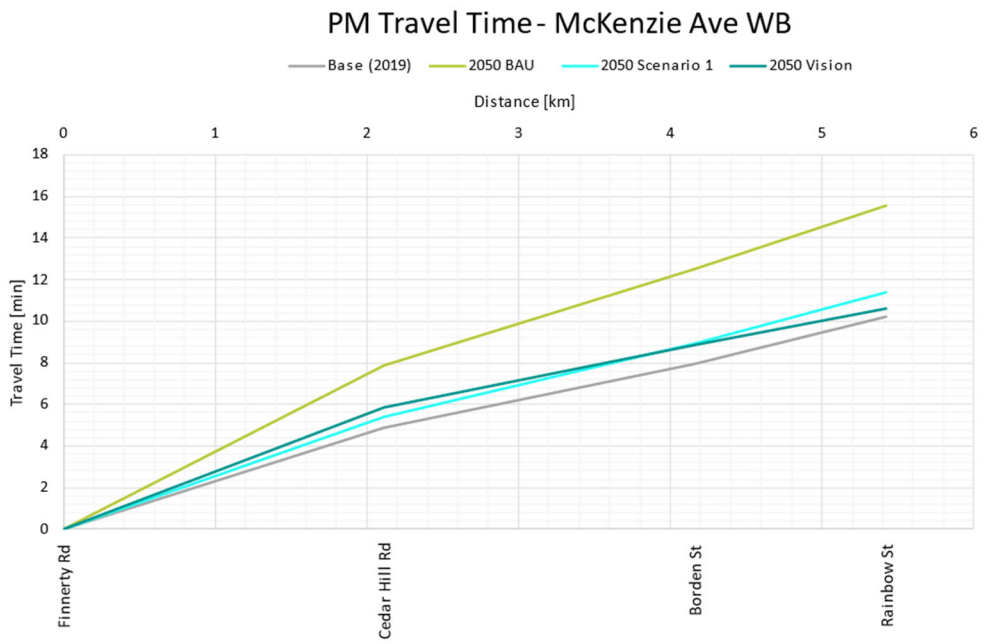


Figure 28: Westbound Time-Space Diagram, Vision Scenario, Scenario 1 and 2050 BAU

Table 12 summarizes the forecast traffic operations at the busiest intersections along the corridor for the 'Vision' Scenario. Below are key observations:

- Similar to Scenario 1, traffic operations at east-west approaches improve due to the large number of cars diverted away from the corridor, right turning vehicles utilizing the bus lane to turn right and the removal of north/south right turn lanes and channels at Shelbourne St and Gordon Head Rd. Average delay at cross street approaches, however, increases due to the diverted traffic.

- Eastbound-left queues at Quadra St improve substantially, due to the addition of a left-turn bay at Saanich Rd.

- The longest queues are observed at Shelbourne in the westbound direction (110m on average). Bus access to the intersection can get blocked by right-turning vehicles as well as traffic merging into the GP lane.

- Traffic operations at the newly added signal at McGill Rd performs well.

Table 12: 'Vision' Scenario Intersection Analysis

Intersection	2050 Vision	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	Overall
McKenzie and Saanich Rd	Volume	110	120	80	10	130	30	30	530	100	90	640	40	
	AVG Queue	20	20	5	0	10	10	0	5	10	0	0	0	10
	Max Queue	80	80	40	10	70	70	10	80	90	20	60	60	90
	Average Delay	90	60	40	50	50	40	5	10	5	10	0	0	20
	LOS	F	E	D	D	D	D	A	A	A	B	A	A	B
McKenzie and Quadra St	Volume	160	800	70	210	640	30	50	490	90	50	580	180	
	AVG Queue	360	430	430	20	30	30	10	40	50	5	10	0	120
	Max Queue	460	460	470	110	130	130	40	210	220	30	70	40	470
	Average Delay	160	140	140	60	40	40	70	40	20	50	10	10	70
	LOS	F	F	F	E	D	D	E	D	B	D	B	A	E
McKenzie and Borden St	Volume	80	190	90	160	200	90	80	690	100	70	660	90	
	AVG Queue	20	30	30	10	20	20	0	10	10	0	30	30	10
	Max Queue	130	190	190	70	120	120	20	80	80	30	200	210	250
	Average Delay	100	70	80	40	50	20	20	10	5	40	20	10	30
	LOS	F	E	E	D	D	B	B	A	A	D	B	A	C
McKenzie and Blenkinsop Rd	Volume	100	490	90	80	400	130	150	540	50	110	580	80	
	AVG Queue	20	190	200	10	30	0	5	10	20	5	30	30	50
	Max Queue	220	250	260	40	150	30	50	150	160	40	170	180	260
	Average Delay	100	80	80	60	30	10	30	10	5	30	20	10	40
	LOS	F	F	E	E	C	A	C	B	A	C	B	A	D
McKenzie and Cedar Hill Rd	Volume	90	420	100	30	160	110	150	460	60	120	570	80	
	AVG Queue	10	80	80	0	10	0	5	10	20	5	20	20	20
	Max Queue	90	120	130	20	70	30	50	110	110	30	100	110	140
	Average Delay	70	70	70	50	30	5	30	20	5	20	20	10	30
	LOS	E	E	E	D	C	A	C	B	A	B	B	A	C
McKenzie and Shelbourne St	Volume	120	730	140	150	800	80	130	400	70	200	570	80	
	AVG Queue	180	470	470	470	470	470	10	30	40	20	110	120	230
	Max Queue	330	510	510	510	510	510	60	160	180	130	220	230	510
	Average Delay	210.0	200.0	210.0	180.0	150.0	150.0	70.0	40.0	10.0	70.0	50.0	20.0	120
	LOS	F	F	F	F	F	F	E	D	B	E	D	B	F
McKenzie and Gordon Head Rd	Volume	110	480	60	90	210	110	140	380	100	100	560	150	
	AVG Queue	10	110	120	5	20	0	10	40	10	5	40	40	30
	Max Queue	130	170	180	40	120	20	80	140	70	30	150	160	180
	Average Delay	80	80	80	40	30	30	50	50	20	30	30	10	50
	LOS	F	F	E	D	C	C	D	D	B	C	C	B	D
McKenzie and McGill Rd	Volume	180	-	20	-	-	-	-	380	160	10	630	-	
	AVG Queue	10	-	10	-	-	-	-	10	10	10	10	-	10
	Max Queue	50	-	60	-	-	-	-	100	100	130	130	-	130
	Average Delay	30.0	-	10.0	-	-	-	-	10.0	10.0	10.0	10.0	-	10
	LOS	C	-	A	-	-	-	-	A	A	B	B	-	B
McKenzie and Vikes Way	Volume	100	0	30	10	0	30	5	370	20	10	510	5	
	AVG Queue	5	5	0	0	0	0	0	10	10	0	5	10	5
	Max Queue	30	30	20	10	10	0	0	140	140	10	70	80	150
	Average Delay	20	20	10	20		10	10	10	10	10	10	5	10
	LOS	B	B	A	B		A	B	A	A	A	A	A	A

Figure 29 and ***Figure 30*** show the substantial travel times savings achieved by both the local bus and RapidBus service in the corridor for the 'Vision' Scenario. In the eastbound direction, the RapidBus is faster by about 3 minutes, a 20% improvement relative to the 2050 BAU. In the westbound direction, the RapidBus is faster by about 6 minutes, a 30% improvement relative to the 2050 BAU. This indicates that

the proposed upgrades introduced under the preferred 'Vision' scenario are successful at improving the overall travel experience on the bus making it an attractive and competitive alternative to driving.

Figure 29: Eastbound Bus Travel Times, 'Vision' Scenario vs 2050 BAU

Figure 30: Westbound Bus Travel Times, 'Vision' Scenario vs 2050 BAU

As shown in ***Table 13***, long stretches of bus lanes provide substantial travel time savings at intersections, specially at known congestion hot spots at Quadra St, Borden St and Shelbourne St. The results also

illustrate the benefit of providing a bus lane at the UVic section of the McKenzie corridor in the westbound direction, saving about a minute of travel time at McGill Rd and Gordon Head Rd intersections. Further, substantial savings are achieved at Blenkinsop Rd intersection in the westbound direction. In the BAU scenario, average queues of 90 m blocked bus access to the intersection. The introduction of a shared bus/right turn lane at the intersection head helps the bus move ahead of the queue and reduces overall delay.

Table 13: Bus Delay at Key Intersections: 'Vision Scenario' vs 2050 BAU

Intersection	Bus Delay Compared to 2050 BAU [sec]	
	EB	WB
Saanich Rd	-20	0
Quadra St	-60	0
Borden St	-10	-50
Blenkinsop Rd	-10	-60
Cedar Hill Rd	-10	-20
Shelbourne St	-40	-40
Gordon Head Rd	-20	-30
McGill Rd	5	-30
Total (Eight Intersections)	**- 175 sec**	**- 230 sec**

CLOSING

We trust this memo summarizes the analysis and findings of the Vissim microsimulation analysis. For any questions, please contact the undersigned.

Sincerely,

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