National Capital Region
Transportation Planning Board

MEMORANDUM

TO: Feng Xie, Manager, Model Development Group, COG/TPB

FROM: Bahar Shahverdi, Transportation Engineer, Model Development Group, COG/TPB

SUBJECT: Additional Model Calibration Included in the Gen3/Version 1.1.0 Travel Model

DATE: February 20, 2026

INTRODUCTION

The National Capital Region Transportation Planning Board (TPB)'s Generation 3 (Gen3) Travel Demand Forecasting Model is an activity-based model developed on the open-source ActivitySim and proprietary Bentley Cube platforms to simulate transportation demand and supply in the Metropolitan Washington region. Unlike TPB's current production-use Generation 2 (Gen2) Travel Demand Forecasting Model, which is a classic aggregate trip-based model, the Gen3 Model represents travel behavior at the individual person and household levels, explicitly modeling daily activity patterns and tours. This disaggregated, behaviorally rich framework enables more realistic representation of travel decisions, such as trip chaining within tours and interactions among household members.

The Gen3 Model has been developed over the past six years in three phases. The model is currently in its third and final phase, with an official model release planned for this spring. As a critical component of the Gen3 Model development, model calibration efforts were conducted throughout all the three phases to ensure that model output accurately reflect observed travel patterns.

Two technical reports developed by TPB's model consultants document the calibration results at the end of the Phase 1 and Phase 2 developments, respectively.[1,2] Following a major model update in Phase 3, the consultants produced a third report,[3] dated August 25, 2025, to document the updated calibration results associated with an interim version (v.1.0.4) of the Gen3 Model. Subsequently, TPB staff re-calibrated several model components and incorporated the updated model specification and coefficient files into the next model version (v1.1.0) for the official release. This memo, which amends the August 2025 calibration report, describes the TPB-led effort to re-calibrate select model components and documents the calibration results.

[1] RSG and Baseline Mobility Group. Gen3 Model Phase 1 Calibration and Validation. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, February 1, 2022. https://www.mwcog.org/assets/1/6/Gen3_Model_Phase_1_Calibration_And_Validation_final.pdf

[2] RSG and Baseline Mobility Group. "Gen3 Model Calibration and Validation Report." Final Report. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, February 7, 2024. https://www.mwcog.org/assets/1/6/Gen3_Model_Calibration_and_Validation_Report.pdf

[3] RSG and Baseline Mobility Group. "Gen3/Ver.1.0.4 Model Calibration and Validation Report." Final Report. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, August 25, 2025. https://app.box.com/s/oyytkiq6slfa83a7a7p2yojdkpkpktgu

TRANSIT PASS SUBSIDY AVAILABILITY CALIBRATION

In the recent usability testing of the Gen3 Model, staff noticed that the transit pass subsidy model, which used model parameters inherited from the Southeast Michigan Council of Governments (SEMCOG) Travel Model (the donor model of the Gen3 Model), significantly underestimated the availability of employer-provided transit subsidy benefits for the workforce in our region.

Thus, it was decided to calibrate the transit subsidy availability model to our local 2019 *State of the Commute* (SOC) Survey data. The raw dataset was transmitted to TFEA staff by Dan Sheehan via email on September 23, 2025, in response to an internal data request.

A python script[4] was used to develop the calibration targets which represent the percentage of transit pass subsidy availability by person type (full-time and part-time workers) for the region. The targets were developed in two phases. In the first phase, as a Quality Assurance/Quality Conformity (QA/QC) procedure, the script replicated the weighted transit subsidy percentages reported in the 2019 SOC survey documentation.[5] In the second phase, the script developed new calibration targets for the Gen3 Travel Demand Model by computing the total numbers of full-time and part-time employees and percentages of employees that were offered transit subsidies by their employers. The final calibration targets are summarized in Table 1 showing that 45.90% of full-time workers and 18.22% of part-time workers have access to employer-provided transit pass subsidy.

Table 1 - Transit pass subsidy availability calibration targets

Description	Weighted Number	Weighted Total	Percentage
Full-time workers	1,325,696	2,888,032	45.90%
Part-time workers	42,798	234,854	18.22%
Total	1,368,493	3,122,886	43.82%

The calibration began with a full model run to establish a baseline. Staff then executed a Jupyter notebook script developed by RSG to calibrate the model so that the estimated transit subsidy availability shares match the targets provided in Table 1. Related model coefficients (or alternative-specific constants) were updated in the script, model outputs were updated through partial runs, and this process was iterated until modeled shares matched the targets within a 4×10^{-3} tolerance, which was achieved after six iterations. It is worth noting that staff later developed a Python script that automates this entire process, which eliminated manual intervention and produced identical results. Result from each iteration in terms of modeled shares vs. target shares is shown in Figure 1.[6] The final calibrated coefficients for full-time and part-time workers are given in Table 2.

[4] For internal reference, a copy of the script can be found at: "Z:\team_mem\bshahverdi\Python_Projects\Calibration\Transit_Subsidy\Transit_Subsidy_Percentages.py"

[5] "2019 State of the Commute Survey Report from the Washington DC Metropolitan Region", National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, Published by Commuter Connections® June 2020

[6] For internal reference, a memo can be viewed where the calibration process and logics are described. Feng Xie, Glenn Lang, Bahar Shahverdi "ActivitySim Model Calibration for the Gen3 Travel Model: Methodologies and Current Tools", COG/TPB Memorandum, November 17, 2025.

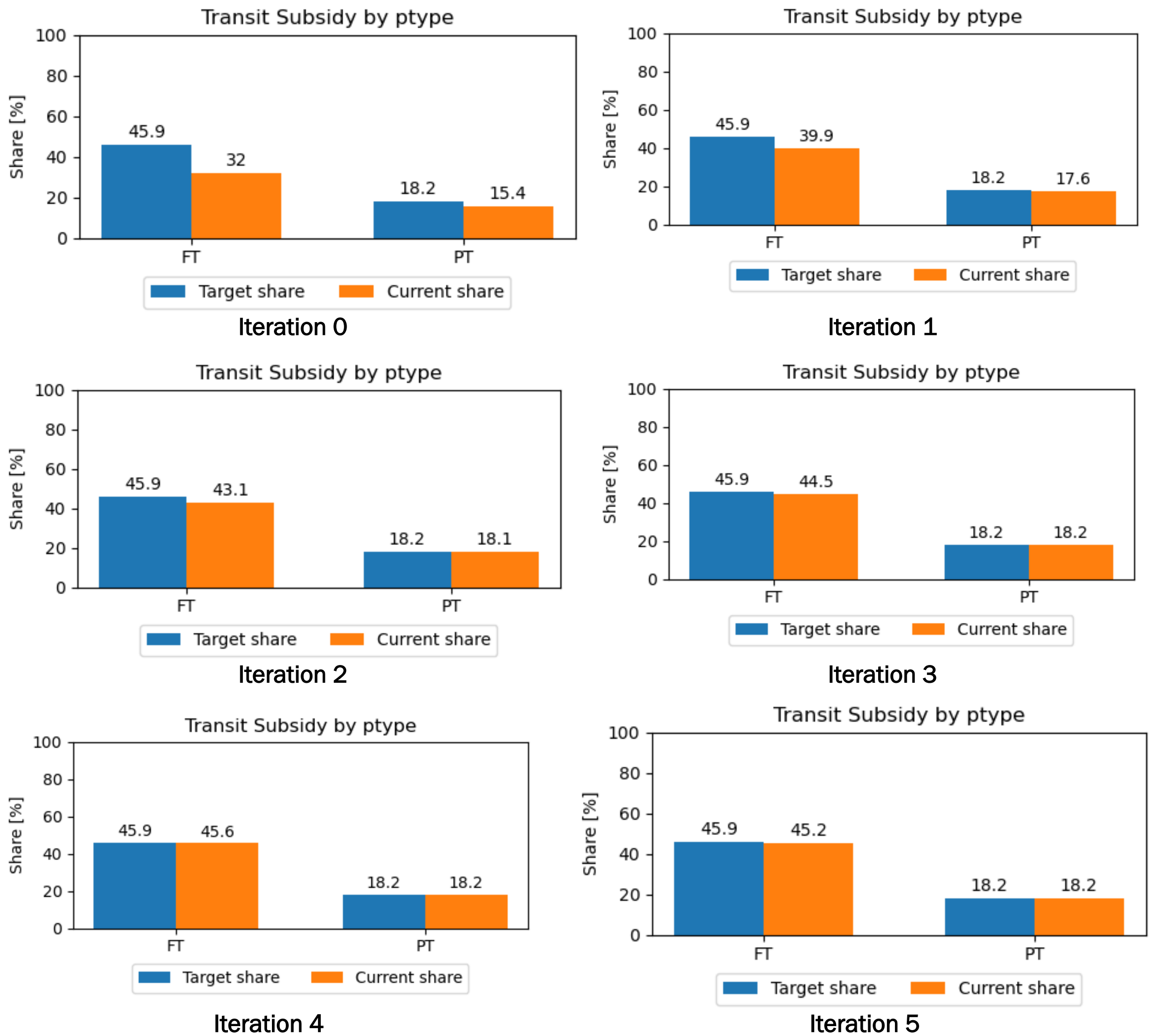

Figure 1 - Convergence of transit pass subsidy model calibration iterations toward desired threshold (4×10^{-3})

Table 2 - Transit pass subsidy calibration constants

Description	Constant
Full-time workers	2.52
Part-time workers	1.65

FREE PARKING ELIGIBILITY CALIBRATION

Similar to the transit pass subsidy model, the free parking eligibility model also uses the model parameters inherited from the SEMCOG Travel Model, which underestimated the availability of employer-provided free parking benefits for the workers in our region. Thus, the free parking eligibility model was also re-calibrated to the local data with calibration targets developed from the 2019 SOC survey data.

A second Python script[7] was used to develop updated targets representing the percentage of free parking eligibility by person type (full-time and part-time workers) for the region. Similar to the script for transit subsidy availability, this process included two phases. In the first phase, the script replicated the weighted free parking percentages reported in the 2019 SOC Survey. In the second phase, it developed new calibration targets for the Gen3 Travel Demand Model by calculating total weighted number of employees and percentages of full-time and part-time employees with free parking. The final calibration targets are summarized in Table 3, showing that 52.90% of full-time workers and 53.80% of part-time workers are eligible for free parking.

Table 3 - Free parking eligibility calibration targets

Description	Weighted Number	Weighted Total	Percentage
Full-time workers	1,528,4612	2,888,032	52.90%
Part-time workers	126,4123	234,854	53.80%
Total	1,654,874	3,122,885	53.00%

The free parking availability model calibration was initially performed in a Jupyter Notebook developed by RSG. This process is semi-automated and requires a lot of manual intervention. Staff developed a Python script that fully automates the free parking availability calibration process. The script conducts the full model run using the original free parking coefficients to establish the baseline, iteratively updates model coefficients and alternative-specific constants to better match the calibration targets, and subsequently conducts partial model runs to update the model output. This automated workflow continues until the modeled shares converge to the target shares within the 4×10^{-3} tolerance, which occurred after seven iterations shown in Figure 2. By eliminating manual intervention while preserving the same calibration logic and stopping criteria, the script reproduces the iteration-by-iteration outcomes from the original Jupyter Notebook calibration process. Table 4 depicts final coefficients for full-time and part-time workers resulting from the calibration.

[7] For internal use, a copy of the script can be found:
"Z:\team_mem\bshahverdi\Python_Projects\Calibration\Free_Parking\Free_Parking_percentages.py"

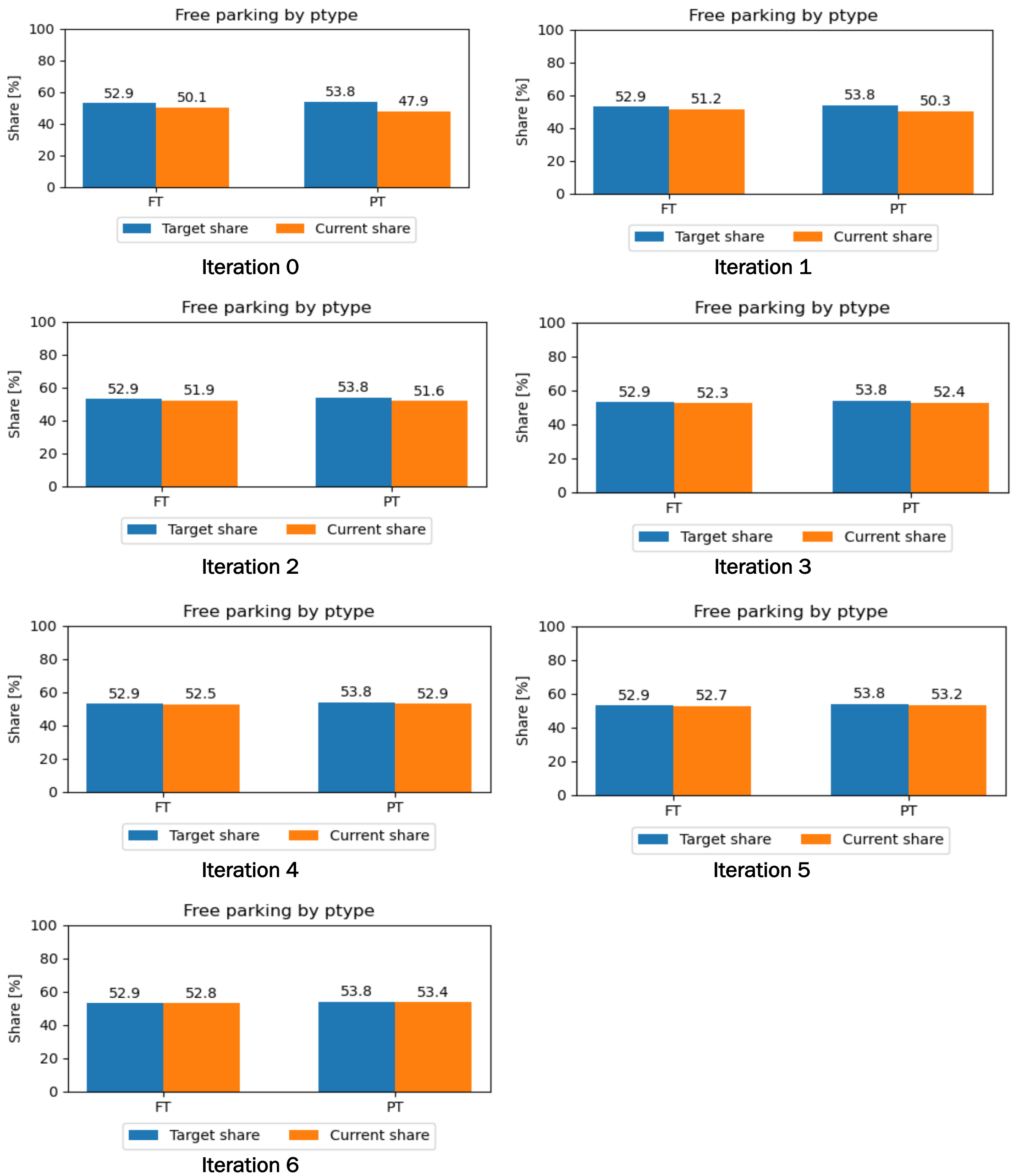

Figure 2 - Convergence of free parking eligibility model calibration iterations toward desired threshold (4×10^{-3})

Table 4 - Free parking calibration constants

Description	Constant
Full-time workers	0.22
Part-time workers	0.48

TOUR AND TRIP MODE CHOICE CALIBRATION

Following the updates to the upstream transit pass subsidy and free parking models, both tour mode choice and trip mode choice models were re-calibrated. Mode choice calibration proved to be particularly challenging for staff for the following reasons:

1. There are so many coefficients in the tour and trip mode choice models that it is impossible for each one of them to converge.

2. Trip mode choice is strongly constrained by tour mode choice; therefore, the quality of tour mode choice calibration directly influences the performance of trip mode choice calibration.

3. Mode choice calibration usually has a significant impact on model validation results, especially on the transit side, and thus a good fit in model calibration does not necessarily lead to a good fit in model validation.[8]

Despite these challenges, staff conducted mode choice calibration with on-call assistance from the consultant and obtained satisfactory results. Specifically, following the suggestion from the consultant, staff used the model data from the previous Gen3/Ver. 1.0.4 Model as proxy calibration targets to expedite the convergence. Staff also iterated between mode choice calibration and transit validation three times until both mode choice calibration and transit validation results were deemed satisfactory. During this iterative process, staff adjusted the mode-specific model coefficients using scaling factors that were computed as a logarithm of the ratio of estimated to observed mode shares to incrementally improve the transit validation performance.

The final mode choice calibration that was obtained in the third iteration is presented below.

[8] In theory, both calibration and validation targets are derived from observed data and should be in line with each other. In practice, however, discrepancies between the calibration and validation targets are not uncommon as they come from different sources - While mode choice calibration targets are usually developed from household travel surveys and transit on-board surveys, transit validation targets are usually developed based on transit boarding counts. An iterative process is usually involved in reconciling these differences, which, however, is as much an art as a science since there is no standard procedure to follow.

TOUR MODE CHOICE

The tour mode choice calibration results in terms of modeled vs. observed tour modal shares are presented in Figure 3. The final calibrated tour mode choice model coefficients can be found in the \source\configs\activitysim\configs\tour_mode_choice_coeffs.csv file that is contained in the Gen3 Model package. The additional overall calibration coefficients are given in Table 5, followed by work related constants in Table 6 and Table 7. Coefficients for all the other tour purposes (i.e. university, school, etc.) can be found in the same coefficient file.

Table 5- Additional overall tour mode choice calibration constants

Description	Constant
Auto Sufficient SOV Tours to DC Destination	-0.18
Auto Sufficient SR2 Tours to DC Destination	-0.64
Auto Sufficient Walk-Access Transit Tours to DC Destination	0.8
Auto Sufficient SOV School Tours	0.14
Metrorail Tours to DC Destination	0.48
Bus-only Tours to DC Destination	-0.4
Bus+ Metrorail Tours to DC Destination	-0.1
Commuter Rail tours to DC Destination	0.3
SOV Tours to DC Destination (all auto sufficiency groups)	-0.18
Bus modes within DC	0.55
SOV modes within DC	-1.1
Shared-Ride 2 tours to DC Destination	0.75
Shared-Ride 3+ tours to DC Destination	0.55
SOV tours to non-DC Destinations	0.5

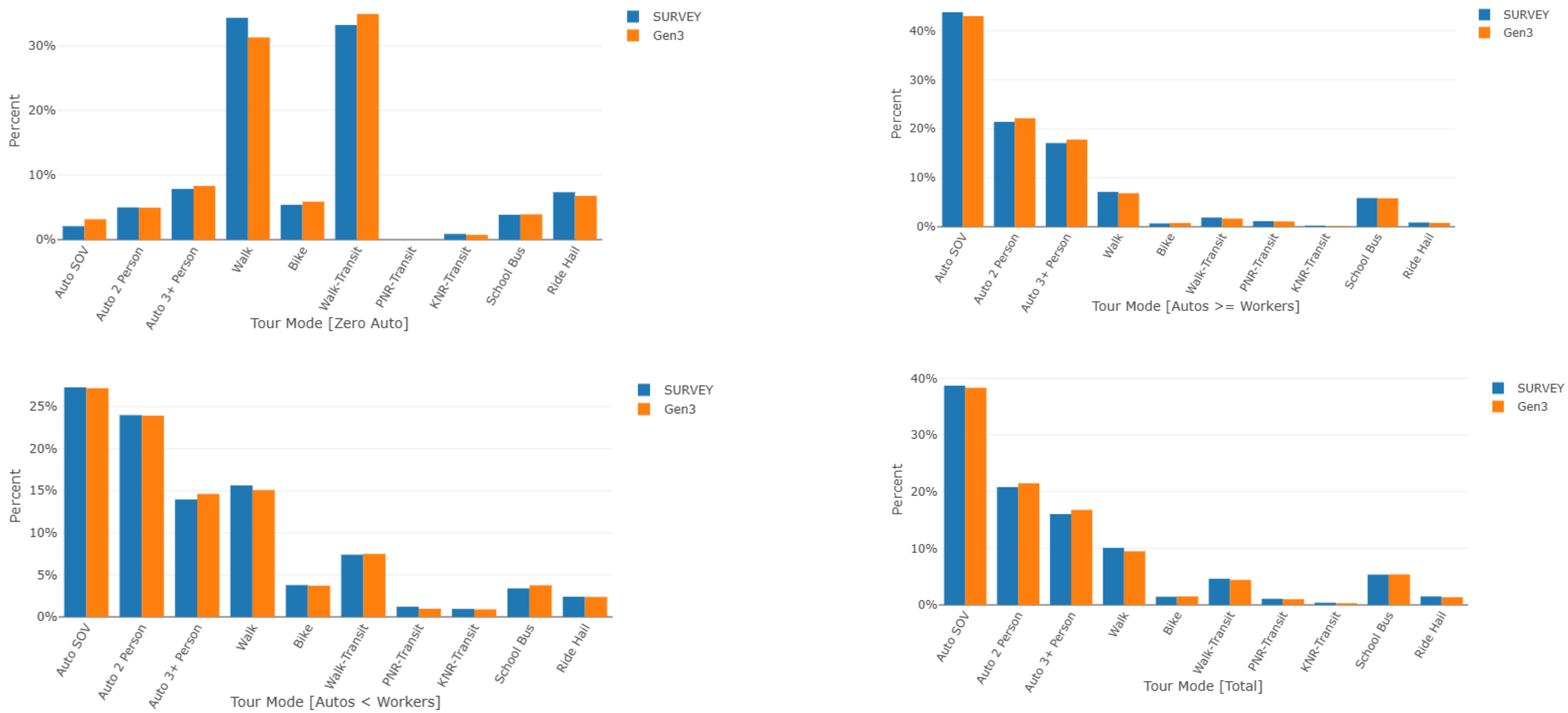

Figure 3- Tour mode choice calibration - all tour purpose

Table 6- Work tour calibration constants (mode + auto sufficiency)

Description	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	12.09	-3.42	0.22
Shared-Ride 2	14.38	-3.39	0.05
Shared-Ride 3+	14.84	-3.99	-0.75
Walk	19.99	-0.15	0.73
Bike	17.12	-3.28	-2.46
Walk Transit	19.68	-0.9	0.27
PNR Transit	-999	-2.98	0.02
KNR Transit	15.53	-4.06	-2.61
Taxi	16.06	-3.93	-2.11
TNC Single	16.76	-3.57	-2.69
TNC Shared	15.06	-5.15	-3.80

Table 7- Work transit access and line haul calibration constants

Description	Walk Access	PNR Access	KNR Access
Bus Only	-0.79	-1.61	-0.68
Metrorail Only	0.2	-0.6	-0.02
Bus + Metrorail	-0.89	-0.26	-0.25
Commuter Rail	-1.72	0.63	0.34

TRIP MODE CHOICE

After conducting the tour mode choice model calibration, a full model run was executed, and the trip mode choice calibration was initiated. The final trip mode choice calibration results in terms of modeled vs. observed trip modal shares are presented in Figure 4 for all tour purposes and Figure 5 for work tours. All the final calibrated trip mode choice model coefficients can be found in the \source\configs\activitysim\configs\trip_mode_choice_coefficients.csv coefficient file that is contained in the Gen3 Model package. Specifically, the miscellaneous trip mode choice calibration coefficients are given in Table 8, calibration coefficients for trips on work tours are shown in Table 9 and Table 10, while those for other tour purposes (i.e. university, school, etc.) can be found in the same coefficient file.

Table 8- Miscellaneous trip calibration constants

Description	Constant
Adjustment for Drive Alone trips to DC	-0.157
Adjustment for bus trips within DC	0.6
Transfer constant for walk access to all-bus transit	-0.12

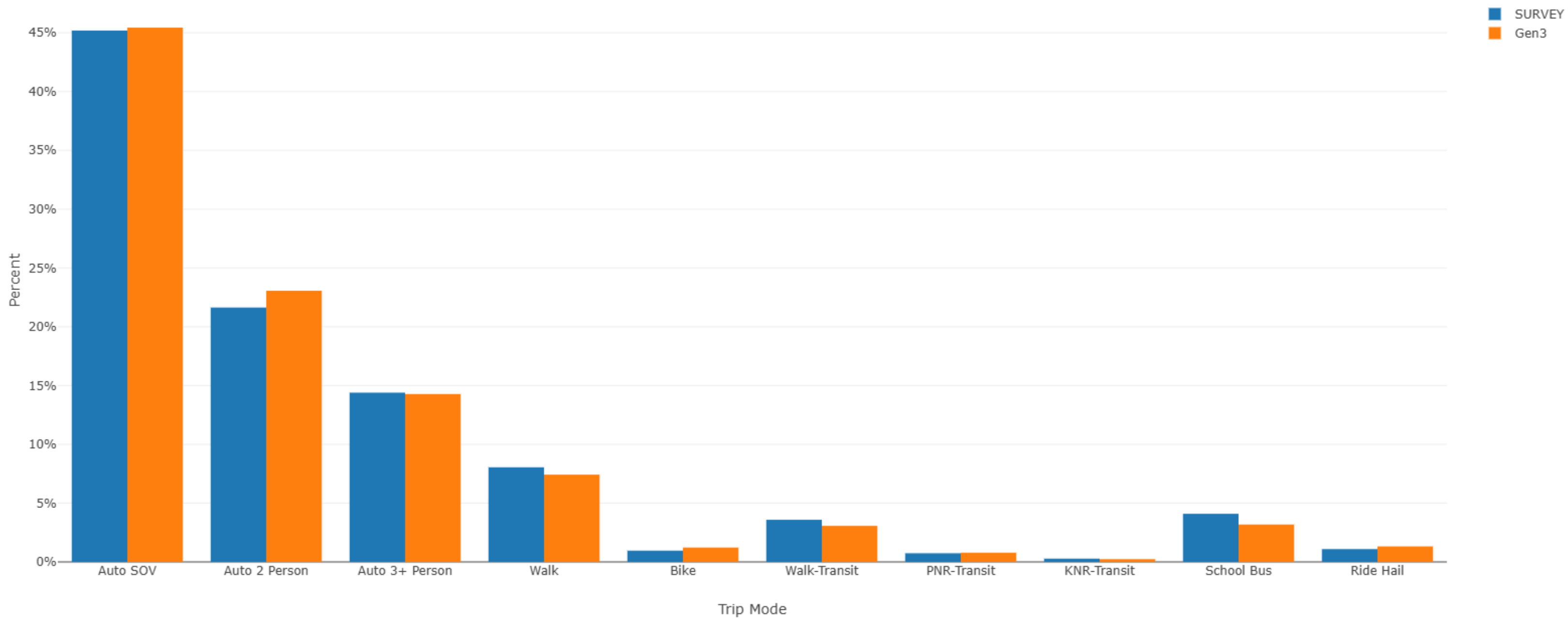

Figure 4- Trip mode choice calibration results for all tour purposes

Table 9- Trip mode choice model calibration constants for work tours

Tour Mode	Trip Mode	Auto Deficient
Shared-Ride 2	Drive Alone	-0.30
Shared-Ride 3+	Drive Alone	0.14
Shared-Ride 3+	Shared-Ride 2	0.20
Walk	Drive Alone	-2.16
Walk	Shared-Ride 2	-3.23
Walk	Shared-Ride 3+	-3.86
Bicycle	Walk	0.47
Walk Transit	Shared-Ride 2	-8.97
Walk Transit	Shared-Ride 3+	-10.47
Walk Transit	Walk	-0.89
Walk Transit	Bicycle	30
Walk Transit	Taxi	-8.24
Walk Transit	TNC Single	-8.03
Walk Transit	TNC Shared	-8.16
Walk Transit	Metrorail	0.13
Walk Transit	Bus+ Metrorail	-1.61
Walk Transit	Commuter Rail	-5.93
Ridehail	Shared-Ride 2	-2.23
Ridehail	Shared-Ride 3+	-2.32
Ridehail	Walk	1.27
Any	PNR Metrorail-Only	5.86
Any	PNR Bus+ Metrorail	-5.03
Any	PNR Commuter Rail	0.53
Any	KNR Metrorail-Only	0.49
Any	KNR Bus+ Metrorail	-0.69
Any	KNR Commuter Rail	13.53
Any	Taxi	-0.13
Any	TNC Single	0.83
Any	TNC Shared	-1.23

Table 10- Stop arrangement calibration constants for trips on work tours

Tour Mode	Trip Mode	Condition	Auto Deficient
Shared-Ride 2	Drive Alone	No Stops	-2.08
Shared-Ride 3+	Drive Alone	No Stops	-2.82
Shared-Ride 3+	Shared-Ride 2	No Stop	-2.59
Shared-Ride 2	Drive Alone	First Outbound Trip in Tour	-0.36
Shared-Ride 3+	Drive Alone	First Outbound Trip in Tour	-0.50
Shared-Ride 3+	Shared-Ride 2	First Outbound Trip in Tour	-1.06
Shared-Ride 2	Drive Alone	Last Inbound Trip in Tour	-0.27
Shared-Ride 3+	Drive Alone	Last Inbound Trip in Tour	-0.30
Shared-Ride 3+	Shared-Ride 2	Last Inbound Trip in Tour	-0.83

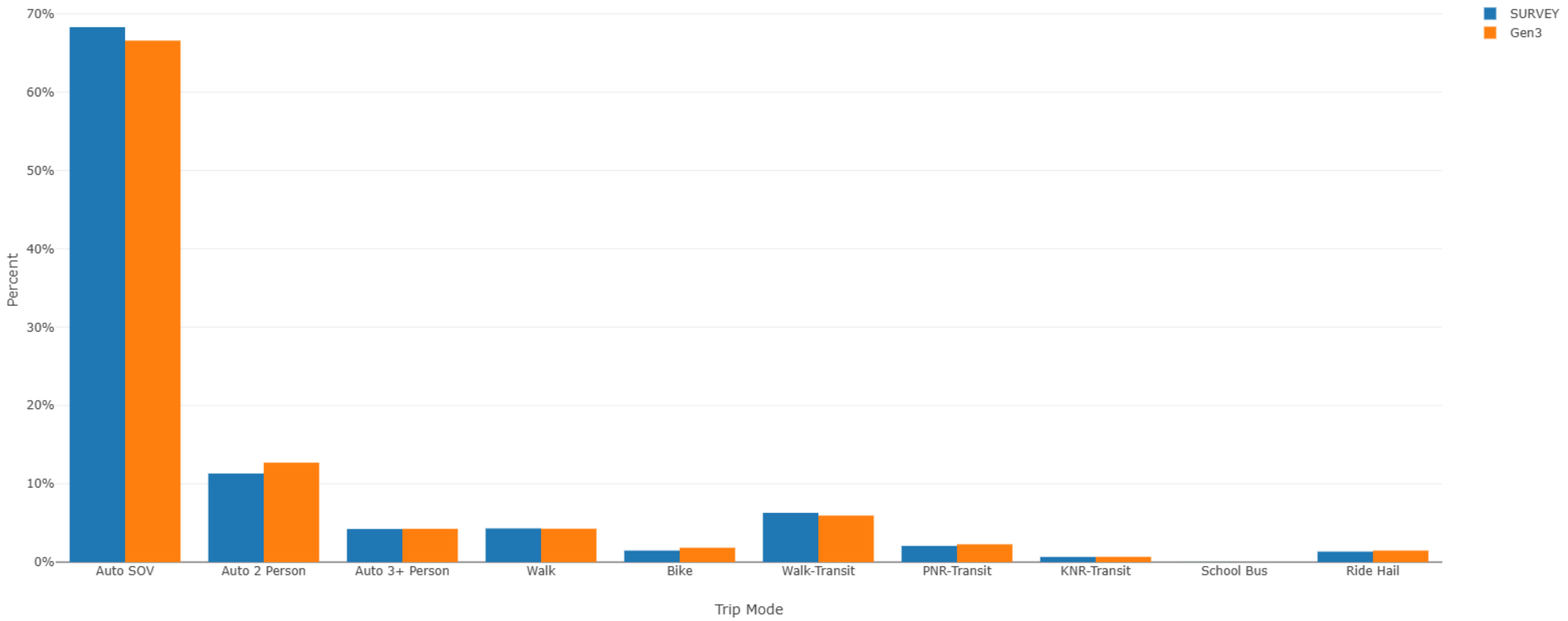

Figure 5- Trip mode choice calibration results for trips on work tours

TRANSIT VALIDATION

After the initial round of mode choice calibration, transit validation was subsequently conducted, and it was found that the model significantly overestimated transit ridership, by about 20%, relative to the observed transit boarding count data. The mode choice calibration coefficients were subsequently adjusted, and tour/trip mode choice calibration and transit validation were repeated three times until both mode choice and transit validation results were deemed satisfactory.

The final transit validation results are shown below in Figure 6. The resulting E/O ratios were 0.97 for Metrorail, 0.99 for commuter rail, 1.01 for all bus, and 0.99 for all transit.

	2018 Daily Boardings and Alightings Estimates (Gen3 Model)														
Mode Name	All Bus: Sum of ONA	All Bus: Sum of OFFB	Bus & Metrorail: Sum of ONA	Bus & Metrorail: Sum of OFFB	Metrorail: Sum of ONA	Metrorail: Sum of OFFB	Metrorail: Boardings without Transfers	Commuter Rail: Sum of ONA	Commuter Rail: Sum of OFFB	**Combined: Sum of ONA**	Combined: Sum of OFFB	**2018 Observed Station ENTRIES or BOARDINGS**	2018 Ratio E/O for Boardings vs. Entries	**Notes**	**Gen 2.4 2014 E/O**
Local Metrobus	222,540	222,541	49,974	49,975	0	0		4,306	4,306	276,820	276,822		n/a		
Express Metrobus	23,568	23,568	13,840	13,840	0	0		271	271	37,679	37,679		n/a		
Metrorail	0	0	162,699	162,699	627,203	627,203	622,225	30,295	30,295	820,197	820,197	641,227	0.97	see Note 1	1.01
Commuter Rail	0	0	0	0	0	0		56,062	56,062	56,062	56,062	56,580	0.99	see Note 2	0.76
Other Local Bus in the WMATA Area	118,671	118,672	40,115	40,114	0	0		2,189	2,189	160,975	160,975		n/a		
Other Express Bus in the WMATA Area	4,343	4,343	1,663	1,663	0	0		142	142	6,148	6,148		n/a		
Other Local Bus beyond the WMATA Area	27,904	27,904	4,414	4,414	0	0		457	457	32,775	32,775		n/a		
Other Express Bus beyond the WMATA Area	41,220	41,221	26,208	26,208	0	0		1,983	1,983	69,412	69,412		n/a		
Bus Rapid Transit and Street Car	1,944	1,944	2,100	2,100	0	0		401	401	4,445	4,445		n/a		
All Bus	438,246	438,248	136,214	136,214	0	0		9,348	9,349	583,809	583,811	575,642	1.01	see Note 3	1.09
Metrobus Total	246,109	246,109	63,815	63,815	0	0	0	4,576	4,576	314,500	314,501	360,000	0.87	see Note 4	
Other Bus in WMATA Area	123,014	123,015	41,777	41,777	0	0	0	2,332	2,332	167,122	167,123	141,390	1.18	see Note 5	
Other Bus not in WMATA Area	69,124	69,124	30,622	30,622	0	0	0	2,441	2,441	102,187	102,187	74,252	1.38	see Note 6	
ALL TRANSIT										1,262,096		1,273,449	0.99		

Figure 6- Final transit validation results: Estimated vs. observed ridership by transit sub-mode

HIGHWAY VALIDATION

The final highway validation results also look reasonable overall. Just to highlight a few key findings, the comparison of estimated vs. observed VMT indicates an E/O ratio of 0.99 for the modeled area, which is satisfactory. More details on the jurisdiction-level VMT comparison can be seen in Figure 7.

Estimate/Observed Ratio								
		Facility Type						
Jurisdiction	Jurisdiction Name	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
0	District of Columbia	-	-	-	-	-	-	0.90
1	Montgomery County	-	-	-	-	-	-	1.01
2	Prince George's County	-	-	-	-	-	-	0.94
3	Arlington County	-	-	-	-	-	-	0.94
4	City of Alexandria	-	-	-	-	-	-	1.23
5	Fairfax County	-	-	-	-	-	-	0.97
6	Loudoun County	-	-	-	-	-	-	1.12
7	Prince William County	-	-	-	-	-	-	1.01
9	Frederick County	-	-	-	-	-	-	1.10
10	Howard County	-	-	-	-	-	-	1.05
11	Anne Arundel County	-	-	-	-	-	-	0.97
12	Charles County	-	-	-	-	-	-	0.96
14	Carrol County	-	-	-	-	-	-	1.33
15	Calvert County	-	-	-	-	-	-	0.74
16	St. Mary's County	-	-	-	-	-	-	0.82
17	King George County	-	-	-	-	-	-	0.89
18	City of Fredericksburg	-	-	-	-	-	-	0.91
19	Stafford County	-	-	-	-	-	-	0.99
20	Spotsylvania County	-	-	-	-	-	-	0.64
21	Fauquier County	-	-	-	-	-	-	0.99
22	Clarke County	-	-	-	-	-	-	1.35
23	Jefferson County	-	-	-	-	-	-	1.42
TOTAL		-	-	-	-	-	-	0.99
0-7, 9, 12	TPB Planning Area	-	-	-	-	-	-	0.99
10-11, 14-23	Non-TPB Member Area	-	-	-	-	-	-	0.99
0-7, 9, 12, 15	Air Quality Nonattainment Area (8-Hour Ozone)							0.98

Figure 7- Final highway validation results: Estimated vs. Observed VMT by jurisdiction

A comparison of simulated vs. observed traffic volumes by regional screenline is displayed in Figure 8. More than half of the screenlines fall within 15% compared to the observed volumes, and approximately two-thirds are within 20%. The results are highly comparable to those from the previous Gen3/Ver. 1.0.4 Model validation effort.

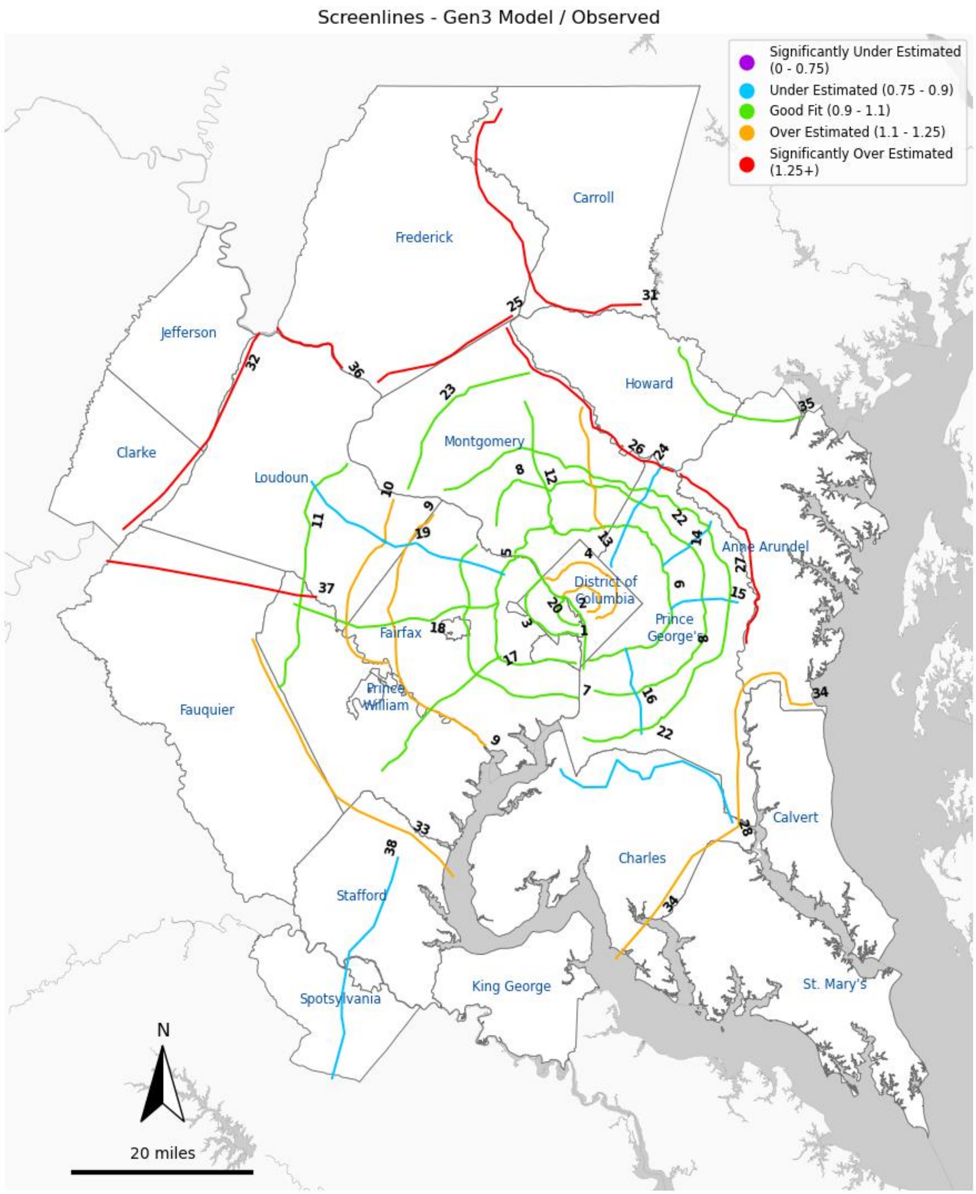

Figure 8- Final highway validation results: Traffic volumes by regional screenline