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Metropolitan Washington Council of Governments

GEN3 MODEL CALIBRATION AND VALIDATION REPORT

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With Baseline Mobility Group

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1.0 INTRODUCTION

The National Capital Region Transportation Planning Board (TPB) Generation 3 (Gen3) Travel Demand Model is an activity-based travel demand model designed to simulate the transportation demand and supply for the metropolitan Washington region.

This model utilizes some components and techniques from the Gen2 Travel Demand Model. These components include highway and transit network processing, path building, skimming, and trip assignment. The major difference from the Gen2 Model is the way transportation demand is simulated. Transportation demand in the Gen2 Model utilizes aggregated household data to simulate trips from each zone, but without the ability to represent tours – groups of trips from when a person leaves a home to when he/she returns home. By contrast, the Gen3 Model uses ActivitySim to simulate travel for each individual person and household in the modeled area. This allows for significantly more decision-making fidelity, including maintaining a connection among trips within a tour to ensure that travel modes are consistent with those actually available to the person and allowing interactions among households regarding whether to travel or not.

The purpose of this calibration and validation report is to report the calibration adjustments in the Gen3 Travel Demand Model that were made to reflect observed surface transportation patterns in the metropolitan Washington region and to document the model's goodness –of fit when compared to the 2017/2018 Regional Travel Survey, Census, traffic, and transit data. There is a Gen3 Model User's Guide[1] that fully documents the model's development, as well as documentation of model estimation[2], [3]. The next section of this document discusses the calibration checks and adjustments for those component models (also referred to as model steps) of ActivitySim where calibration adjustments were made. Following that section, highway validation and transit validation performance of the Gen3 Model are reported in separate sections.

In some cases, specific constants were created and used for the calibration of a model step, and the final adjusted values of these constants are listed in the report. In other instances, additional constants were not created for calibration; Instead, existing constants that were estimated as part of a model estimation process were adjusted and their adjusted values are also reported in this document.

[1] RSG, Baseline Mobility Group, and Metropolitan Washington Council of Governments. *Gen3 Model User Guide.* August 22, 2023 (TO BE UPDATED).
[2] RSG. *Gen3 Tour Mode and Destination Choice Model Estimation.* January 19, 2022.
[3] RSG and Metropolitan Washington Council of Governments. *Gen3 Model Phase 2 Model Estimation.* March 2, 2023.

2.0 MODEL CALIBRATION ADJUSTMENTS IN ACTIVITYSIM

The ActivitySim portion of the Gen3 Model started with a model transferred from the Southeast Michigan Council of Governments (SEMCOG). This provided a starting point for most of the model steps in ActivitySim. Model steps that have the most impact on transportation in the metropolitan Washington region were estimated using the 2017/2018 Regional Travel Survey (RTS) data, which includes the workplace location, auto ownership, telecommute frequency, coordinated daily activity pattern, mandatory tour frequency, tour mode choice, and trip mode choice. Additionally, the transit pass subsidy model was estimated for and used an asserted transit pass subsidy distribution from the Metropolitan Transportation Commission (MTC, nine-county San Francisco Bay Area).

More than a dozen of the component models were then calibrated to the base-year (2018) conditions. Table 1 lists each component model in ActivitySim, the source of the estimated model, the source of the calibration data, and the level of calibration. In this table, “Local Surveys” refers to the survey data listed in the data development documentation.[4] This includes the Regional Travel Survey (RTS) and transit on-board surveys (where applicable). Census data is from the 2019 American Community Survey (ACS). The calibration level refers to the lowest geographic resolution of calibration. Regional calibration means that the model is calibrated to the modeled area (which is shown in Figure 1). ”Region + DC” indicates that the model was calibrated for the region and underwent additional adjustments specifically for the District of Columbia to improve screenline validation performance. “Jurisdiction” indicates that the model was calibrated and validated to counties and cities when the data was available (such as when RTS data was used for calibration).

TABLE 1: ACTIVITYSIM MODEL CALIBRATION SUMMARY

MODEL STEP	SOURCE MODEL	CALIBRATION DATA	CALIBRATION LEVEL
School Location	Estimated in Gen3 Phase 1	Local Surveys	Region
Work From Home	Transfer from SEMCOG	2019 Census ACS	Jurisdiction
Workplace Location	Estimated in Gen3 Phase 1	2019 Census ACS	Jurisdiction
Transit Pass Subsidy	Estimated in Gen3 Phase 2 + MTC Data		

[4] RSG and Baseline Mobility Group. *Gen3 Data Development*. December 29, 2021. https://www.mwcog.org/assets/1/6/Gen3_Phase_1_Data_Development_Report_Final.pdf

AV Ownership	DaySIM		
Auto Ownership	Estimated in Gen3 Phase 2	2019 Census ACS	Jurisdiction
Vehicle Type Choice	ActivitySim Consortium		
Free Parking	Transfer from MTC		
Telecommute Frequency	Estimated in Gen3 Phase 1	Local Surveys	Region
CDAP Simulate	Estimated in Gen3 Phase 2	Local Surveys	Region + DC
Mandatory Tour Frequency	Estimated in Gen3 Phase 2	Local Surveys	Region
Mandatory Tour Scheduling	Transfer from SEMCOG		
Joint Tour Frequency	Transfer from SEMCOG	Local Surveys	
Joint Tour Composition	Transfer from SEMCOG	Local Surveys	
Joint Tour Participation	Transfer from SEMCOG	Local Surveys	
Joint Tour Destination	Estimated in Gen3 Phase 1		
Joint Tour Scheduling	Transfer from SEMCOG		
Non-Mandatory Tour Frequency	Transfer from SEMCOG		
Non-Mandatory Tour Destination	Estimated in Gen3 Phase 1	Local Surveys	Jurisdiction
Non-Mandatory Tour Scheduling	Transfer from SEMCOG		
Vehicle Allocation	ActivitySim Consortium		
Tour Mode Choice	Estimated in Gen3 Phase 1	Local Surveys	Region + DC, transit boardings, traffic counts.
At-Work Subtour Frequency	Transfer from SEMCOG		
At-Work Subtour Destination	Estimated in Gen3 Phase 1		
At-Work Subtour Scheduling	Transfer from SEMCOG		
At-Work Subtour Mode Choice	Estimated in Gen3 Phase 1		
Stop Frequency	Transfer from SEMCOG		
Trip Purpose	Transfer from SEMCOG		
Trip Destination	Transfer from SEMCOG		
Trip Purpose and Destination	Transfer from SEMCOG		

Trip Scheduling	Transfer from SEMCOG		
Trip Mode Choice	Estimated in Gen3 Phase 2	Local Surveys	Region + DC, transit boardings, traffic counts.

The next sub-sections discuss, in turn, those model steps where some form of calibration and validation was performed.

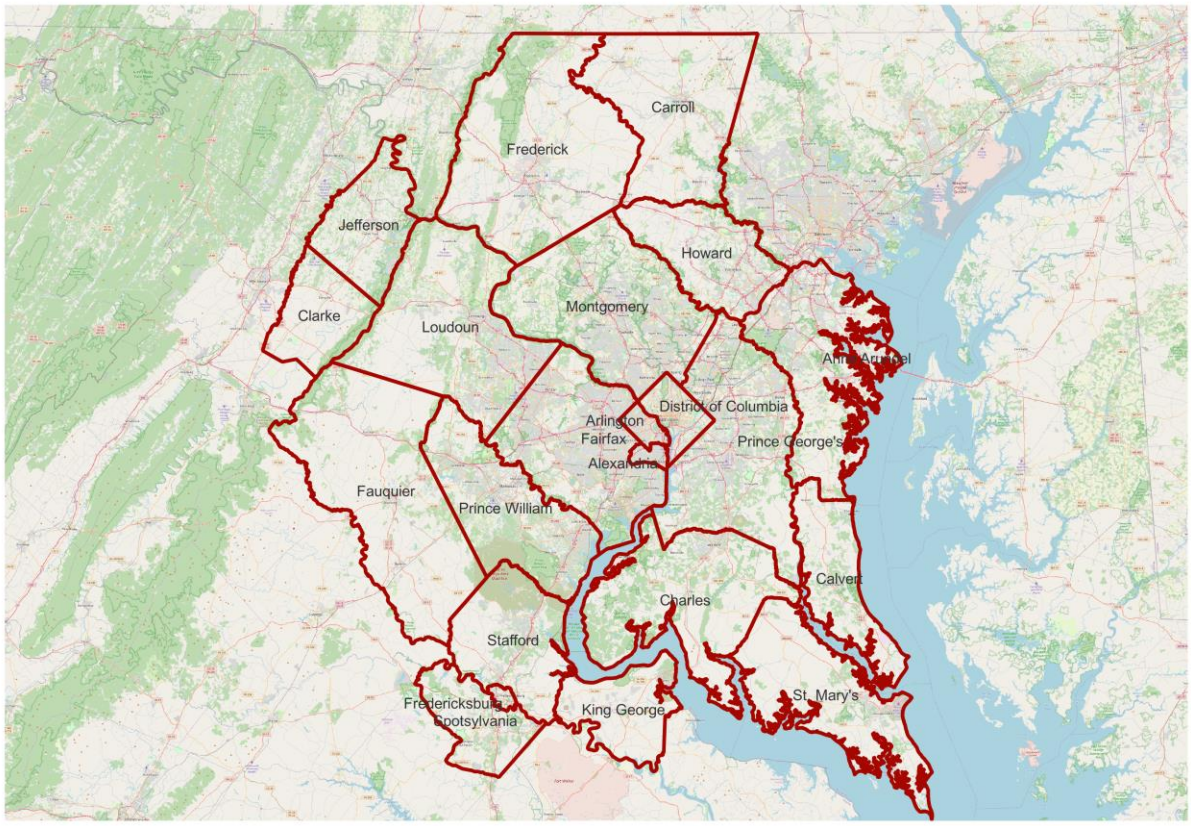

FIGURE 1: MWCOG GEN3 MODEL JURISDICTIONS

2.1 SCHOOL LOCATION MODEL

The school location model step assigns a school location to every student simulated in the model. This model step was estimated in Phase 1 of the Gen3 ActivitySim Model

Implementation Project[5] and calibrated for regional trip length frequency in Phase 2. The adjustment constant is -0.035, which was added to the model as “coef_dist_calib” and applies only to high school and grade school (Kindergarten through 8th grade). The resulting distance to university distribution is shown in Figure 2 and the resulting distance to school distribution is shown in Figure 3. The average distance to university is 10.43 miles, compared to 11.08 miles from the survey. The Gen3 Model shows a significantly higher number of short distances to university due to intrazonal trips made by individuals living in group quarters. Group quarters are not typically surveyed in household travel surveys. The average distance to school (K-12) is 5.02 miles, compared to 4.04 miles from the survey. The distance used for comparison is the midday network skim distance.

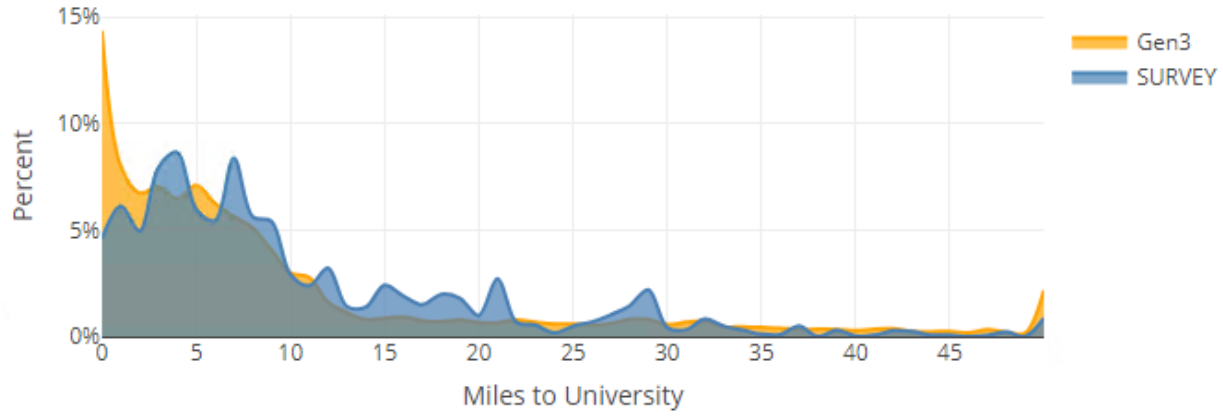

FIGURE 2: DISTANCE TO UNIVERSITY DISTRIBUTION

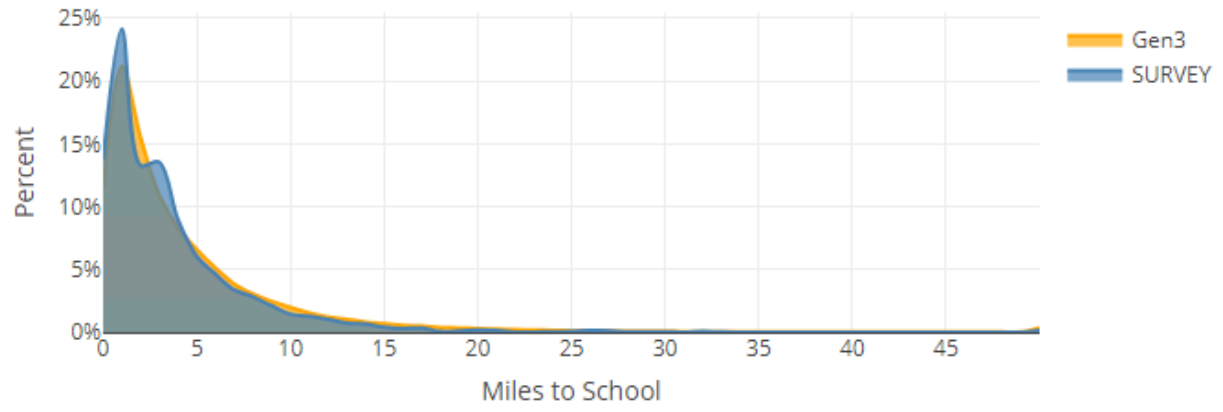

FIGURE 3: DISTANCE TO SCHOOL DISTRIBUTION

[5] RSG. *Tour Mode and Destination Choice Model Estimation*. January 19, 2022.

2.2 WORK FROM HOME MODEL

The work from home model step is used to represent workers who do not have a regular out-of-home workplace location and assigns a flag to the person to indicate if he/she is a worker who works from home or has a regular out-of-home workplace. The work from home model was transferred from SEMCOG and calibrated to Census ACS data at jurisdiction-level geography. The resulting constants are listed in Table 2. The resulting percent of workers working from home is shown in Figure 4. Overall, the observed percentage of workers working from home is 5.11% and the model estimates that 5.08% of workers work from home.

TABLE 2: WORK FROM HOME JURISDICTION-SPECIFIC CONSTANTS

Jurisdiction	Constant
DC	-0.27
Alexandria	-0.42
Anne Arundel	-0.78
Arlington	-0.08
Calvert	-1.03
Carroll	-1.07
Charles	-1.31
Clarke	-0.76
Fairfax	-0.39
Fauquier	-0.47
Frederick	-0.53
Fredericksburg	-0.31
Howard	-0.63
Jefferson	-1.03
King George	-1.27
Loudoun	-0.30
Montgomery	-0.50
Prince George's	-1.25
PrinceWilliam	-0.97
Spotsylvania	-1.01
Stafford	-0.65
St. Mary's	-1.70

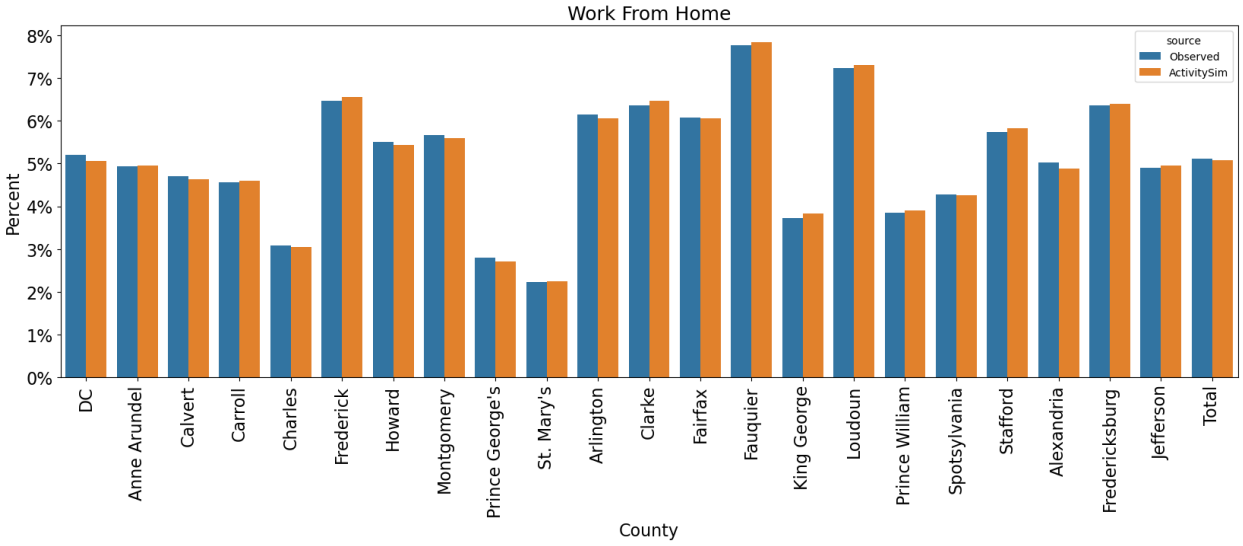

FIGURE 4: WORK FROM HOME MODEL VALIDATION

2.3 WORKPLACE LOCATION MODEL

The work location choice model step assigns a workplace transportation analysis zone (TAZ) to all workers in the model who do not work from home. This model was estimated in Phase 1 of the Gen3 ActivitySim Model Implementation Project. This model was calibrated in Phase 2 of the project using Census ACS Journey-To-Work (JTW) data at the origin-destination geography for local jurisdictions. Calibration constants were added between jurisdictions only where the difference between the model and the observed data was greater than 10%. The final constants are listed in Table 3. The midday network distance frequency comparison is shown in Figure 5. The regional average trip length to work is 12.88 miles observed and 13.19 modeled. The coincidence ratio, which is a percentage of the area of the two curves that coincide[6], of the observed compared to the modeled distances is 0.90. A perfect coincidence ratio is 1.0, and an abysmal coincidence ratio would likely be less than 0.1 (and possibly down to 0.0).

Jurisdiction-to-jurisdiction worker JTW flow comparisons for work location choice are included in the appendix as Table 55 (observed ACS), Table 56 (Gen3 Model), Table 57 (difference), and Table 58 (estimated/observed).

[6] Cambridge Systematics. Travel Model Validation and Reasonableness Checking Manual, Second Edition, prepared for Travel Model Improvement Program, Federal Highway Administration, Washington, D.C. https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/validation_and_reasonableness_2010/fhwahep10042.pdf. Chapter 6 (HTML) / page 6-10 (PDF).

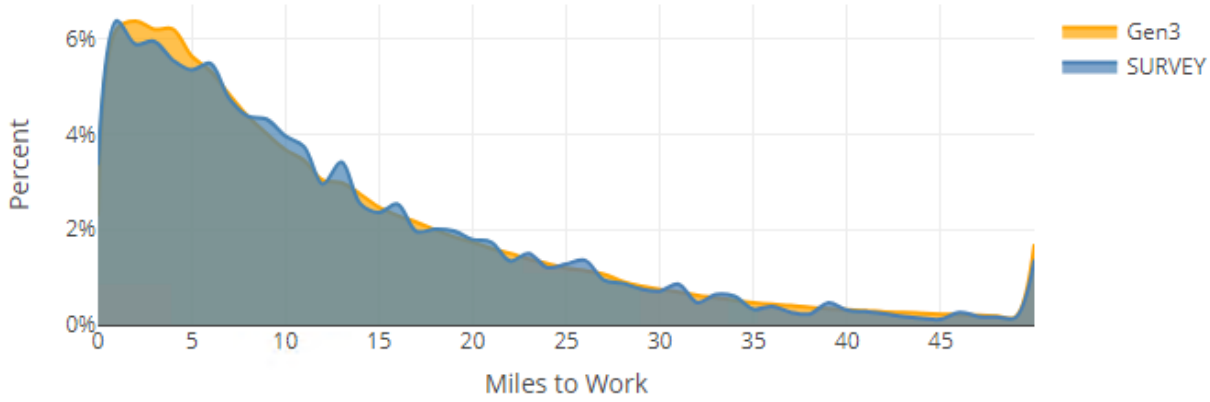

FIGURE 5: WORK LOCATION DISTANCE FREQUENCY COMPARISON

TABLE 3: WORK LOCATION CALIBRATION CONSTANTS

From	To	Coefficient
Washington	Washington	0.032
Washington	Arlington	-0.229
Alexandria	Washington	-0.205
Anne Arundel	Anne Arundel	0.140
Anne Arundel	Howard	-0.206
Anne Arundel	Washington	-0.526
Arlington	Fairfax	0.433
Arlington	Washington	-0.216
Calvert	Calvert	0.322
Carroll	Carroll	0.078
Charles	Charles	0.369
Charles	Washington	-0.385
Clarke	Clarke	0.384
Fairfax	Arlington	0.102
Fairfax	Fairfax	0.094
Fairfax	Montgomery	-0.774
Fairfax	Washington	-0.250
Fauquier	Fauquier	0.802
Frederick	Montgomery	0.319
Howard	Howard	0.128
Howard	Prince George's	0.283
Howard	Washington	-0.342

From	To	Coefficient
Jefferson	Jefferson	0.084
Loudoun	Fairfax	0.154
Loudoun	Loudoun	0.389
Loudoun	Montgomery	-1.078
Montgomery	Fairfax	-0.361
Montgomery	Howard	-0.492
Montgomery	Montgomery	0.650
Montgomery	Washington	-0.112
Prince George's	Anne Arundel	-0.300
Prince George's	Arlington	-0.288
Prince George's	Prince George's	0.287
Prince George's	Washington	-0.245
Prince William	Fairfax	-0.071
Prince William	Prince William	0.140
Prince William	Washington	-0.304
St. Mary's	St. Mary's	0.028
Stafford	Stafford	0.070

2.4 AUTO OWNERSHIP

The auto ownership model step assigns the number of vehicles owned by a household to each household in the model. This model was estimated by MWCOG staff and validated by RSG using Census ACS Data. The calibration constants are shown in Table 4. This model was initially calibrated to regional auto ownership, which is the “Regional” line in Table 4. Additionally, a constant was added to increase the number of 0-auto households with one, two, or three plus workers. In many places, auto ownership and number of workers in a household are highly correlated, but both Census ACS data and local survey data showed that the correlation is weaker in the DC region. These constants are the “1/2/3 Worker HH” lines in Table 4. Finally, the constants for five jurisdictions – DC, City of Alexandria, Arlington County, Montgomery County, and Prince George’s County – were adjusted to increase 0- and 1-auto households to match Census data.

The observed and modeled regional auto ownership is shown in the chart included as Figure 6 and a comparison of 0-auto households by jurisdiction is included as Figure 7. For the modeled region, 8.9% of the households were 0-auto households according to the Census, and 12.1% were estimated by the Gen3 Model. The auto ownership for the regional core jurisdictions – particularly DC – were allowed to be a little higher than the calibration data due to the model underestimating HPMS VMT during calibration.

The auto ownership model includes constants for autonomous vehicle (AV) modeling based on prior research[78]. To ensure that these factors do not affect the calibration of the model, a constant of -999 was used in the AV ownership model.

TABLE 4: AUTO OWNERSHIP CALIBRATION CONSTANTS

Constant Description	0 Autos	1 Auto	2 Autos	3 Autos	4+ Autos
Regional		1.25	-1.03	-3.45	-4.97
1 Worker HHs	0.64				
2 Worker HHs	0.91				
3 Worker HHs	2.27				
DC	4.77	2.03			
Alexandria	2.34	1.01			
Arlington	2.87	1.09			
Montgomery	1.45				
Prince George's	1.46				

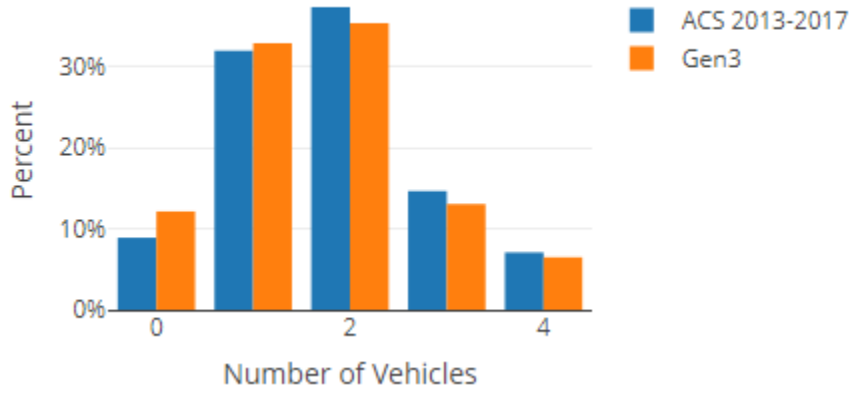

FIGURE 6: HOUSEHOLD AUTO OWNERSHIP SUMMARIZED AT THE REGIONAL LEVEL

[7] Bradley, Mark. AVs and TNCs in Daysim. Presentation to SACOG. 1/17/2009. https://www.sacog.org/sites/main/files/file-attachments/avs_and_tnc_in_daysim-sacsim-rsg_0.pdf?1548293104

[8] Ou, Yanmei and Griesenbeck, Bruce. Estimating the Potential Impacts of AVs and TNCs using ActivityBased Travel Demand Model in MTP/SCS Scenario Development. Presentation at 2018 Innovations in Travel Modeling Conference, Atlanta, GA. 2018. https://onlinepubs.trb.org/onlinepubs/Conferences/2018/ITM/YOu.pdf

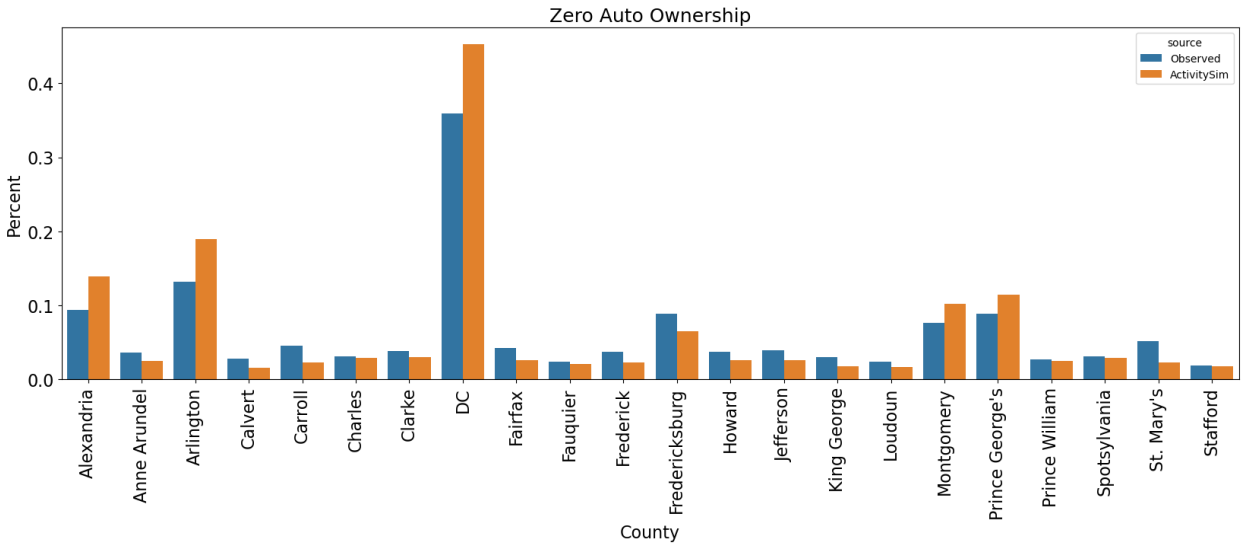

FIGURE 7: ZERO-AUTO HOUSEHOLDS BY JURISDICTION

2.5 TELECOMMUTE FREQUENCY

The telecommute frequency model step assigns a telecommute frequency value to a worker *with a regular out-of-home workplace*. This model was estimated as part of the Gen3 Phase 2 Model Development by RSG. The model's output includes simulated telecommute frequencies of no telecommute, 1 day per week, 2-3 days per week, or 4 days per week for individual workers[9]. The constants for this model are listed in Table 5. The resulting region-level model results are shown in Figure 8.

TABLE 5: TELECOMMUTE FREQUENCY CALIBRATION CONSTANTS

CONSTANT DESCRIPTION	VALUE
1 Day/week Calibration Constant	-3.80
2-3 Days/week Calibration Constant	-4.58
4 Days/week Calibration Constant	-3.36

[9] In the case that a person telecommutes more than five days per week, they are assumed to work from home.

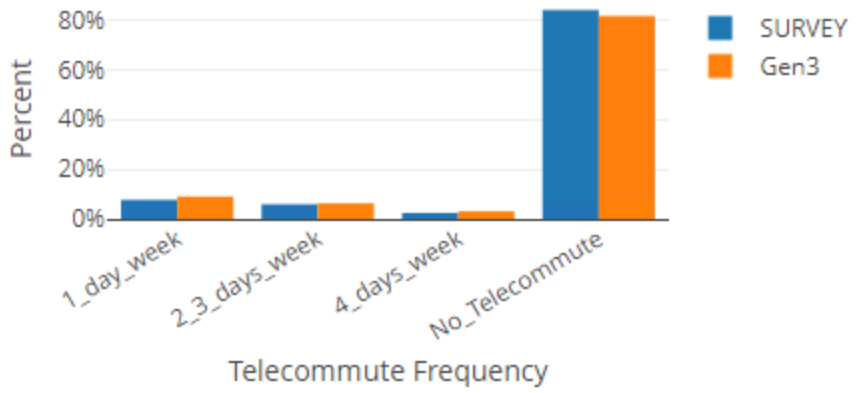

FIGURE 8: REGIONAL TELECOMMUTE FREQUENCY VALIDATION

2.6 COORDINATED DAILY ACTIVITY PATTERN

The coordinated daily activity pattern model step assigns to each person a day pattern value that indicates if they will travel for mandatory purposes (work, school), non-mandatory purposes, or not travel (or be out of the area). This model was estimated by MWCOG. The final model was calibrated by RSG. The calibration constants are listed in Table 6. The first eight rows of this table are a regional calibration for each person type, and the last five rows are a sub-regional calibration for some person types. Note that the model forbids mandatory tours for non-working adults and retired persons, since, according to the current rules of ActivitySim, persons of these types do not work or go to school. The resulting calibrated model output is shown in Figure 9 (full-time workers), Figure 10 (part-time workers), Figure 11 (university students), Figure 12 (non-working adults), Figure 13 (retired persons), Figure 14 (driving-aged students), Figure 15 (school pre-driving aged students), and Figure 16 (preschool-aged students).

In the calibration process, RSG found that traffic counts and HPMS VMT estimates implied significantly more traffic than the household travel survey. To better match the traffic counts and HPMS-based VMT data, the non-working adults and retired adults were calibrated to decrease at-home day patterns for area types 3-6. The decision to do this was largely driven by the effort to improve the highway validation performance of the model, which will be discussed in the next chapter.

TABLE 6: CDAP MODEL CALIBRATION CONSTANTS

Segment	Mandatory	Non-Mandatory	Home or Out of Area
Full-Time Worker	2.51	0.25	
Part-Time Worker	1.45	1.25	
University Student	1.93	0.30	
Non-Working Adult		-0.59	
Retired		0.38	
Driving Age Child	3.11	0.63	
School Pre-Driving Age Child	2.76	0.06	
Preschool Child	3.02	-0.78	
Full-Time Worker, Area Type 3-6			-0.55
Part-Time Worker, Area Type 3-6			-0.55
University Student, Area Type 3-6			-0.55
Non-Working Adult, Area Type 3-6			-0.95
Retired, Area Type 3-6			-0.95

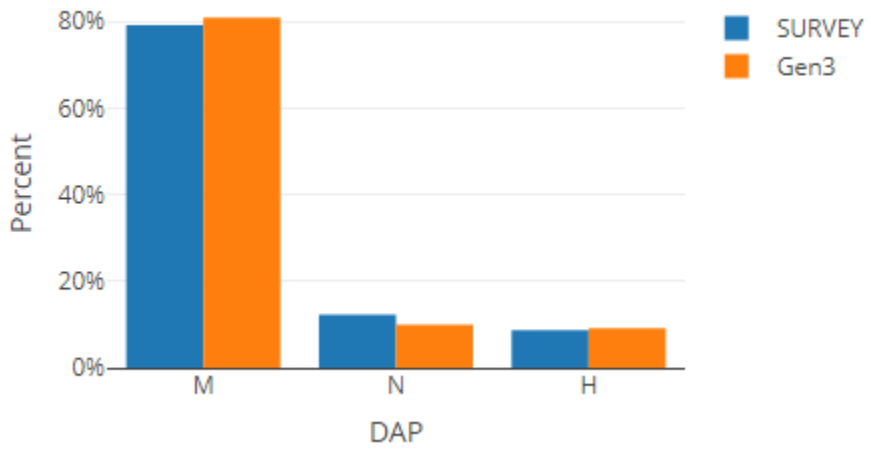

FIGURE 9: FULL-TIME WORKER DAILY ACTIVITY PATTERN VALIDATION

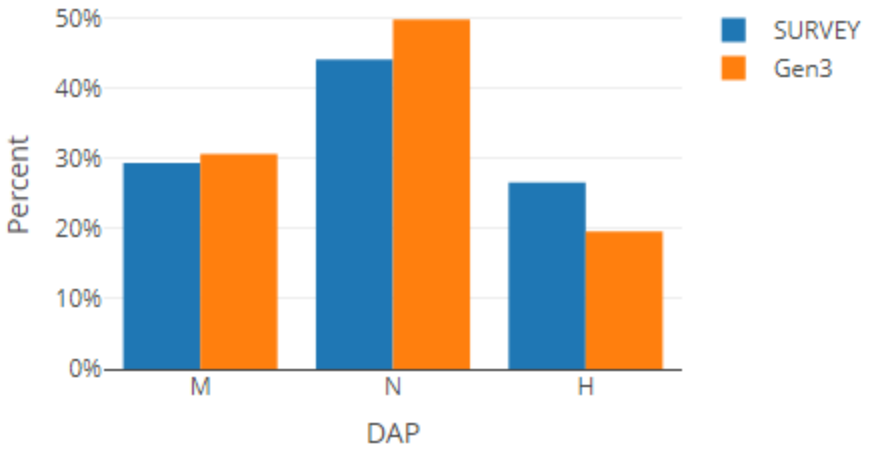

FIGURE 10: PART-TIME WORKER DAILY ACTIVITY PATTERN VALIDATION

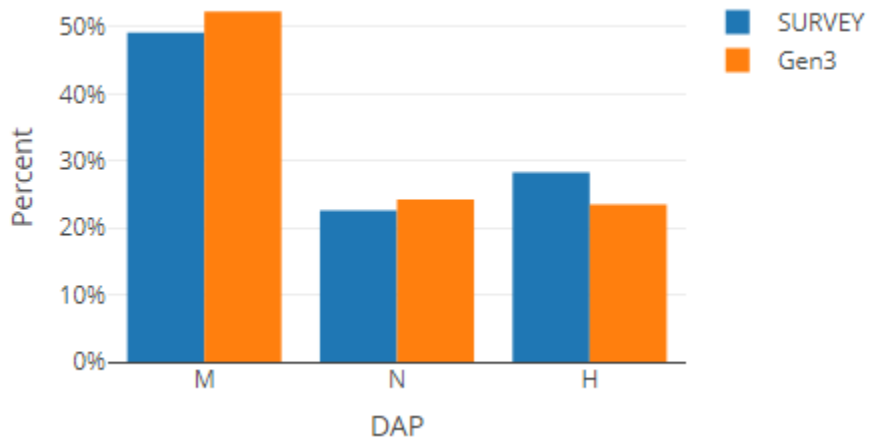

FIGURE 11: UNIVERSITY STUDENT DAILY ACTIVITY PATTERN VALIDATION

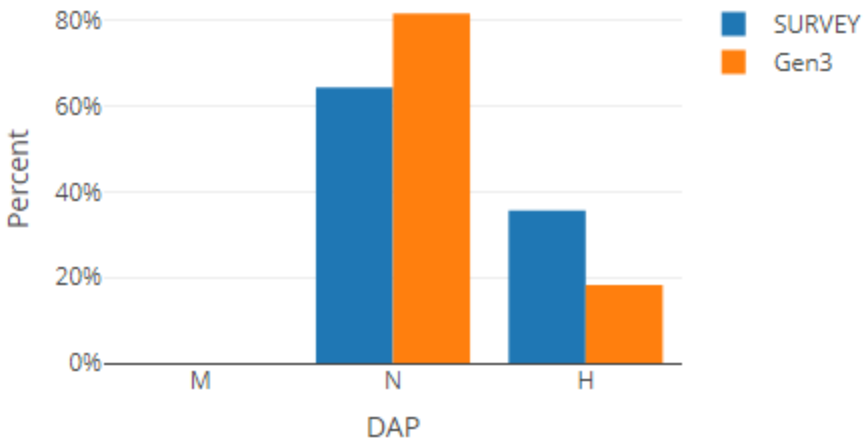

FIGURE 12: NONWORKER DAILY ACTIVITY PATTERN VALIDATION

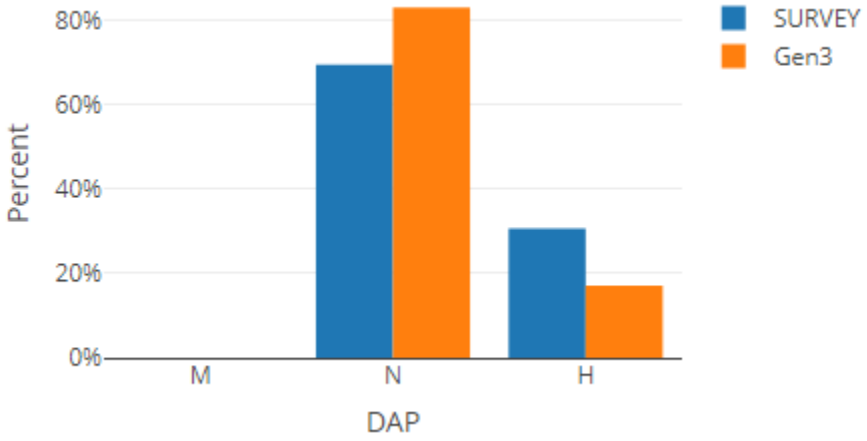

FIGURE 13: RETIRED PERSON DAILY ACTIVITY PATTERN VALIDATION

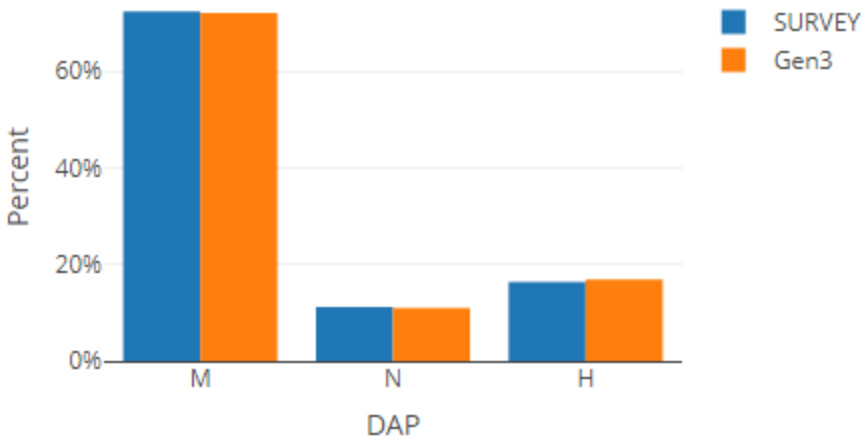

FIGURE 14: DRIVING-AGE STUDENT DAILY ACTIVITY PATTERN VALIDATION

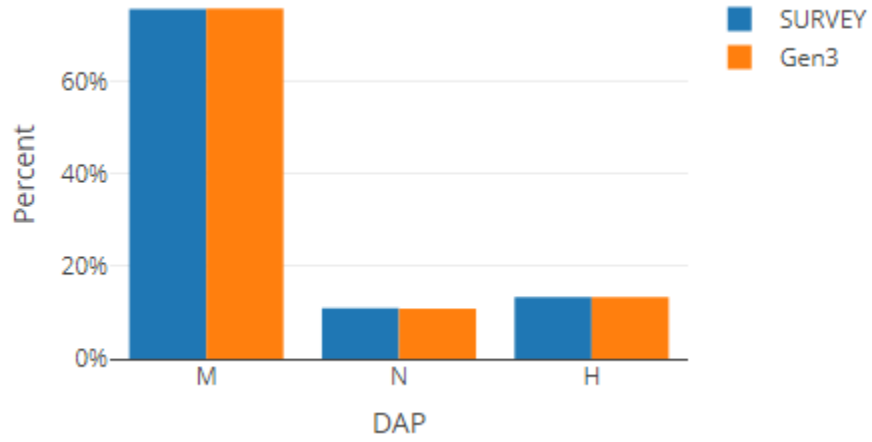

FIGURE 15: SCHOOL PRE-DRIVING AGE STUDENT DAILY ACTIVITY PATTERN VALIDATION

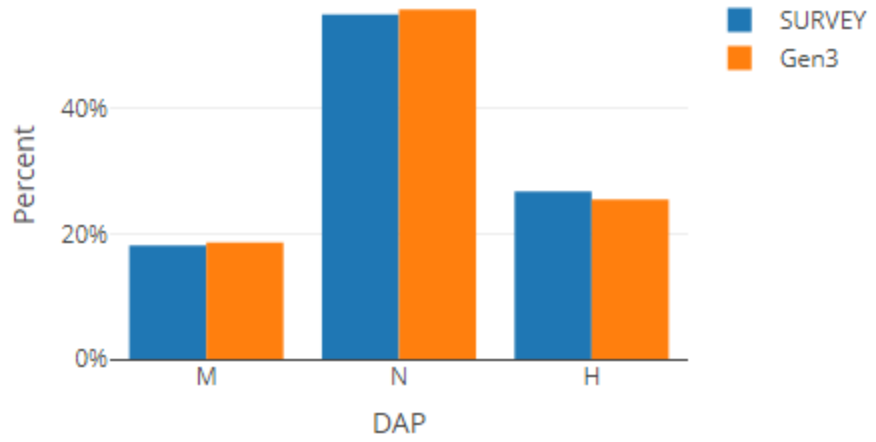

FIGURE 16: PRESCHOOL-AGE CHILD DAILY ACTIVITY PATTERN VALIDATION

2.7 MANDATORY TOUR FREQUENCY

The mandatory tour frequency model step assigns the number of mandatory tours for each person with a mandatory daily activity pattern. This model was estimated by MWCOG and calibrated by RSG. The calibrated constants are listed in Table 7. Note that non-working adults and retired persons are not included in this table since those person types are restricted, according to current rules in ActivitySim, from making mandatory tours. Additionally, full-time workers are not allowed to be students[10]. The resulting calibrated model output is shown in Figure 17 (full-time workers), Figure 18 (part-time workers), Figure 19 (university students), Figure 20 (school driving-aged students), Figure 21 (school pre-driving aged students), and Figure 22 (preschool-aged students).

TABLE 7: MANDATORY TOUR FREQUENCY CALIBRATION CONSTANTS

Person Type	1 Work	2 Work	1 School	2 School	Work & School
Full-Time Worker		-2.23			
Part-Time Worker		-3.05			
University Student	-0.04	-4.27		-3.64	-0.31
Driving Age Child				-2.73	-0.58
School Pre-Driving Age Child				-3.18	

[10] In a review of RTS data, it was found that very few full-time workers made trips as a student (email Andrew Rohne to Feng Xie 9/6/2022). Note that full-time workers are still able to make trips to a school to drop off a student, but these are coded in ActivitySim as escort tours and trips.

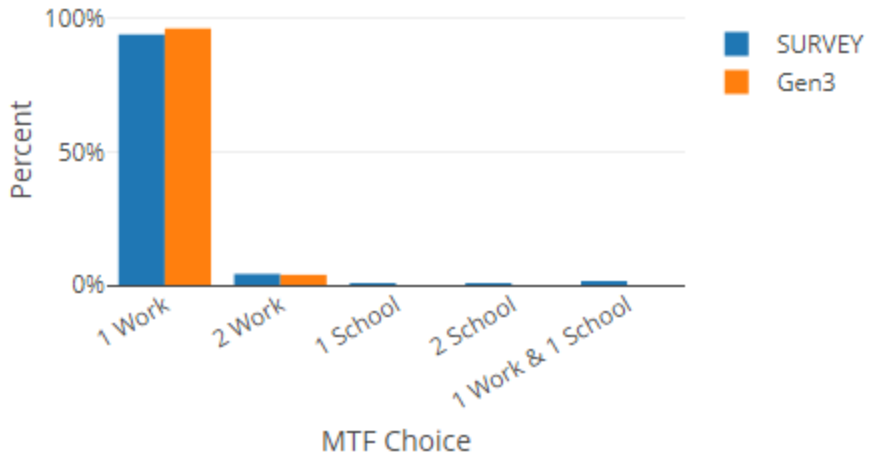

FIGURE 17: MANDATORY TOUR FREQUENCY VALIDATION FOR FULL-TIME WORKERS

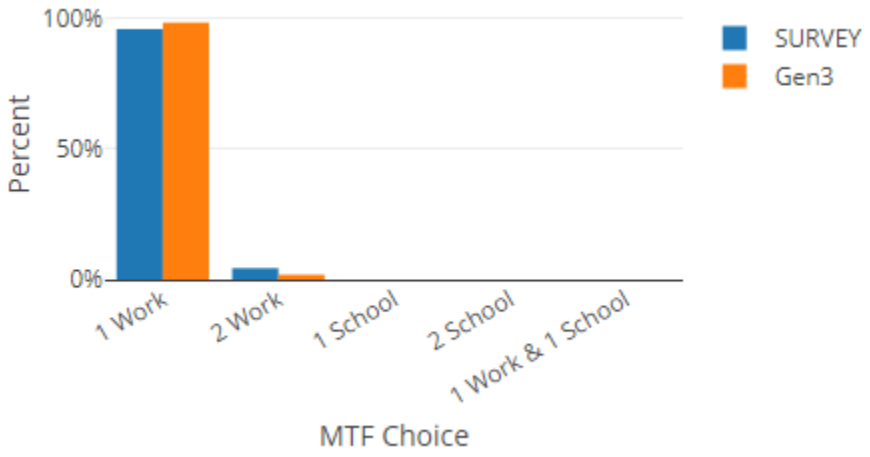

FIGURE 18: MANDATORY TOUR FREQUENCY VALIDATION FOR PART-TIME WORKERS

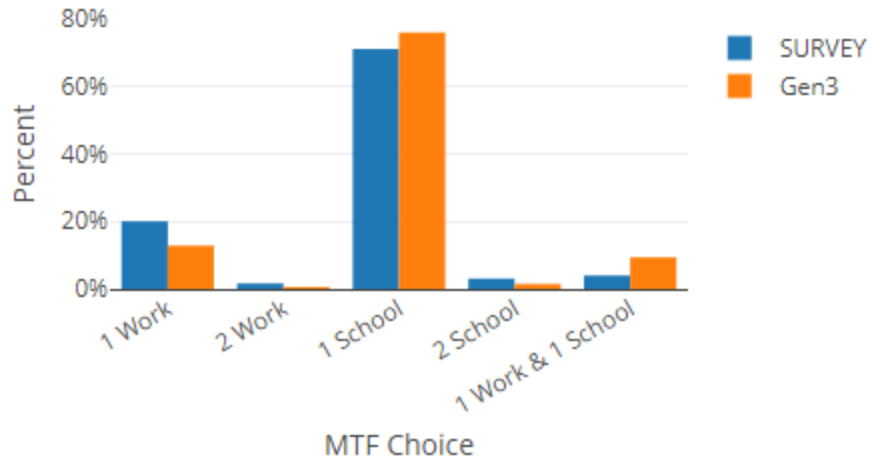

FIGURE 19: MANDATORY TOUR FREQUENCY VALIDATION FOR UNIVERSITY STUDENTS

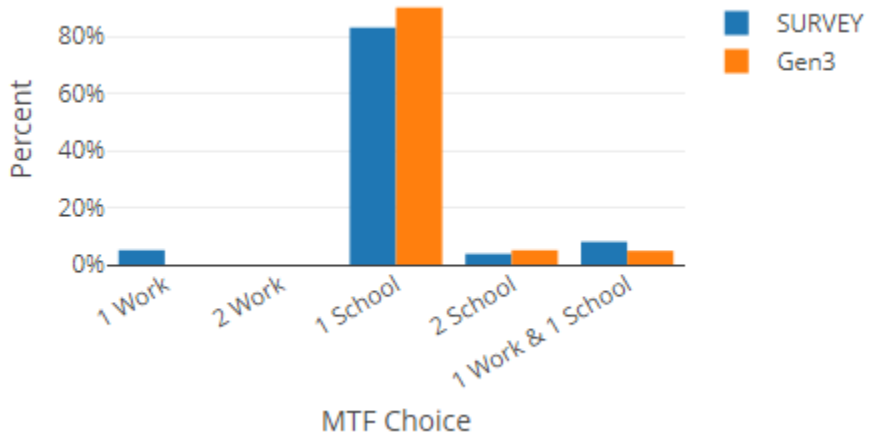

FIGURE 20: MANDATORY TOUR FREQUENCY VALIDATION FOR DRIVING-AGE STUDENTS

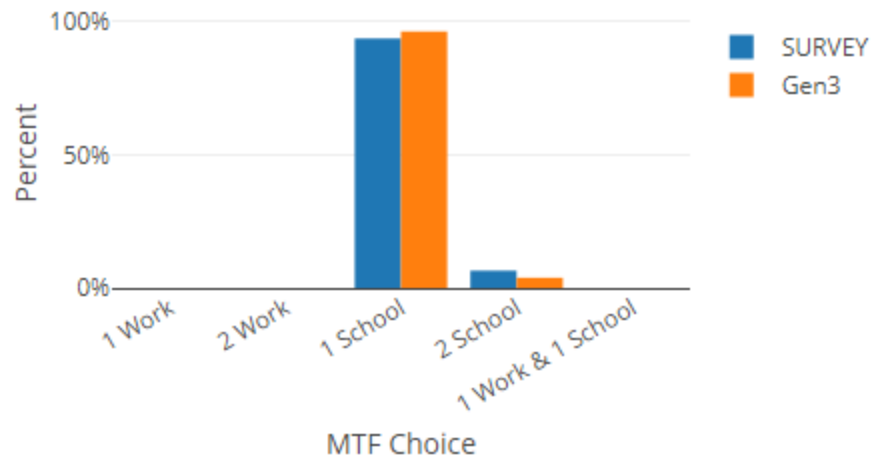

FIGURE 21: MANDATORY TOUR FREQUENCY VALIDATION FOR PRE-DRIVING-AGED STUDENTS

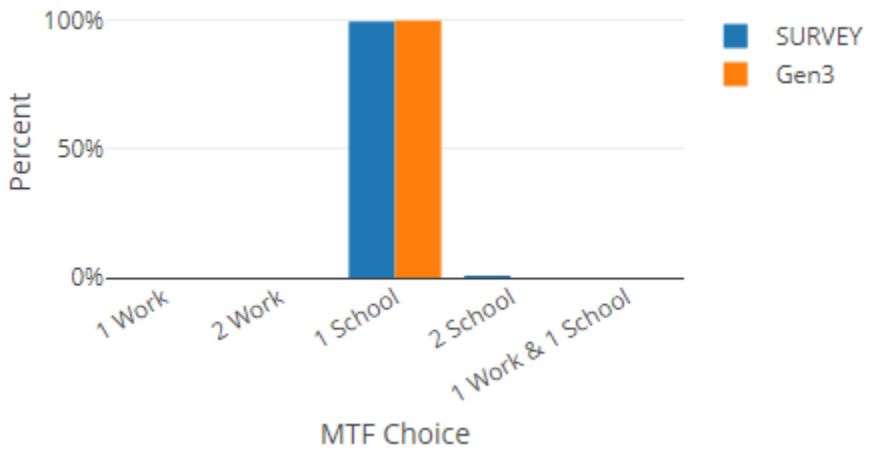

FIGURE 22: MANDATORY TOUR FORMATION FOR PRE-SCHOOL AGED STUDENTS

2.8 JOINT TOUR FREQUENCY

The joint tour frequency model step estimates the number of fully-joint tours that will be made at the household level. Fully-joint tours are tours where more than one household member will be together for the entire tour. The alternatives include none, one discretionary, eating out, maintenance, shopping, or visiting tour, or two tours with a combination of those types. The calibration constants are listed in Table 8 for single tours and Table 9 for two tours (using the

rows as one tour-type and the columns as the second tour-type; the tours are not ordered at this point in ActivitySim). The validated model output is shown in Figure 23.

TABLE 8: JOINT TOUR FREQUENCY SINGLE-TOUR CALIBRATION CONSTANTS

Tour Frequency and Type	Constant
1 Discretionary Tour	-4.84
1 Eat-out Tour	-5.29
1 Maintenance Tour	-5.13
1 Shopping Tour	-4.39
1 Visiting Tour	-5.44

TABLE 9: JOINT TOUR FREQUENCY TWO-TOUR CALIBRATION CONSTANTS

Tour Type	Discretionary	Eat-out	Maintenance	Visiting	Shopping
Discretionary	-12.51	-10.60	-10.68	-10.43	-10.71
Eat-out		-12.02	-10.51	-99.00	-11.98
Maintenance			-10.99	-12.05	-12.48
Visiting				-12.71	-12.71
Shopping					-11.42

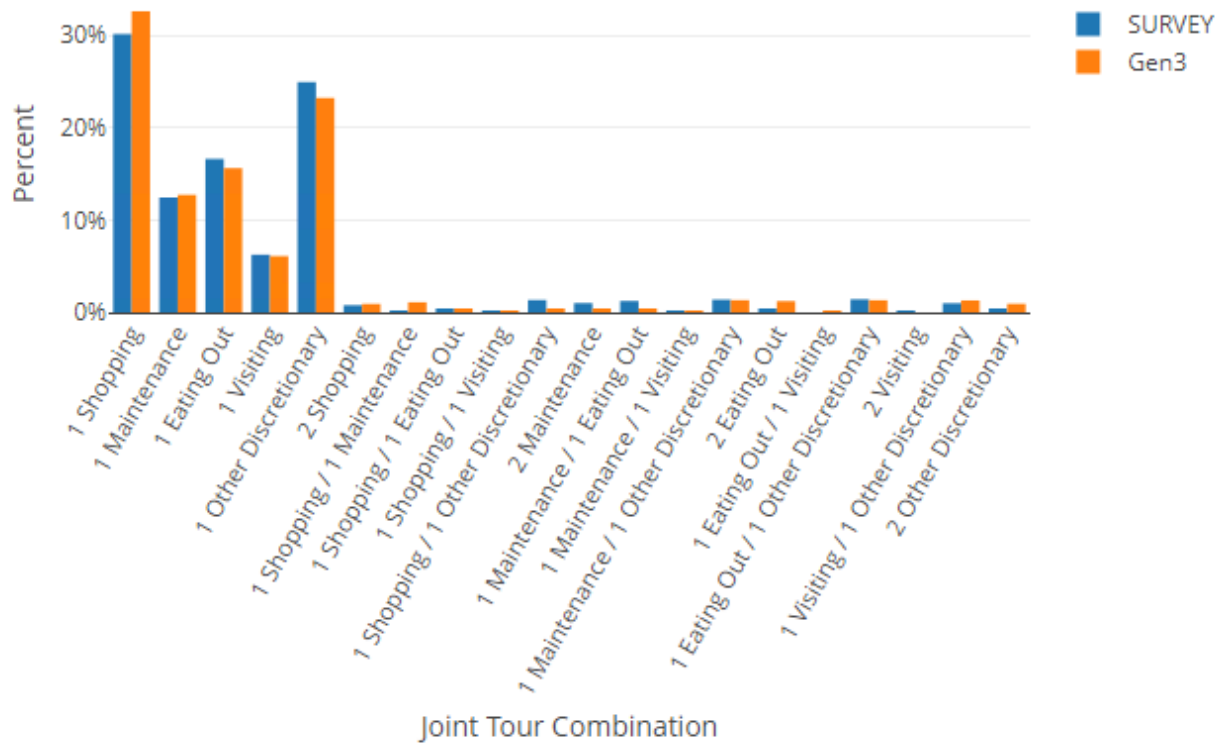

FIGURE 23: JOINT TOUR FREQUENCY VALIDATION

2.9 JOINT TOUR COMPOSITION

The joint tour composition model step assigns a tour composition to each joint tour. Composition refers to if the participants are adults-only, children-only, or mixed. The final calibration constants are listed in Table 10 and the calibrated model output is shown in Figure 24.

TABLE 10: JOINT TOUR COMPOSITION MODEL CALIBRATION CONSTANTS

Tour Composition	Coefficient
Children Only	5.35
Mixed (adults and children)	5.63

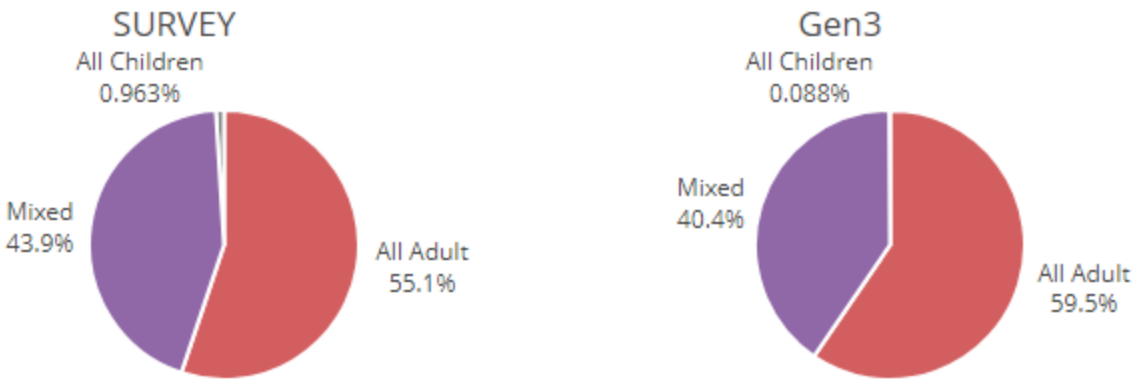

FIGURE 24: JOINT TOUR COMPOSITION VALIDATION

2.10 JOINT TOUR PARTICIPATION

The joint tour participation model step is run for each person in a household and for each joint tour to assign if the person will or will not participate in the tour. The calibration constants for this model are listed in Table 11, and the resulting model calibration output is shown in Figure 25.

TABLE 11: JOINT TOUR PARTICIPATION CALIBRATION CONSTANTS

Constant	Participate	Not Participate
Full-Time Worker, mixed party	-3.57	0.50
Part-Time Worker, adults-only party	-3.57	0.50
Part-Time Worker, mixed party	-0.37	
University Student, mixed party	-3.04	
Non-Worker, adults-only party	-3.16	
Non-Worker, mixed party	0.72	
Child too Young for School, children-only party	-2.79	
Child too Young for School, mixed party	-1.89	
Pre-driving age Student, children-only party	-0.72	
Pre-driving age Student, mixed party	-1.75	
Driving-age Student, children-only party	-1.82	
Driving-age Student, mixed party	-1.35	
Full-Time Worker, specific to eating out joint tours	0.72	0.50
Full-Time Worker, specific to discretionary joint tours	0.44	0.50
Part-Time Worker, specific to eating out joint tours	2.19	
Part-Time Worker, specific to discretionary joint tours	0.29	
University Student, specific to eating out joint tours	-0.82	
University Student, specific to discretionary joint tours	0.00	
Non-worker, specific to eating out joint tours	0.16	
Non-worker, specific to discretionary joint tours	-0.18	
Child too Young for School, specific to eating out joint tours	0.66	
Child too Young for School, specific to discretionary joint tours	0.13	
Pre-driving Age Student, specific to eating out joint tours	1.39	
Pre-driving age Student, specific to discretionary joint tours	0.66	
Driving-age Student, specific to eating out joint tours	2.34	
Driving-age Student, specific to discretionary joint tours	-0.67	

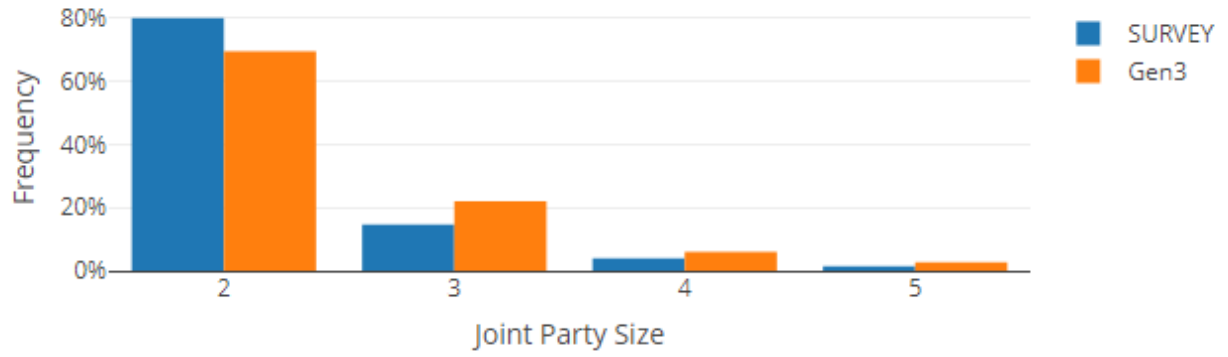

FIGURE 25: JOINT TOUR PARTY SIZE VALIDATION

2.11 JOINT TOUR DESTINATION

The joint tour destination model step assigns the primary destination TAZ to each joint tour. The constants for this model are included in the non-mandatory tour destination model. The model output for joint discretionary tours is shown in Figure 26 and the model output for joint maintenance tours is shown in Figure 27. The average trip lengths and coincidence ratios are listed in Table 12.

TABLE 12: JOINT TOUR DESTINATION SUMMARY

TOUR PURPOSE	OBSERVED AVERAGE TOUR LENGTH	GEN3 MODEL AVERAGE TOUR LENGTH	COINCIDENCE RATIO
Joint Maintenance	6.81	6.13	0.78
Joint Discretionary	7.02	6.90	0.76

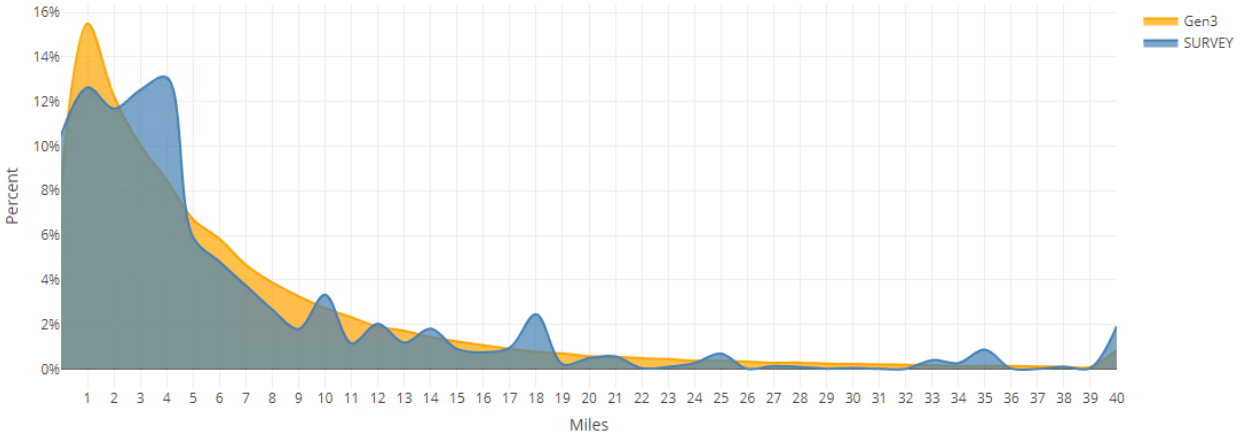

FIGURE 26: JOINT DISCRETIONARY TOUR DESTINATION DISTANCE DISTRIBUTION

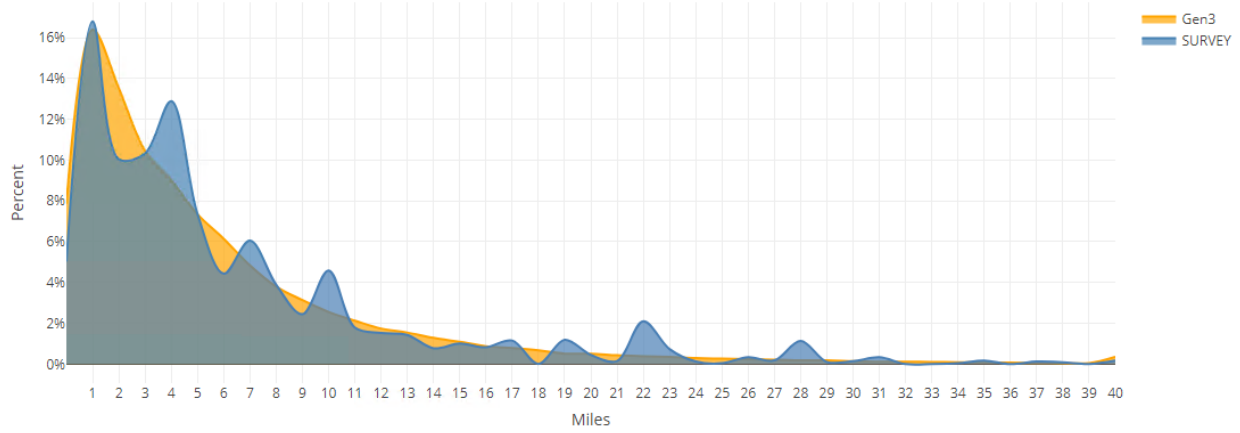

FIGURE 27: JOINT MAINTENANCE TOUR DESTINATION DISTANCE DISTRIBUTION

2.12 NON-MANDATORY TOUR DESTINATION

The non-mandatory tour destination choice model step assigns a primary destination TAZ to each non-mandatory tour. This model was calibrated using both survey data and traffic counts to match the traffic counts on the Potomac River bridges and HPMS VMT estimates. The calibration of this model primarily used calibration constants, but it also used a multiplier against the distance for tours that go in and out of DC. Determining the value of these multipliers utilized survey data. The calibration constants and coefficients are listed in Table 14. The output of the joint discretionary and maintenance tours is shown in Figure 26 and Figure 27 respectively in

the previous section. The output of the individual discretionary and maintenance tour destination choice models is shown in Figure 28 and Figure 29, respectively.

Jurisdiction-to-jurisdiction flow comparisons for non-mandatory tours are included in the appendix as Table 59 (observed ACS), Table 60Table 56 (Gen3 Model), Table 61 (difference), and Table 62 (estimated/observed).

TABLE 13: NON-MANDATORY TOUR SUMMARY STATISTICS

TOUR PURPOSE	OBSERVED AVERAGE TOUR LENGTH	GEN3 MODEL AVERAGE TOUR LENGTH	COINCIDENCE RATIO
Individual Maintenance	5.64	5.85	0.88
Individual Discretionary	6.44	7.42	0.90
Escort	4.20	5.67	0.81

TABLE 14: NON-MANDATORY TOUR DESTINATION CALIBRATION CONSTANTS AND COEFFICIENTS

CONSTANT OR COEFFICIENT DESCRIPTION	CONSTANT OR COEFFICIENT VALUE
Carrol County Intra-county Discretionary Tour Constant	0.14
Jefferson County Intra-county Discretionary Tour Constant	0.13
Clarke County Intra-county Discretionary Tour Constant	0.48
Loudon County Intra-county Discretionary Tour Constant	0.10
Howard County Intra-county Discretionary Tour Constant	0.14
Anne Arundel County Intra-county Discretionary Tour Constant	0.16
Calvert County Intra-county Discretionary Tour Constant	0.29
St. Mary's County Intra-county Discretionary Tour Constant	0.63
Fauquier County Intra-county Discretionary Tour Constant	0.32
Stafford County Intra-county Discretionary Tour Constant	-0.28
Maintenance Tours - out of DC to DC Constant	-3.42
Discretionary Tours - out of DC to DC Constant	-1.68
Montgomery to Fairfax County Constant	-3.00
Fairfax to Montgomery County Constant	-3.00
Montgomery to Prince Georges County Constant	-1.11
Prince Georges County to Montgomery Constant	-0.59
Outside of DC Distance Multiplier for Maintenance Tours	0.02
Outside of DC Distance Multiplier for Discretionary Tours	0.02
DC Distance Multiplier	-0.12

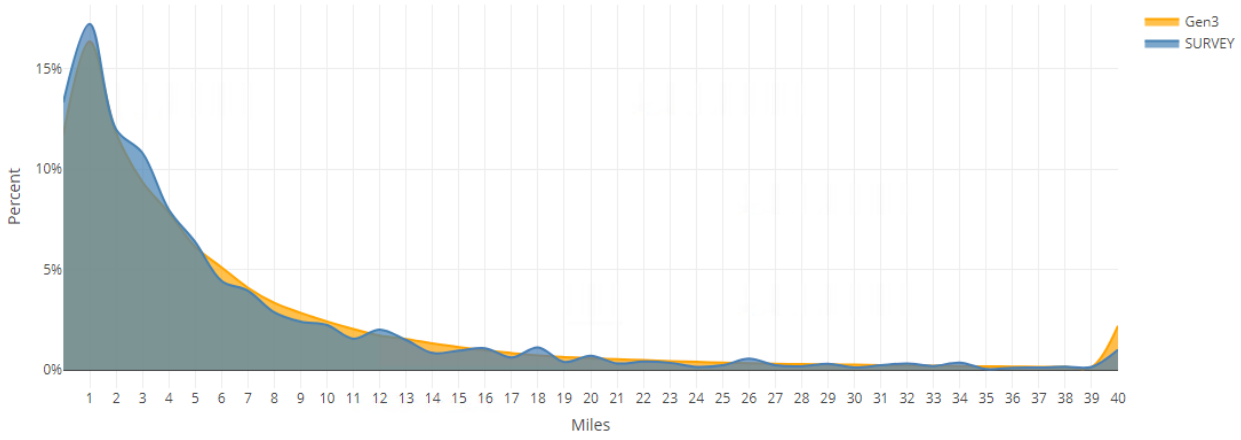

FIGURE 28: INDIVIDUAL DISCRETIONARY TOUR DESTINATION DISTANCE DISTRIBUTION

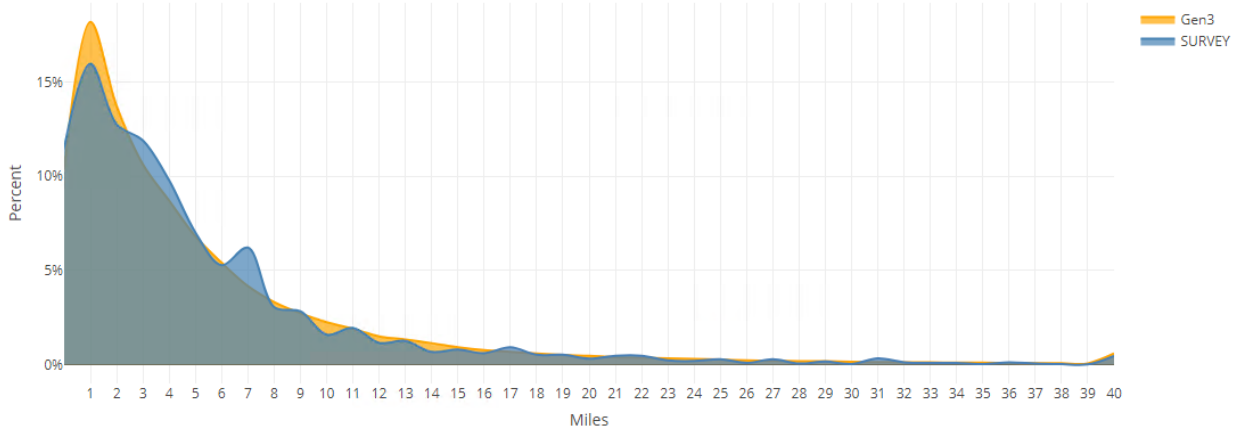

FIGURE 29: INDIVIDUAL MAINTENANCE TOUR DESTINATION DISTANCE DISTRIBUTION

2.13 TOUR MODE CHOICE

The tour mode choice model step assigns a tour mode to all the simulated tours in the model. It uses a nested logit model that is shown in Figure 30. This model was estimated in the first phase of the Gen3 Model development. The model works by selecting an initial mode group (nest), which is one of auto, non-motorized, ride hail, or transit. Tours that select auto modes then select single-occupant vehicle (SOV), two-person shared ride (SR2), or three or more person shared ride (SR3). Tours that select the non-motorized modes then select either walk or bike. Tours selecting the ride hail group then select taxi, single-person transportation network

company[11] (TNC), or a shared TNC service. Tours that select the transit modes group then select an access mode, which can be walk, driving and parking at a park-and-ride location (PNR), or dropped off at a park-and-ride location (KNR[12]). Once the access mode for the tour is selected, a path type is selected, which is one of bus only, Metrorail only, bus and Metrorail combined, or commuter rail (MARC and VRE trains).

During Phase 2, the mode share targets by tour purpose were revised based on comparisons of the household survey, the transit surveys, and the transit ridership data. During calibration, adjustments were made to the model constants to improve boardings by transit mode. Additionally, the calibration of this model uncovered an issue in the auto ownership model where too few 0-auto working households were represented in the model. This was fixed with a constant in the auto ownership model.

Calibration of this model utilized a significant number of constants, since the model includes ten modes and eight purposes as well as some general factors that apply to all purposes. Additionally, many of the constants utilize auto sufficiency groups, which are no auto households, auto deficient households (fewer autos than drivers in the household), and auto sufficient households (at least as many autos as drivers in the household). In addition to these, some constants were added at the end based on traffic counts and transit ridership. These additional constants are listed in Table 15. The overall calibration results are shown in Figure 31. The calibration constants and results for individual tour purposes are discussed in each sub-section below.

[11] Transportation Network Companies at the time of writing are primarily Uber and Lyft.
[12] “Kiss and Ride”

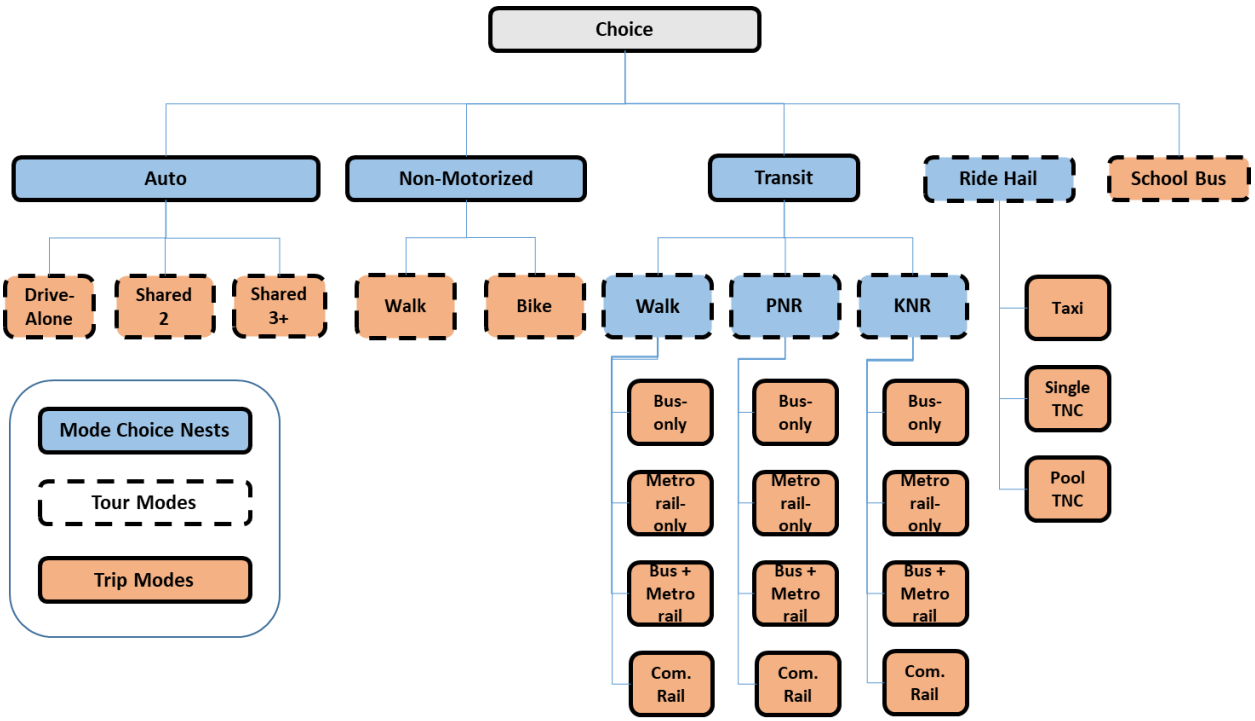

FIGURE 30: TOUR MODE CHOICE NESTING STRUCTURE

TABLE 15: ADDITIONAL OVERALLTOUR 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	0.80
Auto Sufficient SOV School Tours	-0.34
Metrorail Tours to DC Destination	0.48
Bus-only Tours to DC Destination	-0.40
Bus+Metrorail Tours to DC Destination	-0.10
Commuter Rail tours to DC Destination	0.30
SOV Tours to DC Destination (all auto sufficiency groups)	-1.10
Bus modes within DC	0.55
SOV modes within DC	0.20
Shared-Ride 2 tours to DC Destination	0.75
Shared-Ride 3+ tours to DC Destination	0.55
SOV tours to non-DC Destinations	0.50

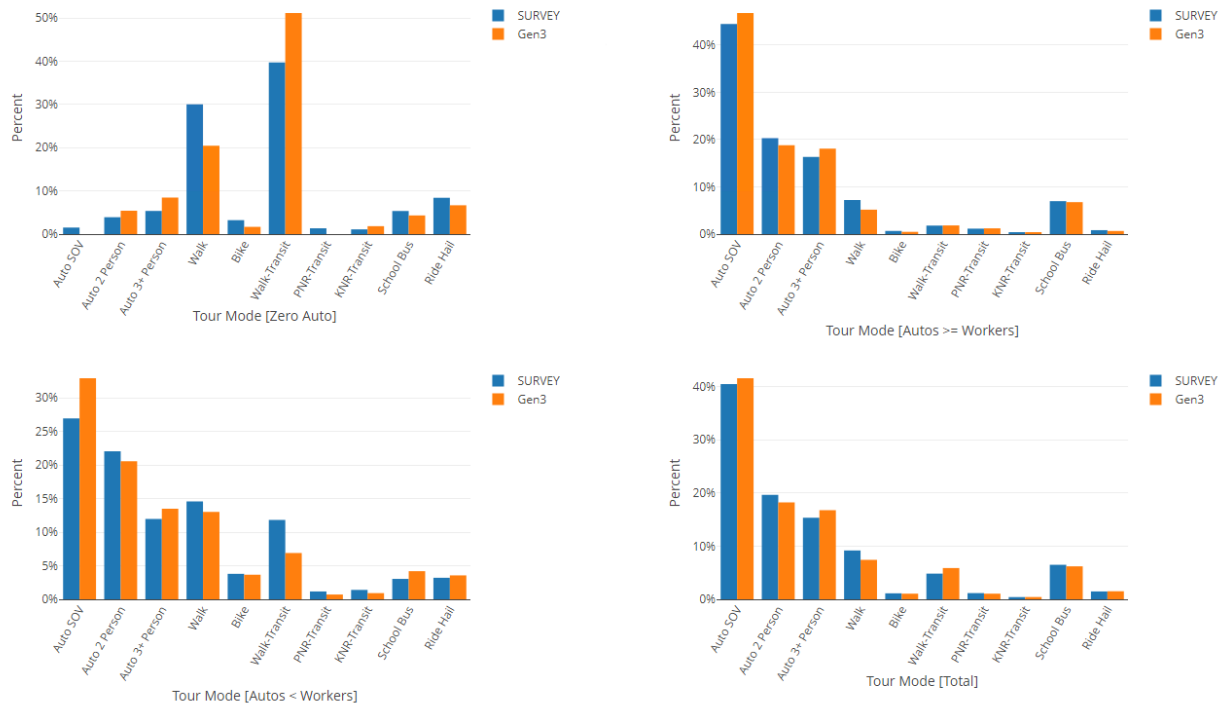

FIGURE 31: TOUR MODE CHOICE CALIBRATION - ALL TOUR PURPOSES

Work Tours

The main work tour mode choice calibration constants by auto sufficiency group are listed in Table 16, and the transit access and path type calibration constants are listed in Table 17. For work tours and households with no autos, PNR transit is disabled via constants (the -999 constant effectively disables a choice). This is because the survey data does not have any zero-auto households that used PNR access to transit. The tour mode choice results for work tours are shown in Figure 32. While overall estimated tours by tour mode is very close to observed, the zero-auto household group does overestimate transit over walking, and the autos < workers group overestimates auto while underestimating walk-access transit.

TABLE 16: WORK TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	-0.08
Shared-Ride 2	10.40	-0.25	-0.41
Shared-Ride 3+	11.33	-1.06	-1.06
Walk	19.10	2.60	0.04
Bike	16.98	-0.41	-3.14
Walk Transit	25.17	1.92	-0.03
PNR Transit	-999	-0.86	-0.92
KNR Transit	21.14	-1.14	-2.86
Taxi	15.13	-0.48	-2.77
TNC Single	15.83	-0.12	-3.35
TNC Shared	14.13	-1.70	-4.46

TABLE 17: WORK TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS

Transit Mode	Walk Access	PNR Access	KNR Access
Bus Only	-0.24	-1.01	0.20
Metrorail Only	-0.20	-0.48	-0.38
Bus + Metrorail	-0.71	-0.27	-0.45
Commuter Rail	-0.30	0.70	-0.10

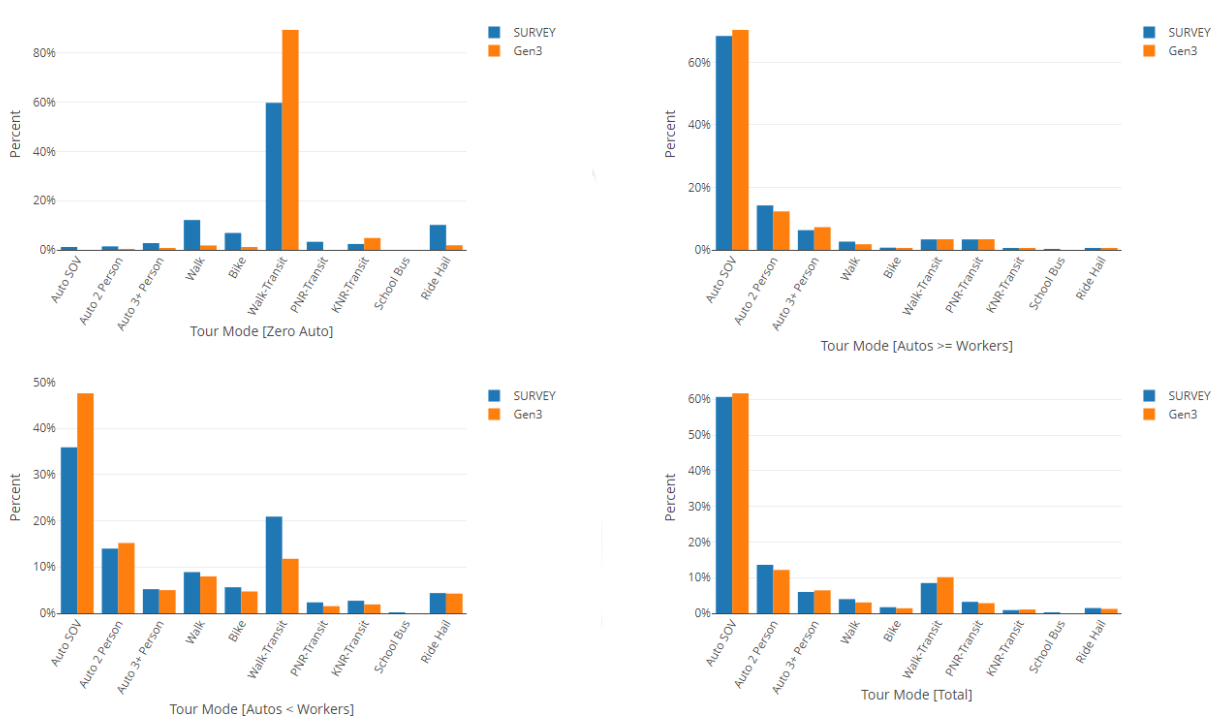

FIGURE 32: TOUR MODE CHOICE VALIDATION - WORK TOURS

University and School Tours

The main university and school tour mode choice calibration constants by auto sufficiency group are listed in Table 18 and Table 19, respectively. For university tours, the surveys did not observe any persons living in zero-auto households using PNR or KNR transit, so those alternatives were disallowed. Additionally, no bicycle tours were observed for auto sufficient households, so that alternative was also disallowed. For school tours, no PNR or KNR transit or rideshare tours from households owning autos were observed in the survey data, so those alternatives were disallowed. The transit access and line-haul constants are shown in Table 20. Similar to the tour mode by auto sufficiency groups, all of the PNR and most of the KNR alternatives were disallowed. The calibration results for university tours are shown in Figure 33. The model's zero-auto households segment overestimates rideshare tours and underestimates walk and walk-access transit. The other segments overestimate drive-alone tours. The validation results for school tours are shown in Figure 34. The results of this group are very close except for underestimating walk and overestimating walk-access transit for zero-auto households.

TABLE 18: UNIVERSITY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	-0.10	0.29	-0.12
Shared-Ride 3+	0.62	-0.19	-0.21
Walk	1.78	-1.06	-0.74
Bike	-0.81	-3.10	-999
Walk Transit	0.87	-0.85	-0.51
PNR Transit	-999	-0.51	-1.60
KNR Transit	-999	-1.87	-3.64
Taxi	0.00	-2.23	-2.92
TNC Single	1.08	-2.23	-2.92
TNC Shared	1.08	-2.23	-2.92

TABLE 19: SCHOOL TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	-999	0.59	0.69
Shared-Ride 3+	4.01	0.80	1.14
Walk	7.15	1.29	1.08
Bike	-6.61	-0.83	-2.04
Walk Transit	8.03	-0.41	-0.42
PNR Transit	0.00	-999	-999
KNR Transit	7.79	-999	-999
Taxi	0.00	-999	-999
TNC Single	0.00	-999	-999
TNC Shared	0.00	-999	-999

TABLE 20: SCHOOL AND UNIVERSITY TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS

Transit Mode	Walk Access	PNR Access	KNR Access
Bus Only	0.03	-999	-0.63
Metrorail Only	-0.40	-999	-999
Bus + Metrorail	-0.01	-999	-999
Commuter Rail	-1.11	-999	-999

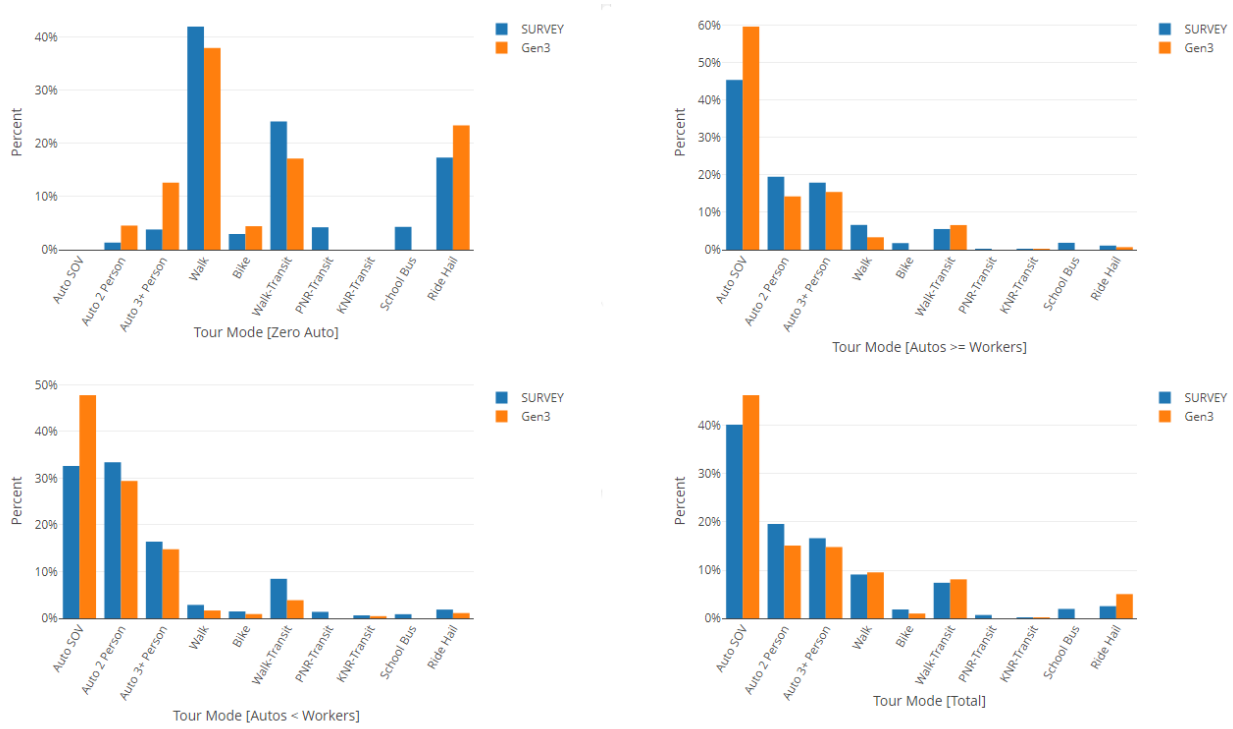

FIGURE 33: TOUR MODE CHOICE VALIDATION - UNIVERSITY TOURS

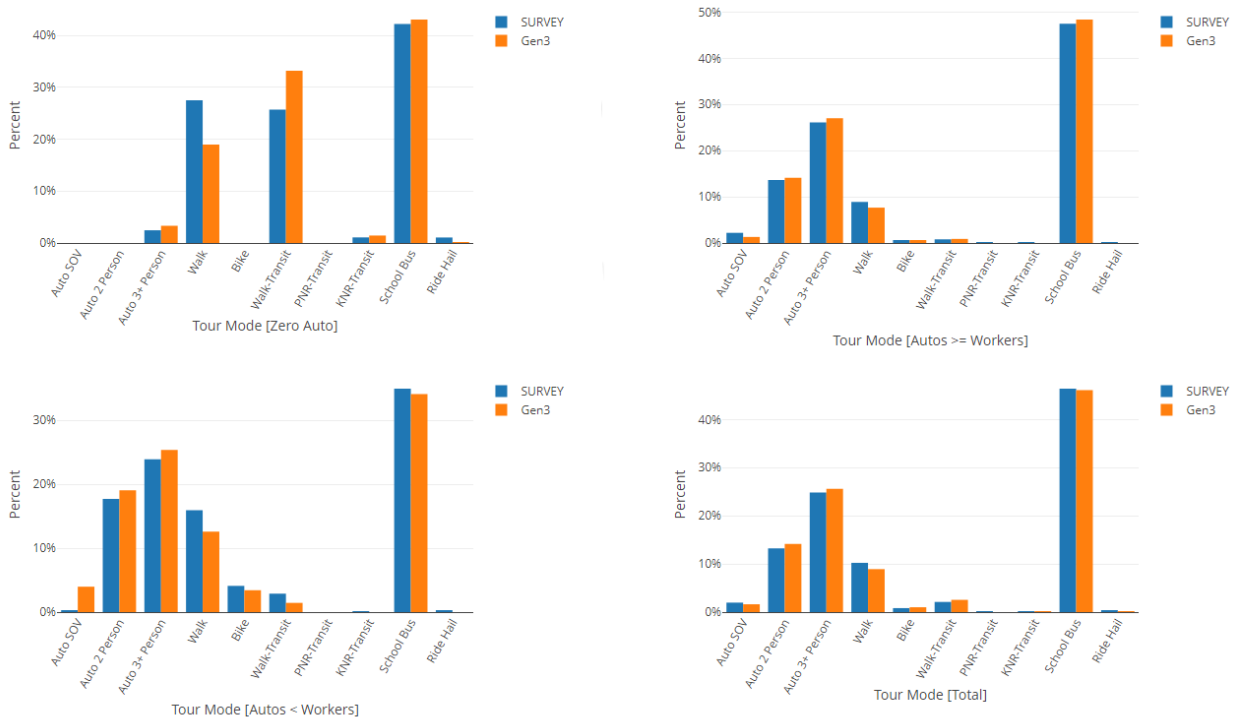

FIGURE 34: TOUR MODE CHOICE VALIDATION - SCHOOL TOURS

Non-Mandatory Tours

In the data used to estimate many of the non-mandatory tour mode choice models, there were no observed PNR- or KNR-access transit trips, so those choices are prohibited in the model via constants. The tour mode choice calibration by market segment is listed in Table 21, Table 22, Table 23, and Table 24 for individual maintenance, individual discretionary, joint maintenance, and joint discretionary, respectively. Table 25 lists the transit line-haul calibration constants for all non-mandatory tour purposes. The results of the individual maintenance mode choice model are shown in Figure 35. This model overestimates drive-alone auto travel but is otherwise close. The results of the individual discretionary mode choice model are shown in Figure 36. Similar to the individual maintenance model, this model overestimates drive-alone auto. The results of the joint maintenance model are shown in Figure 37. Note that the drive-alone auto choice is not allowed for this model, since by definition there has to be more than one person on the tour. This model has some tradeoffs between 2-person auto and 3-person auto but is close with non-auto mode choice. Finally, the results of the joint discretionary model are shown in Figure 38. Similar to the joint maintenance model, the drive-alone auto choice is not allowed.

TABLE 21: INDIVIDUAL MAINTENANCE TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	2.56	-0.72	-1.48
Shared-Ride 3+	3.00	-1.15	-1.59
Walk	6.60	0.86	0.00
Bike	2.27	-2.93	-3.70
Walk Transit	6.57	-1.18	-1.71
PNR Transit	-999	-999	-999
KNR Transit	0.00	-999	-999
Taxi	4.79	-3.13	-3.65
TNC Single	3.80	-3.68	-5.41
TNC Shared	1.32	-4.04	-999

TABLE 22: INDIVIDUAL DISCRETIONARY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	1.51	-1.39	-1.68
Shared-Ride 3+	0.88	-1.82	-1.74
Walk	5.87	1.24	-0.03
Bike	1.95	-2.59	-3.62
Walk Transit	4.92	-0.39	-2.26
PNR Transit	0.00	-999	-3.48
KNR Transit	2.01	-1.18	-2.12
Taxi	3.37	-1.83	-2.67
TNC Single	3.70	-0.91	-2.59
TNC Shared	1.78	-2.09	-4.24

TABLE 23: JOINT MAINTENANCE TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	-6.18	26.52	1.70
Shared-Ride 3+	-4.29	-87.87	0.29
Walk	-999	-999	-999
Bike	-999	-999	-5.55
Walk Transit	-0.95	-999	0.25
PNR Transit	-999	-999	-999
KNR Transit	-999	-999	-999
Taxi	-999	-999	-999
TNC Single	-999	-999	-999
TNC Shared	-999	-999	-999

TABLE 24: JOINT DISCRETIONARY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

Tour Mode	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	0.00	7.92	0.52
Shared-Ride 3+	14.88	-17.23	-0.45
Walk	26.40	-3.99	2.08
Bike	-999	-13.58	-2.48
Walk Transit	31.01	-11.53	-2.51
PNR Transit	-999	-999	-999
KNR Transit	-999	-999	-999
Taxi	0.00	-13.21	-2.49
TNC Single	0.00	-15.19	-2.49
TNC Shared	0.00	-13.79	-2.49

TABLE 25: NON-MANDATORY TOUR TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS

Transit Mode	Walk Access	PNR Access	KNR Access
Bus Only	0.00	0.00	-1.30
Metrorail Only	-0.87	-999	-0.96
Bus + Metrorail	-1.54	-999	-999
Commuter Rail	0.45	-999	-999

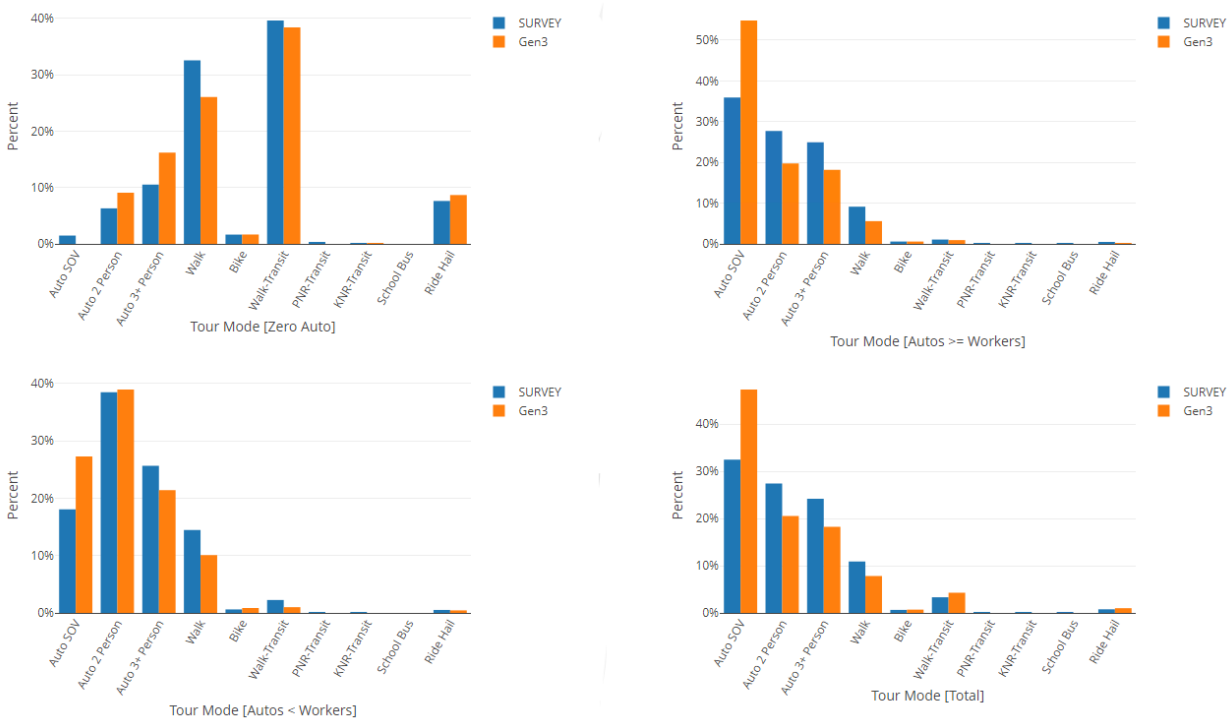

FIGURE 35: TOUR MODE CHOICE CALIBRATION RESULTS- INDIVIDUAL MAINTENANCE TOURS

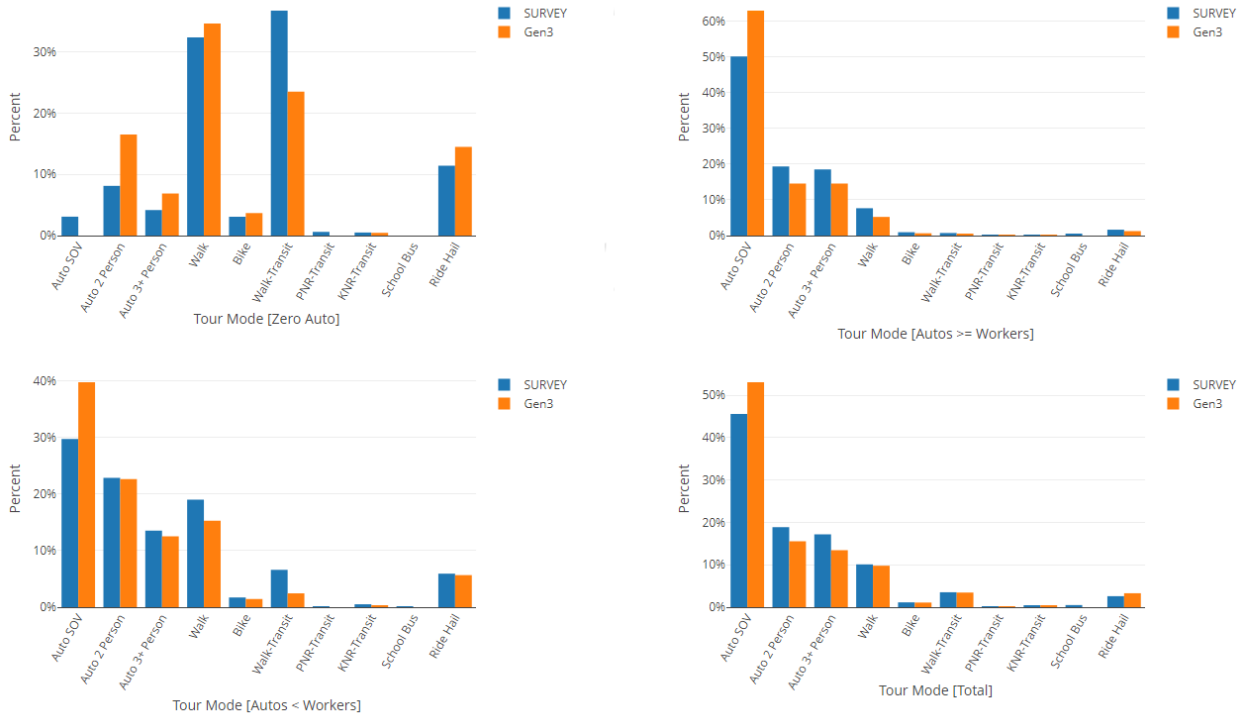

FIGURE 36: TOUR MODE CHOICE CALIBRATION RESULTS - INDIVIDUAL DISCRETIONARY TOURS

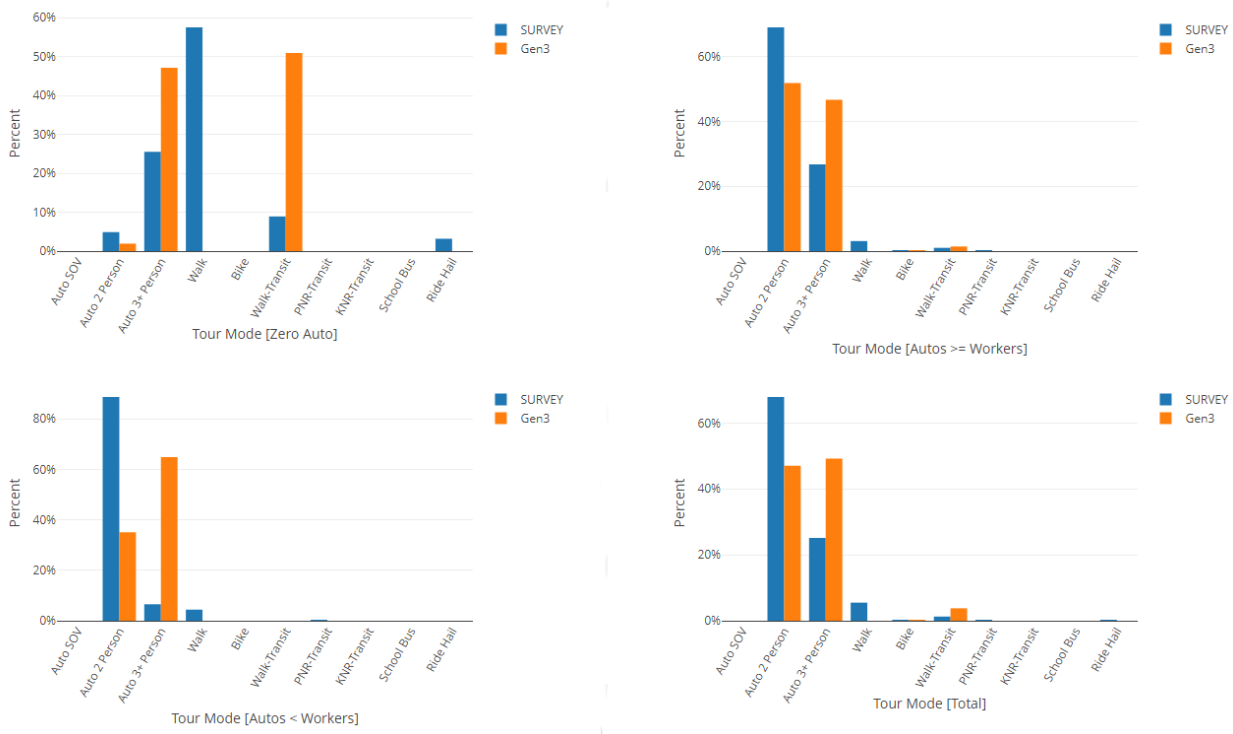

FIGURE 37: TOUR MODE CHOICE CALIBRATION RESULTS - JOINT MAINTENANCE TOURS

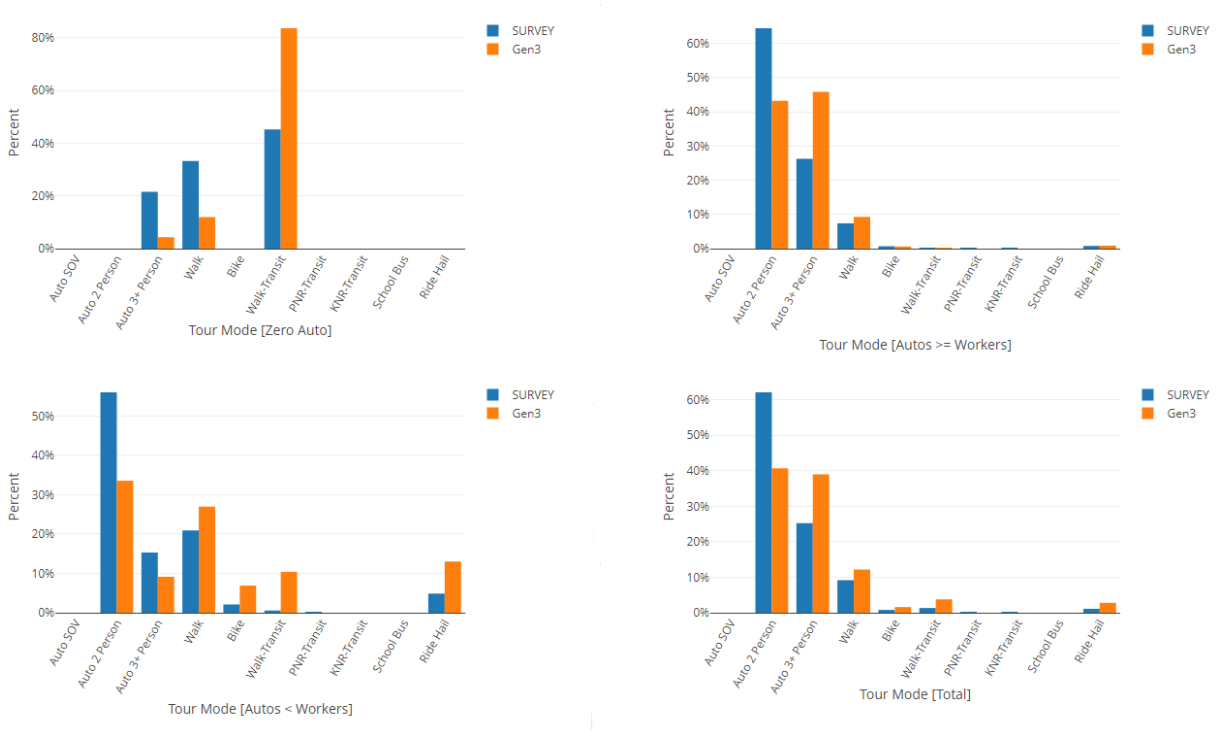

FIGURE 38: TOUR MODE CHOICE CALIBRATION RESULTS - JOINT DISCRETIONARY TOURS

2.14 AT-WORK SUBTOUR FREQUENCY

The at-work subtour frequency model step assigns the number of and types of subtours for work tours. This model step is applied to only work tours and uses a choice set of no-subtours, 1 business subtour, 2 business subtours, 1 eat subtour, 1 eat and 1 business subtour, or 1 maintenance subtour. The calibration constants for this model step are listed in Table 26. The results of this model are shown in Figure 39. This model overestimates eat-out subtours and underestimates maintenance and no subtours.

TABLE 26: AT-WORK SUBTOUR FREQUENCY CALIBRATION CONSTANTS

CONSTANT DESCRIPTION	CONSTANT
1 Business Subtour	-0.54
2 Business Subtour	-2.13
Eat Subtour	0.86
Eat & Business Subtour	-0.97
1 Maintenance Subtour	-0.62
No Subtours	0.00

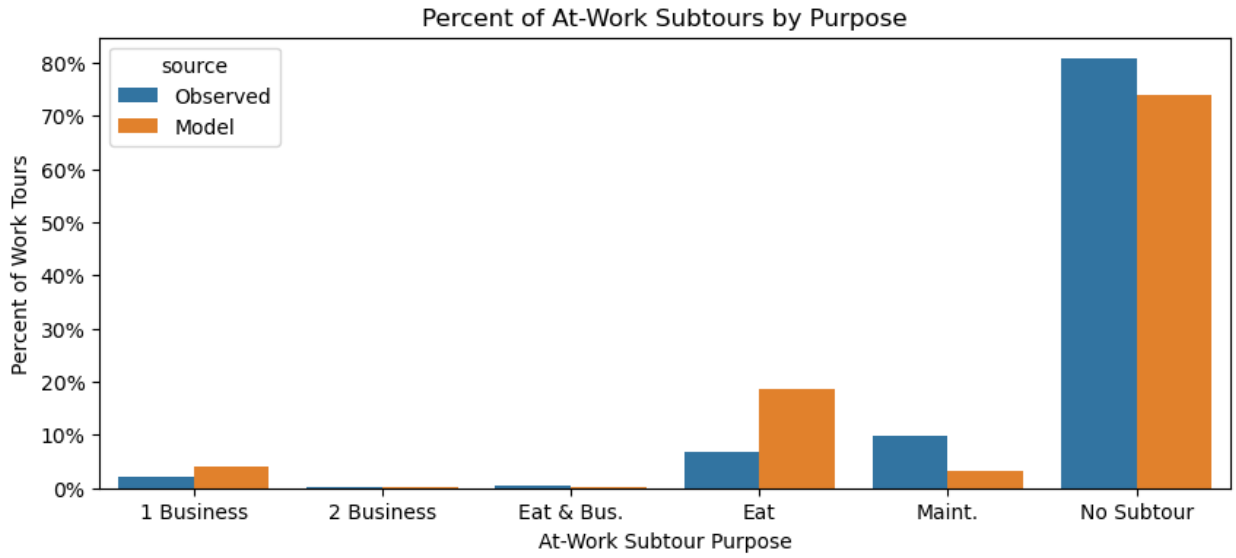

FIGURE 39: AT-WORK SUBTOUR FREQUENCY CALIBRATION RESULTS

2.15 AT-WORK SUBTOUR DESTINATION

The at-work subtour destination location model step assigns the destination TAZ to at-work subtours. Table 27 lists a summary of the at-work subtour tour lengths and coincidence ratio. There was only one constant used in this model, which is listed in Table 28. The resulting tour distance frequency diagram is shown in Figure 40, which shows a very close match to the survey. Table 27

TABLE 27: AT-WORK SUBTOUR SUMMARY STATISTICS

ESTIMATED TOUR LENGTH	OBSERVED TOUR LENGTH	COINCIDENCE RATIO
4.94	5.38	0.80

TABLE 28: AT-WORK SUBTOUR DESTINATION CALIBRATION CONSTANTS

Constant Description	Constant Value
DC Destination	-0.50

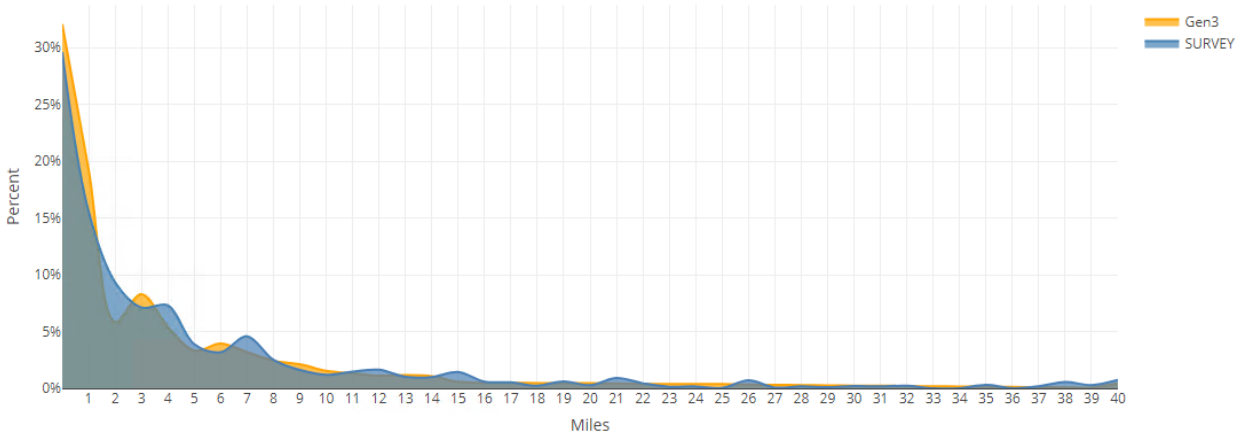

FIGURE 40: AT-WORK SUBTOUR DESTINATION DISTANCE DISTRIBUTION

2.16 AT-WORK SUBTOUR MODE CHOICE

The at-work subtour mode choice model step assigns a mode to at-work subtours. The calibration constants for at-work subtours by mode and auto sufficiency are listed in Table 29. The survey data did not have any persons making an at-work subtour using PNR or KNR transit, so those modes are prohibited via constants. The calibration constants by transit line-haul and access mode are listed in Table 30. The resulting model output is shown in Figure 41. This model has a slight overestimation for drive-alone trips that is offset by an underestimate for walk trips. Note that the overall tour mode choice constants listed in Table 15 are applied to this model.

TABLE 29: AT-WORK SUBTOUR MODE CHOICE CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)

At-Work	No Auto	Auto Deficient	Auto Sufficient
Drive Alone	0.00	0.00	0.00
Shared-Ride 2	26.82	-1.75	-2.18
Shared-Ride 3+	26.38	-2.22	-2.70
Walk	33.11	1.80	0.17
Bike	33.50	4.66	-2.00
Walk Transit	30.76	-1.67	-2.94
PNR Transit	-999	-999	-999
KNR Transit	-999	-999	-999
Taxi	28.03	-1.67	-1.99
TNC Single	28.53	-32.41	-3.10
TNC Shared	-2.47	-20.51	-3.01

TABLE 30: AT-WORK SUBTOUR MODE CHOICE CALIBRATION CONSTANTS (TRANSIT LINE HAUL AND ACCESS MODE)

At-Work	Walk Access	PNR Access	KNR Access
Bus Only	0.32	-999	-999
Metrorail Only	0.82	-999	-999
Bus + Metrorail	-999	-999	-999
Commuter Rail	-2.63	-999	-999

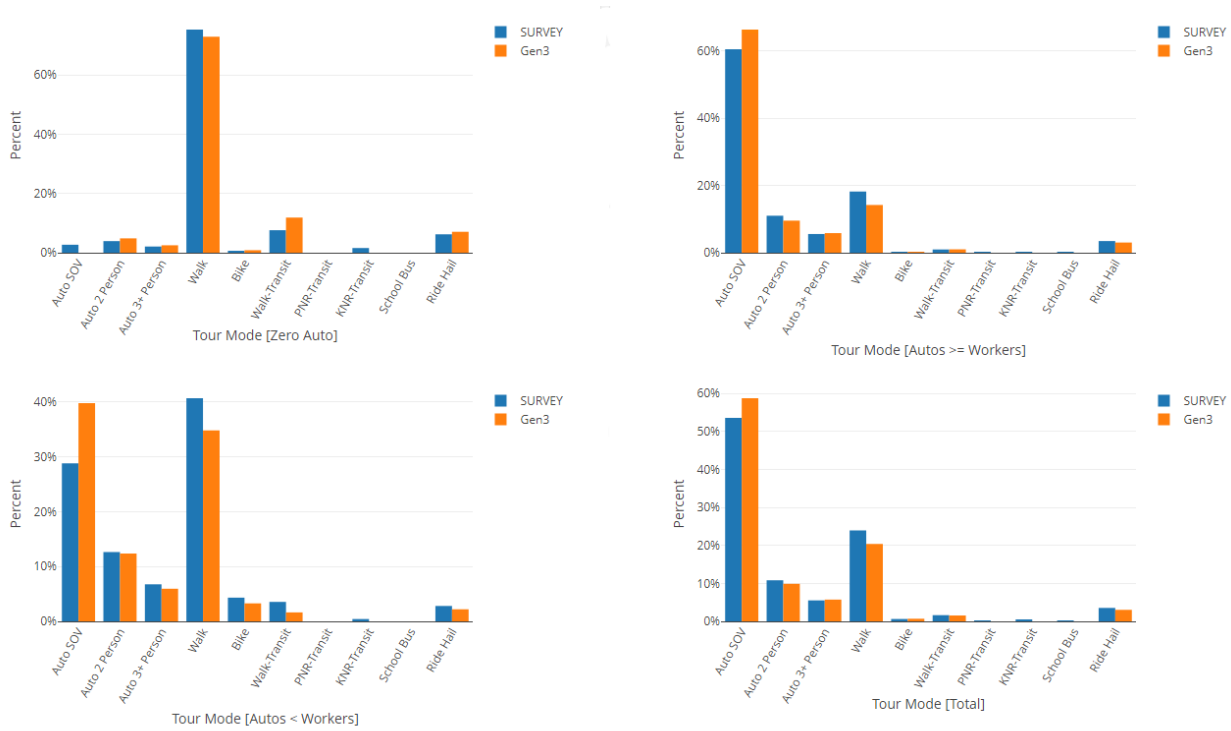

FIGURE 41: AT-WORK SUBTOUR MODE CHOICE CALIBRATION RESULTS

During the trip mode choice model step, at-work trip modes are assigned. The constants and results are included in this section. The trip mode choice calibration constants for at-work subtour trips are listed in Table 31. The results of the model are shown in Figure 42. Similar to the at-work tour mode choice model, there is an overestimate of drive-alone auto that is offset by an underestimate of walk trips.

TABLE 31: AT-WORK SUBTOUR TRIP MODE CHOICE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	-0.29
Shared-Ride 3+	Drive Alone	-0.96
Shared-Ride 3+	Shared-Ride 2	-4.24
Walk	Drive Alone	-3.69
Walk	Shared-Ride 2	-6.87
Walk	Shared-Ride 3+	-9.36
Bicycle	Walk	0.19
Walk Transit	Shared-Ride 2	-4.00
Walk Transit	Shared-Ride 3+	-6.50
Walk Transit	Walk	0.79
Walk Transit	Bicycle	0.00
Walk Transit	Taxi	-5.01
Walk Transit	TNC Single	-4.91
Walk Transit	TNC Shared	-15.00
Walk Transit	Metrorail	2.45
Walk Transit	Bus+Metrorail	0.72
Walk Transit	Commuter Rail	-2.00
Ridehail	Shared-Ride 2	-4.30
Ridehail	Shared-Ride 3+	-4.00
Ridehail	Walk	-1.72

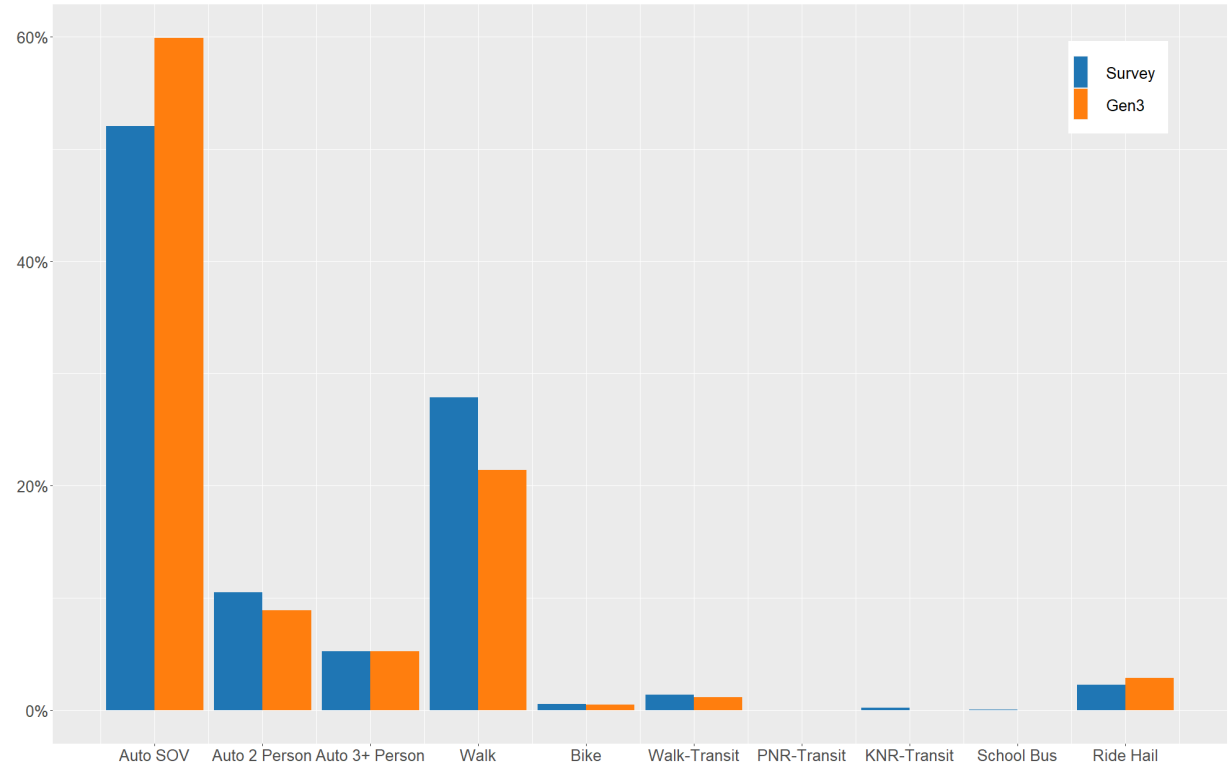

FIGURE 42: TRIP MODE CHOICE CALIBRATION RESULTS FOR AT-WORK SUBTOURS

2.17 STOP FREQUENCY

The stop frequency model step assigns to tours the number of stops and the directionality, which is outbound – from home[13] to the tour destination, or inbound – from the tour destination to home[13]. This step of ActivitySim generates trips that are ultimately output for use with traffic and transit assignment. The calibration for this model was transferred from SEMCOG. The constants are listed in Table 32 for mandatory (work, university, and school) tours, Table 33 for escort, eat-out, and shopping tours, Table 34 for social, other maintenance, and other discretionary tours, and Table 35 for at-work subtours.

Total stop frequency, shown in Figure 43, is very well calibrated with only a slight underestimate in tours with no stops and a slight overestimate in tours with 1 stop.

Work stop frequency, shown in Figure 44, has a small underestimate in zero stop tours and slight overestimate in one and 2 stop tours. This is consistent with expectations that some stops

[13] In the case of at-work subtours tours, these are work to the tour destination and back to work.

are frequently missed in routine work tours, particularly those of a non-routine nature such as an occasional stop for fuel, a beverage, or groceries on the way to or from work.

University and school stop frequency, shown in Figure 45 and Figure 46, respectively, have a small overestimation in tours with no stops and a slight underestimation in tours with stops.

Escort tours, shown in Figure 47, has only slight differences in zero-stop tours and one-stop tours.

Individual maintenance (shopping and other maintenance) and discretionary (eat-out, social, and other discretionary) tour stop frequencies, shown in Figure 35 and Figure 36 respectively, show a small underestimation in tours with no stops and a slight overestimation in tours with one, two, and three stops. Joint maintenance and discretionary tour stop frequencies, shown in Figure 37 and Figure 38, respectively, show a small overestimation in tours with no stops and a slight underestimation in tours with stops.

At-work tours, shown in Figure 39, shows a slight overestimation in tours with no stop and slight underestimation in tours with stops.

TABLE 32: MANDATORY TOUR STOP FREQUENCY CALIBRATION CONSTANTS

CONSTANT	WORK TOURS	UNIV TOURS	SCHOOL TOURS
0 Outbound Stops and 1 Inbound Stop	0.28	-0.96	-2.25
0 Outbound Stops and 2 Inbound Stop	0.38	0.01	-2.01
0 Outbound Stops and 3 Inbound Stop	-0.14	-1.13	-2.14
1 Outbound Stop and 0 Inbound Stops	-0.20	-0.82	-2.62
1 Outbound Stop and 1 Inbound Stops	-0.15	0.37	-2.06
1 Outbound Stop and 2 Inbound Stops	-0.04	1.56	-1.80
1 Outbound Stop and 3 Inbound Stops	-0.46	-1.36	-2.18
2 Outbound Stop and 0 Inbound Stops	-0.24	-0.88	-2.92
2 Outbound Stop and 1 Inbound Stops	-0.37	-1.28	-3.08
2 Outbound Stop and 2 Inbound Stops	0.96	-1.56	-3.89
2 Outbound Stop and 3 Inbound Stops	-0.05	-0.14	-1.09
3 Outbound Stop and 0 Inbound Stops	0.10	-1.29	-5.18
3 Outbound Stop and 1 Inbound Stops	-1.08	-1.05	-4.55
3 Outbound Stop and 2 Inbound Stops	-0.96	-1.34	-3.32
3 Outbound Stop and 3 Inbound Stops	-0.17	-2.40	-0.13

TABLE 33: ESCORT, EAT-OUT, AND SHOPPING TOUR STOP FREQUENCY CALIBRATION CONSTANTS

CONSTANT	ESCORT TOURS	EAT-OUT TOURS	SHOPPING TOURS
0 Outbound Stops and 1 Inbound Stop	-0.46	-0.13	0.02
0 Outbound Stops and 2 Inbound Stop	-0.32	0.19	0.03
0 Outbound Stops and 3 Inbound Stop	-0.79	0.42	-0.13
1 Outbound Stop and 0 Inbound Stops	0.03	0.31	0.21
1 Outbound Stop and 1 Inbound Stops	-0.08	0.68	0.02
1 Outbound Stop and 2 Inbound Stops	-0.24	1.93	0.46
1 Outbound Stop and 3 Inbound Stops	-0.92	-0.12	0.16
2 Outbound Stop and 0 Inbound Stops	0.35	1.32	0.85
2 Outbound Stop and 1 Inbound Stops	0.71	1.71	1.34
2 Outbound Stop and 2 Inbound Stops	-2.17	1.48	1.19
2 Outbound Stop and 3 Inbound Stops	1.93	-0.33	-0.04
3 Outbound Stop and 0 Inbound Stops	0.62	1.68	1.61
3 Outbound Stop and 1 Inbound Stops	1.18	0.77	1.91
3 Outbound Stop and 2 Inbound Stops	1.98	1.89	1.07
3 Outbound Stop and 3 Inbound Stops	3.38	1.53	1.38

TABLE 34: SOCIAL, OTHER MAINTENANCE, AND OTHER DISCRETIONARY TOUR STOP FREQUENCY CALIBRATION CONSTANTS

CONSTANT	SOCIAL	OTHER MAINTENANCE	OTHER DISCRETIONARY
0 Outbound Stops and 1 Inbound Stop	-0.23	0.21	0.29
0 Outbound Stops and 2 Inbound Stop	0.53	0.21	0.47
0 Outbound Stops and 3 Inbound Stop	0.54	0.65	0.76
1 Outbound Stop and 0 Inbound Stops	0.22	0.79	0.69
1 Outbound Stop and 1 Inbound Stops	-0.32	0.80	0.52
1 Outbound Stop and 2 Inbound Stops	1.03	0.31	0.69
1 Outbound Stop and 3 Inbound Stops	-2.51	1.12	-0.05
2 Outbound Stop and 0 Inbound Stops	1.39	1.10	1.23
2 Outbound Stop and 1 Inbound Stops	-1.16	0.47	1.27
2 Outbound Stop and 2 Inbound Stops	0.22	0.63	0.05
2 Outbound Stop and 3 Inbound Stops	0.90	1.88	-1.08
3 Outbound Stop and 0 Inbound Stops	2.97	1.42	2.34
3 Outbound Stop and 1 Inbound Stops	0.47	2.39	-0.48
3 Outbound Stop and 2 Inbound Stops	3.17	0.86	1.10
3 Outbound Stop and 3 Inbound Stops	3.35	1.27	2.16

TABLE 35: AT-WORK SUBTOUR STOP FREQUENCY CALIBRATION CONSTANTS

CONSTANT	VALUE
0 Outbound Stops and 1 Inbound Stop	-2.63
0 Outbound Stops and 2 Inbound Stop	-2.78
0 Outbound Stops and 3 Inbound Stop	-0.49
1 Outbound Stop and 0 Inbound Stops	-3.62
1 Outbound Stop and 1 Inbound Stops	-0.72
1 Outbound Stop and 2 Inbound Stops	-2.12
1 Outbound Stop and 3 Inbound Stops	-4.46
2 Outbound Stop and 0 Inbound Stops	-3.66
2 Outbound Stop and 1 Inbound Stops	0.27
2 Outbound Stop and 2 Inbound Stops	0.25
2 Outbound Stop and 3 Inbound Stops	-0.51
3 Outbound Stop and 0 Inbound Stops	-5.08
3 Outbound Stop and 1 Inbound Stops	0.39
3 Outbound Stop and 2 Inbound Stops	2.07
3 Outbound Stop and 3 Inbound Stops	2.89

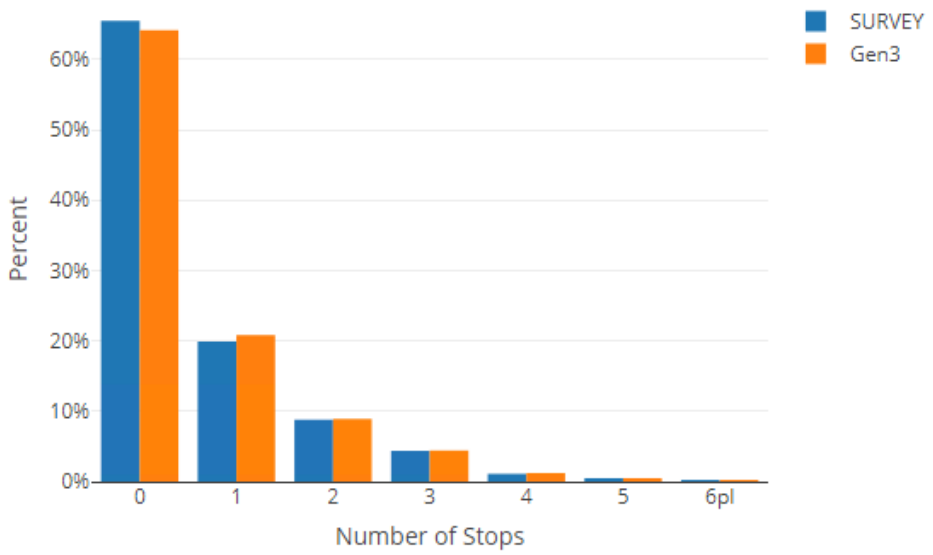

FIGURE 43: TOTAL STOP FREQUENCY

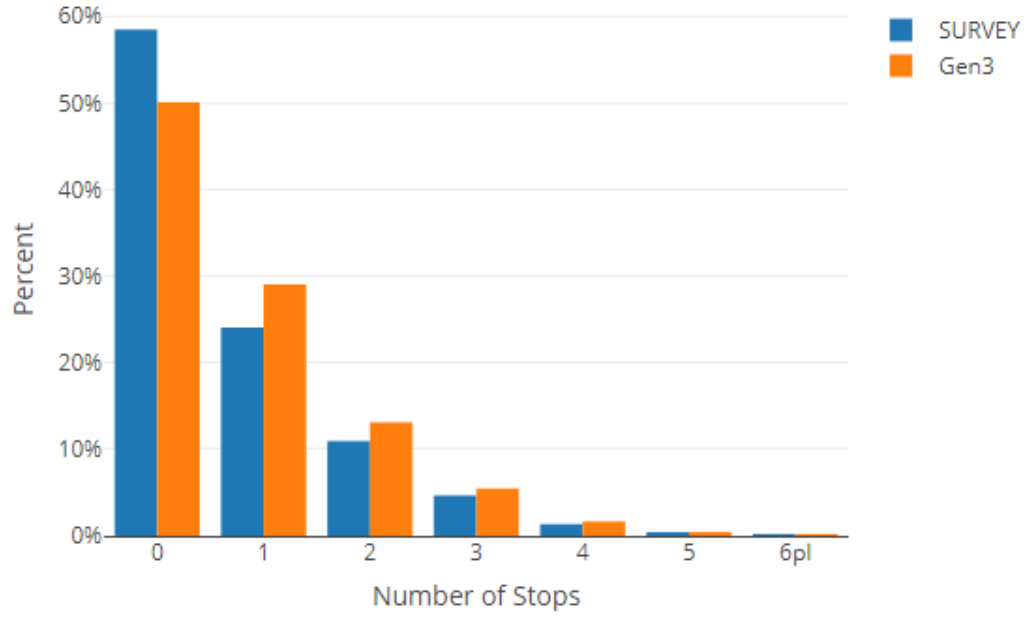

FIGURE 44: WORK TOUR STOP FREQUENCY

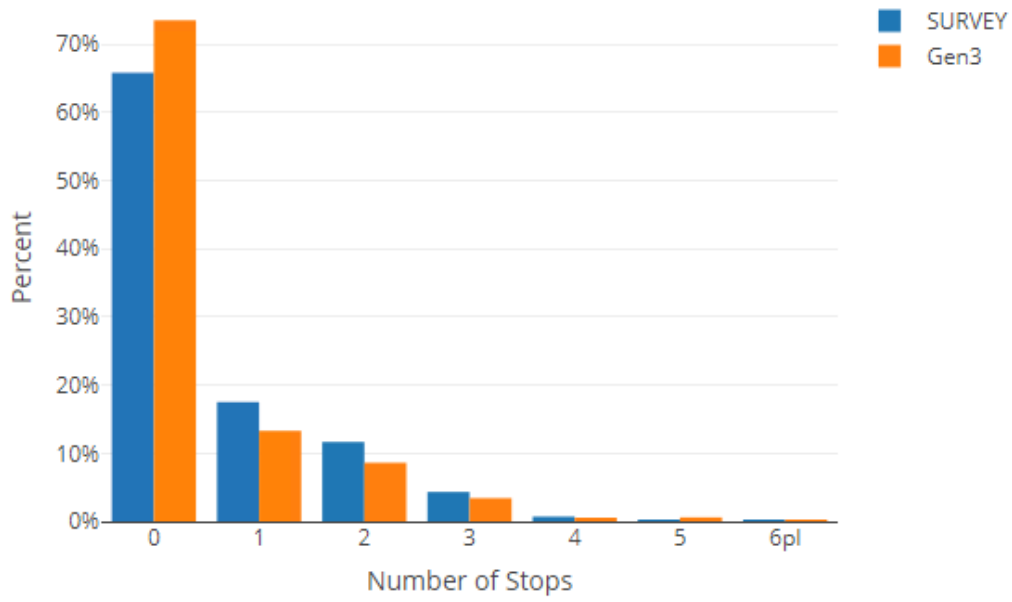

FIGURE 45: UNIVERSITY TOUR STOP FREQUENCY

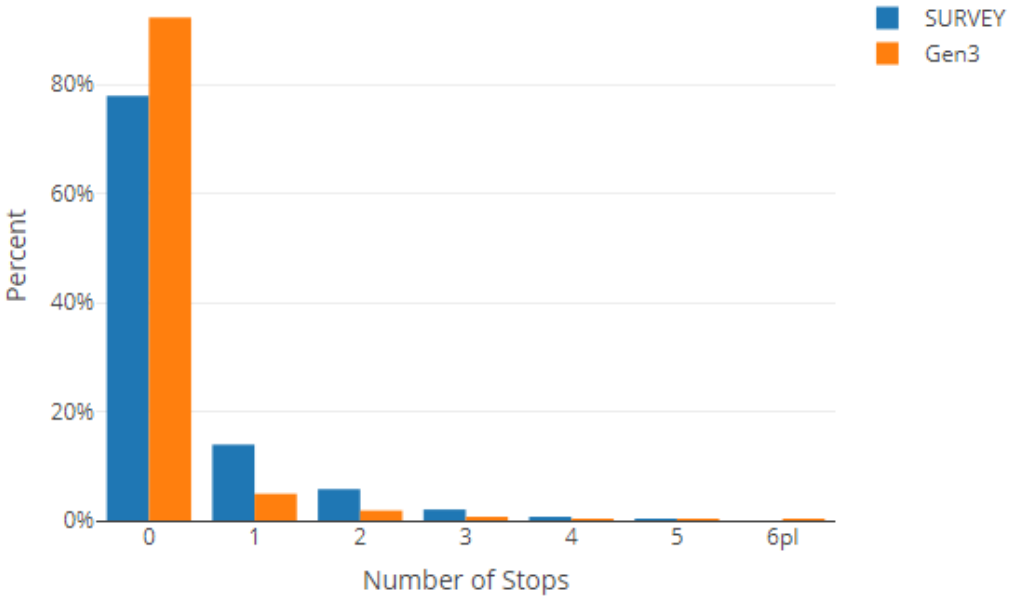

FIGURE 46: SCHOOL TOUR STOP FREQUENCY

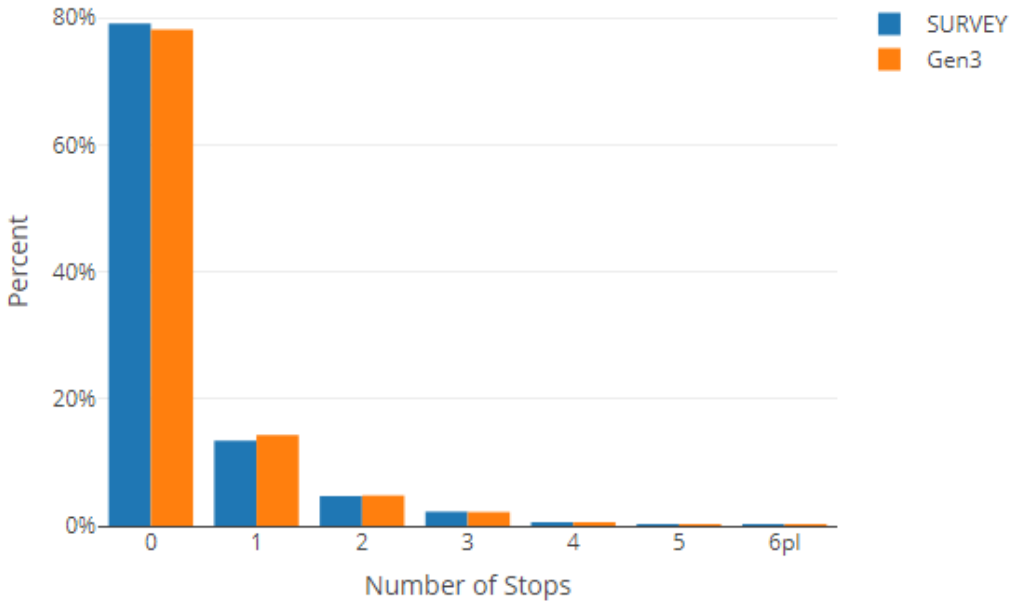

FIGURE 47: ESCORTING TOUR STOP FREQUENCY

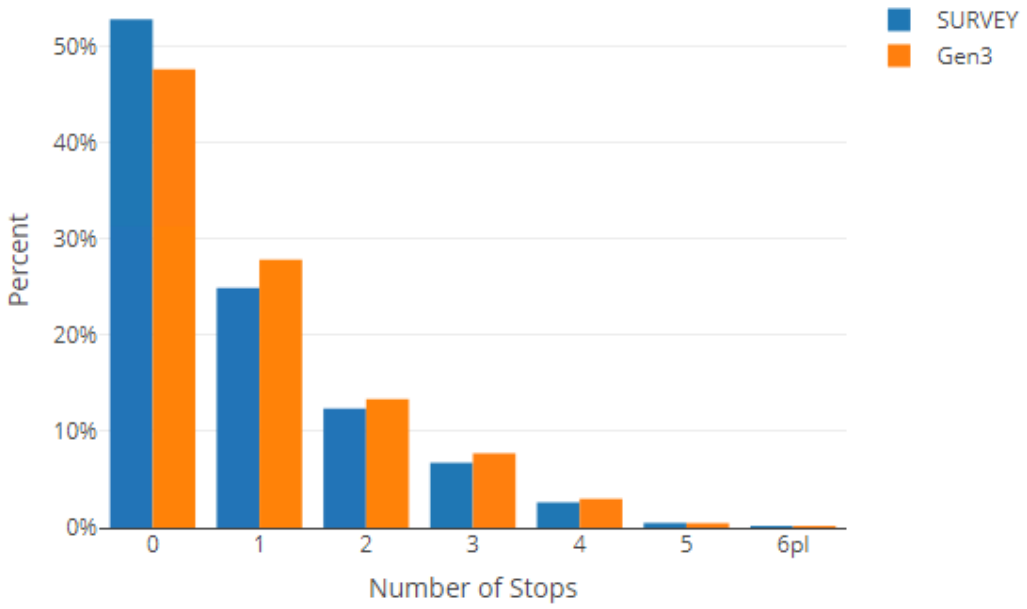

FIGURE 48: INDIVIDUAL MAINTENANCE TOUR STOP FREQUENCY

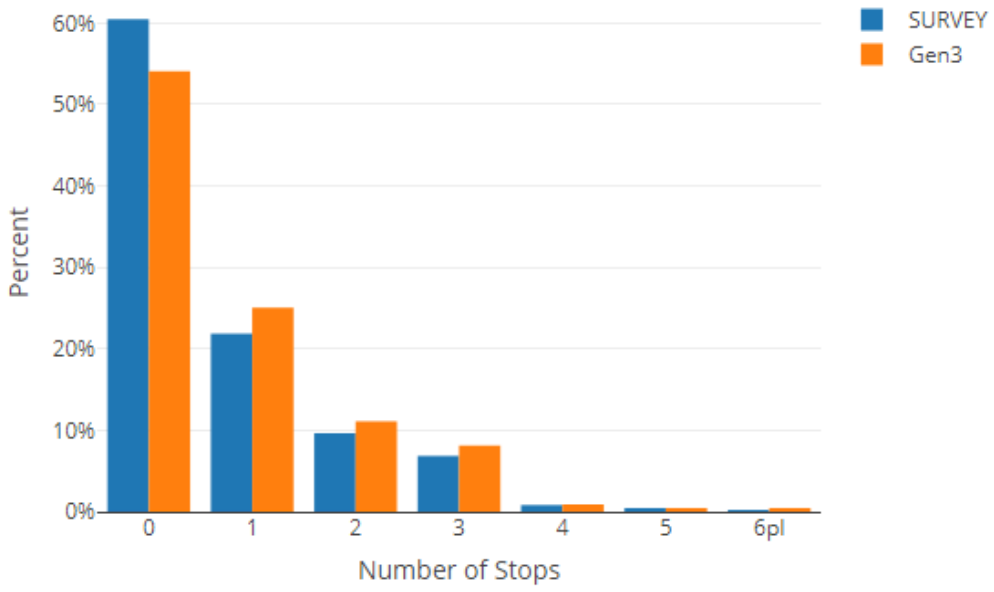

FIGURE 49: INDIVIDUAL DISCRETIONARY TOUR STOP FREQUENCY

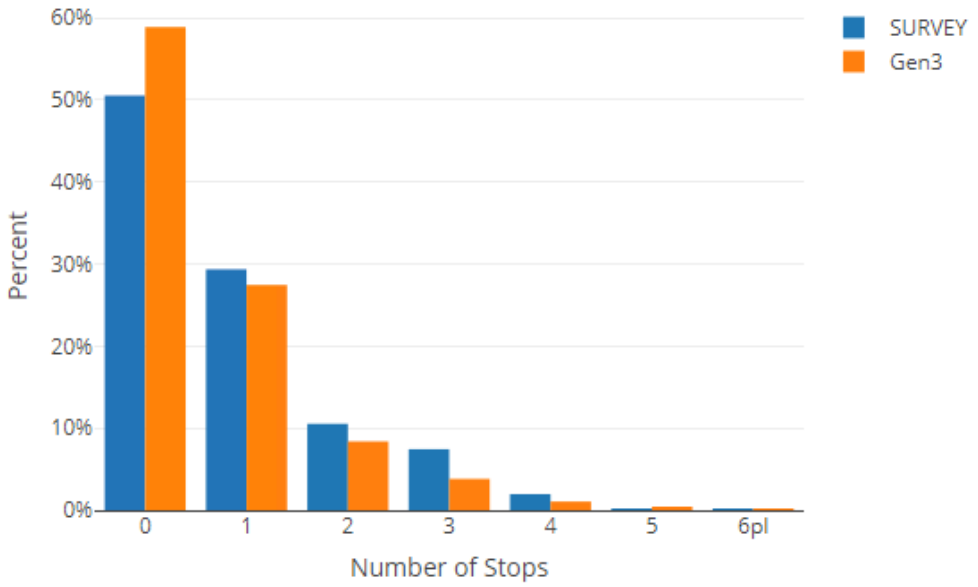

FIGURE 50: JOINT MAINTENANCE TOUR STOP FREQUENCY

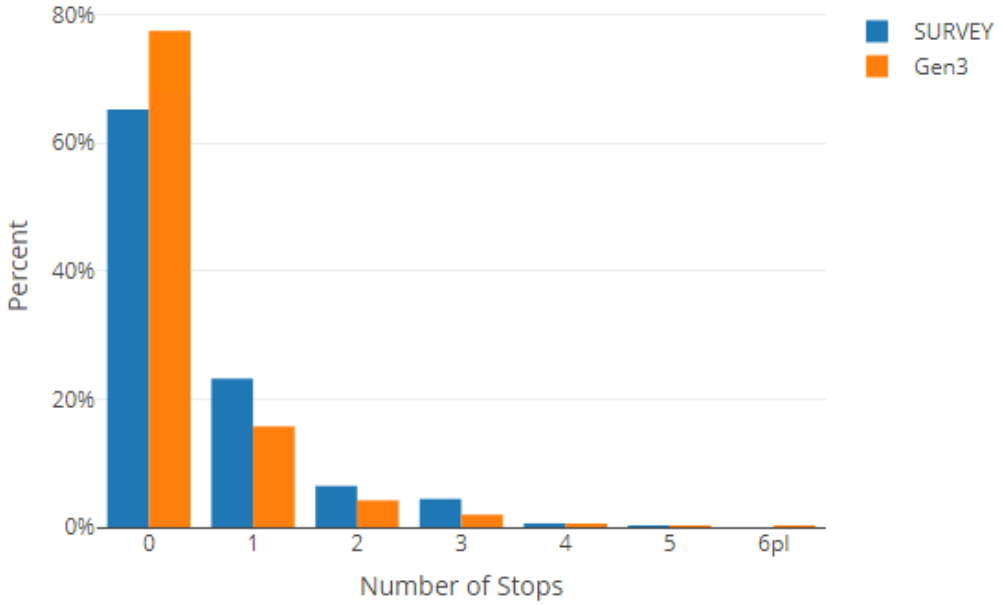

FIGURE 51: JOINT DISCRETIONARY TOUR STOP FREQUENCY

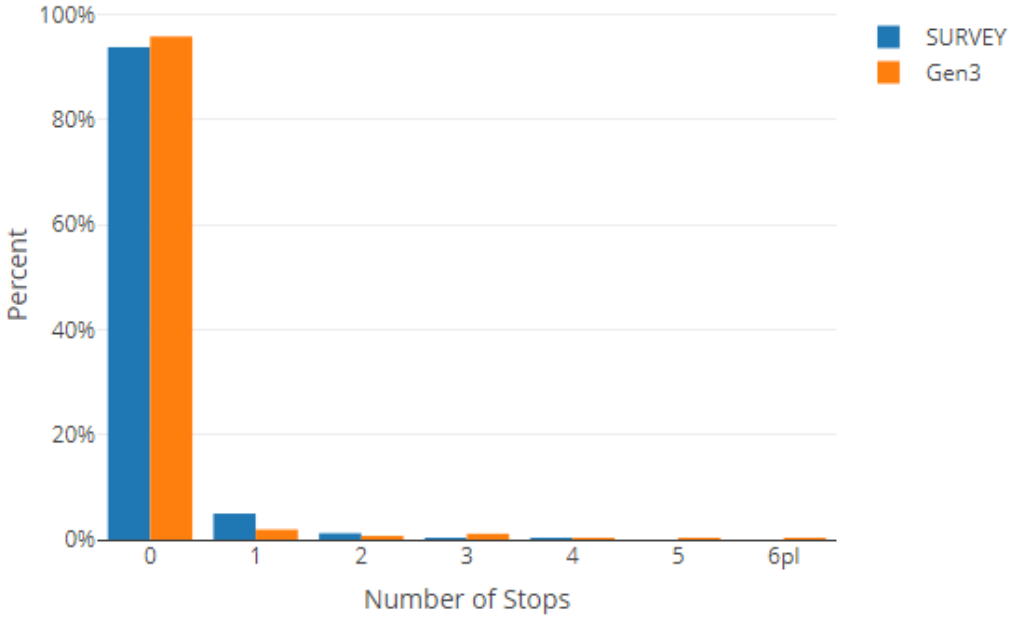

FIGURE 52: AT-WORK TOUR STOP FREQUENCY

2.18 TRIP MODE CHOICE

The trip mode choice model step is a multinomial logit model that assigns the travel mode used to each trip. It is setup the same way as the tour mode choice model (shown in Figure 30), but the nesting coefficients are set to 1.0, which effectively collapses the nested logit structure into a multinomial logit structure.[14]

The mode share targets by trip purpose were revised based on comparisons of the household survey, the transit surveys, and the transit ridership data. During calibration, adjustments were made to the model constants to improve boardings by transit mode. Additionally, the transit surveys were used to estimate the observed number of transfers, which was calibrated in this model step.

The model includes some overall constants that are used in all trip purposes, and those are listed in Table 36. These were added after survey-based calibration to adjust trips based on traffic volumes and transit ridership comparisons. The overall calibration output for the model is shown in Figure 53. The model somewhat overestimates single-occupant vehicle trips, and underestimates 2-person shared-ride and school bus trips.

TABLE 36: MISCELLANEOUS TRIP CALIBRATION CONSTANTS

Description	Constant
Adjustment for Drive Alone trips to DC	-0.16
Adjustment for bus trips within DC	0.60
Transfer constant for walk access to all-bus transit[15]	-0.10

[14] See Koppelman and Bhat, *A Self-Instructing Guide to Mode Choice Modeling.* U.S. Department of Transportation, Federal Transit Administration, June 30, 2006. Page 163.
[15] In the model setup, this constant is split into trip purposes (work, university, school, maintenance, discretionary, and at-work), but the constant is the same for all trip purposes.

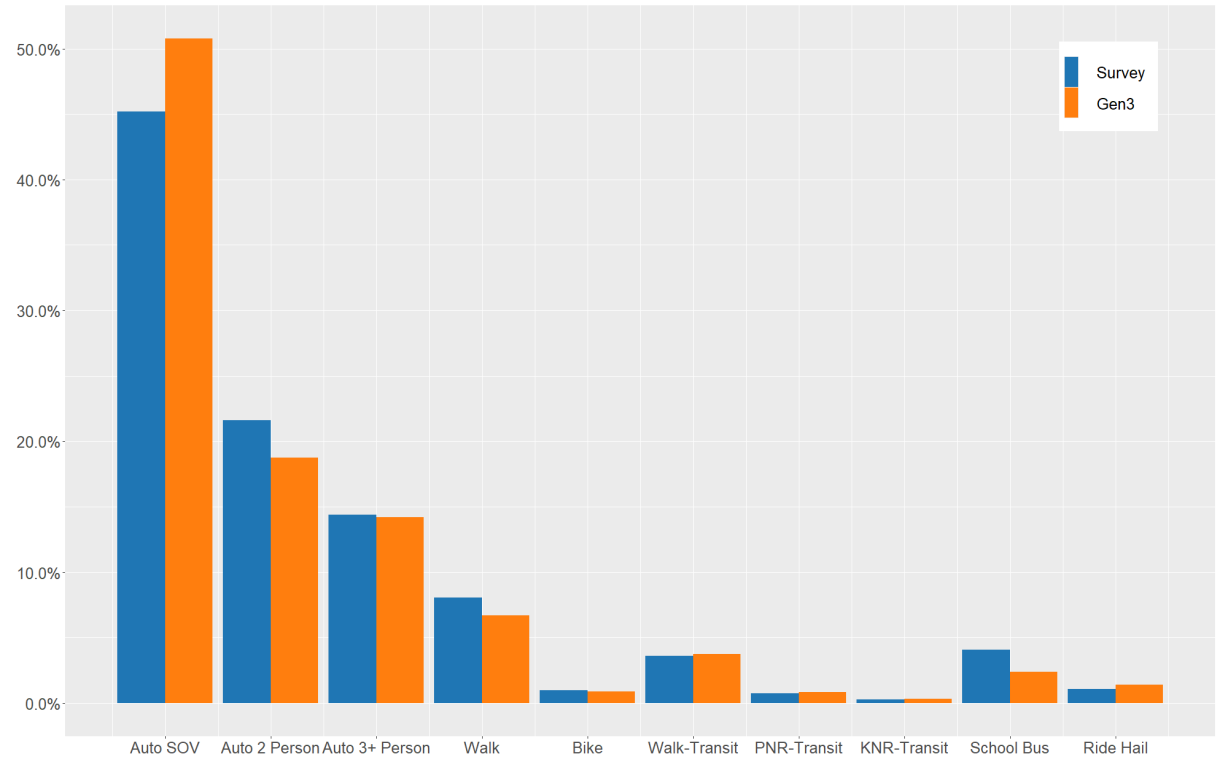

FIGURE 53: TRIP MODE CHOICE CALIBRATION RESULTS FOR ALL TOUR PURPOSES

The calibration constants and results for individual trip purposes are discussed, in turn, in the sub-sections below.

Work Trips

The work trip mode choice calibration constants by tour mode and trip mode are listed in Table 37. These constants link the tour mode with trips that may be different from the tour mode (e.g., a drive-alone trip on a shared-ride 2-person tour). Additionally, there are some adjustments used for tour composition – such as when a tour has no stops or for the first or last trip on a tour. Those are listed in Table 38. The calibration results for trips on work tours is shown in Figure 54. The model slightly overestimates single-occupant vehicle and slightly underestimates 2-person shared-ride trips.

TABLE 37: WORK TRIP PURPOSE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	0.83
Shared-Ride 3+	Drive Alone	1.19
Shared-Ride 3+	Shared-Ride 2	0.35
Walk	Drive Alone	-2.13
Walk	Shared-Ride 2	-3.58
Walk	Shared-Ride 3+	-4.73
Bicycle	Walk	-0.49
Walk Transit	Shared-Ride 2	-4.76
Walk Transit	Shared-Ride 3+	-6.21
Walk Transit	Walk	0.31
Walk Transit	Bicycle	4.00
Walk Transit	Taxi	-6.07
Walk Transit	TNC Single	-5.63
Walk Transit	TNC Shared	-11.35
Walk Transit	Metrorail	1.59
Walk Transit	Bus+Metrorail	0.05
Walk Transit	Commuter Rail	0.28
Ridehail	Shared-Ride 2	-1.75
Ridehail	Shared-Ride 3+	-3.52
Ridehail	Walk	2.39
Any	PNR Metrorail-Only	1.70
Any	PNR Bus+Metrorail	-0.30
Any	PNR Commuter Rail	2.20
Any	KNR Metrorail-Only	2.04
Any	KNR Bus+Metrorail	-0.48
Any	KNR Commuter Rail	7.59
Any	Taxi	-0.14
Any	TNC Single	-1.23
Any	TNC Shared	0.84

TABLE 38: WORK TRIP PURPOSE STOP ARRANGEMENT CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Condition	Constant
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 Stops	-2.59
Shared-Ride 2	Drive Alone	First Outbound Trip in Tour	-0.36
Shared-Ride 3+	Drive Alone	First Outbound Trip in Tour	-0.51
Shared-Ride 3+	Shared-Ride 2	First Outbound Trip in Tour	-1.06
Shared-Ride 2	Drive Alone	Last Inbound Trip in Tour	-0.28
Shared-Ride 3+	Drive Alone	Last Inbound Trip in Tour	-0.31
Shared-Ride 3+	Shared-Ride 2	Last Inbound Trip in Tour	-0.84

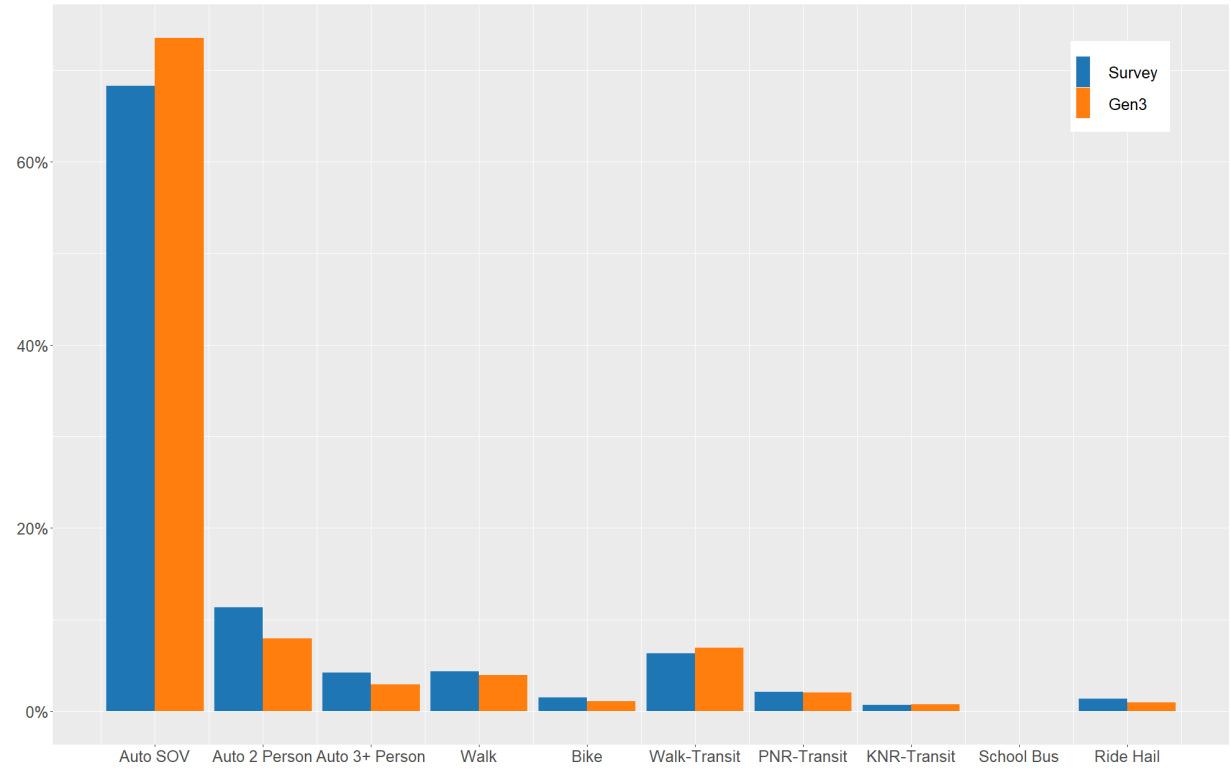

FIGURE 54: TRIP MODE CHOICE CALIBRATION RESULTS FOR TRIPS ON WORK TOURS

University and School Trips

The calibration constants for university trips are listed in Table 39 and the calibration constants for school trips are listed in Table 40. These trip purposes do not use any additional tour

composition constants like the work trip mode choice model does. The calibration results for trips on university tours are shown in Figure 55. University trip mode choice overestimates single-occupant vehicle, walk, and ridehail (taxi, TNC); the model underestimates shared-ride and walk access transit. Additionally, the university mode choice model does not allow a selection of school bus, which is shown in the survey data. The calibration results for trips on school tours are shown in Figure 56. The school mode choice model overestimates shared-ride trips and underestimates school bus trips.

TABLE 39: UNIVERSITY TRIP PURPOSE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	-1.10
Shared-Ride 3+	Drive Alone	0.31
Shared-Ride 3+	Shared-Ride 2	-1.75
Walk	Drive Alone	-2.75
Walk	Shared-Ride 2	-1.84
Walk	Shared-Ride 3+	-4.00
Bicycle	Walk	0.03
Walk Transit	Shared-Ride 2	-4.72
Walk Transit	Shared-Ride 3+	-4.00
Walk Transit	Walk	1.60
Walk Transit	Bicycle	0.00
Walk Transit	Taxi	-4.89
Walk Transit	TNC Single	-2.40
Walk Transit	TNC Shared	-15.00
Walk Transit	Metrorail	2.07
Walk Transit	Bus+Metrorail	2.36
Walk Transit	Commuter Rail	-4.00
Ridehail	Shared-Ride 2	-4.00
Ridehail	Shared-Ride 3+	-4.00
Ridehail	Walk	-0.32
Any	PNR Metrorail-Only	2.02
Any	PNR Bus+Metrorail	0.00
Any	PNR Commuter Rail	0.00
Any	KNR Metrorail-Only	9.05
Any	KNR Bus+Metrorail	-4.00
Any	KNR Commuter Rail	-4.00

TABLE 40: SCHOOL TRIP PURPOSE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	-1.24
Shared-Ride 3+	Drive Alone	-3.56
Shared-Ride 3+	Shared-Ride 2	-1.35
Walk	Drive Alone	-2.60
Walk	Shared-Ride 2	-3.09
Walk	Shared-Ride 3+	-5.70
Bicycle	Walk	-2.67
Walk Transit	Shared-Ride 2	-3.08
Walk Transit	Shared-Ride 3+	-4.00
Walk Transit	Walk	1.16
Walk Transit	Bicycle	0.00
Walk Transit	Taxi	-4.00
Walk Transit	TNC Single	-4.00
Walk Transit	TNC Shared	-15.00
Walk Transit	Metrorail	2.17
Walk Transit	Bus+Metrorail	1.14
Walk Transit	Commuter Rail	-4.00
Ridehail	Shared-Ride 2	-4.00
Ridehail	Shared-Ride 3+	-2.00
Ridehail	Walk	-2.00
School Bus	Shared-Ride 2	-11.31
School Bus	Shared-Ride 3+	-11.25
School Bus	Walk	-10.76
Any	PNR Metrorail-Only	2.71
Any	PNR Bus+Metrorail	0.00
Any	PNR Commuter Rail	0.00
Any	KNR Metrorail-Only	-4.00
Any	KNR Bus+Metrorail	1.65
Any	KNR Commuter Rail	-4.00

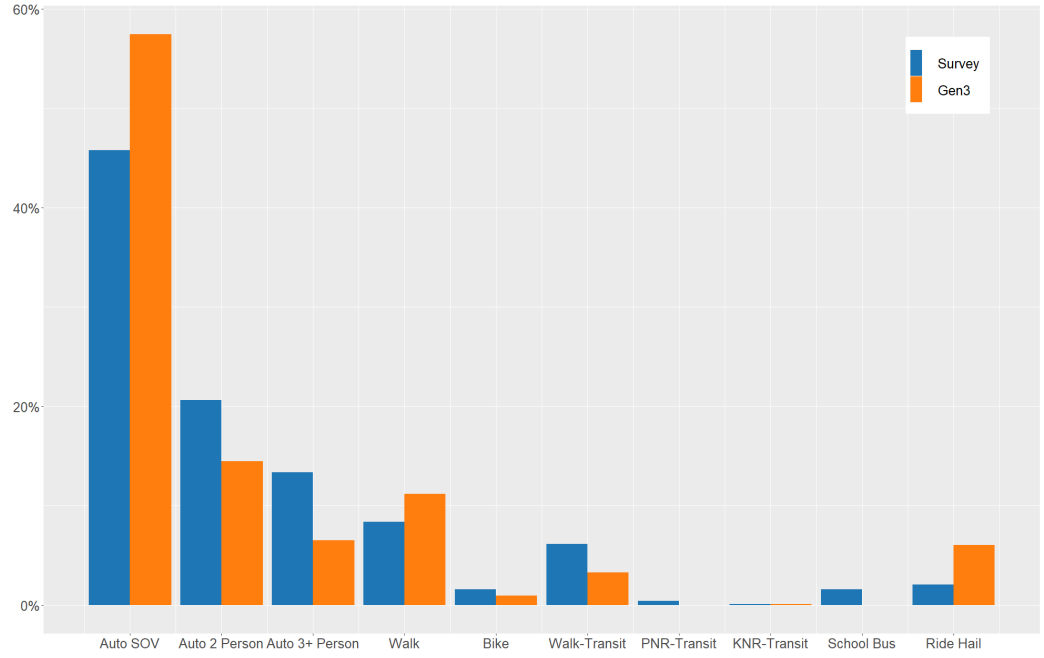

FIGURE 55: TRIP MODE CHOICE CALIBRATION RESULTS FOR UNIVERSITY TOURS

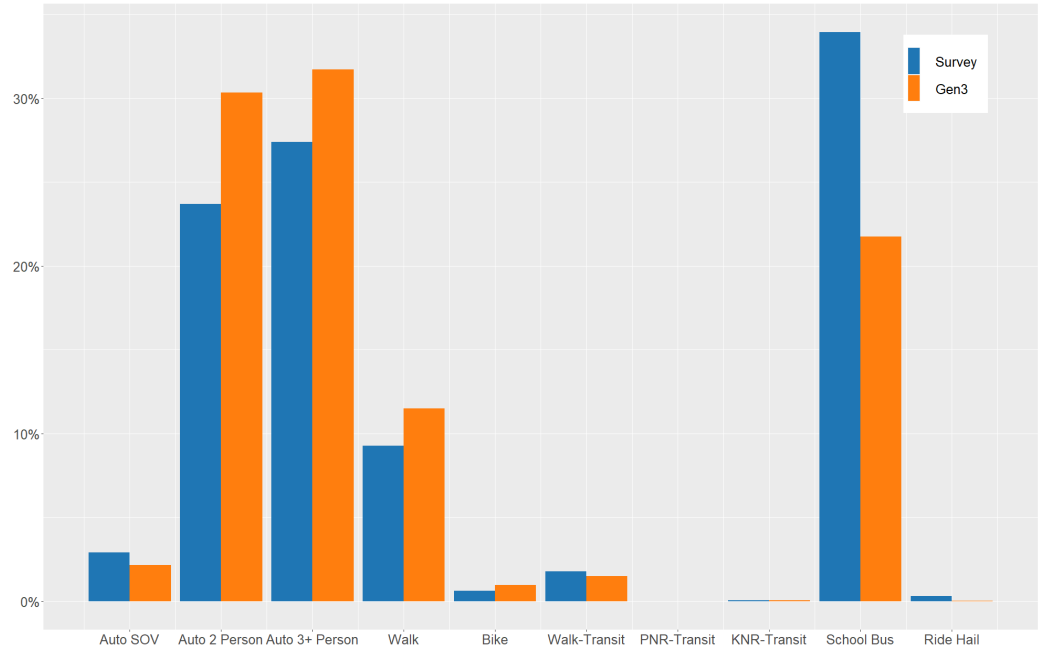

FIGURE 56: TRIP MODE CHOICE CALIBRATION RESULTS FOR SCHOOL TOURS

Non-Mandatory Trips

Non-mandatory trips include maintenance (shopping, escort, other maintenance) and discretionary trips (eat out, social-recreation, and other discretionary) trips. The calibration constants for maintenance trips are listed in Table 41 and the calibration constants for discretionary trips are listed in Table 42.

The calibration results for trips on individual maintenance tours is shown in Figure 57 and the calibration of trips on joint maintenance tours is shown in Figure 58. The individual trip model overestimates single-occupant vehicle trips and slightly underestimates shared-ride and walk trips. The joint tours model underestimates 2-person shared-ride trips and overestimates 3-person shared-ride trips.

The calibration of trips on individual discretionary tours is shown in Figure 59, and the calibration of trips on joint discretionary tours is shown in Figure 60. The individual trip mode choice model overestimates single-occupant vehicles and slightly underestimates shared-ride and walk trips. The joint trip mode choice model underestimates 2-person shared-ride trips and overestimates 3-person shared-ride trips.

TABLE 41: MAINTENANCE TRIP PURPOSE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	-0.67
Shared-Ride 3+	Drive Alone	-1.03
Shared-Ride 3+	Shared-Ride 2	-1.19
Walk	Drive Alone	-2.89
Walk	Shared-Ride 2	-4.08
Walk	Shared-Ride 3+	-5.96
Bicycle	Walk	-4.00
Walk Transit	Shared-Ride 2	-5.15
Walk Transit	Shared-Ride 3+	-5.86
Walk Transit	Walk	0.98
Walk Transit	Bicycle	4.00
Walk Transit	Taxi	-5.29
Walk Transit	TNC Single	-3.94
Walk Transit	TNC Shared	-15.00
Walk Transit	Metrorail	1.00
Walk Transit	Bus+Metrorail	1.43
Walk Transit	Commuter Rail	-4.00
Ridehail	Shared-Ride 2	-6.16
Ridehail	Shared-Ride 3+	-3.57
Ridehail	Walk	0.68
Any	PNR Metrorail-Only	0.00
Any	PNR Bus+Metrorail	0.00
Any	PNR Commuter Rail	0.00
Any	KNR Metrorail-Only	-1.21
Any	KNR Bus+Metrorail	0.00
Any	KNR Commuter Rail	0.00

TABLE 42: DISCRETIONARY TRIP PURPOSE CALIBRATION CONSTANTS

Tour Mode	Trip Mode	Constant
Shared-Ride 2	Drive Alone	-0.73
Shared-Ride 3+	Drive Alone	-0.90
Shared-Ride 3+	Shared-Ride 2	-1.46
Walk	Drive Alone	-3.16
Walk	Shared-Ride 2	-4.30
Walk	Shared-Ride 3+	-5.76
Bicycle	Walk	-0.42
Walk Transit	Shared-Ride 2	-4.71
Walk Transit	Shared-Ride 3+	-5.44
Walk Transit	Walk	0.71
Walk Transit	Bicycle	4.00
Walk Transit	Taxi	-5.56
Walk Transit	TNC Single	-2.79
Walk Transit	TNC Shared	-10.40
Walk Transit	Metrorail	1.54
Walk Transit	Bus+Metrorail	0.32
Walk Transit	Commuter Rail	1.07
Ridehail	Shared-Ride 2	-3.79
Ridehail	Shared-Ride 3+	-3.43
Ridehail	Walk	0.76
Any	PNR Metrorail-Only	5.29
Any	PNR Bus+Metrorail	1.17
Any	PNR Commuter Rail	6.65
Any	KNR Metrorail-Only	1.32
Any	KNR Bus+Metrorail	-2.24
Any	KNR Commuter Rail	5.88

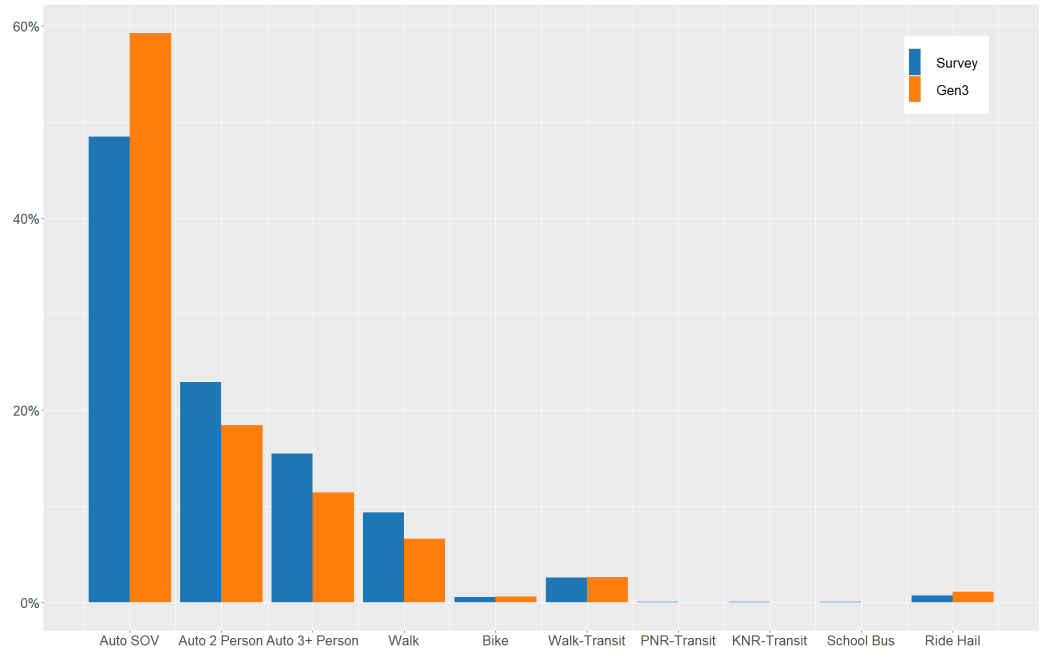

FIGURE 57: TRIP MODE CHOICE CALIBRATION RESULTS FOR INDIVIDUAL MAINTENANCE TOURS

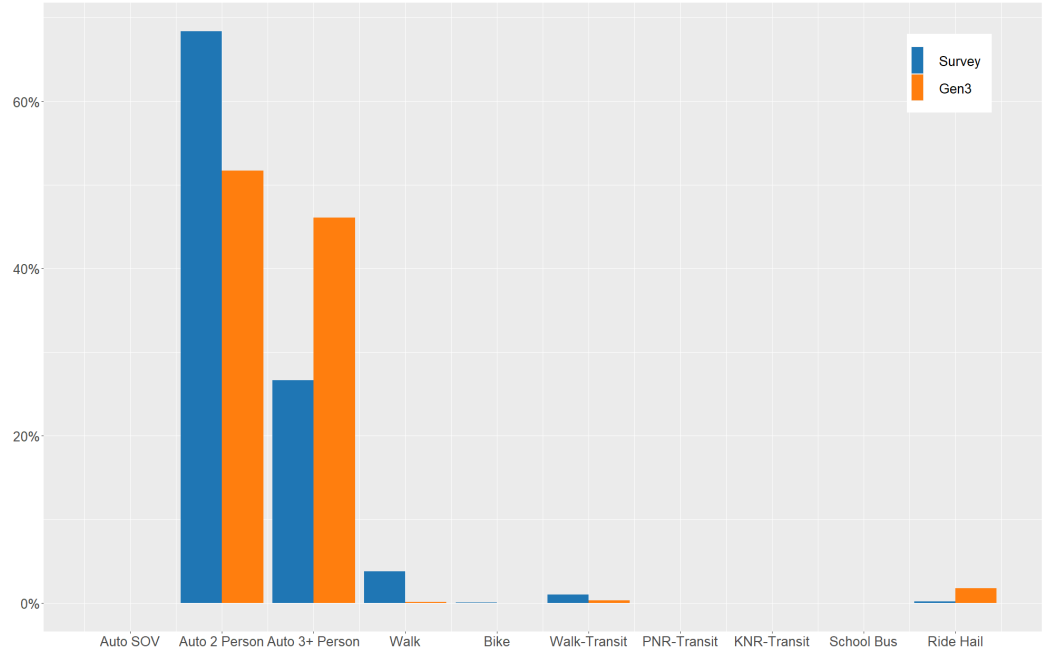

FIGURE 58: TRIP MODE CHOICE CALIBRATION RESULTS FOR JOINT MAINTENANCE TOURS

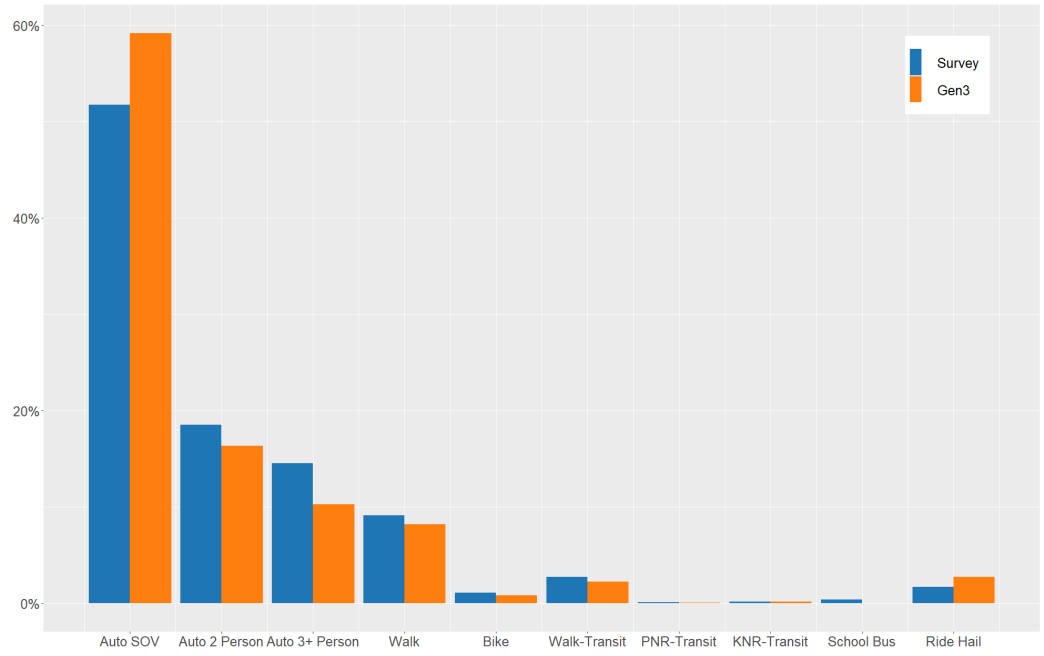

FIGURE 59: TRIP MODE CHOICE CALIBRATION RESULTS FOR INDIVIDUAL DISCRETIONARY TOURS

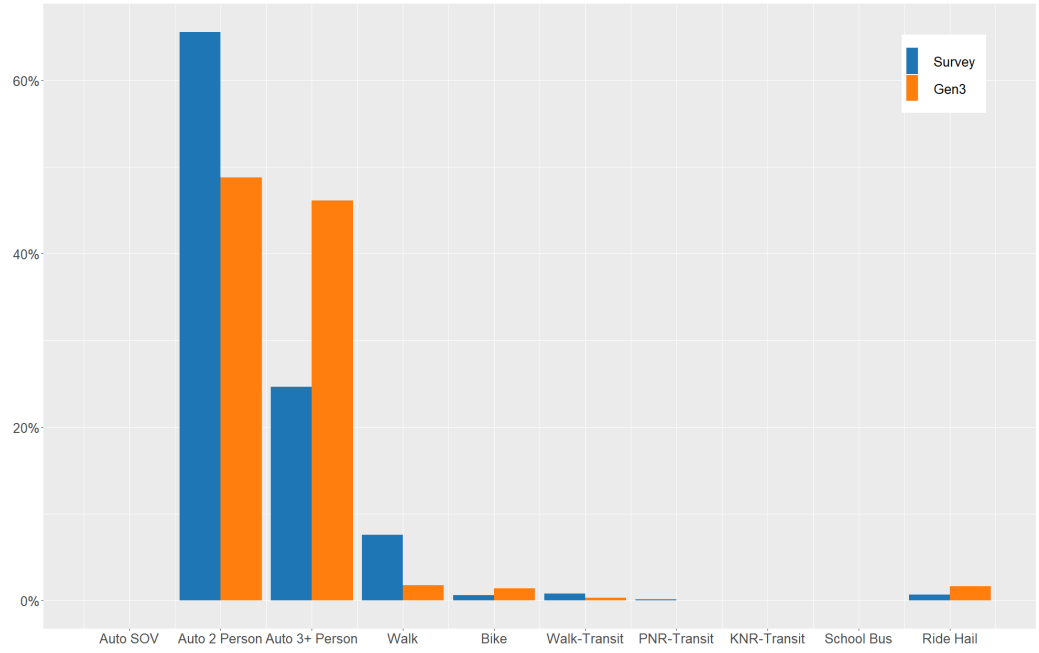

FIGURE 60: TRIP MODE CHOICE CALIBRATION RESULTS FOR JOINT DISCRETIONARY TOURS

3.0 HIGHWAY VALIDATION

The highway assignment validation is based on a comparison of model highway assignment output to observed data, which includes traffic count data collected by local jurisdictions and the Highway Performance Monitoring System (HPMS) vehicle miles of travel (VMT) data, which is developed based on data collected by the state departments of transportation (DOTs). Table 43lists the comparison of highway assignment to traffic counts by jurisdiction and facility type, as well as the ratio of estimated volume to observed count. This table shows that the model estimates are 2% higher than observed traffic counts. Area types are numbered one through six, where one is extremely densely developed, and area type 6 is very sparsely developed. Estimated traffic for area types 1-5 is within 6% of counts. All facility types except collectors are within 8% of counts; collector model assignment is 14% lower than counts.

Table 43 lists the comparison of estimated average weekday traffic volumes to observed AAWDT traffic counts by jurisdiction. Most of the TPB planning area jurisdictions have overall estimated-to-observed ratios for traffic volumes that are within 10%.

TABLE 43: HIGHWAY ASSIGNMENT VOLUME TO OBSERVED COUNT COMPARISON BY JURISDICTION AND FACILITY TYPE (ON LINKS WITH COUNTS)

JURISDICTION	FREE-WAY	MAJOR ARTERIAL	MINOR ARTERIAL	COLLECTOR	EXPRESS-WAY	TOTAL*
District of Columbia	0.90	1.24	1.14	1.05	0.78	1.10
Montgomery County	0.99	1.13	1.08	0.82	1.44	1.07
Prince George's County	0.94	0.97	0.92	0.71	0.92	0.93
Arlington County	0.93	0.89	0.91	0.87	1.06	0.91
City of Alexandria	1.04	1.03	1.02	1.46	-	1.04
Fairfax County	0.96	0.92	0.95	0.89	0.93	0.94
Loudoun County	0.74	1.08	1.31	0.97	0.75	1.06
Prince William County	1.12	1.11	0.94	0.79	1.08	1.02
Frederick County	1.11	1.12	1.33	0.95	1.05	1.14
Howard County	1.09	1.27	1.16	1.06	0.94	1.08
Anne Arundel County	1.02	1.02	1.01	1.00	1.06	1.02
Charles County	-	1.18	0.92	0.76	-	1.08
Carrol County	1.15	1.31	2.00	0.98	-	1.48
Calvert County	-	0.87	1.05	0.76	-	0.88
St. Mary's County	-	0.93	0.88	0.93	-	0.91
King George County	-	0.93	0.91	0.82	-	0.91
City of Fredericksburg	0.93	0.94	1.65	0.46	-	1.05
Stafford County	1.14	1.17	1.08	0.62	-	1.02
Spotsylvania County	0.97	0.91	0.72	0.55	-	0.78
Fauquier County	1.23	0.96	1.41	1.76	-	1.13
Clarke County	-	1.43	1.65	-	-	1.52
Jefferson County	1.23	1.87	2.29	1.09	-	1.73
TOTAL	1.00	1.07	1.04	0.86	0.92	1.02

* The FDOT standard for estimated/observed VMT areawide is +/- 5% (acceptable) and +/- 2% (preferable)Table 44 lists the comparison of estimated volume to observed count on screenlines, which is also shown in Figure 61. Over half of the screenlines are within 15% of the observed volume, and two thirds of them are within 20% of the observed volume.

It is worth noting that, in an iterative process to improve the highway validation performance, incremental model adjustments were made both on the demand side and on the supply (network) side. On the demand side, the calibration adjustments in ActivitySim have been discussed in the previous chapter. On the network side, RSG kept the 11-minute Potomac River crossing time penalty that is implemented in the Gen2 Regional Travel Demand Model and introduced a 5-minute time penalty on all the Anacostia River bridge crossings. RSG also changed the facility type coding on some of the Anacostia River bridges and their upstream/downstream links based on aerial photography. In addition, COG reviewed the coding of screenline links in DC (specifically, Screenline 2 and Screenline 4) and their upstream and downstream links and revised the number-of-lane coding on those links in consideration of the time-of-day on-street parking in DC. The final highway validation results presented in this report reflect all these model adjustments.

TABLE 44: ESTIMATE/OBSERVED TRAFFIC VOLUMES ON REGIONAL SCREENLINES

SCREEN-LINE	FREEWAY	MAJOR ARTERIAL	MINOR ARTERIAL	COLLECTOR	EXPRESS-WAY	TOTAL	STD
1	1.17	0.64	1.04	1.07	-	0.98	+/- 0.1
2	-	1.24	1.39	1.20	0.76	1.18	+/- 0.1
3	1.04	0.97	0.87	0.73	-	0.98	+/- 0.1
4	0.00	1.40	1.22	1.17	0.76	1.17	+/- 0.1
5	0.88	1.00	1.14	1.00	-	0.99	+/- 0.1
6	0.97	1.05	0.90	0.50	0.80	0.93	+/- 0.1
7	0.92	0.98	0.97	0.62	0.84	0.93	+/- 0.1
8	0.98	1.19	0.93	0.67	1.19	1.04	+/- 0.1
9	1.03	1.53	1.01	1.00	-	1.14	+/- 0.1
10	0.96	1.14	0.94	1.48	-	1.12	+/- 0.1
11	1.03	0.87	1.15	0.86	-	0.96	+/- 0.1
12	0.96	1.28	1.44	0.78	-	1.10	+/- 0.1
13	0.96	1.26	1.62	-	-	1.11	+/- 0.1
14	0.89	1.10	0.66	0.39	-	0.85	+/- 0.1
15	0.78	0.94	0.92	0.83	-	0.84	+/- 0.1
16	0.83	1.14	0.83	0.32	-	0.80	+/- 0.1
17	1.00	0.92	0.95	0.89	-	0.96	+/- 0.1
18	0.95	0.71	1.10	1.28	0.76	0.91	+/- 0.1
19	0.89	1.08	0.97	0.73	0.74	0.86	+/- 0.1

SCREEN-LINE	FREEWAY	MAJOR ARTERIAL	MINOR ARTERIAL	COLLECTOR	EXPRESS-WAY	TOTAL	STD
20	1.21	1.15	-	-	0.80	1.06	+/- 0.1
22	0.95	1.09	0.97	0.59	1.01	0.96	+/- 0.1
23	1.25	1.46	0.87	0.28	-	1.05	+/- 0.2
24	0.88	0.91	0.80	0.88	-	0.87	+/- 0.1
25	1.35	-	1.60	2.22	-	1.43	+/- 0.1
26	1.23	-	1.60	3.31	1.35	1.39	+/- 0.2
27	1.37	1.19	0.98	1.31	-	1.28	+/- 0.1
28	-	0.88	0.93	0.88	-	0.89	+/- 0.1
31	-	2.12	2.50	2.50	-	2.38	+/- 0.1
32	-	1.80	1.72	-	-	1.77	+/- 0.2
33	1.27	1.00	1.39	-	-	1.21	+/- 0.2
34	-	1.11	1.52	-	-	1.20	+/- 0.1
35	1.07	0.82	0.80	0.39	0.77	0.92	+/- 0.1
36	-	1.76	3.17	-	-	1.91	+/- 0.2
37	-	-	1.91	2.87	-	1.94	+/- 0.2
38	-	1.04	0.47	0.66	-	0.76	+/- 0.1

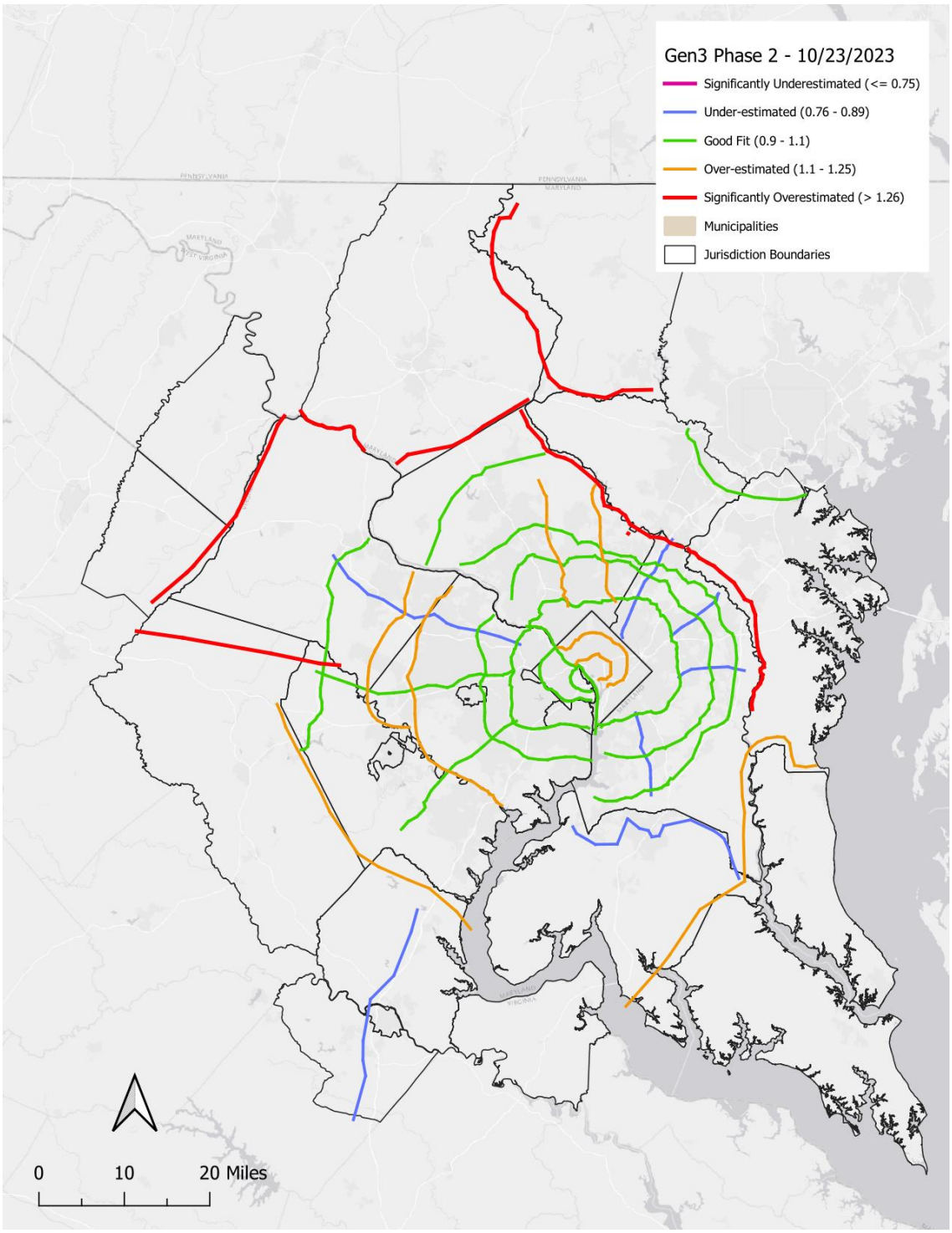

FIGURE 61: ESTIMATED-TO-OBSERVED TRAFFIC VOLUMES ON SCREENLINES

Table 45 shows the estimated VMT compared to the observed VMT by jurisdiction. This table includes the comparison for links with counts available. Table 47, on the other hand, shows the estimated VMT compared to the HPMS-based VMT data for all network links. As shown in the two tables, most of the jurisdictions are within 10% of both count-based VMT and HPMS VMT estimates. Almost all the jurisdictions are within 20% of count-based VMT and only a few of them fall outside the +/- 20% range when compared to the HPMS VMT data.

TABLE 45: ESTIMATED VMT COMPARED TO OBSERVED VMT BY AREA TYPE BASED ON LINKS WITH COUNTS

AREA TYPE	OBSERVED 2018	GEN3 2018	GEN2 2018	GEN 3 E/O	GEN2 E/O	STANDARD (ACCEPTABLE/ PREFERABLE)
1: High mixed employment and population density	9,843,948	10,471,897	10,328,977	1.06	1.04	± 25% / ± 15%
2: Medium/high mixed density	31,266,106	30,135,265	31,049,705	0.96	0.98	± 25% / ± 15%
3: Medium employment density	27,384,672	26,084,149	26,166,926	0.95	0.96	± 25% / ± 15%
4: Medium population density	17,129,636	17,155,266	17,739,028	1.00	1.03	± 25% / ± 15%
5: Low density	19,077,729	20,074,303	19,874,883	1.05	1.04	± 25% / ± 15%
6: Rural	10,562,619	13,299,889	12,944,715	1.26	1.23	± 25% / ± 15%
TOTAL	115,264,710	117,220,770	118,104,234	1.02	1.02	

* Based on 7,889 directional links with daily traffic counts in 2018

TABLE 46: ESTIMATED VMT COMPARED TO OBSERVED VMT BY FACILITY TYPE BASED ON LINKS WITH COUNTS

FACILITY TYPE	OBSERVED 2018	GEN3 2018	GEN2 2018	GEN 3 E/O	GEN2 E/O	STANDARD (ACCEPTABLE/ PREFERABLE)
Freeway	39,264,889	39,220,971	41,149,106	1.00	1.04	± 7% / ± 6%
Major Arterial	35,108,530	37,684,917	37,418,680	1.07	1.06	± 15% / ± 10%
Minor Arterial	25,577,725	26,581,807	26,101,599	1.04	1.02	± 15% / ± 10%
Collector	6,046,370	5,193,325	4,865,434	0.86	0.80	± 25% / ± 20%
Expressway	9,233,286	8,539,749	8,536,418	0.92	0.92	± 15% / ± 10%
TOTAL	115,264,710	117,220,770	118,104,234	1.02	1.02	± 5% / ± 2%

* Based on 7,889 directional links with daily traffic counts in 2018

A comparison of the VMT by jurisdiction to HPMS is listed in Table 46. The Gen3 model is closer to the observed HPMS VMT for the TPB planning area, the air quality nonattainment area, and the non-TPB member area. The City of Alexandria, Loudon County, St. Mary's County, and Stafford County have the largest differences between the Gen2 and Gen3 models.

Compared to the Gen2 Model, the Gen3 model performs better for most TPB Member jurisdictions (Montgomery County, Prince George's County, City of Alexandria, Loudon County, Prince William County, Frederick County, and Charles County). In the cases where the Gen2 model performed better than the Gen3 model, no model-related problems have been identified. The underestimation for DC can be attributed to screenline counts that indicate less traffic should be going to DC while VMT suggests more traffic in DC. In DC and in other TPB member jurisdictions, the assignment underperformance can be attributed to one or more factors of land use problems, potential traffic count problems, or network coding errors. Outside of the TPB member area, Spotsylvania County's observed VMT includes the entire county while the Gen3 model VMT includes only the northern portion of the county. The remaining non-TPB member counties may have similar potential issues as the member counties but may also have travel patterns that differ significantly from the rest of the region, thus leading to model volumes that are over- or under-assigned.

TABLE 47: MODELED VS. HPMS-BASED OBSERVED VMT BY JURISDICTION (FOR ALL LINKS)

JURISDICTION NAME	OBSERVED (HPMS) VMT	GEN3 ESTIMATED VMT	GEN2 ESTIMATED VMT	GEN3 ESTIMATED / OBSERVED	GEN2 ESTIMATED/ OBSERVED
District of Columbia	8,410,547	7,910,970	8,160,131	0.94	0.97
Montgomery County	20,844,658	21,262,946	20,794,264	1.02	1.00
Prince George's County	25,320,822	23,804,090	22,659,440	0.94	0.89
Arlington County	4,115,600	3,954,138	4,109,213	0.96	1.00
City of Alexandria	1,851,663	2,313,215	2,140,651	1.25	1.16
Fairfax County	28,284,350	27,625,667	28,111,767	0.98	0.99
Loudoun County	7,342,782	8,242,056	7,449,609	1.12	1.01
Prince William County	10,300,396	10,334,469	10,162,646	1.00	0.99
Frederick County	8,391,370	9,187,713	9,066,690	1.09	1.08
Howard County	11,526,986	12,039,208	11,426,554	1.04	0.99
Anne Arundel County	16,518,082	16,091,749	16,058,595	0.97	0.97
Charles County	3,426,164	3,344,053	3,237,059	0.98	0.94
Carrol County	3,408,904	4,557,115	4,381,657	1.34	1.29
Calvert County	2,019,452	1,537,028	1,652,935	0.76	0.82

St. Mary's County	2,367,534	1,960,673	2,134,629	0.83	0.90
King George County	932,207	839,996	835,845	0.90	0.90
City of Fredericksburg	990,749	888,728	894,269	0.90	0.90
Stafford County	4,358,421	4,301,302	4,716,562	0.99	1.08
Spotsylvania County**	3,774,287	2,402,300	2,376,420	0.64	0.63
Fauquier County***	3,686,566	3,659,825	3,802,460	0.99	1.03
Clarke County	827,733	1,125,154	1,082,114	1.36	1.31
Jefferson County	1,069,310	1,517,889	1,505,290	1.42	1.41
Total	169,768,582	168,900,286	166,758,800	0.99	0.98
TPB Planning Area	118,288,351	117,979,318	115,891,470	1.00	0.98
Non-TPB Member Area	51,480,231	50,920,968	50,867,330	0.99	0.99
Air Quality Nonattainment Area (8-Hour Ozone)	120,307,803	119,516,346	117,544,405	0.99	0.98

* The observed VMT data is from HPMS.

** Observed VMT is for the entire Spotsylvania County while Estimated is for northern portion of county only.

*** Fauquier County urbanized area was part of TPB Planning Area as of 2023. Fauquier County, however, is not included as a TPB member in this summary as the HPMS VMT data is only available for the whole county.

§ Florida DOT standard for estimated-over-observed VMT Areawide is ±5% (acceptable) and ±2% (preferable).

§§ MWCOG standard for estimated-over-observed VMT for DC is between 1.0 and 1.03[16].

The percent root mean square error (RMSE) by facility type is listed in Table 48. RMSE for freeways is excellent, and the RMSE for expressways and major arterials is good.

TABLE 48: HIGHWAY ASSIGNMENT RMSE BY FACILITY TYPE

FACILITY TYPE	NUMBER OF OBSERVED COUNTS	SUM OF SQUARED DIFFERENCE	SUM OF OBSERVED COUNTS	GEN3 PERCENT RMSE	GEN2 PERCENT RMSE*
Freeway	661	105,864,531,190	39,175,583	21.4%	24.38%
Major Arterial	2,069	88,440,506,272	35,160,052	38.5%	38.96%
Minor Arterial	3,375	51,530,973,881	25,794,076	51.1%	48.52%
Collector	1,711	14,808,473,651	6,445,884	78.1%	76.67%
Expressway	251	48,875,176,740	9,255,438	37.8%	36.14%

[16] MWCOG. Gen3 Model Development Task Order 5 Scope of Work. 7/5/2023.

Ramp	2	26,027,583	33,910	21.3%	4.11%
TOTAL	8,069	309,545,689,318	115,864,943	43.1%	44.22%

* Year 2018 Validation of TPB Version 2.4 Travel Model

The RMSE by area type is listed in Table 49. The RMSE for area types 1-5 is good. The RMSE by jurisdiction is listed in Table 50. Many jurisdictions have good RMSE scores (below 40% RMSE).

TABLE 49: HIGHWAY ASSIGNMENT RMSE BY AREA TYPE

AREA TYPE	NUMBER OF OBSERVED COUNTS	SUM OF SQUARED DIFFERENCE	SUM OF OBSERVED COUNTS	GEN3 PERCENT RMSE
1	807	42,154,854,383	10,038,017	58.1%
2	1,982	83,919,692,104	31,530,660	40.9%
3	1,271	75,491,391,528	27,407,090	35.7%
4	1,137	37,576,215,433	17,191,331	38.0%
5	1,275	40,419,796,495	19,109,588	37.6%
6	1,597	29,983,739,375	10,588,257	65.4%
TOTAL	8,069	309,545,689,318	115,864,943	43.1%

TABLE 50: HIGHWAY ASSIGNMENT RMSE BY JURISDICTION

JURISDICTION	NUMBER OF OBSERVED COUNTS	SUM OF OBSERVED COUNTS	GEN3 PERCENT RMSE	GEN2 PERCENT RMSE
District of Columbia	1,363	13,689,128	67.6%	64.6%
Montgomery County	857	15,104,533	30.3%	29.5%
Prince George's County	830	17,192,570	36.4%	37.9%
Arlington County	348	4,912,374	49.2%	51.3%
City of Alexandria	132	2,391,200	30.2%	33.9%
Fairfax County	1,540	23,864,008	40.0%	43.9%
Loudoun County	338	3,070,888	57.4%	54.6%
Prince William County	445	6,265,650	39.3%	43.6%
Frederick County	374	3,827,168	47.2%	48.6%
Howard County	222	5,584,580	31.4%	31.8%

Anne Arundel County	456	9,991,954	33.6%	32.5%
Charles County	176	1,356,056	59.2%	60.5%
Carrol County	174	1,241,916	84.6%	80.9%
Calvert County	98	806,624	32.6%	22.6%
St. Mary's County	120	815,868	32.0%	30.7%
King George County	50	271,000	36.7%	31.6%
City of Fredericksburg	44	777,134	37.7%	38.5%
Stafford County	148	1,852,468	44.7%	62.1%
Spotsylvania County	96	986,600	42.0%	41.7%
Fauquier County	134	1,117,082	36.0%	34.7%
Clarke County	38	321,500	64.5%	58.4%
Jefferson County	86	424,642	116.9%	119.4%
Total	8,069	115,864,943	43.1%	44.2%

The Root Mean Square Error comparison by volume group is shown in Table 51. The RMSE for the Gen2 and Gen3 models are very similar.

TABLE 51: VOLUME GROUP RMSE COMPARISON

VOLUME GROUP	NUMBER OF OBSERVED COUNTS	GEN3 PERCENT RMSE	GEN2 PERCENT RMSE	STANDARD
< 5,000	2,635	116.0%	112.7%	100%
5,000 – 9,999	1,969	56.9%	58.3%	45%
10,000 – 14,999	1,169	42.6%	42.3%	35%
15,000 – 19,999	727	34.4%	33.5%	30%
20,000 – 29,999	731	29.5%	31.1%	27%
30,000 – 49,999	392	27.4%	27.9%	25%
50,000 – 59,999	116	23.8%	22.7%	20%
60,000 +	330	19.4%	21.3%	19%

4.0 TRANSIT VALIDATION

The transit validation is based on observed transit data from the transit providers (WMATA, MARC, VRE, and the Federal Transit Administration's National Transit Data). A summary of the transit validation is listed in Table 52. All of the major modes – Metrorail, Commuter Rail, and bus (All Bus in the table) are within 5% and overall transit is 2% overestimated.

TABLE 52: TRANSIT LOADING SUMMARY

TRANSIT MODE	MODEL ESTIMATE	OBSERVED RIDERSHIP	EST / OBS	STANDARD (ACCEPTABLE)[17]	STANDARD (PREFERABLE)
Metrorail*	**653,644**	**641,227**	**1.02**	**+/- 9%**	**+/- 3%**
Commuter Rail	**54,014**	**57,989**	**0.93**	**+/- 9%**	**+/- 3%**
MARC	*38,895*	*39,498*	*0.98*	+/- 9%	+/- 3%
VRE	*15,119*	*18,491*	*0.82*	+/- 9%	+/- 3%
All Bus**	**592,719**	**575,642**	**1.03**	**+/- 9%**	**+/- 3%**
Metrobus Total	*363,780*	*360,000*	*1.01*	+/- 9%	+/- 3%
Other Bus in WMATA Area	*162,414*	*141,390*	*1.15*	+/- 9%	+/- 3%
Other Bus not in WMATA Area	*66,525*	*74,252*	*0.90*	+/- 9%	+/- 3%
Total Transit[18]	**1,300,377**	**1,273,449**	**1.02**	+/- 9%	+/- 3%

** Source: RSG. Gen3 Data Development. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, December 29, 2021, Table 3-11, https://www.mwcog.org/assets/1/6/Gen3_Phase_1_Data_Development_Report_Final.pdf*

** * Source: Meseret Seifu and Sanghyeon Ko, "Year-2018 Validation of TPB Version 2.4 Travel Model", COG/TPB Memorandum, August 17, 2021. Note that the observed bus ridership data includes I-X and X-I bus trips made by residents/non-residents of the TPB modeled area while the Ver. 2.4 Model simulates only resident I-I trips. However, the I-X and X-I bus trips which likely use commuter buses, accounted for only a very small fraction of total bus ridership (0.63 %). The Gen3 Model similarly models only resident I-I trips but does include visitor and I-X and X-I transit trips. Again, this is a small fraction of bus ridership, but a slightly larger fraction of commuter rail ridership (about 1%).*

Table 53 lists the station group ridership for Metrorail. Most station groups are within 20% of the observed data.

[17] Cambridge Systematics. FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards. 10/2/2008.
[18] Metrorail + Commuter Rail + All Bus; note that Metrobus Total + Other Bus in WMATA Area + Other Bus not in WMATA Area = All Bus

TABLE 53: METRORAIL STATION GROUP BOARDING COMPARISON

STATION GROUP	STATION GROUP NAME	MODEL ESTIMATE	OBSERVED RIDERSHIP	EST / OBS	STANDARD (ACCEPTABLE/ PREFERABLE)
1	Red Line - "A" route MD outside Beltway	20,049	28,038	0.72	± 20% / ± 15%
2	Red Line - "A" route MD inside Beltway	21,954	22,663	0.97	± 20% / ± 15%
3	Red Line - "A" route DC non-core	25,655	22,157	1.16	± 20% / ± 15%
4	Red Line - DC core	146,992	134,602	1.09	± 20% / ± 15%
5	Red Line - "B" route DC non-core	26,139	24,075	1.09	± 20% / ± 15%
6	Red Line - "B" route MD	20,393	22,873	0.89	± 20% / ± 15%
7	Green Line - "E" route MD	11,119	17,003	0.65	± 25% / ± 20%
8	Green Line - "E" route DC non-core	16,710	22,469	0.74	± 20% / ± 15%
9	Green Line - DC core	44,443	38,192	1.16	± 20% / ± 15%
10	Green Line - "F" route DC non-core	27,143	21,253	1.28	± 20% / ± 15%
11	Green Line - "F" route MD	14,440	17,359	0.83	± 25% / ± 20%
12	Blue/Yellow Line - VA Fairfax	16,350	16,027	1.02	± 25% / ± 20%
13	Blue/Yellow Line - VA Alexandria	12,063	13,536	0.89	± 25% / ± 20%
14	Blue/Yellow Line - VA Core	30,156	45,438	0.66	± 20% / ± 15%
15	Orange Line - VA Fairfax	9,814	15,724	0.62	± 25% / ± 20%
16	Orange Line - VA Arlington non-core	30,919	28,802	1.07	± 20% / ± 15%
17	Orange/Blue Line - VA/DC core	112,339	95,840	1.17	± 20% / ± 15%
18	Orange/Blue Line - DC non-core	15,918	11,628	1.37	± 25% / ± 20%
19	Orange Line - DC/MD	14,443	13,401	1.08	± 25% / ± 20%
20	Blue Line - DC/MD	20,130	13,680	1.47	± 25% / ± 20%
21	Silver Line - Phase I & Phase 2	16,473	16,466	1.00	± 25% / ± 20%
	Total for Red Line Station Groups	261,183	254,408	1.03	± 20% / ± 15%
	Total for Green Line Station Groups	113,856	116,276	0.98	± 20% / ± 15%

STATION GROUP	STATION GROUP NAME	MODEL ESTIMATE	OBSERVED RIDERSHIP	EST / OBS	STANDARD (ACCEPTABLE/ PREFERABLE)
	Total for Blue/Yellow Line Station Groups	58,569	75,001	0.78	± 20% / ± 15%
	Total for Orange/Blue Line Station Groups	203,563	179,075	1.14	± 20% / ± 15%
	Total for Silver Line Station Groups	16,473	16,466	1.00	± 20% / ± 15%
	Grand Total	653,644	641,226	1.02	± 9% / ± 3%

Note: * FDOT standard for transit ridership >20,000 passengers per day is ±20% (acceptable) and ±15% (preferable) and is ±25% (acceptable) and ±20% (preferable) for 10k-20k passengers per day.

Table 54 lists the station boardings for commuter rail stations. There is a lot of variability from station to station, which may be due to reasons that the model cannot replicate (such as personal preference, as opposed to the closest station).

TABLE 54: COMMUTER RAIL STATION BOARDING COMPARISON

CR SERVICE	CR LINE	STATION NAME	MODEL ESTIMATE	OBSERVED BOARDINGS*	EST / OBS	STANDARD (ACCEPTABLE/ PREFERABLE)
MARC	Penn	***External***	6,956	6,421	1.08	± 35% / ± 25%
MARC	Penn	BWI Airport	444	2,339	0.19	± 65% / ± 35%
MARC	Penn	Odenton	3,664	3,334	1.10	± 65% / ± 35%
MARC	Penn	Bowie State	853	265	3.22	± 150% / ± 100%
MARC	Penn	Seabrook	1,716	517	3.32	± 150% / ± 100%
MARC	Penn	New Carrollton	1,628	1,763	0.92	± 100% / ± 65%
MARC	Camden	***External***	469	440	1.07	± 150% / ± 100%
MARC	Camden	Dorsey	422	554	0.76	± 150% / ± 100%
MARC	Camden	Jessup	9	10	0.96	± 150% / ± 100%
MARC	Camden	Savage	263	461	0.57	± 150% / ± 100%
MARC	Camden	Laurel	1,762	658	2.68	± 150% / ± 100%
MARC	Camden	Muirkirk	595	444	1.34	± 150% / ± 100%
MARC	Camden	Greenbelt	47	71	0.66	± 150% / ± 100%
MARC	Camden	College Park	559	213	2.63	± 150% / ± 100%
MARC	Camden	Riverdale	240	109	2.20	± 150% / ± 100%
MARC	Brunswick	***External***	195	77	2.53	± 150% / ± 100%

CR SERVICE	CR LINE	STATION NAME	MODEL ESTIMATE	OBSERVED BOARDINGS*	EST / OBS	STANDARD (ACCEPTABLE/ PREFERABLE)
MARC	Brunswick	Duffields	175	98	1.79	± 150% / ± 100%
MARC	Brunswick	Harpers Ferry	270	66	4.07	± 150% / ± 100%
MARC	Brunswick	Brunswick	269	367	0.73	± 150% / ± 100%
MARC	Brunswick	Point of Rocks	320	334	0.96	± 150% / ± 100%
MARC	Brunswick	Dickerson	5	29	0.16	± 150% / ± 100%
MARC	Brunswick	Barnesville	2	90	0.02	± 150% / ± 100%
MARC	Brunswick	Boyds	23	22	1.03	± 150% / ± 100%
MARC	Brunswick	Germantown	665	756	0.88	± 150% / ± 100%
MARC	Brunswick	Metropolitan Grove	116	357	0.32	± 150% / ± 100%
MARC	Brunswick	Gaithersburg	574	549	1.05	± 150% / ± 100%
MARC	Brunswick	Washington Grove	20	88	0.23	± 150% / ± 100%
MARC	Brunswick	Rockville	981	336	2.92	± 150% / ± 100%
MARC	Brunswick	Garrett Park	28	224	0.13	± 150% / ± 100%
MARC	Brunswick	Kensington	63	192	0.33	± 150% / ± 100%
MARC	Brunswick	Silver Spring	1,105	452	2.45	± 150% / ± 100%
MARC	Brunswick	Monocacy/I-270	194	195	1.00	± 150% / ± 100%
MARC	Brunswick	Frederick	4	114	0.04	± 150% / ± 100%
VRE	Fredericksburg	Spotsylvania	333	661	0.71	± 150% / ± 100%
VRE	Fredericksburg	Fredericksburg	2,277	817	2.79	± 150% / ± 100%
VRE	Fredericksburg	Leeland Road	172	832	0.21	± 150% / ± 100%
VRE	Fredericksburg	Brooke	538	479	1.12	± 150% / ± 100%
VRE	Fredericksburg	Quantico	803	457	1.76	± 150% / ± 100%
VRE	Fredericksburg	Rippon	432	572	0.75	± 150% / ± 100%
VRE	Fredericksburg	Woodbridge	788	619	1.27	± 150% / ± 100%
VRE	Fredericksburg	Lorton	240	749	0.32	± 150% / ± 100%
VRE	Fredericksburg	Franconia-Spgfld	250	327	0.77	± 150% / ± 100%
VRE	Manassas	Broad Run/Airport	121	1,005	0.12	± 100% / ± 65%

CR SERVICE	CR LINE	STATION NAME	MODEL ESTIMATE	OBSERVED BOARDINGS*	EST / OBS	STANDARD (ACCEPTABLE/ PREFERABLE)
VRE	Manassas	Manassas City	1,080	809	1.33	± 150% / ± 100%
VRE	Manassas	Manassas Park	426	687	0.62	± 150% / ± 100%
VRE	Manassas	Burke Center	397	977	0.41	± 150% / ± 100%
VRE	Manassas	Rolling Road	164	453	0.36	± 150% / ± 100%
VRE	Manassas	Backlick Road	143	284	0.50	± 150% / ± 100%
VRE	Fredericksburg+ Manassas	Alexandria	1,556	759	2.05	± 150% / ± 100%
VRE	Fredericksburg+ Manassas	Crystal City	229	1,644	0.14	± 100% / ± 65%
VRE	Fredericksburg+ Manassas	L'Enfant Plaza	2,498	3,813	0.65	± 65% / ± 35%
	All Lines	Union Station	16,494	19,240	0.86	± 25% / ± 20%
MARC	MARC Lines	MARC Stations	38,738	38,795	1.00	± 20% / ± 15%
VRE	VRE Lines	VRE Stations	14,839	18,332	0.81	± 25% / ± 20%
TOTAL			**53,576**	**57,128**	**0.94**	

* Station boardings only, does not include transfers

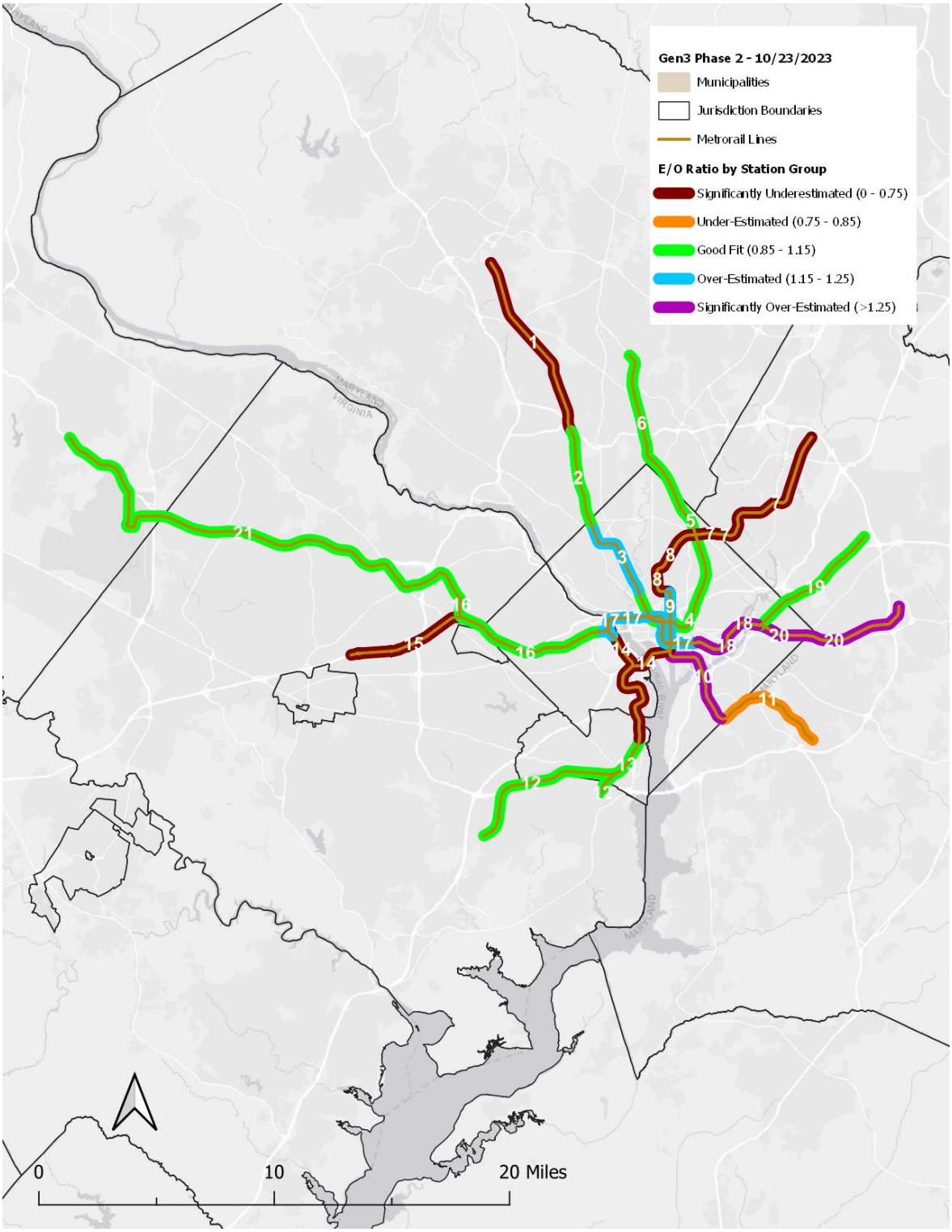

FIGURE 62: METRORAIL STATION GROUP GEN3 ESTIMATED/OBSERVED

5.0 CONCLUSION

The highway and transit validation results for the Gen3, Version 1.0, Model are reasonable for regional model scenarios testing highway and transit capacity projects. The validation metrics of the model generally conform to the federal and state benchmarking standards. The highway validation performance is comparable to that of the current adopted, production-use Gen2 Travel Demand Model; the transit validation performance remains solid for Metrorail and has largely improved for commuter rail and bus as compared to the Gen2 Model (for both validation years of 2014 and 2018).the model validation results presented in this report suggest that the Gen3 Model is ready for use with COG/TPB's production work activities, although COG plans to further evaluate the usability of the model for production work by running it for the upcoming air quality conformity analysis for the Visualize 2050 Long-Range Transportation Plan (LRTP) update.

In addition to the highway and transit validation discussed in this documentation, the Gen3 model has undergone five sensitivity tests that included:

- Auto Operating Cost Increase
- Bridge Closure
- Doubling the Frequency of High-Capacity Transit
- Increased Telecommuting to DC
- Hypothetical AV Ownership in the Horizon Year

The results of the sensitivity testing are documented in a separate report[19]. In general, the Gen3 Model showed sensible reactions to various model input changes in those tests, and the project team (MWCOG, RSG, and BMG) have found the outcomes of these tests to be satisfactory.

[19] RSG, Baseline Mobility Group, and Metropolitan Washington Council of Governments. Gen3 Model Phase 2 Sensitivity Test Report, date pending.

6.0 APPENDIX

TABLE 55: CENSUS ACS JOURNEY TO WORK FLOWS

	ALEXANDRIA CITY	ANNE ARUNDEL COUNTY	ARLINGTON COUNTY	CALVERT COUNTY	CARROLL COUNTY	CHARLES COUNTY	CLARKE COUNTY	DC	FAIRFAX COUNTY	FAUQUIER COUNTY	FREDERICK COUNTY	FREDERICKSBURG CITY	HOWARD COUNTY	JEFFERSON COUNTY	KING GEORGE COUNTY	LOUDOUN COUNTY	MONTGOMERY COUNTY	PRINCE GEORGE'S COUNTY	PRINCE WILLIAM COUNTY	SPOTSYLVANIA COUNTY	ST. MARY'S COUNTY	STAFFORD COUNTY	TOTAL
Alexandria city	25,007	350	14,036	51	45	207	0	27,707	18,653	43	23	42	220	0	6	791	1,889	2,279	1,112	0	22	42	92,525
Anne Arundel County	846	168,876	2,103	1,323	272	440	0	18,474	2,571	0	331	0	18,565	0	0	346	8,142	27,927	223	0	255	22	250,716
Arlington County	5,614	483	46,632	16	99	78	0	49,463	28,382	18	60	9	189	18	5	1,067	4,644	2,492	1,127	8	0	83	140,487
Calvert County	520	2,992	471	17,276	7	1,384	0	4,951	761	0	18	0	371	0	10	110	931	9,316	122	0	4,949	43	44,232
Carroll County	26	5,049	62	10	39,419	0	0	934	474	0	3,102	19	8,617	40	0	143	3,998	1,354	47	0	0	0	63,294
Charles County	1,813	1,356	3,083	1,132	15	28,979	0	15,719	3,624	0	9	0	358	0	457	421	1,527	14,062	203	13	2,610	28	75,409
Clarke County	9	15	55	0	0	0	1,640	105	792	65	35	0	0	202	0	2,018	71	0	70	0	11	0	5,088
DC	6,054	1,290	16,190	0	32	262	0	252,256	12,673	0	162	56	960	19	0	898	22,447	16,214	410	0	14	49	329,986
Fairfax County	31,778	1,954	50,516	183	0	499	0	100,085	358,096	666	443	238	983	44	11	25,309	16,191	11,265	13,872	270	159	923	613,485
Fauquier County	239	79	519	0	12	0	33	983	6,484	13,958	0	262	11	0	10	1,868	159	50	6,897	124	0	413	32,101
Frederick County	262	1,718	921	0	2,654	37	27	4,549	2,362	2	71,718	0	3,215	428	0	1,765	25,783	1,897	53	0	16	3	117,410
Fredericksburg city	95	0	120	0	0	232	35	472	575	15	5	5,229	0	0	672	35	0	0	895	2,437	0	1,905	12,722
Howard County	412	17,598	1,003	29	1,465	96	0	9,226	1,926	0	799	0	65,811	0	0	259	16,240	14,783	108	0	35	0	129,790
Jefferson County	85	31	316	0	42	0	226	777	1,463	33	1,829	0	87	11,227	0	4,282	1,455	102	122	0	0	21	22,098
King George County	138	33	123	0	0	783	0	307	433	0	0	1,221	0	0	5,624	0	59	266	405	837	148	1,281	11,658
Loudoun County	1,327	421	4,704	0	17	5	173	10,600	65,915	450	540	29	292	230	12	88,958	3,609	667	3,036	33	63	181	181,262
Montgomery County	3,306	5,249	10,151	88	484	175	0	111,756	21,166	15	5,972	0	8,339	66	84	1,853	318,806	30,835	826	21	135	138	519,465
Prince George's County	8,324	16,075	15,687	805	181	4,431	0	139,856	21,002	52	678	15	9,546	52	94	1,709	46,799	177,993	1,280	55	461	153	445,248
Prince William County	8,132	828	13,283	39	16	218	28	24,699	75,653	2,240	193	635	206	29	60	9,848	2,860	3,130	105,996	763	22	3,003	251,881
Spotsylvania County	499	13	1,156	0	0	40	30	2,939	3,910	211	10	9,750	70	0	1,699	302	313	224	4,906	23,460	15	7,689	57,236
St. Mary's County	132	312	311	2,507	0	4,065	0	2,234	341	0	20	11	133	0	151	21	363	2,325	20	0	41,526	0	54,472
Stafford County	1,415	207	2,768	15	0	28	0	6,119	8,780	457	10	5,849	15	0	856	547	321	448	11,970	3,136	29	23,234	66,204
Total	96,033	224,929	184,210	23,474	44,760	41,959	2,192	784,211	636,036	18,225	85,957	23,365	117,988	12,355	9,751	142,550	476,607	317,629	153,700	31,157	50,470	39,211	3,516,769

TABLE 56: GEN3 WORK COUNTY FLOWS

	ALEXANDRIA	ANNE ARUNDEL	ARLINGTON	CALVERT	CARROLL	CHARLES	CLARKE	DC	FAIRFAX	FAUQUIER	FREDERICK	FREDERICKSBURG	HOWARD	JEFFERSON	KING GEORGE	LOUDOUN	MONTGOMERY	PRINCE GEORGE'S	PRINCE WILLIAM	SPOTSYLVANIA	ST. MARY'S	STAFFORD	TOTAL
Alexandria	18,802	299	15,909	44	5	243	2	25,120	20,804	23	34	12	214	0	16	734	3,522	4,016	1,042	9	41	62	90,953
Anne Arundel	1,512	180,480	4,148	1,638	259	788	0	18,812	4,584	11	247	1	22,483	3	66	433	11,676	32,688	340	3	347	14	280,533
Arlington	7,837	364	36,800	27	6	140	1	46,402	33,778	26	53	6	279	0	9	1,216	6,478	3,940	926	12	21	43	138,364
Calvert	592	2,845	1,066	17,324	4	1,262	0	6,504	1,422	2	14	13	233	0	69	47	1,052	5,488	94	4	5,467	11	43,513
Carroll	159	3,182	563	29	42,725	19	9	4,121	1,678	30	7,771	1	10,111	51	6	1,123	8,676	1,766	241	2	18	3	82,284
Charles	3,080	1,312	3,622	1,502	1	29,687	0	13,324	5,811	5	18	90	343	0	885	254	1,805	12,853	392	72	2,623	140	77,819
Clarke	35	12	111	0	13	4	1,019	298	1,370	133	226	6	22	540	0	1,980	193	28	408	2	0	8	6,408
DC	6,410	1,666	20,779	125	24	455	0	259,672	16,301	29	115	8	1,392	2	43	1,240	25,572	20,582	810	5	77	37	355,344
Fairfax	31,400	1,318	51,738	141	38	818	7	85,521	336,467	552	355	138	1,130	29	45	26,604	13,312	14,166	20,643	122	122	675	585,341
Fauquier	259	30	618	1	3	11	12	1,721	6,647	11,008	50	441	29	19	29	1,965	570	191	6,987	355	6	1,259	32,211
Frederick	387	1,403	1,289	16	4,514	25	49	7,111	4,874	137	65,615	5	4,188	529	4	7,965	24,891	1,509	798	2	6	10	125,327
Fredericksburg	126	6	153	5	0	37	0	528	694	74	0	4,721	5	0	365	54	57	48	724	2,610	22	2,463	12,692
Howard	708	21,528	2,538	83	1,605	102	1	13,794	3,482	26	1,249	2	75,012	14	21	647	22,240	17,830	359	2	64	13	161,320
Jefferson	131	106	408	2	159	1	685	975	3,232	90	3,922	0	241	9,491	0	5,720	1,583	143	509	4	1	7	27,410
King George	122	67	152	85	1	809	0	821	571	37	3	1,135	11	0	4,033	26	134	441	507	976	359	1,338	11,628
Loudoun	1,622	283	4,846	18	78	56	71	12,959	72,263	484	2,255	19	311	402	2	86,928	2,602	1,340	6,522	18	8	82	193,169
Montgomery	4,760	7,208	16,351	161	849	265	2	101,639	23,808	114	4,248	8	7,091	22	31	5,656	311,096	26,342	2,032	9	88	45	511,825
Prince George's	13,167	14,983	19,407	1,458	114	5,128	1	151,002	26,661	35	238	22	11,018	3	277	1,659	40,449	169,757	1,514	17	752	75	457,737
Prince William	7,901	390	10,601	48	13	254	11	22,729	79,822	2,040	148	696	253	23	93	10,274	5,348	3,503	106,715	518	25	3,638	255,043
Spotsylvania	453	40	650	28	1	169	0	2,202	3,024	342	10	9,494	24	1	1,293	211	315	284	2,793	18,062	104	7,250	46,750
St. Mary's	379	381	538	2,993	2	3,193	0	3,678	941	1	6	52	97	1	437	50	475	2,382	79	42	40,400	88	56,215
Stafford	1,498	100	1,873	30	5	187	2	6,324	9,694	773	20	6,546	65	4	1,164	590	836	733	11,000	4,901	113	20,779	67,237
Total	101,340	238,003	194,160	25,758	50,419	43,653	1,872	785,257	657,928	15,972	86,597	23,416	134,552	11,134	8,888	155,376	482,882	320,030	165,435	27,747	50,664	38,040	3,619,123

TABLE 57: DIFFERENCE BETWEEN CENSUS JTW AND MODEL WORK LOCATION CHOICE

	ALEXANDRIA CITY	ANNE ARUNDEL COUNTY	ARLINGTON COUNTY	CALVERT COUNTY	CARROLL COUNTY	CHARLES COUNTY	CLARKE COUNTY	DC	FAIRFAX COUNTY	FAUQUIER COUNTY	FREDERICK COUNTY	FREDERICKSBURG CITY	HOWARD COUNTY	JEFFERSON COUNTY	KING GEORGE COUNTY	LOUDOUN COUNTY	MONTGOMERY COUNTY	PRINCE GEORGE'S COUNTY	PRINCE WILLIAM COUNTY	SPOTSYLVANIA COUNTY	ST. MARY'S COUNTY	STAFFORD COUNTY	TOTAL
Alexandria city	-6,205	-51	1,873	-7	-40	36	2	-2,587	2,151	-20	11	-30	-6	0	10	-57	1,633	1,737	-70	9	19	20	-1,572
Anne Arundel County	666	11,604	2,045	315	-13	348	0	338	2,013	11	-84	1	3,918	3	66	87	3,534	4,761	117	3	92	-8	29,817
Arlington County	2,223	-119	-9,832	11	-93	62	1	-3,061	5,396	8	-7	-3	90	-18	4	149	1,834	1,448	-201	4	21	-40	-2,123
Calvert County	72	-147	595	48	-3	-122	0	1,553	661	2	-4	13	-138	0	59	-63	121	-3,828	-28	4	518	-32	-719
Carroll County	133	-1,867	501	19	3,306	19	9	3,187	1,204	30	4,669	-18	1,494	11	6	980	4,678	412	194	2	18	3	18,990
Charles County	1,267	-44	539	370	-14	708	0	-2,395	2,187	5	9	90	-15	0	428	-167	278	-1,209	189	59	13	112	2,410
Clarke County	26	-3	56	0	13	4	-621	193	578	68	191	6	22	338	0	-38	122	28	338	2	-11	8	1,320
DC	356	376	4,589	125	-8	193	0	7,416	3,628	29	-47	-48	432	-17	43	342	3,125	4,368	400	5	63	-12	25,358
Fairfax County	-378	-636	1,222	-42	38	319	7	-14,564	-21,629	-114	-88	-100	147	-15	34	1,295	-2,879	2,901	6,771	-148	-37	-248	-28,144
Fauquier County	20	-49	99	1	-9	11	-21	738	163	-2,950	50	179	18	19	19	97	411	141	90	231	6	846	110
Frederick County	125	-315	368	16	1,860	-12	22	2,562	2,512	135	-6,103	5	973	101	4	6,200	-892	-388	745	2	-10	7	7,917
Fredericksburg city	31	6	33	5	0	-195	-35	56	119	59	-5	-508	5	0	-307	19	57	48	-171	173	22	558	-30
Howard County	296	3,930	1,535	54	140	6	1	4,568	1,556	26	450	2	9,201	14	21	388	6,000	3,047	251	2	29	13	31,530
Jefferson County	46	75	92	2	117	1	459	198	1,769	57	2,093	0	154	-1,736	0	1,438	128	41	387	4	1	-14	5,312
King George County	-16	34	29	85	1	26	0	514	138	37	3	-86	11	0	-1,591	26	75	175	102	139	211	57	-30
Loudoun County	295	-138	142	18	61	51	-102	2,359	6,348	34	1,715	-10	19	172	-10	-2,030	-1,007	673	3,486	-15	-55	-99	11,907
Montgomery County	1,454	1,959	6,200	73	365	90	2	-10,117	2,642	99	-1,724	8	-1,248	-44	-53	3,803	-7,710	-4,493	1,206	-12	-47	-93	-7,640
Prince George's County	4,843	-1,092	3,720	653	-67	697	1	11,146	5,659	-17	-440	7	1,472	-49	183	-50	-6,350	-8,236	234	-38	291	-78	12,489
Prince William County	-231	-438	-2,682	9	-3	36	-17	-1,970	4,169	-200	-45	61	47	-6	33	426	2,488	373	719	-245	3	635	3,162
Spotsylvania County	-46	27	-506	28	1	129	-30	-737	-886	131	0	-256	-46	1	-406	-91	2	60	-2,113	-5,398	89	-439	-10,486
St. Mary's County	247	69	227	486	2	-872	0	1,444	600	1	-14	41	-36	1	286	29	112	57	59	42	-1,126	88	1,743
Stafford County	83	-107	-895	15	5	159	2	205	914	316	10	697	50	4	308	43	515	285	-970	1,765	84	-2,455	1,033
Total	5,307	13,074	9,950	2,284	5,659	1,694	-320	1,046	21,892	-2,253	640	51	16,564	-1,221	-863	12,826	6,275	2,401	11,735	-3,410	194	-1,171	102,354

TABLE 58: WORK LOCATION CHOICE GEN3 / ACS JTW

	ALEXANDRIA CITY	ANNE ARUNDEL COUNTY	ARLINGTON COUNTY	CALVERT COUNTY	CARROLL COUNTY	CHARLES COUNTY	CLARKE COUNTY	DC	FAIRFAX COUNTY	FAUQUIER COUNTY	FREDERICK COUNTY	FREDERICKSBURG CITY	HOWARD COUNTY	JEFFERSON COUNTY	KING GEORGE COUNTY	LOUDOUN COUNTY	MONTGOMERY COUNTY	PRINCE GEORGE'S COUNTY	PRINCE WILLIAM COUNTY	SPOTSYLVANIA COUNTY	ST. MARY'S COUNTY	STAFFORD COUNTY	TOTAL
Alexandria city	0.75	0.85	1.13	0.86	0.11	1.17		0.91	1.12	0.53	1.48	0.29	0.97		2.67	0.93	1.86	1.76	0.94		1.86	1.48	0.98
Anne Arundel County	1.79	1.07	1.97	1.24	0.95	1.79		1.02	1.78		0.75		1.21			1.25	1.43	1.17	1.52		1.36	0.64	1.12
Arlington County	1.40	0.75	0.79	1.69	0.06	1.79		0.94	1.19	1.44	0.88	0.67	1.48	0.00	1.80	1.14	1.39	1.58	0.82	1.50		0.52	0.98
Calvert County	1.14	0.95	2.26	1.00	0.57	0.91		1.31	1.87		0.78		0.63		6.90	0.43	1.13	0.59	0.77		1.10	0.26	0.98
Carroll County	6.12	0.63	9.08	2.90	1.08			4.41	3.54		2.51	0.05	1.17	1.28		7.85	2.17	1.30	5.13				1.30
Charles County	1.70	0.97	1.17	1.33	0.07	1.02		0.85	1.60		2.00		0.96		1.94	0.60	1.18	0.91	1.93	5.54	1.00	5.00	1.03
Clarke County	3.89	0.80	2.02				0.62	2.84	1.73	2.05	6.46			2.67		0.98	2.72		5.83		0.00		1.26
DC	1.06	1.29	1.28		0.75	1.74		1.03	1.29		0.71	0.14	1.45	0.11		1.38	1.14	1.27	1.98		5.50	0.76	1.08
Fairfax County	0.99	0.67	1.02	0.77		1.64		0.85	0.94	0.83	0.80	0.58	1.15	0.66	4.09	1.05	0.82	1.26	1.49	0.45	0.77	0.73	0.95
Fauquier County	1.08	0.38	1.19		0.25		0.36	1.75	1.03	0.79		1.68	2.64		2.90	1.05	3.58	3.82	1.01	2.86		3.05	1.00
Frederick County	1.48	0.82	1.40		1.70	0.68	1.81	1.56	2.06	68.50	0.91		1.30	1.24		4.51	0.97	0.80	15.06		0.38	3.33	1.07
Fredericksburg city	1.33		1.28			0.16	0.00	1.12	1.21	4.93	0.00	0.90			0.54	1.54			0.81	1.07		1.29	1.00
Howard County	1.72	1.22	2.53	2.86	1.10	1.06		1.50	1.81		1.56		1.14			2.50	1.37	1.21	3.32		1.83		1.24
Jefferson County	1.54	3.42	1.29		3.79		3.03	1.25	2.21	2.73	2.14		2.77	0.85		1.34	1.09	1.40	4.17			0.33	1.24
King George County	0.88	2.03	1.24			1.03		2.67	1.32			0.93			0.72		2.27	1.66	1.25	1.17	2.43	1.04	1.00
Loudoun County	1.22	0.67	1.03		4.59	11.20	0.41	1.22	1.10	1.08	4.18	0.66	1.07	1.75	0.17	0.98	0.72	2.01	2.15	0.55	0.13	0.45	1.07
Montgomery County	1.44	1.37	1.61	1.83	1.75	1.51		0.91	1.12	7.60	0.71		0.85	0.33	0.37	3.05	0.98	0.85	2.46	0.43	0.65	0.33	0.99
Prince George's County	1.58	0.93	1.24	1.81	0.63	1.16		1.08	1.27	0.67	0.35	1.47	1.15	0.06	2.95	0.97	0.86	0.95	1.18	0.31	1.63	0.49	1.03
Prince William County	0.97	0.47	0.80	1.23	0.81	1.17	0.39	0.92	1.06	0.91	0.77	1.10	1.23	0.79	1.55	1.04	1.87	1.12	1.01	0.68	1.14	1.21	1.01
Spotsylvania County	0.91	3.08	0.56			4.23	0.00	0.75	0.77	1.62	1.00	0.97	0.34		0.76	0.70	1.01	1.27	0.57	0.77	6.93	0.94	0.82
St. Mary's County	2.87	1.22	1.73	1.19		0.79		1.65	2.76		0.30	4.73	0.73		2.89	2.38	1.31	1.02	3.95		0.97		1.03
Stafford County	1.06	0.48	0.68	2.00		6.68		1.03	1.10	1.69	2.00	1.12	4.33		1.36	1.08	2.60	1.64	0.92	1.56	3.90	0.89	1.02
Total	1.06	1.06	1.05	1.10	1.13	1.04	0.85	1.00	1.03	0.88	1.01	1.00	1.14	0.90	0.91	1.09	1.01	1.01	1.08	0.89	1.00	0.97	1.03

TABLE 59: OBSERVED (SURVEY) NON-MANDATORY TOURS BY COUNTY

	DC	ALEXANDRIA	ANNE ARUNDEL	ARLINGTON	CALVERT	CARROLL	CHARLES	CLARKE	FAIRFAX	FAUQUIER	FREDERICK	FREDERICKSBURG	HOWARD	JEFFERSON	KING GEORGE	LOUDOUN	MONTGOMERY	PRINCE GEORGE'S	PRINCE WILLIAM	SPOTSYLVANIA	ST. MARY'S	STAFFORD	TOTAL
DC	225,880	18,956	19,444	6,154	3,052	3,484	803	0	161	68	398	11	0	145	265	0	0	0	0	0	0	69	278,891
Alexandria	24,313	413,033	6,054	1,526	101	3,536	1,072	20	2,152	1,417	2,619	59	1,421	0	0	0	0	0	0	0	0	0	457,323
Anne Arundel	25,666	14,959	239,049	956	2,198	3,212	14	231	84	5,618	12,807	4,744	0	2,441	438	0	0	0	0	355	0	43	312,816
Arlington	7,343	547	814	86,353	4,568	21,098	112	253	0	0	26	0	0	0	123	0	0	72	0	0	0	0	121,309
Calvert	905	227	323	11,036	50,050	11,400	0	51	0	0	0	0	0	0	0	0	40	0	0	0	0	0	74,032
Carroll	5,146	3,889	2,861	17,126	11,141	429,436	10,503	6,099	45	0	809	0	32	0	0	118	0	100	0	783	0	0	488,089
Charles	1,474	574	1,803	0	1,990	23,902	123,077	3,070	325	0	40	0	164	0	0	0	0	0	0	368	77	0	156,863
Clarke	3,056	1,685	583	1,107	1,257	12,243	6,192	157,023	0	0	42	0	0	0	0	0	0	1,046	542	440	0	0	185,217
Fairfax	634	6,172	49	0	0	0	680	0	90,500	151	1,149	0	6,096	0	0	0	0	0	0	0	0	85	105,516
Fauquier	554	1,821	3,926	0	0	211	0	0	0	105,495	2,884	0	1,224	0	0	0	0	0	0	0	0	0	116,115
Frederick	3,075	908	7,754	294	0	581	0	0	232	4,430	207,662	0	38	584	36	0	0	92	0	0	0	0	225,687

Fredericksburg	1,736	753	6,397	105	0	68	0	0	0	47	137	53,692	0	575	2,248	0	0	0	0	0	0	0	65,758
Howard	0	1,010	0	0	0	0	82	0	666	996	182	534	55,945	22	0	0	0	0	0	0	0	0	59,437
Jefferson	0	0	1,206	0	0	71	0	0	0	0	1,191	377	0	22,883	1,833	0	0	0	0	0	0	0	27,561
King George	0	166	240	0	0	0	0	0	0	0	555	1,521	0	741	41,609	0	0	0	0	0	0	0	44,832
Loudoun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,850	1,643	117	191	0	0	0	10,800
Montgomery	0	0	0	0	0	0	0	361	0	0	0	0	0	0	0	0	8,526	945	1,330	0	0	0	11,162
Prince George's	528	88	0	0	815	456	0	1,455	0	0	0	0	0	0	0	61	4,001	41,867	5,423	0	0	0	54,692
Prince William	37	0	0	183	0	37	584	0	0	0	0	0	0	0	0	0	4,062	2,284	22,675	0	0	0	29,861
Spotsylvania	0	57	0	53	26	586	66	1,810	0	0	0	0	0	0	0	0	0	30	0	17,393	0	0	20,021
St. Mary's	0	0	0	0	0	283	391	0	343	0	0	0	0	0	0	0	0	0	0	201	4,046	47	5,311
Stafford	52	0	0	0	0	0	825	0	579	0	0	0	0	0	0	0	0	0	0	0	0	19,529	20,985
Total	300,400	464,845	290,503	124,894	75,199	510,601	144,400	170,372	95,089	118,222	230,501	60,938	64,921	27,391	46,552	9,029	18,272	46,552	30,160	19,541	4,122	19,773	2,872,279

TABLE 60: GEN3 NON-MANDATORY TOURS BY COUNTY

	DC	ALEXANDRIA	ANNE ARUNDEL	ARLINGTON	CALVERT	CARROLL	CHARLES	CLARKE	FAIRFAX	FAUQUIER	FREDERICK	FREDERICKSBURG	HOWARD	JEFFERSON	KING GEORGE	LOUDOUN	MONTGOMERY	PRINCE GEORGE'S	PRINCE WILLIAM	SPOTSYLVANIA	ST. MARY'S	STAFFORD	TOTAL
DC	150,728	9,122	15,029	5,124	913	1,206	24	28	1	83	99	28	0	7	1	0	0	0	0	0	0	0	182,393
Alexandria	4,078	234,295	6,173	3,566	814	317	583	294	1,950	4,634	1,969	106	367	35	38	8	23	36	23	29	6	23	259,367
Anne Arundel	7,735	10,722	178,333	5,272	4,307	5,540	266	498	166	3,967	7,714	3,933	41	315	160	20	22	64	37	32	0	17	229,161
Arlington	1,134	1,059	681	34,793	4,489	8,450	102	121	10	24	38	15	7	1	2	0	1	13	1	6	0	0	50,947
Calvert	455	356	765	6,408	20,738	6,792	48	160	4	15	28	27	0	4	0	1	1	15	4	2	0	0	35,823
Carroll	1,482	261	3,611	17,272	16,883	230,585	9,485	9,475	77	177	261	142	12	17	16	8	41	197	64	188	6	18	290,278
Charles	95	859	216	511	182	13,959	68,702	1,802	901	83	55	11	31	5	2	2	5	32	6	207	132	316	88,114
Clarke	176	674	583	1,035	861	13,698	1,785	99,641	45	51	91	43	10	7	15	13	126	1,046	149	1,168	8	14	121,239
Fairfax	105	4,165	447	131	58	581	940	95	56,260	901	321	25	2,430	10	19	2	5	14	9	21	25	246	66,810
Fauquier	152	4,837	3,576	135	52	269	49	29	508	62,164	5,514	16	916	4	10	1	3	7	1	7	1	7	78,258
Frederick	297	1,672	8,617	342	176	546	69	84	98	5,395	130,791	198	56	640	38	3	7	19	14	11	2	9	149,084
Fredericksburg	308	515	5,573	553	624	1,128	77	175	25	117	454	28,567	11	460	1,011	346	29	54	47	12	1	4	40,091
Howard	57	1,651	342	77	32	210	108	43	2,469	1,983	432	11	38,129	10	8	1	4	12	9	7	5	29	45,629
Jefferson	119	385	2,172	112	121	290	30	53	14	98	1,215	513	4	17,083	1,518	15	3	19	9	5	0	2	23,780
King George	93	222	964	120	75	313	41	75	31	66	224	1,276	9	728	25,448	71	15	35	27	8	0	4	29,845
Loudoun	23	54	165	48	26	159	17	173	3	11	28	204	0	25	53	4,105	411	547	460	22	2	2	6,538
Montgomery	8	21	15	12	9	63	9	61	9	5	16	7	2	0	4	20	4,385	906	1,274	12	0	0	6,838
Prince George's	55	164	171	213	139	1,176	102	3,054	11	16	39	25	4	4	11	170	4,896	23,028	2,792	324	2	1	36,397
Prince William	26	74	66	71	40	345	37	363	17	16	52	16	5	2	8	75	4,613	1,913	19,083	49	0	5	26,876
Spotsylvania	28	162	94	150	86	1,500	716	3,099	46	17	26	11	2	1	5	12	195	741	217	12,107	45	31	19,291
St. Mary's	5	58	22	21	10	261	568	115	82	17	7	3	7	0	0	1	0	10	4	82	2,535	317	4,125
Stafford	28	424	104	58	21	406	1,080	137	930	107	73	8	67	4	10	4	5	14	8	38	503	12,845	16,874
Total	167,187	271,752	227,719	76,024	50,656	287,794	84,838	119,575	63,657	79,947	149,447	35,185	42,110	19,362	28,377	4,878	14,790	28,722	24,238	14,337	3,273	13,890	1,807,758

TABLE 61: DIFFERENCE BETWEEN GEN3 AND SURVEY NON-MANDATORY TOURS BY COUNTY

	DC	ALEXANDRIA	ANNE ARUNDEL	ARLINGTON	CALVERT	CARROLL	CHARLES	CLARKE	FAIRFAX	FAUQUIER	FREDERICK	FREDERICKSBURG	HOWARD	JEFFERSON	KING GEORGE	LOUDOUN	MONTGOMERY	PRINCE GEORGE'S	PRINCE WILLIAM	SPOTSYLVANIA	ST. MARY'S	STAFFORD	TOTAL
DC	-75,152	-9,834	-4,415	-1,030	-2,139	-2,278	-779	28	-160	15	-299	17	0	-138	-264	0	0	0	0	0	0	-69	-96,498
Alexandria	-20,235	-178,738	119	2,040	713	-3,219	-489	274	-202	3,217	-650	47	-1,054	35	38	8	23	36	23	29	6	23	-197,956
Anne Arundel	-17,931	-4,237	-60,716	4,316	2,109	2,328	252	267	82	-1,651	-5,093	-811	41	-2,126	-278	20	22	64	37	-323	0	-26	-83,655
Arlington	-6,209	512	-133	-51,560	-79	-12,648	-10	-132	10	24	12	15	7	1	-121	0	1	-59	1	6	0	0	-70,362
Calvert	-450	129	442	-4,628	-29,312	-4,608	48	109	4	15	28	27	0	4	0	1	-39	15	4	2	0	0	-38,209
Carroll	-3,664	-3,628	750	146	5,742	-198,851	-1,018	3,376	32	177	-548	142	-20	17	16	-110	41	97	64	-595	6	18	-197,811
Charles	-1,379	285	-1,587	511	-1,808	-9,943	-54,375	-1,268	576	83	15	11	-133	5	2	2	5	32	6	-161	55	316	-68,749
Clarke	-2,880	-1,011	0	-72	-396	1,455	-4,407	-57,382	45	51	49	43	10	7	15	13	126	0	-393	728	8	14	-63,978
Fairfax	-529	-2,007	398	131	58	581	260	95	-34,240	750	-828	25	-3,666	10	19	2	5	14	9	21	25	161	-38,706
Fauquier	-402	3,016	-350	135	52	58	49	29	508	-43,331	2,630	16	-308	4	10	1	3	7	1	7	1	7	-37,857
Frederick	-2,778	764	863	48	176	-35	69	84	-134	965	-76,871	198	18	56	2	3	7	-73	14	11	2	9	-76,603
Fredericksburg	-1,428	-238	-824	448	624	1,060	77	175	25	70	317	-25,125	11	-115	-1,237	346	29	54	47	12	1	4	-25,667
Howard	57	641	342	77	32	210	26	43	1,803	987	250	-523	-17,816	-12	8	1	4	12	9	7	5	29	-13,808
Jefferson	119	385	966	112	121	219	30	53	14	98	24	136	4	-5,800	-315	15	3	19	9	5	0	2	-3,781
King George	93	56	724	120	75	313	41	75	31	66	-331	-245	9	-13	-16,161	71	15	35	27	8	0	4	-14,987
Loudoun	23	54	165	48	26	159	17	173	3	11	28	204	0	25	53	-4,745	-1,232	430	269	22	2	2	-4,262
Montgomery	8	21	15	12	9	63	9	-300	9	5	16	7	2	0	4	20	-4,141	-39	-56	12	0	0	-4,324
Prince George's	-473	76	171	213	-676	720	102	1,599	11	16	39	25	4	4	11	109	895	-18,839	-2,631	324	2	1	-18,295
Prince William	-11	74	66	-112	40	308	-547	363	17	16	52	16	5	2	8	75	551	-371	-3,592	49	0	5	-2,985
Spotsylvania	28	105	94	97	60	914	650	1,289	46	17	26	11	2	1	5	12	195	711	217	-5,286	45	31	-730
St. Mary's	5	58	22	21	10	-22	177	115	-261	17	7	3	7	0	0	1	0	10	4	-119	-1,511	270	-1,186
Stafford	-24	424	104	58	21	406	255	137	351	107	73	8	67	4	10	4	5	14	8	38	503	-6,684	-4,111
Total	-133,213	-193,093	-62,784	-48,870	-24,543	-222,807	-59,562	-50,797	-31,432	-38,275	-81,054	-25,753	-22,811	-8,029	-18,175	-4,151	-3,482	-17,830	-5,922	-5,204	-849	-5,883	-1,064,521

TABLE 62: GEN3 / SURVEY NON-MANDATORY TOURS BY COUNTY

	DC	ALEXANDRIA	ANNE ARUNDEL	ARLINGTON	CALVERT	CARROLL	CHARLES	CLARKE	FAIRFAX	FAUQUIER	FREDERICK	FREDERICKSBURG	HOWARD	JEFFERSON	KING GEORGE	LOUDOUN	MONTGOMERY	PRINCE GEORGE'S	PRINCE WILLIAM	SPOTSYLVANIA	ST. MARY'S	STAFFORD	TOTAL
DC	0.67	0.48	0.77	0.83	0.30	0.35	0.03		0.01	1.22	0.25	2.49		0.05	0.00							0.00	0.65
Alexandria	0.17	0.57	1.02	2.34	8.04	0.09	0.54	14.73	0.91	3.27	0.75	1.79	0.26										0.57
Anne Arundel	0.30	0.72	0.75	5.51	1.96	1.72	18.90	2.16	1.97	0.71	0.60	0.83		0.13	0.37					0.09		0.39	0.73
Arlington	0.15	1.94	0.84	0.40	0.98	0.40	0.91	0.48			1.48				0.02			0.18					0.42
Calvert	0.50	1.57	2.37	0.58	0.41	0.60		3.17									0.02						0.48
Carroll	0.29	0.07	1.26	1.01	1.52	0.54	0.90	1.55	1.69		0.32		0.37			0.07		1.96		0.24			0.59
Charles	0.06	1.50	0.12		0.09	0.58	0.56	0.59	2.77		1.38		0.19							0.56	1.72		0.56
Clarke	0.06	0.40	1.00	0.93	0.68	1.12	0.29	0.63			2.17							1.00	0.27	2.65			0.65
Fairfax	0.17	0.67	9.16				1.38		0.62	5.95	0.28		0.40									2.90	0.63
Fauquier	0.27	2.66	0.91			1.28				0.59	1.91		0.75										0.67
Frederick	0.10	1.84	1.11	1.16		0.94			0.42	1.22	0.63		1.46	1.10	1.06			0.21					0.66
Fredericksburg	0.18	0.68	0.87	5.24		16.68				2.51	3.32	0.53		0.80	0.45								0.61
Howard		1.63					1.32		3.71	1.99	2.37	0.02	0.68	0.46									0.77
Jefferson			1.80			4.09					1.02	1.36		0.75	0.83								0.86
King George		1.34	4.02								0.40	0.84		0.98	0.61								0.67
Loudoun																0.46	0.25	4.69	2.41				0.61
Montgomery								0.17									0.51	0.96	0.96				0.61
Prince George's	0.10	1.87			0.17	2.58		2.10								2.79	1.22	0.55	0.51				0.67
Prince William	0.70			0.39		9.28	0.06										1.14	0.84	0.84				0.90
Spotsylvania		2.83		2.85	3.27	2.56	10.90	1.71										24.81		0.70			0.96
St. Mary's						0.92	1.45		0.24											0.41	0.63	6.74	0.78
Stafford	0.54						1.31		1.61													0.66	0.80
Total	0.56	0.58	0.78	0.61	0.67	0.56	0.59	0.70	0.67	0.68	0.65	0.58	0.65	0.71	0.61	0.54	0.81	0.62	0.80	0.73	0.79	0.70	0.63

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