MOTT MACDONALD

Project:	Neighbourhood Transportation GHG Emissions Study		
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Subject:	Study Results		

1 Introduction

The University of British Columbia (UBC) retained Mott MacDonald to estimate transportation-related greenhouse gas (GHG) emissions for portions of the campus designated as neighbourhoods. This work baselined current and future (2050) transportation GHG emissions and will be used to inform the UBC Neighbourhood Climate Action Plan. Future GHG emissions resulting from possible policy and infrastructure interventions will be compared to the baseline identified in this study, in order to evaluate their efficacy in reducing emissions.

For the purposes of this work, a UBC neighbourhood resident is defined as someone whose primary residential address is located within a UBC Neighbourhood. This excludes those living on the institutional lands, such as in purpose built student housing. The UBC neighbourhoods are shown in **Figure 1.1**, including the future Acadia East Neighbourhood referenced in the draft 30-Year Vision.[1]

1.1 Modelling Scenarios

Three scenarios were investigated:

Existing: this scenario utilized TransLink's RTM v3.4, which reflects conditions in 2017.

2050 with campus shuttles, no SkyTrain: this scenario utilized TransLink's 2050 scenario using projected UBC 2050 population and employment obtained from the 30-Year Vision process. This scenario includes the two intra-transit campus shuttles identified in the draft 30-Year Vision. SkyTrain extension to UBC is not included in this scenario.

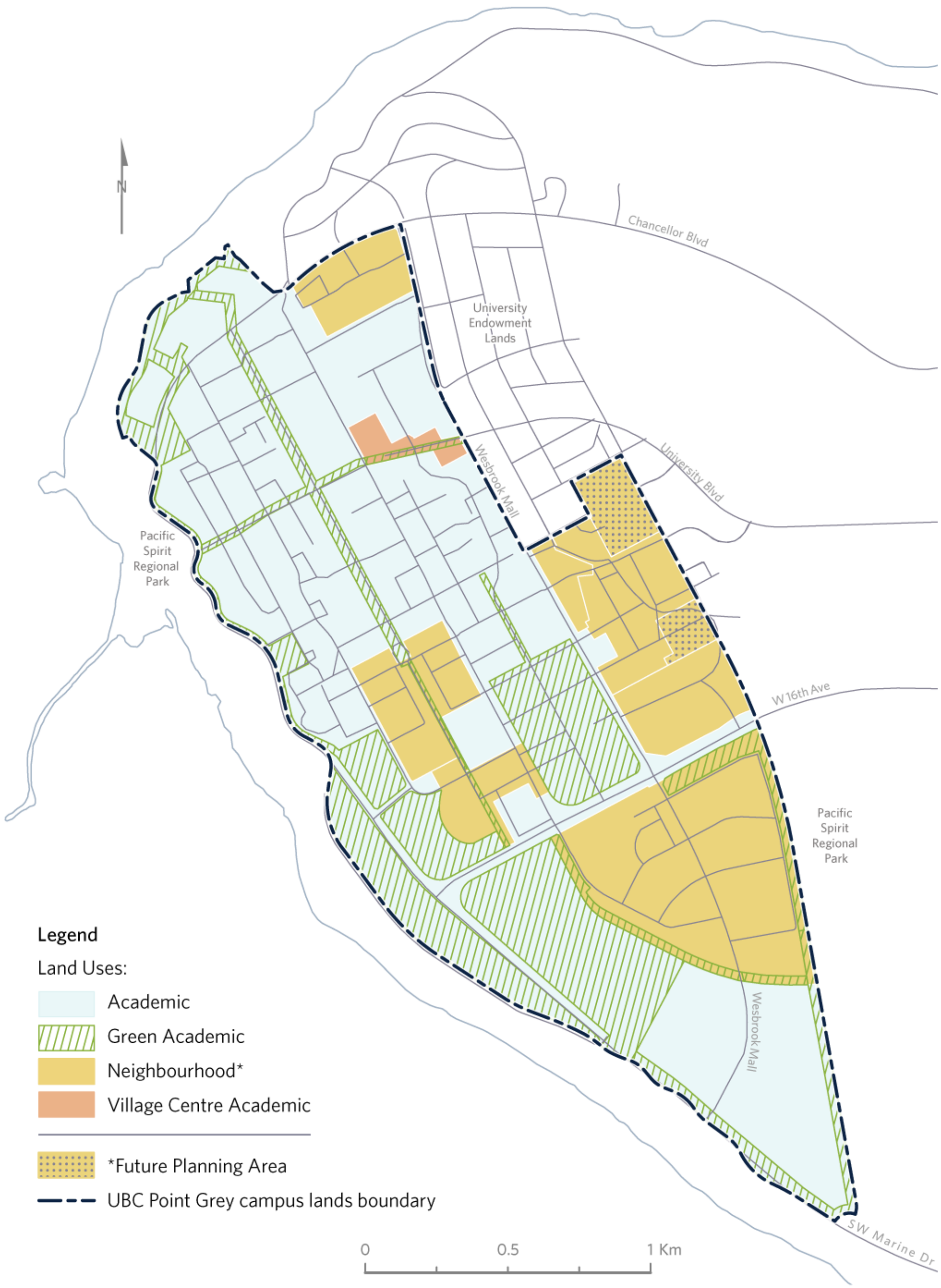
2050 with campus shuttles and SkyTrain: This scenario builds on the previous scenario by including the additional assumption of SkyTrain extension to UBC with one station at the UBC Trolley Loop.

This technical work involved two steps:

1. Estimating vehicle-kilometers travelled (VKT) for neighbourhood-induced auto travel using TransLink's Regional Transportation Model (RTM) under three scenarios
2. Calculating the corresponding transportation GHG emissions for each of the three scenarios

[1] University of British Columbia (2023). 30-Year Vision: Draft for Input. https://campusvision2050.ubc.ca/33812/widgets/138564/documents/95997.

Figure 1.1: UBC Neighbourhoods. Source: Draft UBC 30-Year Vision



2 Methodology

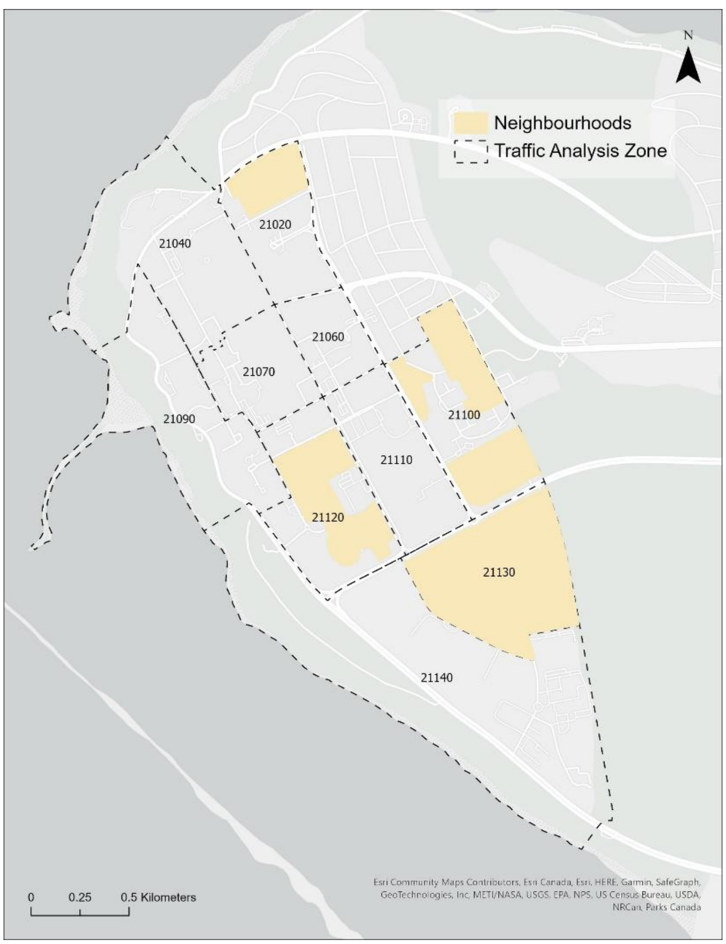
2.1 Study Area

Figure 2.1 shows the traffic analysis zones (TAZs) for UBC. **Table 2-1** provides the list of UBC TAZs that contain one or more neighbourhoods.

Table 2-1: UBC Traffic Analysis Zones and Corresponding Neighbourhoods

Traffic Analysis Zone	Neighbourhood(s)
21020	Chancellor Place
21100	Acadia East; East Campus; Hampton Place
21120	Hawthorn Place; Stadium
21130	Wesbrook Place

Figure 2.1: UBC Traffic Analysis Zones and Neighbourhood Areas



2.2 Estimating Vehicle Kilometers Traveled

Current and future VKT were estimated using TransLink's RTM by analyzing the scenarios noted in Section 1.1.

2.2.1 Trip Purpose

Auto vehicle kilometers travelled (VKT) was calculated using TransLink's RTM model outputs. For both existing and future scenarios, the RTM estimates all neighbourhood-induced travel undertaken by residents and non-residents during a given day. This travel includes trips for work, school, shopping, etc.

Information about trip purpose, extracted from the RTM, has been used to assign each trip to either a resident or non-resident. **Table 2-2** provides the definitions of each trip purpose.

Table 2-2: TransLink RTM Trip Purpose Definitions. Source: TransLink RTM Manual

Trip Purpose	Definition
Home-Based Work	Commute to and from work
Home-Based Escorting	Can include short trips, such as dropping children at school, or longer distance trips such as dropping a friend at the airport or ferry terminal.
Home-Based Personal Business	Can include short distance trips, such as trips to the bank or potentially longer distance trips such as servicing a car
Home-Based School	School trips are for primary and secondary school students, the vast of whom are under 18 years old. It is assumed that these minors would need to live with an adult. Therefore, households of with only one occupant are assumed to be adults and not generate primary and secondary school trips.
Home-Based Shopping	Trips for shopping
Home-Based Social	Trips for social/recreational activities
Home-Based University	Trips to and from university/post secondary activity
Non Home-Based Work	Non-home-work trips can be very short, such as going to a restaurant at lunch hour, or much longer, such as stopping at a shopping center close to home on the way back from the office.
Non-Home-Based Other	All other non-home-based trips

The RTM demand model categorizes trips as either 'home-based' or 'non-home-based.' Home-based trips start or finish at the trip-maker's home. Depending on trip origin, destination, and time of day, home-based trips have been categorized as resident or non-resident.

2.2.1.1 Home-Based Trips

Table 2-3 outlines trip-maker assignment for home-based trips occurring during the peak morning (AM) (07:30 – 08:30) and mid-day (MD) (12:00 – 13:00). Given typical travel patterns, it is assumed that the trip origin is the trip-maker's home (i.e., commuting from home to work in the morning). Thus, a morning or mid-day trip that originates from a UBC neighbourhood is assumed to be made by a resident. A morning or mid-day trip that originates outside of a UBC neighbourhood is assumed to be made by a non-resident.

Table 2-3: Morning and Mid-Day Trip-Maker Assignment for Home-Based Trips

		Destination	
		UBC Neighbourhood	**Outside UBC Neighbourhood**
Origin	**UBC Neighbourhood**	Resident	Resident
	Outside UBC Neighbourhood	Non-Resident	Non-Resident

In the evening (PM) (16:30-17:30), the assumption for which end of the trip is the trip-maker's home is reversed (**Table 2-4**). For evening trips, it is assumed that the destination is the trip-maker's home (i.e., commuting from work to home in the evening). Thus, an evening trip destined to a UBC neighbourhood is assumed to be made by a resident. An evening trip destined for outside of a UBC neighbourhood is assumed to be made by a non-resident.

Table 2-4: Evening Trip-Maker Assignment for Home-Based Trips

		Destination	
		UBC Neighbourhood	**Outside UBC Neighbourhood**
Origin	**UBC Neighbourhood**	Resident	Non-Resident
	Outside UBC Neighbourhood	Resident	Non-Resident

After estimating peak morning, mid-day, and evening VKT, daily and annual TransLink expansion factors were applied to obtain full day and annual VKT.

2.2.1.2 Non-Home-Based Trips

Non-home-based trips are trips that do not begin or end at the home (e.g., traveling from work to a grocery store). While these trips are most often part of a tour of trips that together start and end at the home, the trip maker's place of residence cannot be inferred or extracted from the RTM. As a result, VKT and corresponding transportation GHG emissions for non-home-based trips are reported as a stand-alone category.

2.2.2 Extracting the Neighbourhoods from the Traffic Analysis Zones

As shown in **Figure 1.1**, the TAZs cover greater area than the neighbourhood areas. Three steps were taken to estimate the VKT induced by land uses in neighbourhoods as a subset from the total VKT induced by all land uses in a TAZ.

2.2.2.1 Home-Based Work Trips

Home-based work trips to/from each TAZ containing a neighbourhood were adjusted according to an estimation of the number of jobs within the neighbourhood versus the TAZ. It was not possible to know or accurately predict the number of current or future jobs in either the neighbourhood or the TAZ directly, so an estimation was made by counting the number of retail & service locations currently within each TAZ versus the neighbourhoods and using that ratio to assign VKT to the neighbourhood and the rest of the TAZ.

The UBC 'POI' shapefile was used and filtered to only include the following service type assumed to generate jobs: athletics, attraction, bank, café, campus service, childcare, commercial services, grocery, hospital, library, medical, minimart, pharmacy, restaurant, retail, and school (**Figure 2.2**).

Figure 2.2: UBC TAZ, Neighbourhoods, and Employment Opportunities

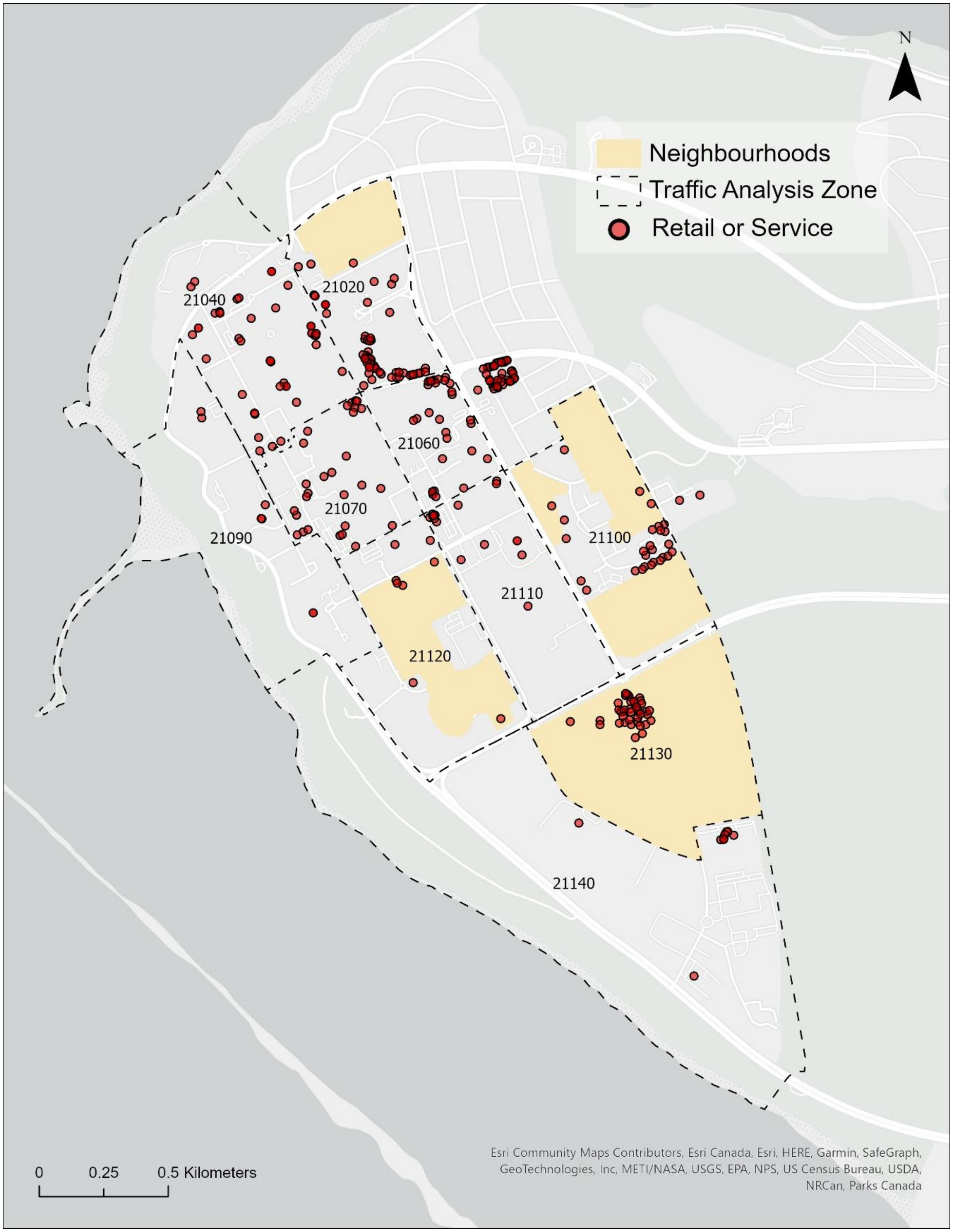


Table 2-5 provides the proportions that were applied to the home-based work VKT and demand for each UBC TAZ containing a neighbourhood. The proportions were applied to trips **destined** to a UBC neighbourhood in the **AM peak** and **Mid Day** (MD) and applied to trips **originating** from a UBC neighbourhood in the **PM peak**. These proportions were applied to all scenarios – thus, it was assumed that proportion of TAZ employment opportunities located within the neighbourhoods is the same in 2050.

Table 2-5: Proportion of TAZ Employment Opportunities in Neighbourhoods

Traffic Analysis Zone (TAZ)	Count of Points in TAZ	Neighbourhood(s)	Count of Points in Neighbourhood(s)	% of TAZ Employment Opportunities in Neighbourhood(s)
21020	68	Chancellor Place	1	1%
21100	27	Acadia East; East Campus; Hampton Place	3	11%
21120	8	Hawthorn Place; Stadium	5	63%
21130	42	Wesbrook Place	42	100%

2.2.2.2 Home-Based University Trips

There are no university/institutional uses within the neighbourhood areas. To reflect this, home-based university trips (VKT and demand) **destined** to a UBC neighbourhood in the **peak AM** and **MD** were reduced to zero, as well as trips **originating** from a UBC neighbourhood in the **peak PM** for all scenarios.

2.2.2.3 Home-Based School Trips

There are no elementary or secondary school within the neighbourhood areas, except for Wesbrook Place. To reflect this, home-based school trips **destined** to a UBC neighbourhood (except Wesbrook Place) in the **peak AM** and **MD** were reduced to zero, as well as trips **originating** from a UBC neighbourhood in the **peak PM** for all scenarios.

2.3 Estimating GHG Emissions

Transportation GHG emissions will be calculated according to the 'Induced Activity Method' described by the Global Protocol for Community-Scale Greenhouse Gas Inventories.[2] This method of estimating GHG emissions aims to include emissions resulting from auto trips that originate, terminate, or are contained within the study area boundary. GHG emissions are calculated using 100% of in-boundary VKT and 50% of transboundary VKT. Transboundary trips are discounted by 50% to demonstrate a shared responsibility for trips that start and end in more than one community.

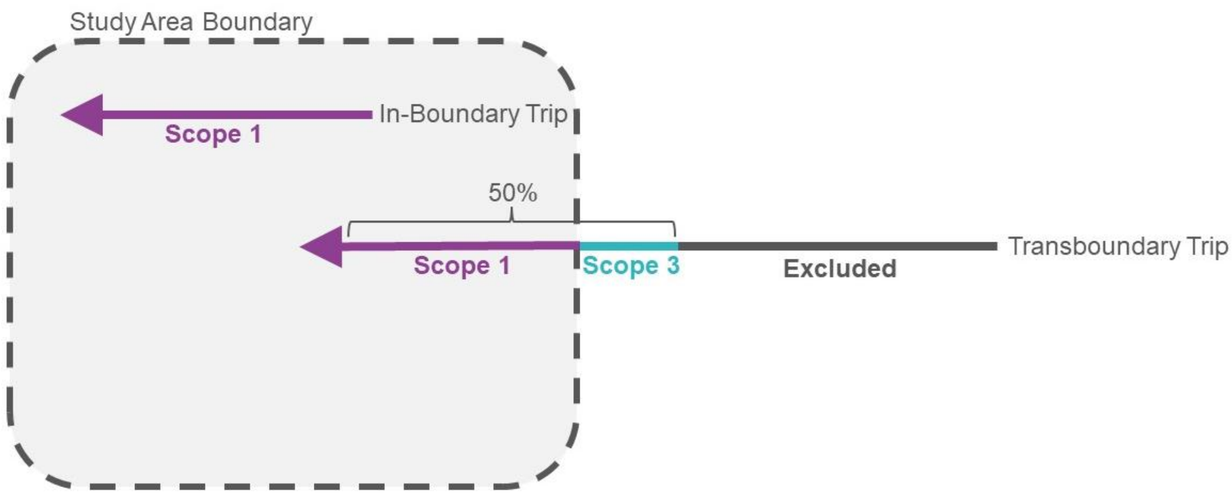
Scope 1 and Scope 3 transportation GHG emissions will be calculated for UBC's residential neighbourhoods. The Global Protocol defines Scope 1 and Scope 3 emissions as follows and is illustrated in **Figure 2.3**:

Scope 1 In-boundary trips and in-boundary portion of 50% of transboundary trips (pass through trips excluded)

Scope 3 Out-of-boundary portion of 50% of transboundary trips

[2] Fong, W.K., Sotos, M., Doust, M., Schultz, S., Marques, A., Deng-Beck, C. (2014). Global Protocol for Community-Scale Greenhouse Gas Emission Inventories. World Resources Institute.

Figure 2.3: Scope 1 and Scope 3 Allocation



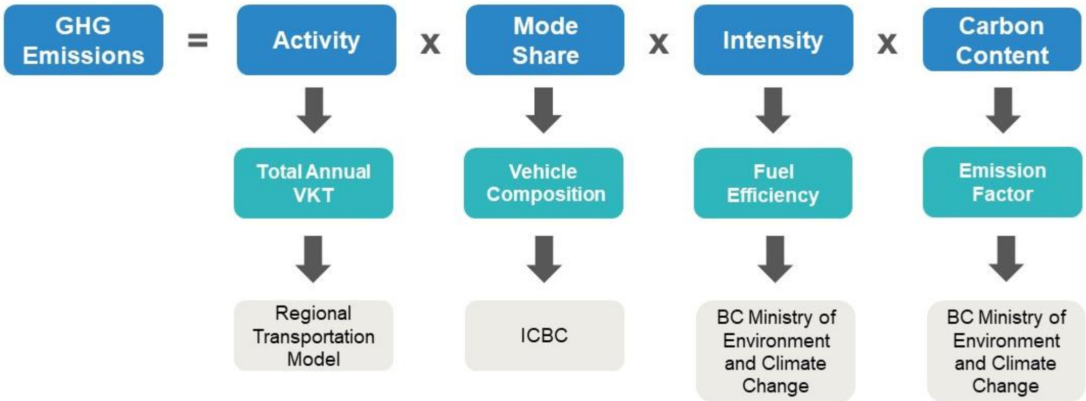
The origin and destination of trips were extracted from the RTM to determine the total VKT exclusive to in-boundary and transboundary trips. VKT from transboundary trips was discounted by 50%. To determine the proportion of the remaining transboundary VKT allocated to Scope 1 and Scope 3 emissions, it was assumed that 1-kilometre of each transboundary trip occurred within the study area boundary.[3] This was a necessary assumption given the difficulty of determining exact travel paths using the RTM.

GHG emissions will be calculated using the framework illustrated in **Figure 2.4**. Key sources for inputs included:

- ICBC Vehicle Population Data Vehicle type (light-duty vehicle, light-duty truck, and heavy duty vehicle)
  - By fuel type (gasoline, diesel, propane, hybrid, and electric)
- BC Ministry of Environment and Climate Change (2021). 2020 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions.
- Various sources to inform current and projected vehicle fuel efficiencies and emissions factors for electric vehicles
  - See **Appendix Table A.4** and **Table A.5** for values used in analysis and data sources

[3] This assumption is based on the approximate average distance between the UBC boundary and neighbourhoods.

Figure 2.4: GHG Emissions Framework



2.3.1 2050 Vehicle Composition

To estimate GHG emissions in 2050, vehicle composition – the mix of vehicle types that are expected to make up the fleet of all vehicles on the road - is assumed to be the primary variable affecting future emissions. While other factors beyond vehicle composition, such as increasing fuel efficiencies or renewable contents in fuel, may also impact emissions over time, their impact and trajectory are not yet explicitly known and thus are not included in this work. This work only includes policy targets adopted at the time of analysis.

Vehicle composition is assumed to be affected by the following provincial ZEV sales targets:[4]

- 26% of new light-duty vehicles by 2026
- 90% by 2030
- 100% by 2035

2.4 Limitations

The methodology described is subject to two limitations that should be considered when interpreting its results. First, the RTM, and macroscopic demand modelling techniques in general, are limited in their ability to account for land use and transportation interactions in the long run. As such, these models typically underestimate the impact of land use densification on walkability. While the RTM provides the useful ability to estimate and forecast vehicle travel as population and demographics change, the RTM is not a robust walking and cycling model, and its results should be considered as a conservative (i.e., slightly higher than actual) estimation of auto VKT. This is an appropriate modelling approach, recognizing that smaller scale infrastructure and policy interventions will provide significant potential to reduce reliance on auto travel and reduce auto VKT accordingly.

Second, each persons' travel patterns are complex and unique, depending on factors such as household structure, employment, childcare responsibilities, and gender. The assignment of resident or non-resident as described in **Section 2.2.1.2** is based on 'typical' travel patterns throughout the day – best reflecting those who are employed with morning to evening working hours. Although not all demographic groups can be reflected by this method, this method is considered a best approximation for inferring the trip-maker's primary residence.

[4] Province of BC (2021). CleanBC Roadmap to 2030.

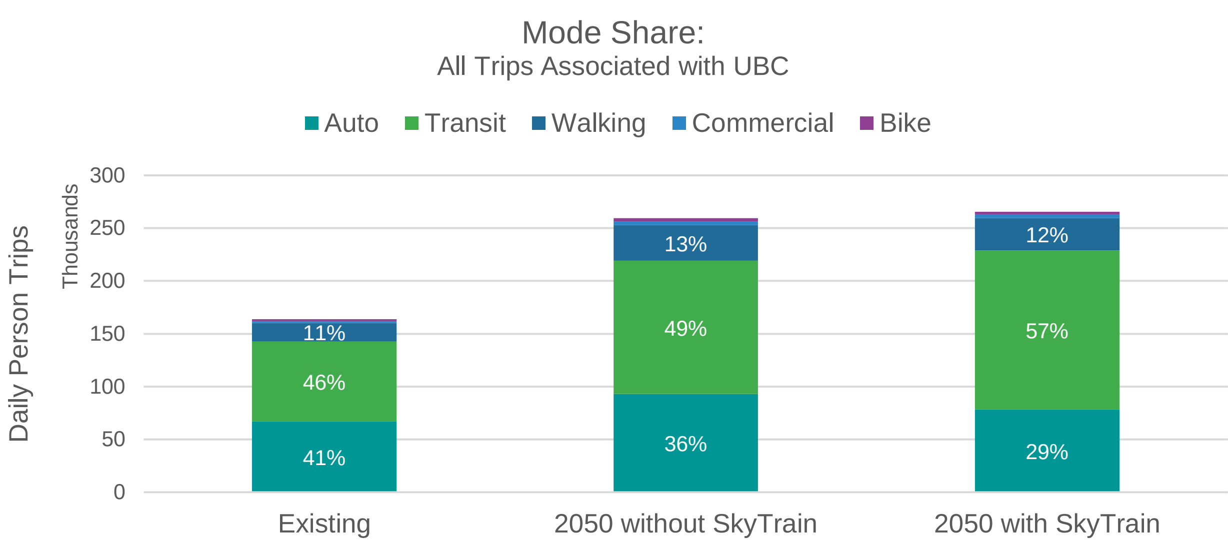
3 Results

3.1 Mode Share

The mode shares presented in **Figure 3.1** represents both trips to/from campus, as well as trips contained within campus. Compared with Scenario 1 (Existing), Scenario 2 (2050 with campus shuttles, no SkyTrain) is predicted to see a larger share of trips conducted by transit and walking and less trips by auto. Scenario 3 (2050 with campus shuttles and SkyTrain) is predicted to further increase the transit mode share and reduce the auto mode share. Specifically, the transit mode share in 2050 is predicted to be 8 percentage points higher with SkyTrain compared to without.

Figure 3.1 also provides the number of daily person trips. Despite the auto mode share continuously decreasing from Scenario 1 to 3, the absolute number of auto person trips in Scenario 3 is still similar to Scenario 1. This is a result of the expected population growth between today and 2050 and is an important nuance to consider when interpreting mode share predictions.

Figure 3.1: Mode Share for All Trips Associated with UBC



Figures Figure 3.2 and **Figure 3.3** present the mode shares for trip within campus and trips to/from campus, respectively. Trips within campus are primarily made by walking, while trips to/from campus are primarily made by transit.

For trips within campus (**Figure 3.2**), approximately half of all trips are conducted by walking across all three scenarios. In 2050 without SkyTrain (Scenario 2), the walking mode share is predicted to be 4 percentage points higher than today, or 3 percentage point higher with SkyTrain. Overall, trips within campus are quite inelastic to population and infrastructure changes.

Trips to/from campus are, however, affected by population and infrastructure changes (**Figure 3.3**). Compared to today, 2050 without SkyTrain (Scenario 2) is predicted to have a higher transit mode share (from 52% to 57%) and lower auto mode share (from 45% to 40%). Extension of the SkyTrain to UBC (Scenario 3) is predicted to increase the transit mode share significantly further – from 52% (Scenario 1) to 65% (Scenario 3) (13 percentage points).

Figure 3.2: Mode Share for Trips Within Campus

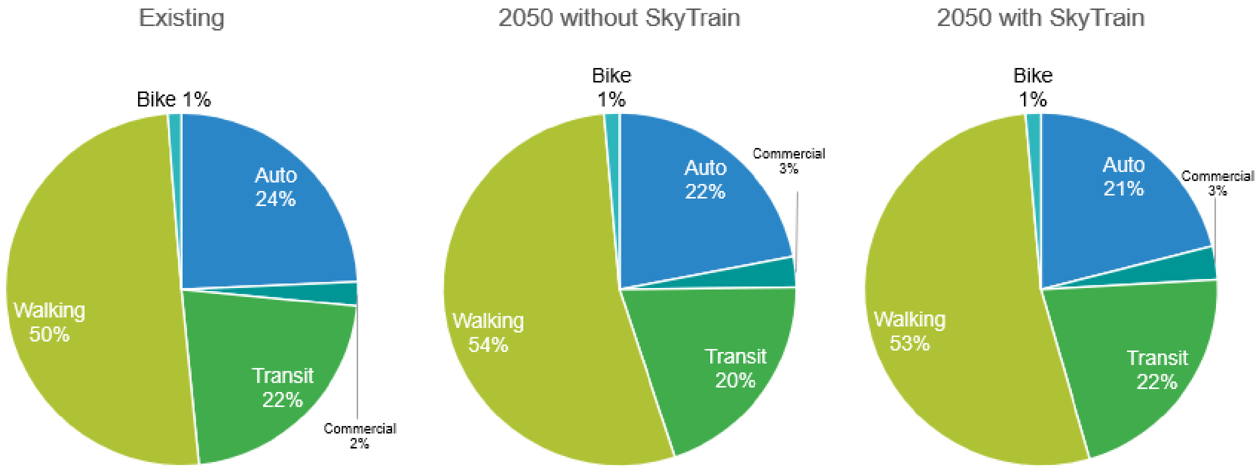
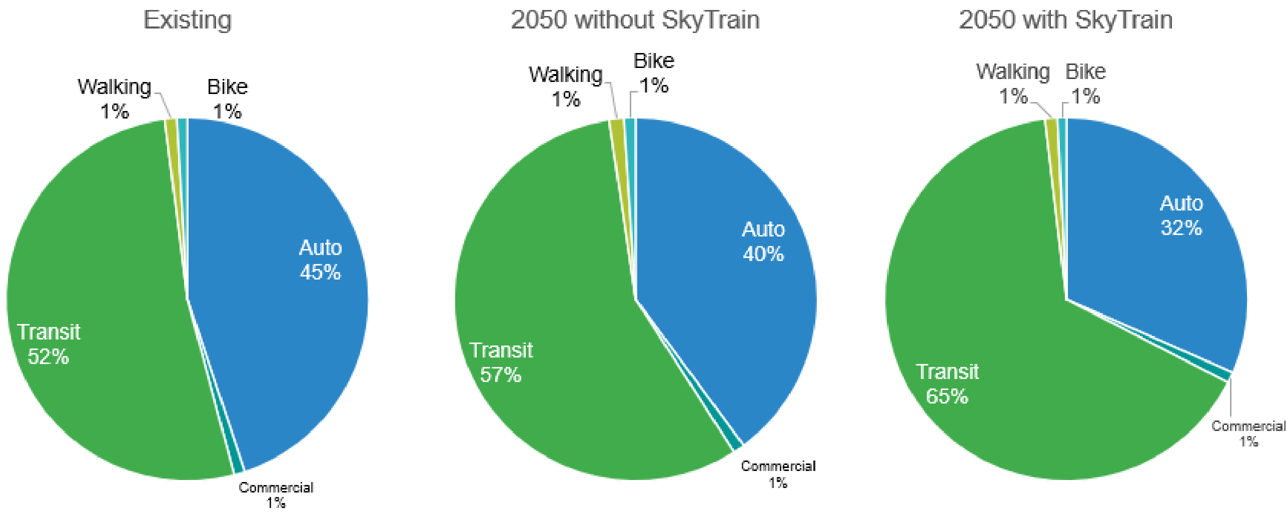


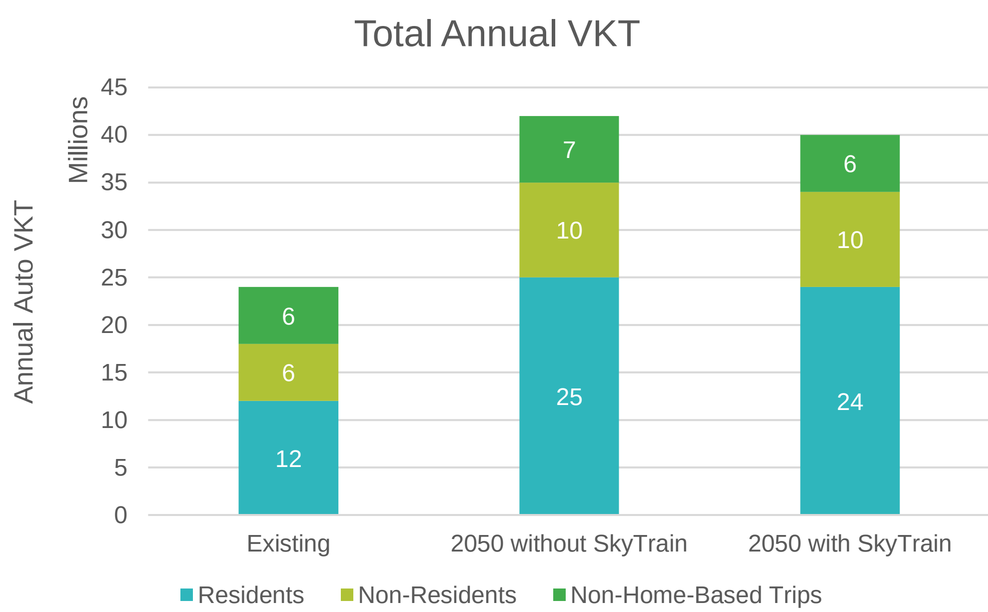
Figure 3.3: Mode Share for Trips to/from Campus



3.2 Vehicle-Kilometres Travelled

Total annual auto VKT is presented in **Figure 3.4** (rounded to the nearest million) (see **Appendix Table A.1** for detailed scenario and scope results and **Appendix** Table A.2 for detailed unadjusted VKT from the RTM). Annual auto VKT is predicted to be higher in both 2050 scenarios, compared to today. Annual VKT is predicted to be approximately 75% higher in 2050 without SkyTrain compared to today – 42 million VKT in the future compared to 24 million VKT today. With SkyTrain, annual VKT is predicted to be 67% higher than today (40 million). From another perspective, SkyTrain extension to UBC is predicted to avoid approximately 2 million vehicle-kilometers travelled annually (from 42 million in Scenario 2 to 40 million in Scenario 3).

Figure 3.4: Total Annual Auto VKT

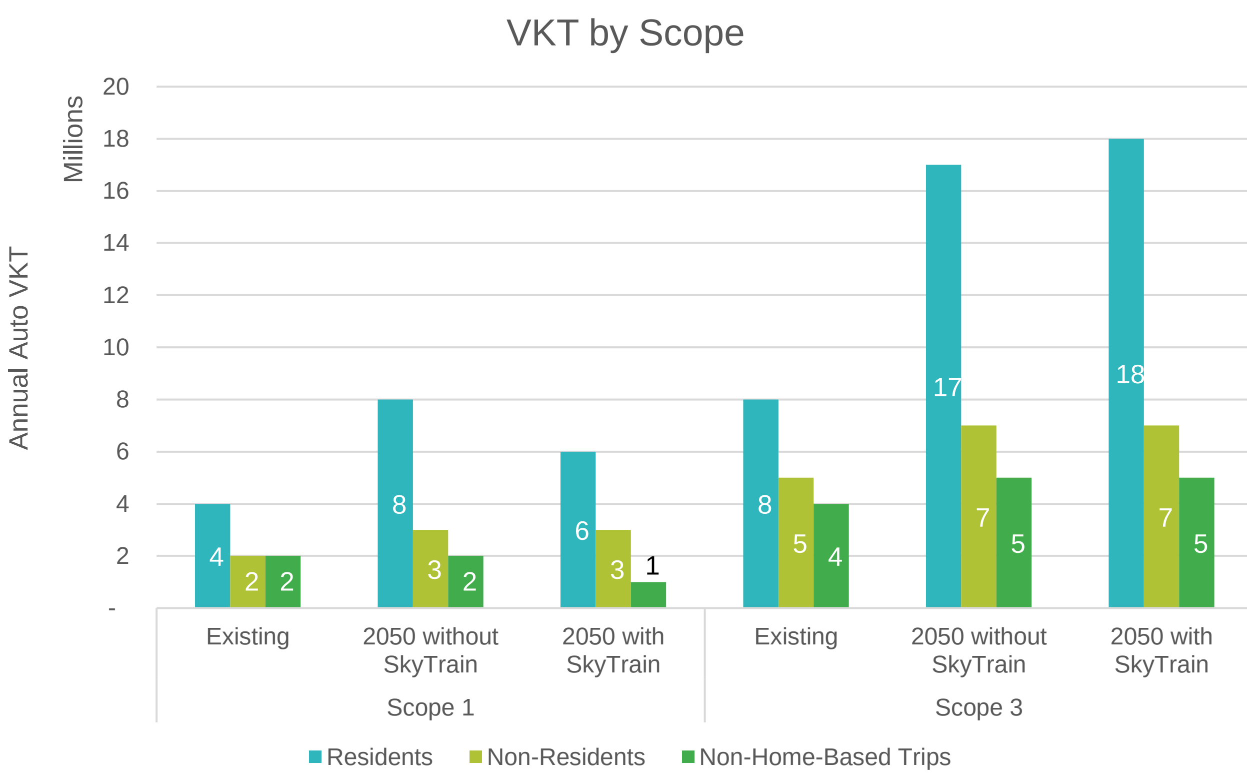


3.2.1 VKT by Scope

Figure 3.5 presents annual auto VKT by scope (refer to Section 2.3). This figure indicates that residents' scope 1 VKT decreases with SkyTrain extension while residents' scope 3 VKT increases. The decrease in residents' scope 1 VKT comes from the in-boundary portion of transboundary trips, rather than a change to within-boundary trips. This reduction in scope 1 VKT indicates that in 2050, residents are predicted to be make fewer transboundary trips by car with SkyTrain extension compared to without.[5]

At the same time, residents' scope 3 VKT is predicted to be higher in 2050 with SkyTrain than without. This suggests that while the number of transboundary trips made by residents in cars decreases, the length of those trips increases. This is an expected outcome of an activity-based demand model such as RTM, which seeks a balance of demand for travel. While this may not accurately reflect future behaviour, it is a conservative estimate of VKT appropriate for this baselining exercise.

Figure 3.5: Total Annual Auto VKT by Scope



[5] In Section 2.3, it was discussed that the in-boundary portion of transboundary trips would be assumed to be one kilometer. Therefore, scope 1 VKT is = VKT from within-boundary trips + (1 kilometer * number of transboundary trips) which can be reduced to = VKT from within-boundary trips + number of transboundary trips. Thus, knowing that VKT from within-boundary trips has not changed between scenarios, it can be deduced that the change in scope 1 VKT is a result of a change to the number of transboundary trips (i.e. a change in the demand).

3.2.2 VKT by Trip Purpose

To better understand neighbourhood-induced travel, VKT by trip purpose was investigated. **Figure 3.6** to **Figure 3.8** presents VKT by trip purpose for each scenario. The RTM predicts that residents travel is primarily driven by work trips, followed by social, shopping, escorting, personal business, and university. Non-residents' trip purpose is more evenly distributed across work, shopping, social, personal business, and escorting. Overall, the analysis suggests that interventions contemplated in the future scenarios do not have a significant impact on VKT by trip purpose.

Figure 3.6: VKT by Trip Purpose – Existing

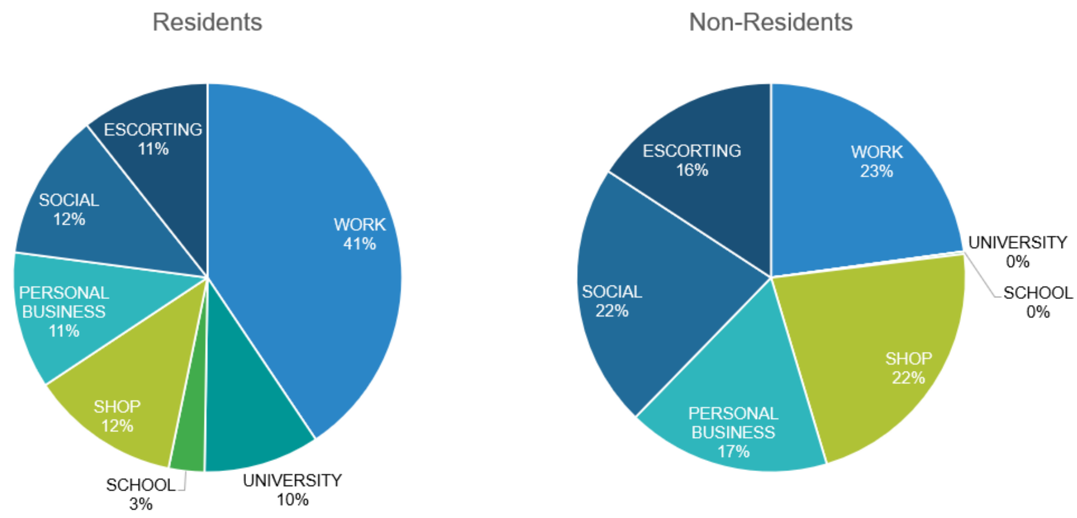


Figure 3.7: VKT by Trip Purpose – 2050 with campus shuttles, no SkyTrain

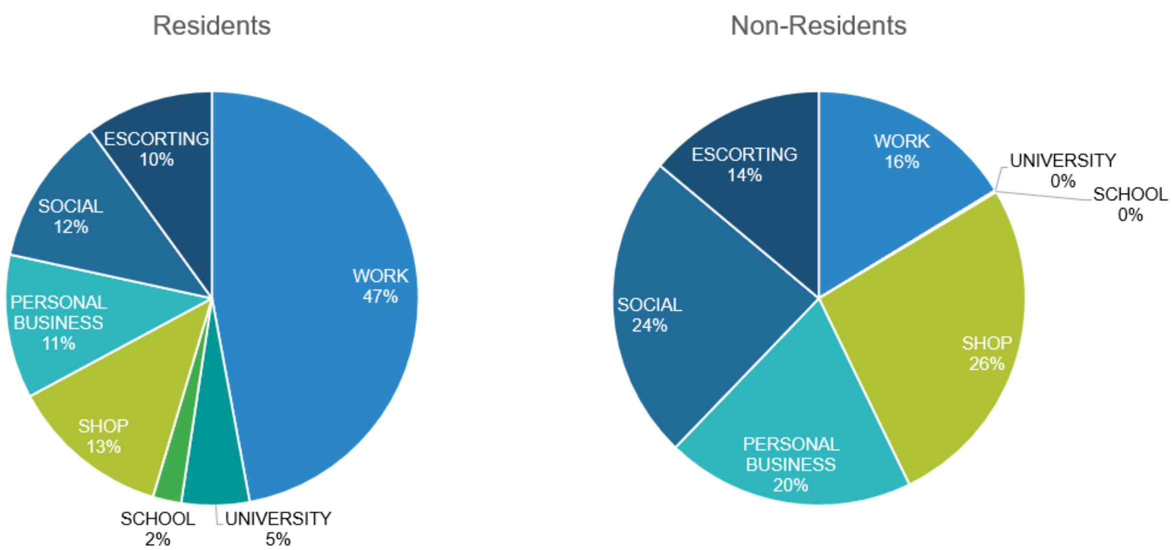
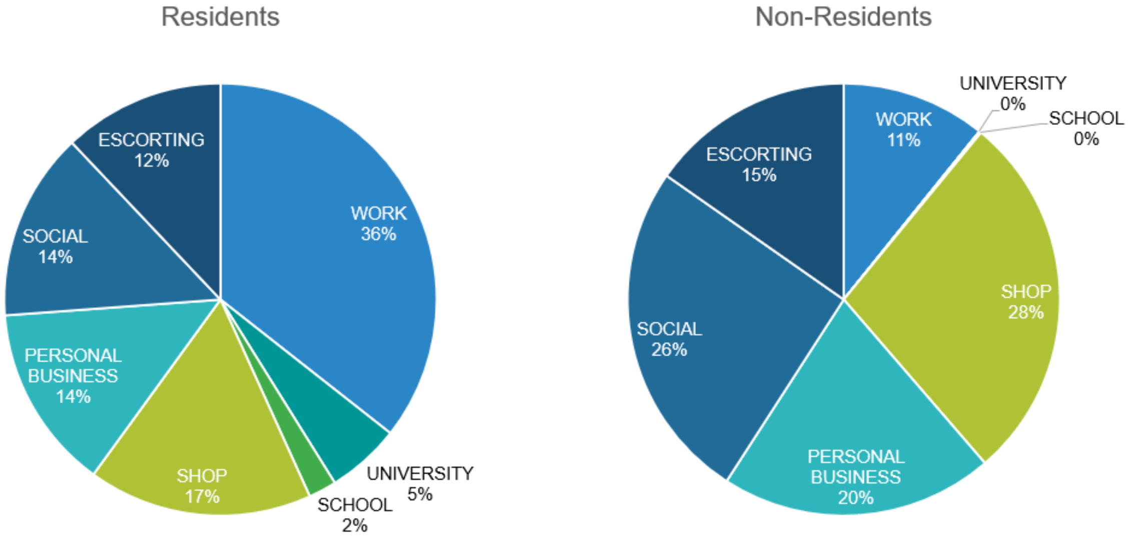


Figure 3.8: VKT by Trip Purpose – 2050 with campus shuttles and SkyTrain



3.3 GHG Emissions

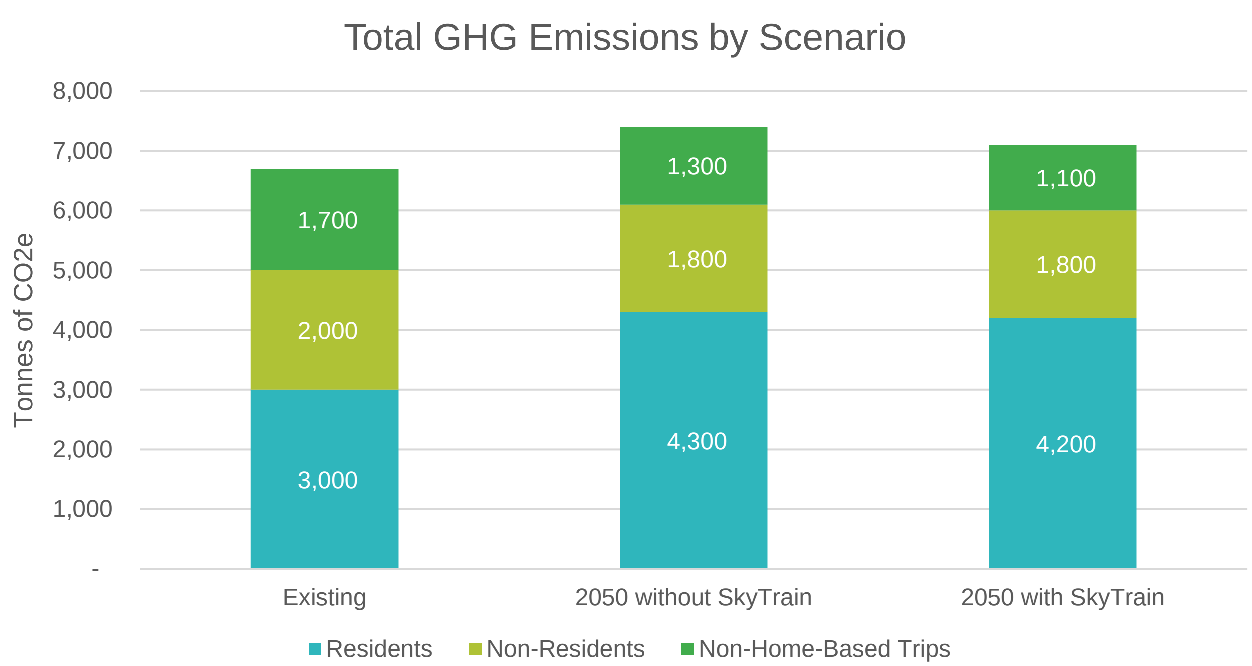
Figure 3.9 presents estimated total GHG emissions (in tonnes of CO2e) for each scenario (see **Appendix Table A.3** for detailed results).

Total GHG emissions for each scenario were estimated to be:

- **Existing:** 6,700 tonnes of CO2e
- **2050 with campus shuttles, no SkyTrain:** 7,400 tonnes of CO2e
- **2050 with campus shuttles and SkyTrain:** 7,100 tonnes of CO2e

Although VKT is predicted to significantly increase in both 2050 scenarios, GHG emissions are predicted to be similar across the three scenarios. This is a result of a shift towards ZEVs by 2050, assuming that provincial ZEV sales targets are met. In 2050 without SkyTrain, neighbourhood-induced travel is predicted to emit 7,500 tonnes of CO2e. SkyTrain extension to UBC reduces the annual emissions to 7,100 tonnes of CO2e. From another perspective, SkyTrain extension to UBC is predicted to avoid 300 tonnes of CO2e per year from neighbourhood-induced travel.

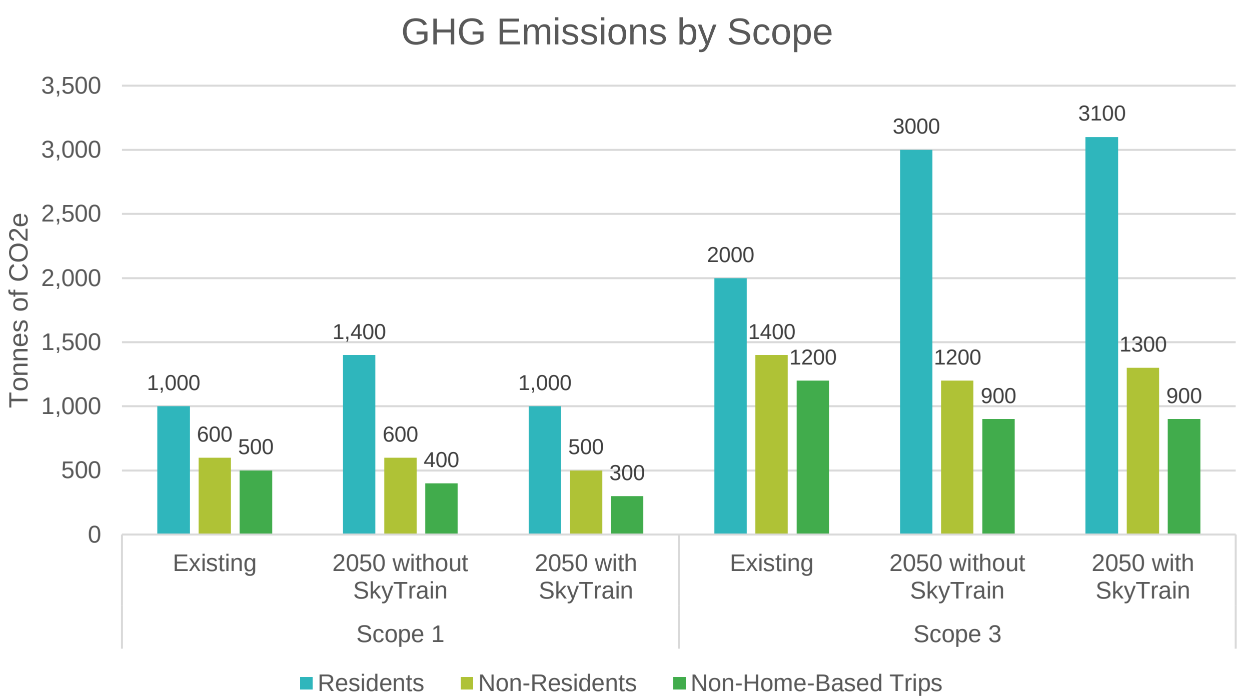
Figure 3.9: GHG Emissions by Scenario



3.3.1 GHG Emissions by Scope

Figure 3.10 presents GHG emissions by scope (rounded to the nearest 100 tonnes). Similar to **Figure 3.5**, which showed VKT by scope, this figure suggests that it is primarily resident scope 1, rather than resident scope 3, emissions that are affected by SkyTrain extension.

Figure 3.10: GHG Emissions by Scenario and Scope



4 Conclusion

The University of British Columbia (UBC) retained Mott MacDonald to estimate transportation-related greenhouse gas (GHG) emissions for portions of the campus designated as neighbourhoods. This work has baselined current and future (2050) transportation to inform the UBC Neighbourhood Climate Action Plan.

This work estimated mode shares, VKT, and GHG emissions for three scenarios:

Existing: utilized TransLink's most recent model, which reflects conditions in 2017.

2050 with campus shuttles, no SkyTrain: this scenario utilized TransLink's 2050 scenario using projected UBC 2050 population and employment obtained from the 30-Year Vision process. This scenario includes the two intra-transit campus shuttles identified in the draft 30-Year Vision. SkyTrain extension to UBC is not included in this scenario.

2050 with campus shuttles and SkyTrain: this scenario builds on the previous scenario by including the additional assumption of SkyTrain extension to UBC with one station at the UBC Trolley Loop

This analysis made the following findings:

1. Mode share estimation revealed that **SkyTrain extension is predicted to significantly increase the sustainable mode share**. The transit mode share for trips to/from campus is predicted to increase by 8 percentage points compared to 2050 without SkyTrain (from 57% to 65%). This increase is predicted to come directly from the auto mode share (from 40% to 32%).
2. Annual auto VKT to and from UBC neighbourhoods is predicted to be higher in 2050, both with and without SkyTrain, as a result of population growth. However, VKT in 2050 with SkyTrain is lower than without – **SkyTrain extension would avoid an estimated 2 million neighbourhood-induced vehicle-kilometers annually**.
3. Neighbourhood-induced GHG emissions were estimated to be 7,400 tonnes of CO2e in 2050 without SkyTrain, representing a 10% increase from today's values, despite 75% growth in auto VKT. This disproportionate increase is a result of a significant shift in vehicle composition towards ZEVs that is expected by 2050. **SkyTrain extension to UBC is estimated to avoid 300 tonnes of CO2e per year from neighbourhood-induced travel – representing a 4% reduction from the 2050 scenario without SkyTrain.**

A. Appendix

Table A.1: Annual VKT by Scenario and Scope

Scenario	Scope	Residents	Non-Residents	Non-Home-Based Trips	Total	
Existing	Scope 1	4,029,580	1,886,557	1,505,298	7,421,435	24,166,751
	Scope 3	8,119,763	4,527,754	4,097,798	16,745,316	
2050 without SkyTrain	Scope 1	7,851,769	3,211,709	2,057,209	13,120,687	41,515,713
	Scope 3	16,797,111	6,711,407	4,886,508	28,395,025	
2050 with SkyTrain	Scope 1	5,916,793	2,505,150	1,450,185	9,872,129	39,802,323
	Scope 3	17,761,275	7,436,342	4,732,577	29,930,194	

Table A.2: Total Raw Annual VKT from RTM

	Existing		2050 without SkyTrain		2050 with SkyTrain	
	Scope 1	Scope 3	Scope 1	Scope 3	Scope 1	Scope 3
Residents						
Home-based work	1,326,976	8,522,774	2,895,573	20,264,568	1,723,081	13,982,757
Home-based university	358,188	1,982,479	416,496	2,203,023	312,529	1,886,416
Home-based school	316,462	404,723	392,402	705,774	156,226	700,592
Home-based shop	499,106	2,489,923	1,093,674	4,986,049	1,074,101	4,691,241
Home-based personal business	417,094	2,310,244	898,004	4,530,230	859,184	4,322,537
Home-based social	536,196	2,395,468	1,097,696	4,475,044	934,124	4,135,785
Home-based escorting	575,558	1,906,204	1,057,923	3,681,227	857,547	3,397,926
Non-residents						
Home-based work	344,238	2,586,957	431,590	2,799,820	298,798	1,658,763
Home-based university	-	-	-	-	-	-
Home-based school	7,290	19,507	8,255	20,718	3,882	18,285
Home-based shop	464,278	2,398,693	886,925	4,344,609	721,606	4,098,125
Home-based personal business	310,485	1,857,055	603,451	3,250,969	510,339	2,779,247
Home-based social	435,454	2,379,836	799,165	3,935,442	606,152	3,002,868
Home-based escorting	324,813	1,700,018	482,323	2,282,964	364,374	1,701,335
Non-home-based trips						
Non-home-based work	898,321	6,506,328	1,108,768	7,301,842	986,557	5,813,075
Non-home-based other	606,977	3,154,279	948,441	4,452,677	463,629	2,750,119

Table A.3: Annual GHG Emissions by Scenario and Scope (tonnes of CO2e)

Scenario	Scope	Residents	Non-Residents	Non-Home-Based Trips	Total	
Existing	Scope 1	997	574	458	2,029	6,672
	Scope 3	2,009	1,378	1,247	4,634	
2050 without SkyTrain	Scope 1	1,380	580	371	2,331	7,452
	Scope 3	2,952	1,211	882	5,045	
2050 with SkyTrain	Scope 1	1,040	452	262	1,754	7,144
	Scope 3	3,121	1,342	854	5,318	

Table A.4: Summary of Electric Vehicle Efficiency Factors Used Within the Analysis

Vehicle Type	Definition[6]	Efficiency (kWh/km)	Source
Light-duty vehicles, Passenger and Commercial	Vehicles with a Gross Vehicle Weight Rating (GVWR) of 3,900 kg or less. Excludes trucks, SUVs, and minivans.	0.2 (2017) 0.16 (2050)	2017 values from: Electric Vehicles - World Nuclear Association (world-nuclear.org), referenced within: Emission Factors used in Reporting the B.C. Government's GHG Emissions from Business Travel - 2010 2050 - TAG data book - GOV.UK (www.gov.uk) - very developed source of efficiency/emissions factors from UK Government
Light-duty trucks, Passenger and Commercial	Vehicles with a GVWR of 3,900 kg or less. Includes trucks, SUVs, and minivans.	0.26 (2017 and 2050)	Data from TAG data book - TAG data book - GOV.UK (www.gov.uk) – using ordinary goods vehicles categories. If only calculating for passenger light-duty trucks (i.e., not combining with commercial vehicles), 0.2 could more accurately be used as passenger light-duty trucks are likely to weigh less on average than commercial light-duty trucks (data from: Range of full electric vehicles cheatsheet - EV Database (ev-database.org)
Commercial - Heavy-duty vehicles	Vehicles with a GVWR greater than 3,900 kg.	N/A As a proxy use Public Service Vehicles	Not commercially available at the moment, and data not projected for 2050 – likely to be hydrogen/alternative energy sources not electric. However, a proxy could be to use Public Service Vehicles as indicative intensity due to weight and size.
Commercial – Public Service Vehicle (buses, shuttles, etc.)	Vehicles with a GVWR greater than 3,900 kg usually with more than 16 seats.	1.19 (2017) 1.12 (2050)	Using TAG data for Public Service Vehicles - includes all public service vehicles and works buses.

[6] Definitions for light-duty vehicles, light-duty trucks, and heavy-duty vehicles are sourced from the BC Ministry of Environment and Climate Change 2020 B.C. Best Practices Methodology for Quantifying Greenhouse Gas Emissions. The definition for commercial – public service vehicles is sourced from the TAG data book.

Table A.5: Electric Vehicle Emission Factors Used within the Analysis

Scenario	Emission Factor (kg of CO_2/kWh)	Source
Existing	0.0078	Government of Canada’s Greenhouse Gas Offset Credit System, Emission Factors and Reference Values, Version 1.0 (2022)
2050 without SkyTrain 2050 with SkyTrain	0.001	Government of Canada’s GHG and Air Pollutant Emissions Projections (2021)