

Supplementary Information

A Detailed Case Study Scenarios

Case Study	Scenario	Existing	Trajectory	Optimized
Arbutus Station, Vancouver	Population ¹	22433	41422	41422
	Employment ²	12590	13486	13804
	Residential Units ³	13423	26519	26284
	New Affordable Units	—	12.23%	11.13%
	Residential Area ⁴	91.86%	91.54%	91.54%
	Commercial Area ⁴	0.94%	1.26%	1.26%
	Industrial Area ⁴	3.20%	3.20%	3.20%
	Public Area ⁴	4.00%	4.00%	4.00%
McKernan-Belgravia Station, Edmonton	Population	6060	9064	9996
	Employment	2900	2990	3828
	Residential Units	2602	4674	4762
	New Affordable Units	—	3.19%	2.78%
	Residential Area	77.83%	77.42%	77.42%
	Commercial Area	0.00%	0.41%	0.41%
	Industrial Area	4.32%	4.32%	4.32%
	Public Area	17.85%	17.85%	17.85%
Northfield Station, Waterloo	Population	2908	25862	25862
	Employment	335	20391	15056
	Residential Units	1123	15469	15274
	New Affordable Units	—	1.02%	1.01%
	Residential Area	19.11%	19.11%	19.11%
	Commercial Area	0.00%	0.56%	0.56%
	Industrial Area	80.89%	80.33%	80.33%
	Public Area	0.00%	0.00%	0.00%
Cooksville Station, Mississauga	Population	16770	51891	66200
	Employment	3185	22178	22178
	Residential Units	7356	33372	27060
	New Affordable Units	—	13.72%	13.24%
	Residential Area	72.83%	72.86%	72.86%
	Commercial Area	11.55%	11.80%	11.80%
	Industrial Area	3.84%	3.81%	3.81%
	Public Area	11.78%	11.53%	11.53%
Panama Station, Brossard	Population	5167	16626	20183
	Employment	3367	7435	8410
	Residential Units	2123	10026	9673
	New Affordable Units	—	14.61%	14.57%
	Residential Area	64.02%	64.01%	64.01%
	Commercial Area	26.95%	27.26%	27.26%
	Industrial Area	0.00%	0.00%	0.00%
	Public Area	9.03%	8.73%	8.73%

Table SI 1. Detailed population, employment, and land-use changes for the development scenarios in each station area (¹Statistics Canada 2021, ²Statistics Canada (Business Register Division) 2022, ³EnviroNics Analytics 2025, ⁴DMTI Spatial 2023, changes are based on authors' calculations)

B GTFS Modification

Arbutus Station is located at the terminus of the Millennium SkyTrain Extension which is expected to be completed in 2027. The extension adds 6 stops (one existing connection) on the western side of the line (Figure SI 1).

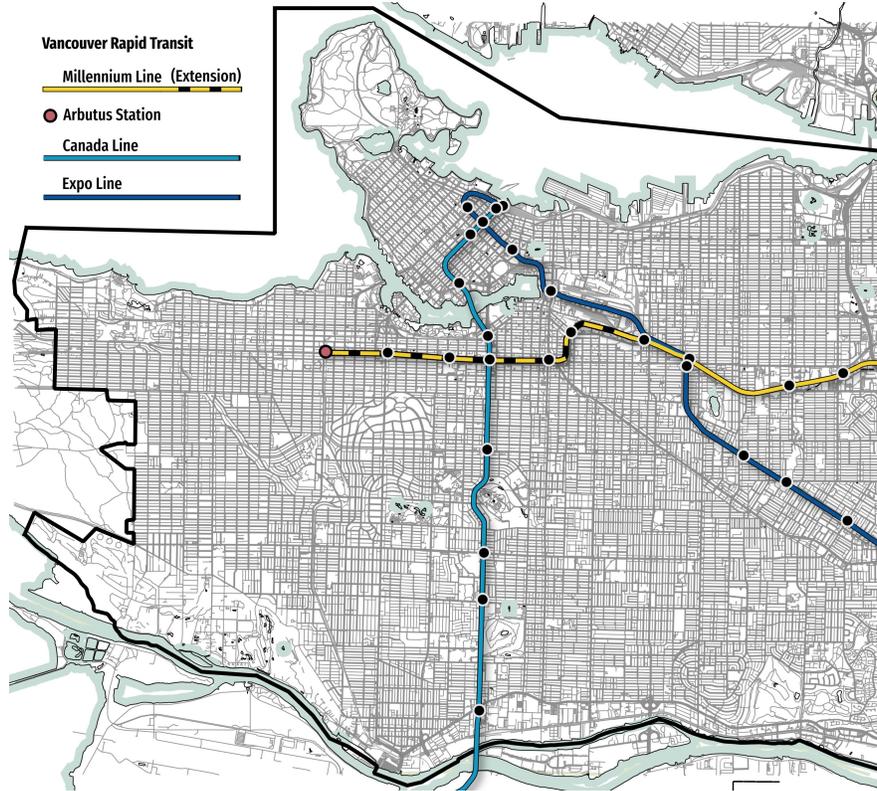


Fig. SI 1. Vancouver SkyTrain network with Millennium Line extension.

To create the modified GTFS feed, we created a template stop_times using the existing service file. We then added the new stops (when not already existing) to the stops file. Since the stop distribution of the extension is similar to the original line, we calculated the average travel speed from the existing GTFS feed and applied it to the distance between stops along the extension, since this would include station boardings, to create the template stop_times for the full line. Assuming the extended line would have similar service, we used the existing headways of 3 minutes (TransLink, 2026) to create the full trips and stop_times files. We then removed the existing trips and stop_times entries for the existing Millennium line service.

To verify the modified gtfs, we created a set of test locations along the existing Millennium Line and ran a travel time matrix with the original and modified GTFS files. If the service was properly recreated, we expected to find approximately the same travel times between both files, with minor potential variations (roughly 1 minute) due to differences in how the files are created. We then ran another travel time matrix on a set of locations along the extension portion of the line, expecting to find significantly improved travel times compared to the existing file, and travel times that align with the approximate speed of travel calculated previously. Both tests ran as expected.

C Equations

C.1 FGT Index

The FGT index takes the form:

$$P_{\alpha}(y; z) = \frac{1}{n} \sum_{i=1}^q \left(\frac{g_i}{z}\right)^{\alpha}$$

where z is the transport poverty threshold, $g_i = z - y_i$ is the accessibility, shortfall of the i^{th} household, q is the number of low-income households below the poverty line, n is the total low-income households, and α is a hyperparameter representing a “measure of poverty aversion” or how intensely to weight the poorest households.

C.2 Accessibility Measure

To calculate the accessibility (A) of location i , we use the equations

$$A_i = \sum_{j=1}^J E_j f(t_{i,j})$$

$$f(t_{i,j}) = 180(90 + t_{i,j})^{-1} - 1$$

where E_j is the employment at location j , $t_{i,j}$ is the travel time in minutes between location i and j , and $f(t_{i,j})$ is an inverse-power impedance function. The impedance function is tuned to return a maximum value of 1 at $t_{i,j} = 0$ and a value of 0.5 at $t_{i,j} = 30$ minutes, which is the approximate median commute time in Canada (Statistics Canada, 2024). Transit travel times were calculated using R5PY (Conway et al., 2017, 2018; Conway and Stewart, 2019; Fink et al., 2022) with network data from OpenStreetMap (OpenStreetMap contributors, 2025) and GTFS data from the Canadian Public Transit Network Database (Statistics Canada, 2025). We calculated transit travel times for every minute from 8am to 9am, taking the median value for the final travel time. Vehicle travel times were calculated using ArcGIS (ESRI, 2023) congested vehicle travel times at 8am.

References

- Conway, M. W., A. Byrd, and M. Van Der Linden (2017, January). Evidence-Based Transit and Land Use Sketch Planning Using Interactive Accessibility Methods on Combined Schedule and Headway-Based Networks. *Transportation Research Record: Journal of the Transportation Research Board* 2653(1), 45–53.
- Conway, M. W., A. Byrd, and M. Van Eggermond (2018, July). Accounting for uncertainty and variation in accessibility metrics for public transport sketch planning. *Journal of Transport and Land Use* 11(1), 541–558.
- Conway, M. W. and A. F. Stewart (2019, September). Getting Charlie off the MTA: a multiobjective optimization method to account for cost constraints in public transit accessibility metrics. *International Journal of Geographical Information Science* 33(9), 1759–1787.
- DMTI Spatial (2023). Land Cover Region.
- EnviroNics Analytics (2025). DemoStats.
- ESRI (2023). ArcGIS Online.

Fink, C., W. Klumpenhouwer, M. Saraiva, R. Pereira, and H. Tenkanen (2022, September). `r5py`: Rapid Realistic Routing with R5 in Python.

OpenStreetMap contributors (2025). Canada OSM Data. Published: <https://www.openstreetmap.org>.

Statistics Canada (2021). Data Tables, 2021 Census, Population (v_ca21_1), In low income based on the Low-income cut-offs, after tax (v_ca21_1070).

Statistics Canada (2024, August). More Canadians commuting in 2024. Technical report, Statistics Canada.

Statistics Canada (2025). Canadian Public Transit Network Database.

Statistics Canada (Business Register Division) (2022). Canadian business counts, dissemination area (DA) level [custom tabulation].

TransLink (2026). Millennium Line Schedules and Maps.