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Metropolitan Washington Council of Governments

GEN3 MODEL PHASE 1 CALIBRATION AND VALIDATION RESULTS

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PREPARED FOR:

METROPOLITAN WASHINGTON COUNCIL OF GOVERNMENTS

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1.0 INTRODUCTION

The National Capital Region Transportation Planning Board (NCRTPB or TPB), staffed by the Metropolitan Washington Council of Governments (MWCOG or COG), is the federally designated metropolitan planning organization (MPO) for metropolitan Washington. COG/TPB staff develops, maintains, applies, and improves the TPB's family of regional travel demand forecasting models, which are used for regional, long-range transportation planning in the metropolitan Washington region. In 2018, COG/TPB set out to develop a next-generation travel demand model. The project team, consisting of RSG and Baseline Mobility Group, recommended that COG transition from its current aggregate, trip-based travel demand model (i.e., Gen2 Model) to a simplified activity-based model (ABM) implemented in the open-source ActivitySim software platform, to be known as the Generation 3, or Gen3, Travel Model.

The model is being implemented in two phases. Phase 1 is to be a prototype model that can be tested by the COG/TPB staff. Phase 2 is to be a production-use model that can be used for regional planning work, such as the air quality conformity analysis. The purpose of a phased approach to model development is to use the initial deployment and calibration efforts to inform the scope of final model development and calibration/validation tasks, rather than scope the entire model development project at the project initiation. This allows the project team to learn from the initial deployment and prioritize resource allocation in Phase 2, to ensure that the final delivered Gen3 Model meets the needs of MWCOG, partner agencies and decision-makers.

In Phase 1, a synthetic population for the modeled region was created for both 2018 (model base year) and 2045 (horizon year), and the ActivitySim model system was transferred from Metropolitan Transportation Commission (MTC) region (San Francisco Bay Area) and the Southeast Michigan Council of Governments (SEMCOG) region (Detroit, Michigan) to MWCOG. Under Phase 1 deployment, tour mode choice and tour destination choice models were estimated[1]. After implementation of the estimated models, several model components such as auto ownership, tour mode choice, trip mode choice, individual non-mandatory tour frequency and intermediate stop frequency models were calibrated[2] to the observed distributions from the 2017-18 MWCOG Regional Travel Survey (RTS) and the 2018-19 Maryland Travel Survey (MTS) data[3]and transit on-board survey (TOBS) data. The processing of RTS/MTS data and TOBS data was documented in the Phase 1 data development report. The 2018 traffic counts

[1] Estimation in this context refers to the process of using a statistical technique (maximum likelihood) to fit multinomial or nested logit model parameters to observed data.
[2] Calibration in this context refers to the process of adjusting model parameters to observed data as explained in the following chapter.
[3] RSG, "Gen3 Phase 1 Data Development" Report, December 29, 2021 (https://app.box.com/s/xe5vb28daox1aqtw895iy2r5ocy584w8)

and transit boarding counts that are used for Phase 1 model validation were provided by MWCOG staff and were documented separately. Thus, the preparation of the count data is not covered in this report. The following models were calibrated to RTS/MTS data:

- Auto ownership
- Coordinated daily activity pattern (CDAP)
- Tour mode choice
- Trip mode choice
- Individual non-mandatory tour frequency
- Stop frequency
- Tour destination choice
- Stop location choice

Tour mode choice and the tour destination choice models were first estimated using the RTS/MTS data. ActivitySim uses a lookup probability distribution table to simulate trip purpose and trip departure period. These probability distributions were updated from the RTS/MTS data. Figure 1 shows the Gen3 Phase 1 model structure, indicating the source of each model component and which models were estimated and/or calibrated in Phase 1.

We note that both the observed data and the base year for model calibration represent pre-pandemic conditions. Any changes in the magnitude of travel, the timing of activities, mode usage, and any other potential travel behaviors impacted by the COVID-19 pandemic are not reflected in the results presented herein. As post-pandemic travel patterns (hopefully) stabilize, model inputs should be updated to a post-pandemic base year, and adjustments should be made to model parameters to reflect more current observed travel behavior.

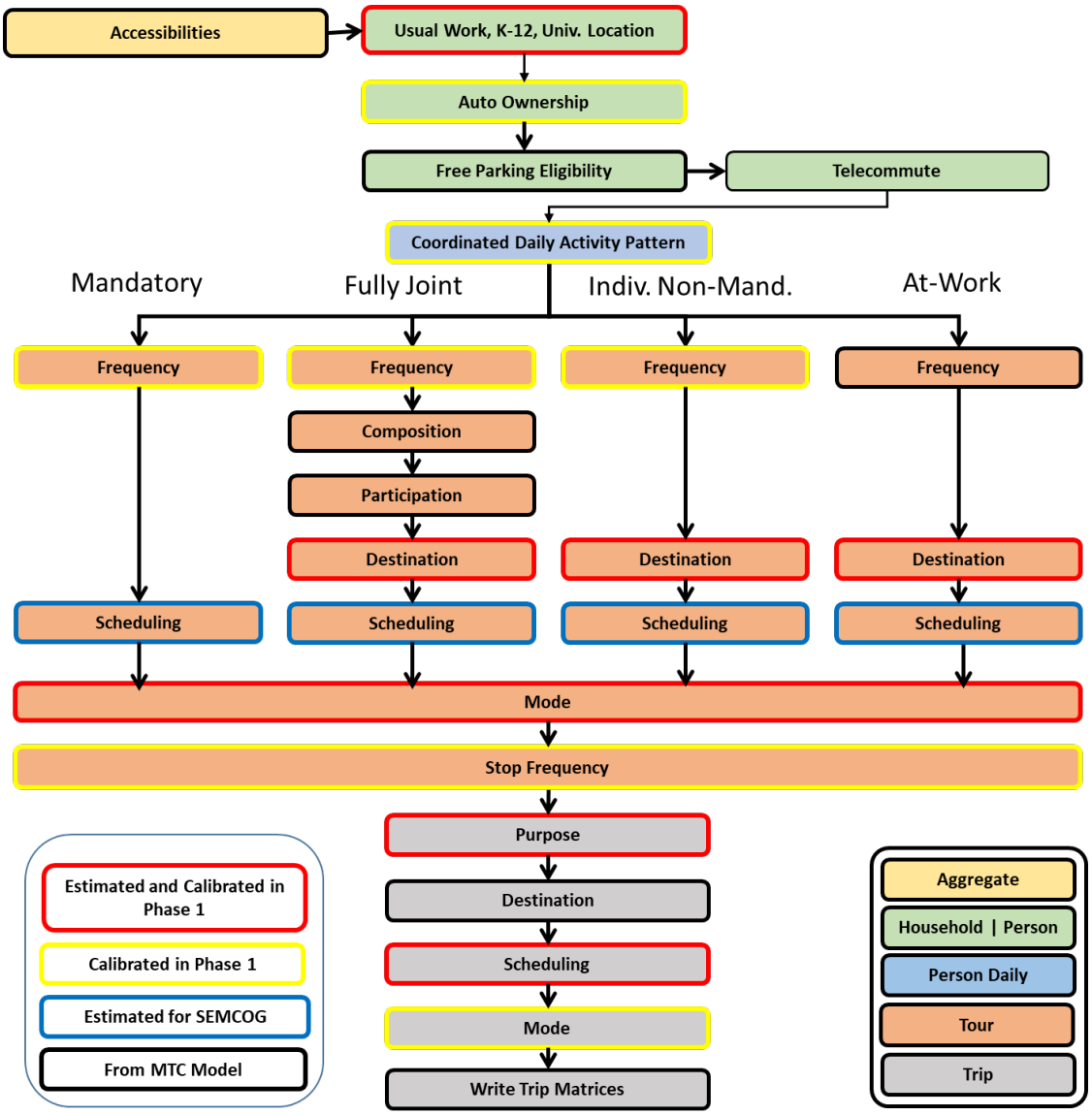


FIGURE 1: GEN3 PHASE 1 MODEL STRUCTURE

RSG implemented a visualization tool (ABM Visualizer) to compare ActivitySim outputs against RTS/MTS data and American Community Survey (ACS) worker commuting flow data. The ABM Visualizer creates a static HTML dashboard of summary comparisons of various models in the ActivitySim framework. The dashboard is a standalone HTML file that can be opened with an internet browser but does not require an internet connection to open. The dashboard opens with

a welcome page and contains multiple pages. Users may navigate to different areas of the dashboard using the navigation bar at the top of the page. Figure 2 shows the screen shot of the overview page. Most charts have a drop-down menu to apply a filter based on a grouping variable.

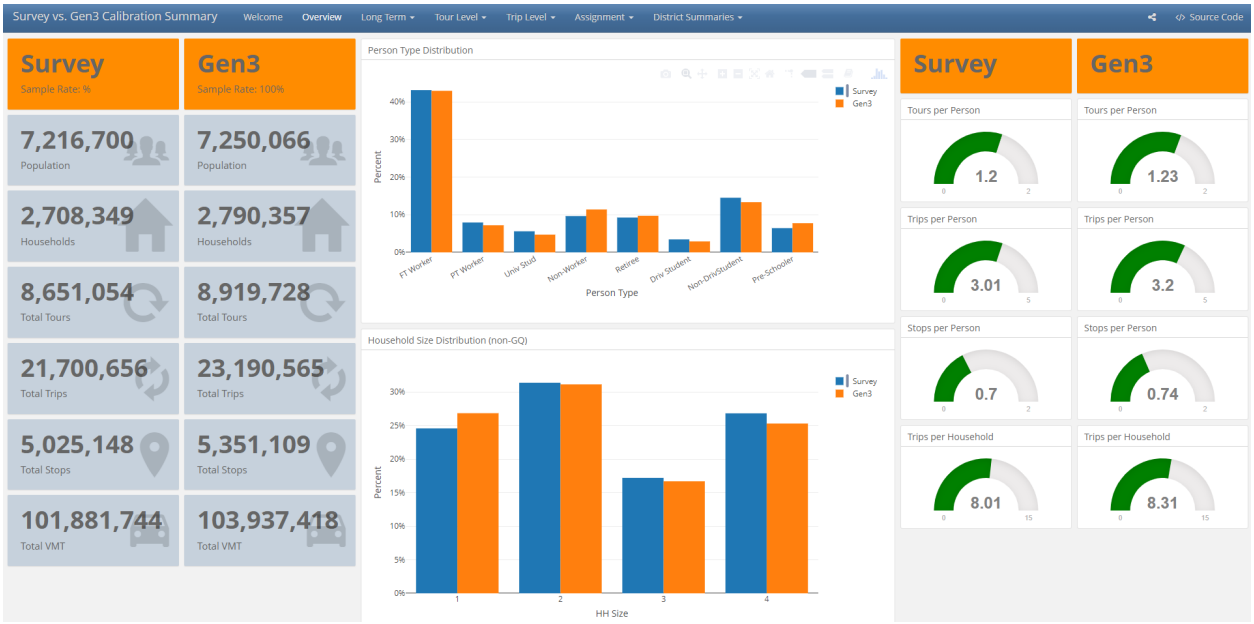


FIGURE 2: ABM VISUALIZER OVERVIEW PAGE

The summaries and charts in the dashboard have been grouped based on their order of implementation within ActivitySim. The tab names on the navigation bar bears the name of these groups – Overview, Long Term, Tour Level and Trip Level. Table 1 presents the list of summaries within each group.

TABLE 1: LIST OF SUMMARIES IN ABM VISUALIZER

GROUP	SUMMARIES
Overview	Totals – household, population, tour, trips, etc. Rates – tour rates, trip rates, etc. Aggregate summaries – household size and person type distribution
Long Term	Auto Ownership, Usual work and school location choice, District-District flow of workers, average mandatory trip

GROUP	SUMMARIES
	lengths, Jobs vs Workers comparison
Tour Level	Tour Summaries - Daily Activity Pattern, mandatory tour frequency, tour rates by person type, non-mandatory tour frequency
	Joint tours – joint tour frequency and composition and party size summaries
	Tour destination – non-mandatory trip length frequency, average trip lengths
	TOD – Tour departure/arrival profile
	Tour Mode – Tour mode choice
Trip Level	Stop frequency – stop frequency and purpose summaries
	Stop location – stop location choice summaries
	TOD – stop and trip departure profiles
	Trip mode – trip mode choice summaries

The results of the initial Phase 1 calibration are described by these groups in the next section. We also describe the Phase 1 validation performance based on traffic and transit assignment results. The report ends with conclusions and directions for Phase 2 development.

2.0 MODEL CALIBRATION

In model calibration, we iteratively adjust the travel model until it generates a demand that reasonably fits travel patterns in the observed data. Calibrating an ABM involves adjustments to different sub-components. Most models in the ActivitySim framework are modeled as a Multi-Nominal Logit (MNL) or Nested Logit (NL) Model. Calibrating an MNL or NL model involves updating the alternative-specific constants (ASCs) and/or other model parameters to move the aggregate model predictions in the desired direction.

Generally, the process starts with comparing observed distributions of a given travel attribute (for example, the number of tours by person type and purpose) against the predicted outputs. The ABM Visualizer is used to make this comparison. The following steps are implemented if the model distributions do not match the target distributions.

1. ASC adjustments are calculated in a spreadsheet or using a Jupyter notebook as follows for each alternative:
    a. $New\ ASC = Old\ ASC + \ln\left(\frac{Target\ Proportion}{Model\ Proportion}\right)$
2. The ActivitySim specification and coefficients file for the appropriate model is updated with the new coefficients.
3. The model is run with the updated coefficients.
4. If the model reasonably matches the observed data, stop; otherwise, go to step 1.

The following sections describe an overview of the Phase 1 calibration and then present the results.

2.1 PHASE 1 CALIBRATION OVERVIEW

The Phase 1 travel demand models were implemented for a 2018 base year. The network inputs for 2018 were developed based on the network/project assumptions from the 2020 Amendment of Visualize 2045, the region's Long-Range Transportation Plan (LRTP). In support of the Gen3 Model development, COG staff prepared the network files in four time-of-day periods (AM Peak, Mid-day, PM Peak and Night Time) and exported them from the network database in Cube Public Transport (PT) format. The network inputs also incorporated fare inputs that were proposed as part of the PT fare specifications in the COG's developmental Gen2/Version 2.4_PT Model. The land use data for 2018 came from COG's Round 9.1a Cooperative Forecasts of Land Use.

The Phase 1 calibration and validation was performed in rounds. After implementing the estimated tour mode choice and tour destination choice models, model performance was assessed. Since the tour frequency models were not estimated in Phase 1, the Gen3 Model generated tours per person at rates similar to the transferred SEMCOG ActivitySim model. Initially, the Gen3 Model was generating a tour rate of over 1.4 tours per person compared to 1.2 tours per person in RTS/MTS data. The share of auto modes was also overestimated compared to RTS/MTS share, suggesting the need to calibrate tour and trip mode choice model alternative-specific constants. Therefore, in the first round of calibration, we focused on auto ownership and tour/trip mode choice model calibration.

After this initial round of calibration, we found that the Gen3 Model was overestimating traffic regionally by over 20%, with significantly higher over-estimates for certain jurisdictions and facilities. As a result, the focus of second round of calibration was to make the travel rates more consistent with the RTS/MTS data. In the second round of calibration, the daily activity pattern (DAP) model was calibrated for part-time workers, retirees, and non-workers. The non-mandatory tour frequency and stop frequency models were adjusted to match the RTS/MTS distributions. The tour destination choice and intermediate stop location choice models were also adjusted to match the RTS/MTS average tour and intermediate stop out-of-direction lengths.

The second round of calibration resulted in a person tour rate of 1.23 tours per person and a total trip rate of 8.31 trips per person. Again, a full model run was completed after the second round of calibration. The estimated traffic and Vehicle Miles Traveled (VMT) were within a reasonable range of the observed data for most jurisdictions. The traffic and VMT were still being overestimated for some of the jurisdictions, specifically the District of Columbia (DC). The overestimation in the DC was investigated. The key findings from this investigation and other traffic assignment results are presented in the next chapter. The estimated transit boardings were also within a reasonable range of the observed boardings at the line-haul-mode level.

Further rounds of calibration and validation will be completed in Phase 2 of model development.

2.2 PHASE 1 CALIBRATION RESULTS

This section presents the summaries from the ABM Visualizer comparing the ActivitySim outputs with RTS/MTS data and Census data in some cases. The Visualizer summaries label the observed data as “Survey” and the ActivitySim output as “Gen3”. The final Phase 1 ABM Visualizer dated 2021-12-09 can be accessed from the following Box repository link: https://app.box.com/s/qckk8ehw06urdvbbyt87ppsq4tief108.

Overview

This section presents a general overview of goodness of fit of the synthetic population to observed survey distributions and an overall assessment of total travel.

Figure 3 shows the distribution of persons by person type (e.g., full-time worker, part-time worker, university student) between the expanded survey data and the Gen3 Model. The distributions match very well, not surprisingly since the base-year synthetic population was thoroughly validated[4] and the household survey was carefully expanded to Census data. Figure 4 compares households by household size (HH size, 1 person, 2 person, …, 4+ person) in the synthetic population against the expanded RTS/MTS data, also demonstrating a close fit.

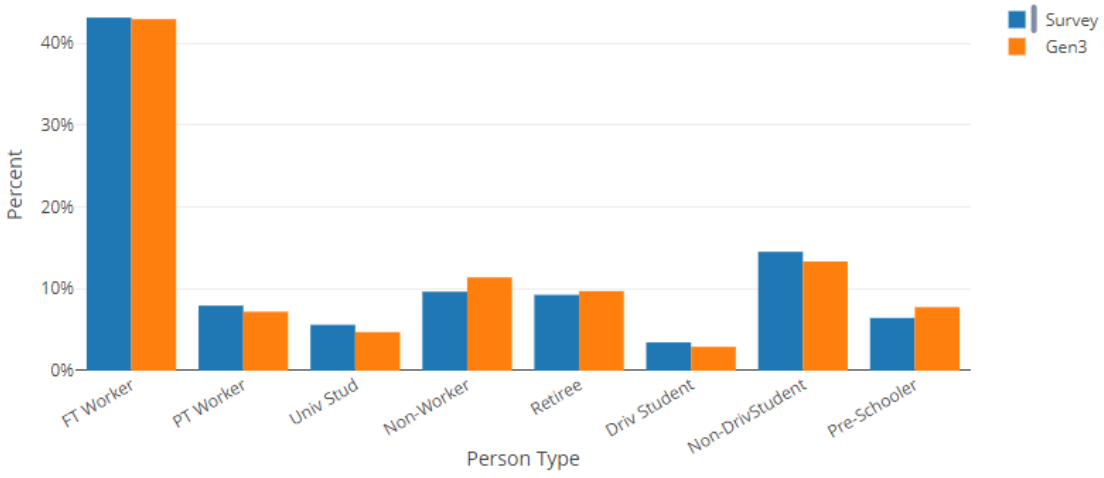


FIGURE 3: PERSON TYPE DISTRIBUTION

[4] See MWCOG Population Synthesizer Final Report, August 4, 2021.

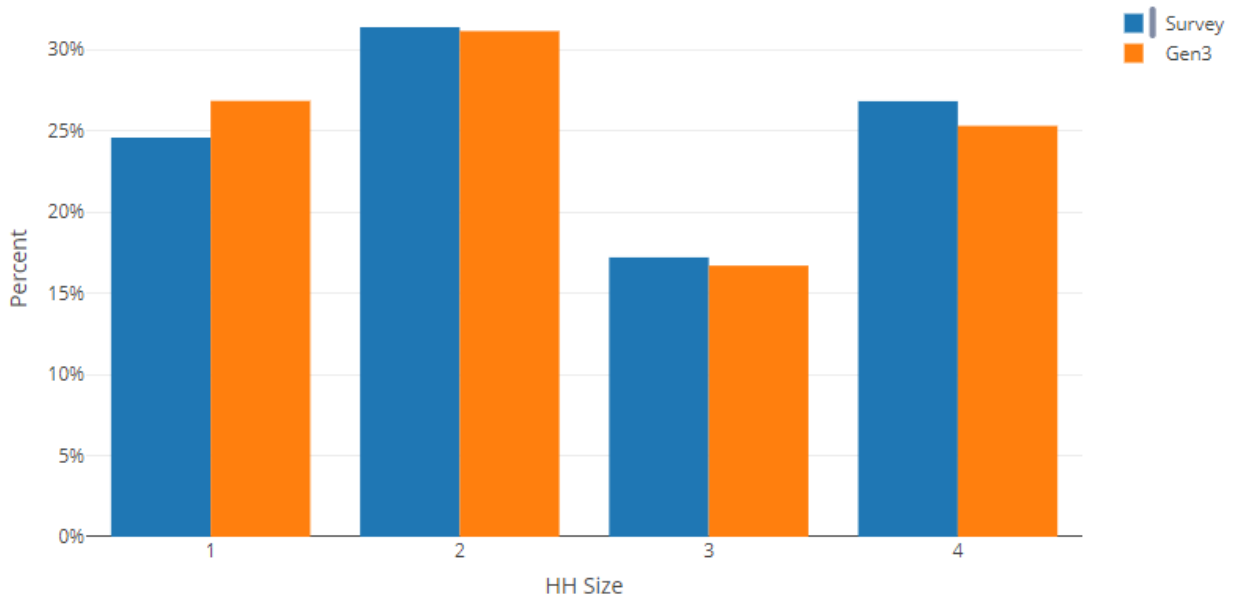


FIGURE 4: HOUSEHOLD SIZE DISTRIBUTION

Table 2 shows aggregate travel summary comparisons between the Gen3 Phase 1 Model and the expanded RTS/MTS data. Total households and population match closely; the difference is mostly explained by the non-institutional group quarters population in the Gen3 Model that are not included in the survey data. Non-institutional group quarters population is approximately 1.2% of total population in the base year. The total number of tours is somewhat higher in the Gen3 Model compared to survey data; this is explained further below. This leads to a somewhat higher number of total trips. The intermediate stop models also generate more stops on tours compared to the household survey data. Trips per person and trips per household is somewhat higher in the model compared to the survey given the higher stop rate. Overall Vehicle Miles of Travel (VMT), as measured by appending travel distance values ("skims") to the auto trips and dividing by auto occupancy, is relatively close between the RTS/RTS/MTS data and the Gen3 Phase 1 models.

TABLE 2: OVERVIEW AGGREGATE SUMMARIES

Variable	Survey	Model	Difference	Percent Difference
Population	7,216,700	7,250,066	33,366	0.5%
Households	2,708,349	2,790,357	82,008	3.0%

Total Tours	8,651,054	8,919,728	268,674	3.1%
Total Trips	21,700,656	23,190,565	1,489,909	6.9%
Total Stops	5,025,148	5,351,109	325,961	6.5%
Tours per Person	1.20	1.23	0.03	2.6%
Trips Per Person	3.01	3.20	0.19	6.4%
Stops Per Person	0.70	0.74	0.04	6.0%
Trips Per Household	8.01	8.31	0.19	6.4%
Total Vehicle Miles of Travel (VMT)	101,881,744	103,937,418	2,055,674	2.0%

Long Term and Mobility Travel Choices

Long-term and mobility models include usual work and school location choice, work-from-home choice, auto ownership and telecommute frequency. Results are presented in the order in which these models are run.

Mandatory Location Choice

Mandatory tour length frequency distributions for work, university, and Kindergarten through 12th grade (K-12) school purposes are shown in Figure 5, Figure 6, and Figure 7 respectively. Distance is capped at 50 miles, therefore the distributions show a small spike at the cap. Each distribution plots the distance between home and the primary destination location. As shown in the plots, the distributions for work and K-12 school match household survey data closely, while the Gen3 Model does match the survey distribution for the university purpose well. Both the work and K-12 mandatory location choice models were estimated in Phase 1, while the university model was transferred from the Metropolitan Transportation Commission (MTC) donor model. The university model was not calibrated to survey data as the RTS/MTS survey did not include group quarters such as on-campus housing. Due to the survey bias, we do not recommend calibrating the university model in Phase 2, either.

Table 3 shows average work location choice distance by residence jurisdiction. Overall, the average home to work distance is within 1% of observed data. While most jurisdictions are within 15% of the observed home to work distance, a few jurisdictions (City of Falls Church, Fauquier County, King George County, City of Manassas) have greater differences. The R-squared across all jurisdictions is 0.904[5].

Figure 8 compares jurisdiction-to-jurisdiction worker flows between the Gen3 model and 2011-2015 Census American Community Survey (ACS) Journey-To-Work data. Each point represents a jurisdiction-to-jurisdiction pair with observed or estimated workers, colored by destination jurisdiction as shown in the legend. The plot shows a good match between Census data and the Gen3 model with most points falling along the 45-degree line. The R-squared is 0.984.

Note that currently, the Gen3 Phase 1 Model sends all resident workers and students to internal TAZs. This could add some bias to the results, especially for workers residing in zones that are close to the model boundary, since their work tours would not be reflected in the observed data. Figure 9 compares estimated workers by chosen work TAZ to input jobs by TAZ; each point represents a TAZ with either workers or employment. The estimated slope (shown in blue) is 0.95, slightly below the 45-degree line (which has a slope of 1.00), indicating that on average total workers in the synthetic population is a bit lower than total employment in the land-use data. This may be due to workers who work multiple jobs, which are not explicitly modeled in the Gen3 Model. However, on average, the match to input jobs at a TAZ level is quite good, with an R-squared of 0.975.

The modeled share of workers who regularly work from home is 9%, compared to 8.2% from the 2011-2015 Census American Community Survey.

[5] The formula for R-squared is available here: https://en.wikipedia.org/wiki/Coefficient_of_determination

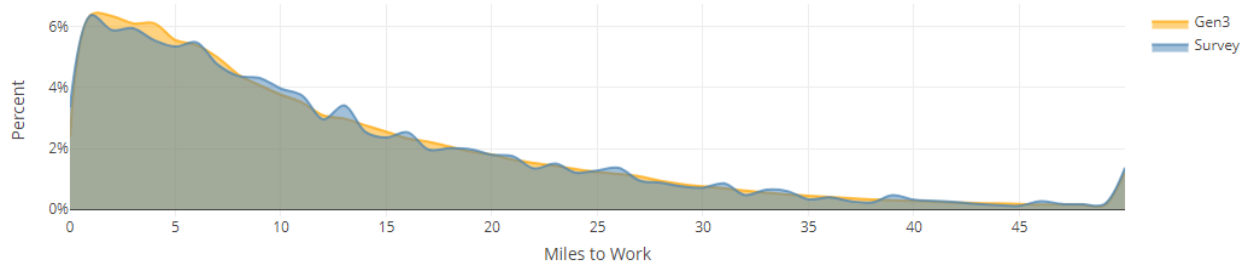


FIGURE 5: HOME TO WORK TOUR LENGTH FREQUENCY DISTRIBUTION

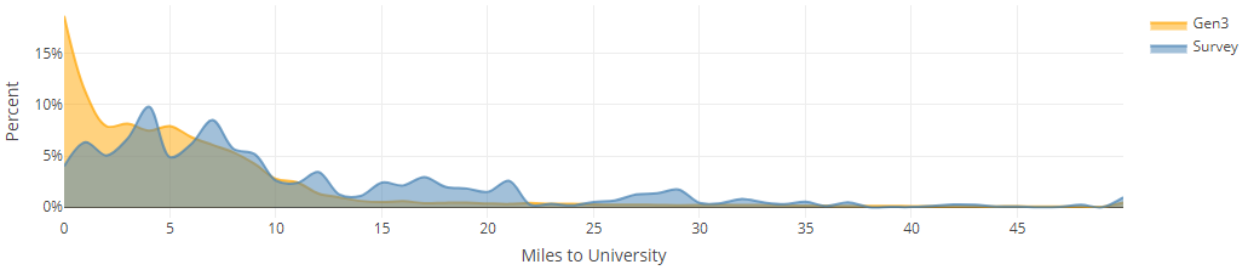


FIGURE 6: HOME TO UNIVERSITY TOUR LENGTH FREQUENCY DISTRIBUTION

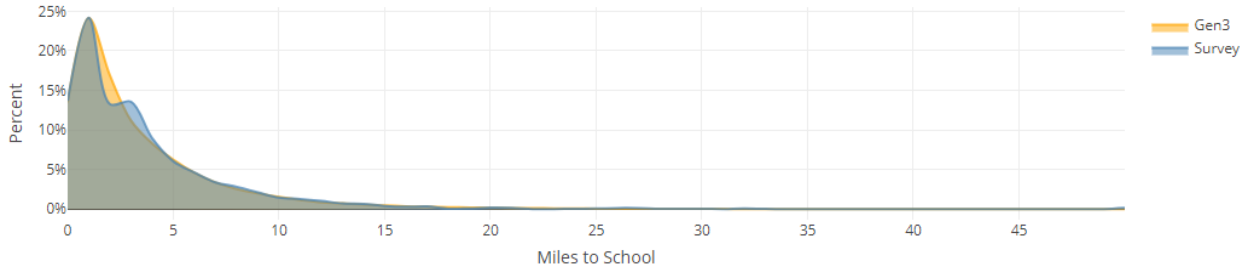


FIGURE 7: HOME TO SCHOOL TOUR LENGTH FREQUENCY DISTRIBUTION

TABLE 3: WORK LOCATION CHOICE AVERAGE DISTANCE BY RESIDENCE JURISDICTION (IN MILES)

Jurisdiction	Survey	Model	Difference	Percent Difference
Alexandria	8.3	8.4	0.1	2%
Anne Arundel	15.2	13.5	-1.8	-12%
Arlington	7.8	6.8	-1.0	-13%
Calvert	21.4	23.9	2.6	12%
Carroll	17.8	16.5	-1.2	-7%
Charles	21.7	22.0	0.3	1%
Clarke	27.9	29.5	1.6	6%
Fairfax	11.2	11.4	0.3	2%
Fairfax City	11.6	10.7	-0.9	-8%
Falls Church	14.2	9.4	-4.8	-34%
Fauquier	21.4	25.2	3.8	18%
Frederick	18.5	16.1	-2.5	-13%
Fredericksburg	8.9	10.2	1.4	15%
Howard	14.8	13.0	-1.9	-13%
Jefferson	21.8	23.6	1.8	8%
King George	21.1	25.9	4.8	23%
Loudoun	15.3	16.0	0.7	4%
Manassas	11.0	13.3	2.3	21%
Manassas Park	13.5	15.0	1.5	11%
Montgomery	11.5	11.8	0.3	3%
Prince George's	12.5	12.6	0.1	1%
Prince William	16.5	16.8	0.4	2%
Spotsylvania	15.2	14.9	-0.4	-2%
St Mary's	18.4	16.9	-1.5	-8%
Stafford	20.1	19.5	-0.7	-3%
Washington, D.C.	5.9	5.4	-0.4	-7%
Total	12.9	12.8	-0.1	-1%

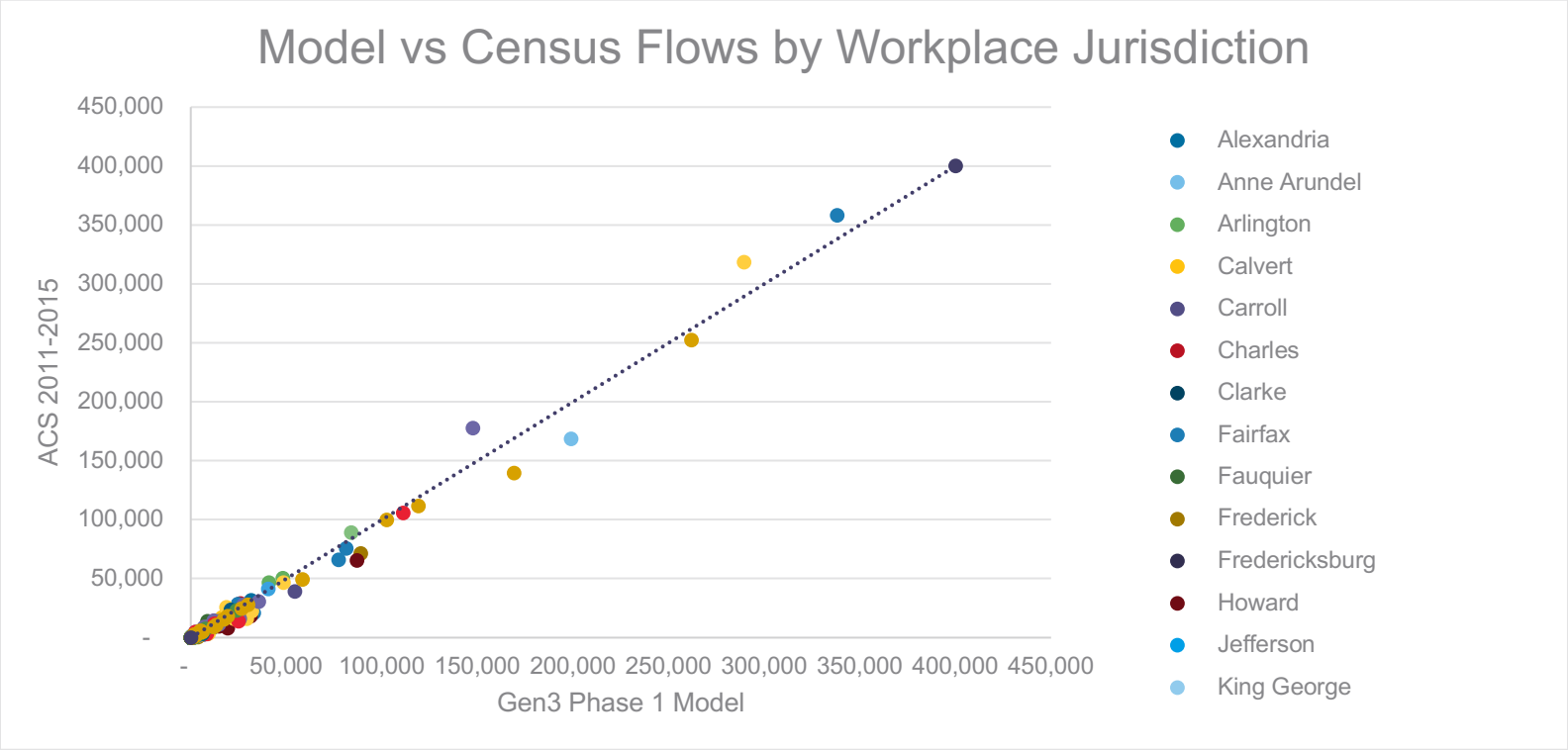


FIGURE 8: JURISDICTION-LEVEL WORKER COMMUTING FLOW COMPARISON

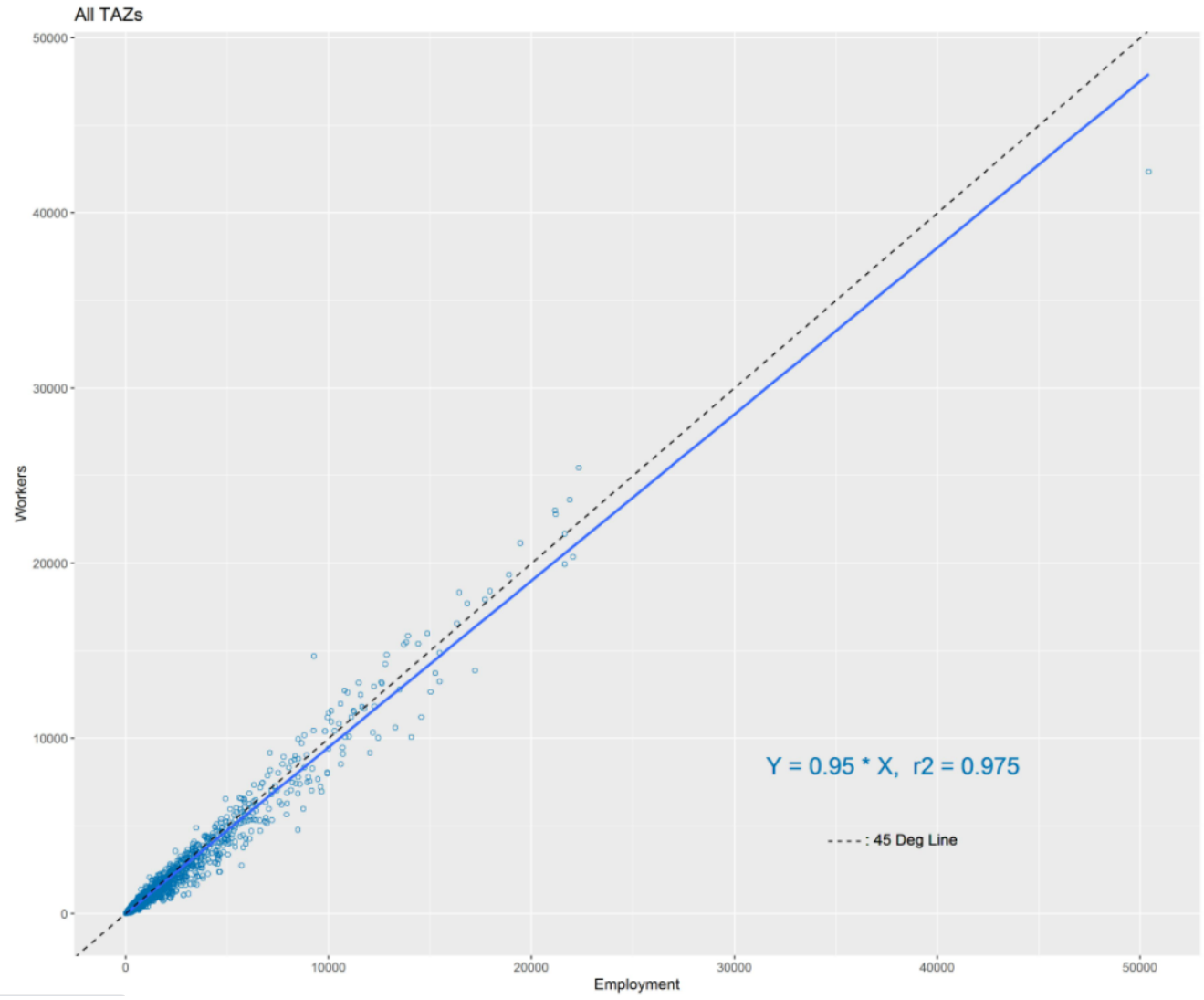


FIGURE 9: ESTIMATED WORKERS VS INPUT JOBS BY TAZS

Table 4 shows average university location choice distance by residence jurisdiction. Overall, the average estimated home to university distance is under the survey distance by 4.8 miles or 43%. As stated previously, we would expect the model to demonstrate a shorter distance to university than the survey due to an under-representation of students living in group quarters and non-family housing in the survey. These students tend to live in close proximity to campus, and therefore tend to have much shorter home to university distances than students living in family households. As a consequence, most jurisdictions also show a shorter home to university distance than the RTS/MTS survey data. The R-squared across all counties is 0.489.

TABLE 4: UNIVERSITY LOCATION CHOICE AVERAGE DISTANCE BY RESIDENCE JURISDICTION (IN MILES)

Jurisdiction	Survey	Model	Difference	Percent Difference
Alexandria	9.7	3.5	-6.2	-63%
Anne Arundel	15.6	9.9	-5.6	-36%
Arlington	8.8	2.5	-6.3	-71%
Calvert	27.7	34.6	6.9	25%
Carroll	24.2	11.5	-12.7	-52%
Charles	15.5	13.1	-2.4	-16%
Clarke	48.1	41.4	-6.8	-14%
Fairfax	7.9	5.1	-2.8	-35%
Fairfax City	4.2	2.5	-1.7	-40%
Falls Church	5.3	5.1	-0.2	-4%
Fauquier	19.4	17.0	-2.4	-12%
Frederick	19.9	8.5	-11.4	-57%
Fredericksburg	0.5	1.7	1.2	234%
Howard	12.8	7.4	-5.5	-43%
Jefferson	15.0	14.2	-0.8	-5%
King George	0.0	30.4	30.4	0%
Loudoun	14.5	9.2	-5.3	-37%
Manassas	6.9	5.1	-1.8	-26%
Manassas Park	6.6	6.7	0.1	2%
Montgomery	11.2	7.4	-3.9	-34%
Prince George's	10.6	4.9	-5.6	-53%
Prince William	14.1	6.4	-7.7	-54%
Spotsylvania	8.1	6.0	-2.1	-26%
St Mary's	14.7	10.5	-4.2	-29%
Stafford	18.3	15.5	-2.8	-15%

Washington, D.C.	3.5	1.9	-1.5	-44%
Total	11.2	6.4	-4.8	-43%

Table 5 shows average K-12 school location choice distance by residence jurisdiction. Overall, the average modeled home to school distance is 0.1 miles or 2 percent lower than the average observed home to school distance. Clearly there is more jurisdiction to jurisdiction variation in the school location choice model compared to the work location choice model, with some jurisdictions more than 30% over or under-estimated. The R-squared across all counties is 0.465. It is possible that some of the larger over or under-estimates are due to lack of sufficient sample in some counties.

TABLE 5: SCHOOL LOCATION CHOICE AVERAGE DISTANCE BY RESIDENCE JURISDICTION (IN MILES)

Jurisdiction	Survey	Model	Difference	Percent Difference
Alexandria	2.3	3.1	0.8	34%
Anne Arundel	4.0	4.1	0.1	2%
Arlington	2.4	3.2	0.9	37%
Calvert	6.3	5.0	-1.3	-20%
Carroll	4.4	5.2	0.8	19%
Charles	5.3	5.2	-0.1	-2%
Clarke	6.6	7.0	0.4	6%
Fairfax	3.3	3.8	0.5	14%
Fairfax City	2.9	3.4	0.5	17%
Falls Church	2.1	3.2	1.0	48%
Fauquier	6.7	7.2	0.5	7%
Frederick	6.0	4.3	-1.8	-29%
Fredericksburg	8.8	3.3	-5.5	-62%
Howard	3.0	4.0	1.0	34%
Jefferson	8.0	5.9	-2.1	-27%
King George	6.1	7.4	1.3	21%
Loudoun	3.7	3.9	0.2	5%
Manassas	2.5	2.4	-0.1	-3%
Manassas Park	2.4	2.6	0.2	8%
Montgomery	3.8	3.7	-0.1	-3%
Prince George's	5.2	4.2	-1.0	-19%
Prince William	4.1	3.6	-0.5	-11%

Spotsylvania	5.0	4.0	-1.0	-20%
St Mary's	8.0	5.8	-2.3	-28%
Stafford	4.9	4.3	-0.6	-11%
Washington, D.C.	2.7	2.8	0.2	6%
Total	4.0	4.0	-0.1	-2%

Telecommute Frequency

The terms "telecommute" and "telework" are often used synonymously.[6] However, in this report, the following definitions are used: "Telework" means that a worker does not have a usual workplace outside the home. Telework is represented in ActivitySim using the new work-at-home model, which is part of work location choice, it determines for each worker whether the worker has a usual, out-of-home work location or works regularly at their home. If the worker's work location is home, then they do not generate work tours. By contrast, "telecommute," applies to only those workers with a usual workplace outside home who participates in a telecommute program, which involves telecommuting at least one day a week. The alternatives for the telecommute model are one day a week, two to three days a week, or four or more days a week. Thus, the telecommute frequency model predicts the number of days each worker who works at an out-of-home location regularly telecommutes to work. The model was estimated using household travel survey data from the San Diego region and calibrated to RTS/RTS/MTS household survey data. The model is applied to workers with a usual workplace outside the home. Workers who telecommute less than one day per week are treated as if they do not telecommute since workers who telecommute less than one day per week were found to have little observable difference in travel than workers who do not telecommute at all. As shown in Figure 10, the calibrated model closely replicates the observed distribution of workers by telecommute frequency. Approximately 16% of workers telecommute regularly in the RTS/MTS data. The RTS/MTS data was collected between 2017 and 2019, which was prior to the COVID-19 pandemic, related closures, and the large increase in telecommuting and telework that happened during 2020 and 2021 due to COVID-19-related restrictions.

[6] See, for example, Mokhtarian, Patricia L., Ilan Salomon, and Sangho Choo. "Measuring the Measurable: Why Can't We Agree on the Number of Telecommuters in the U.S.?" Quality and Quantity 39, no. 4 (August 1, 2005): 423–52. https://doi.org/10.1007/s11135-004-6790-z.

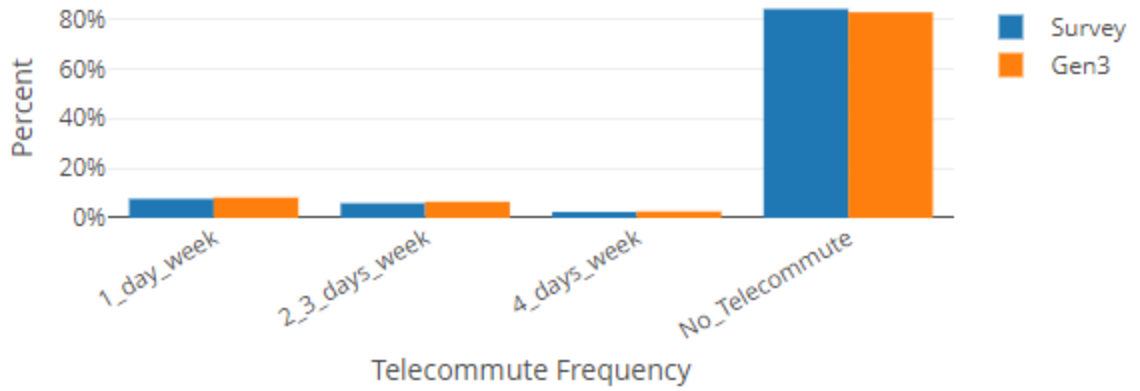
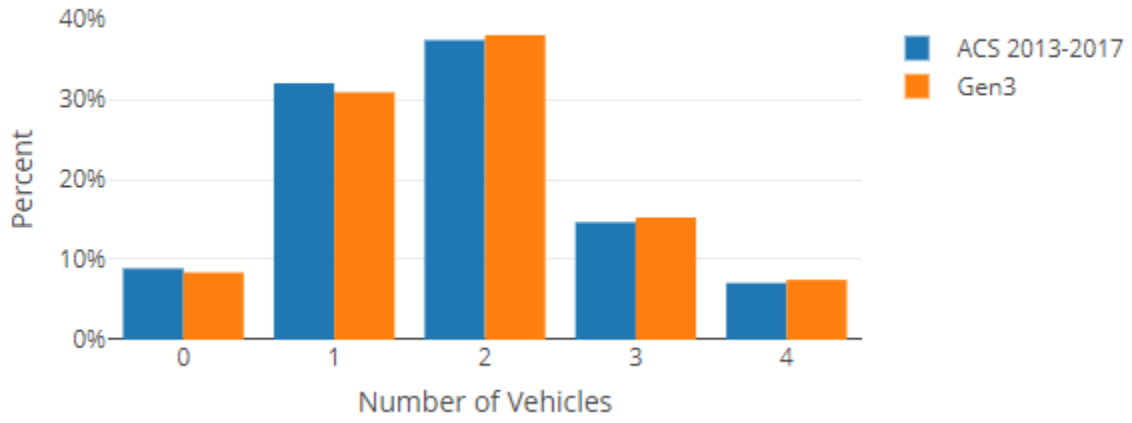


FIGURE 10: TELECOMMUTING FREQUENCY COMPARISON

Auto ownership

The auto ownership model was estimated using data from Southeast Michigan Council of Governments and calibrated to Census American Community Survey (ACS) data from 2013-2017[7]. The model was calibrated regionally, as shown in Figure 11, and then estimated 0-auto households were compared to ACS data at a tract level, as shown in Figure 12. It appears from this plot that 0-auto households may be under-estimated in the District of Columbia. This will be further analyzed in Phase 2.



[7] More recent ACS data was used for auto ownership comparisons than for journey-to-work comparisons because the latest years that commuting flow data is available is for 2011-2015.

FIGURE 11: AUTO OWNERSHIP DISTRIBUTION FOR DISTRICT OF COLUMBIA

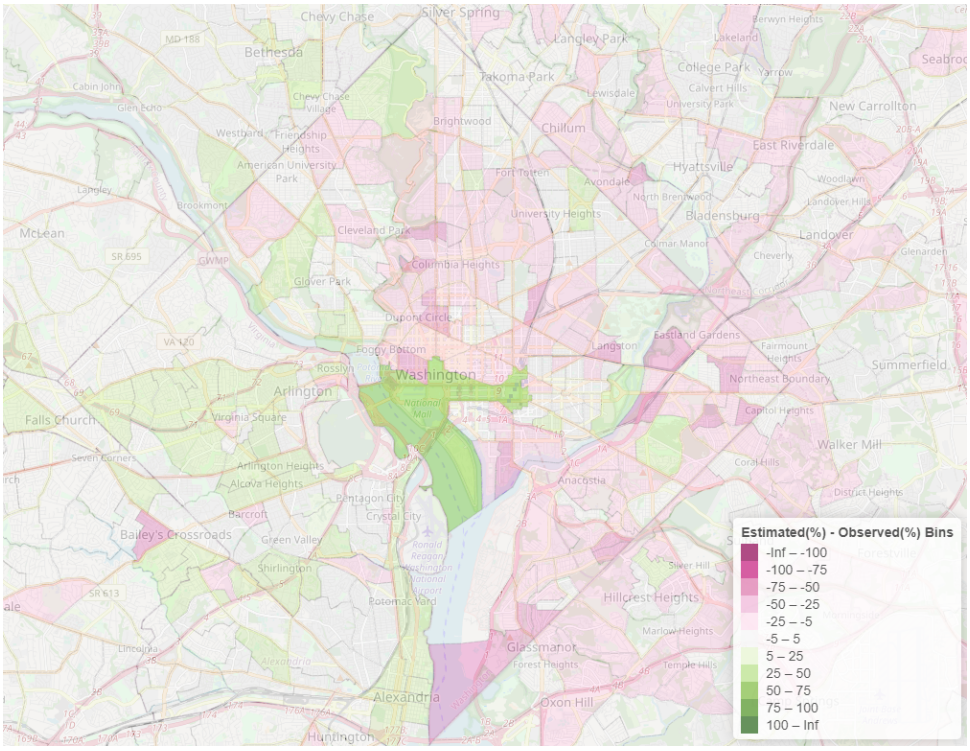


FIGURE 12: ZERO AUTO HOUSEHOLDS COMPARISON

Tour Level Models

Tour level models include the Coordinated Daily Activity Pattern model, Mandatory, Joint, Individual Non-Mandatory, and At-Work Subtour Frequency models, Tour Scheduling models, Non-Mandatory Tour Destination Choice models, Tour Mode Choice Models, and Intermediate Stop Frequency Models. They are described below.

Daily Activity Pattern and Tour Frequency Models

The Coordinated Daily Activity Pattern model assigns a Mandatory (at least one mandatory tour), Non-Mandatory (no mandatory tours, at least one non-mandatory tour), or Home (no travel) day pattern for every household member. A mandatory activity is defined as work or school. The model was transferred from the MTC donor model and calibrated to RTS/RTS/MTS data for each person type. The calibration results for all person types are shown in Figure 13.

Table 6 shows estimated versus observed day pattern shares by person type. The percent of the population for each person type is also noted in the table. Most person types match

observed day pattern shares well; university students and pre-school children have the highest discrepancy. We do not recommend adjusting the day pattern shares for university students due to survey bias. It may be possible to further calibrate day pattern shares for pre-school students in Phase 2. Additional calibration would improve the under-estimate for Mandatory day patterns and over-estimate for non-mandatory day patterns.

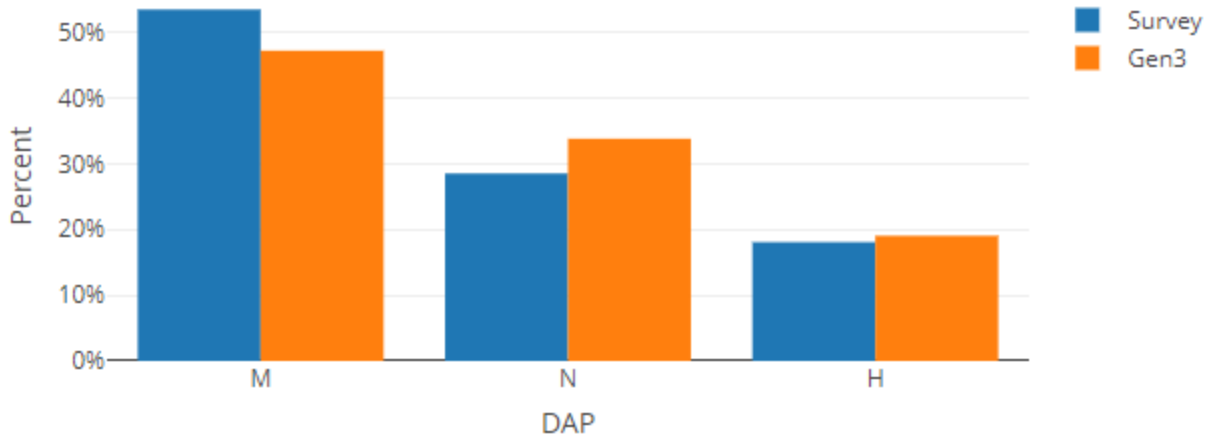


FIGURE 13: DAILY ACTIVITY PATTERN (MANDATORY, NON-MANDATORY, AND HOME) - ALL PERSON TYPES

TABLE 6: ESTIMATED VERSUS OBSERVED DAILY ACTIVITY PATTERN SHARES BY PERSON TYPE

Person Type (% of population)	Day Pattern	Observed Share	Estimated Share	Difference
Full-Time Worker (42.9%)	Mandatory	76%	69%	-7%
	Non-Mandatory	14%	18%	3%
	Home	10%	14%	4%
Part-Time	Mandatory	39%	35%	-4%

Worker (7.2%)	Non-Mandatory	39%	42%	3%
	Home	22%	24%	2%
College/Univ Student (4.7%)	Mandatory	54%	64%	10%
	Non-Mandatory	21%	25%	4%
	Home	25%	11%	-14%
Non-Working Adult (11.4%)	Mandatory	0%	0%	0%
	Non-Mandatory	64%	66%	1%
	Home	36%	34%	-1%
Retiree (9.7%)	Mandatory	0%	0%	0%
	Non-Mandatory	69%	69%	0%
	Home	31%	31%	0%
Driving-Age Student (2.9%)	Mandatory	73%	73%	1%
	Non-Mandatory	11%	12%	1%
	Home	16%	15%	-1%
Non-Driving Student (13.3%)	Mandatory	76%	73%	-3%
	Non-Mandatory	11%	14%	3%
	Home	13%	13%	-1%
Pre-School (7.8%)	Mandatory	18%	4%	-15%
	Non-Mandatory	55%	73%	17%
	Home	27%	24%	-3%
Total	Mandatory	53%	47%	-6%
	Non-Mandatory	29%	34%	5%
	Home	18%	19%	1%

The mandatory tour frequency model predicts the number and purpose of mandatory tours for workers and students in the synthetic population with a Mandatory daily activity pattern. The alternatives are delineated by number of tours: 1 work, 2 work, 1 school, 2 school, or 1 work and 1 school tour. Work tour alternatives are only available for workers, and school tour alternatives are only available for students The model was transferred from the MTC donor model and calibrated to RTS/MTS/MTS data by person type. Figure 14 shows the calibration results for all person types. The model matches observed distributions closely.

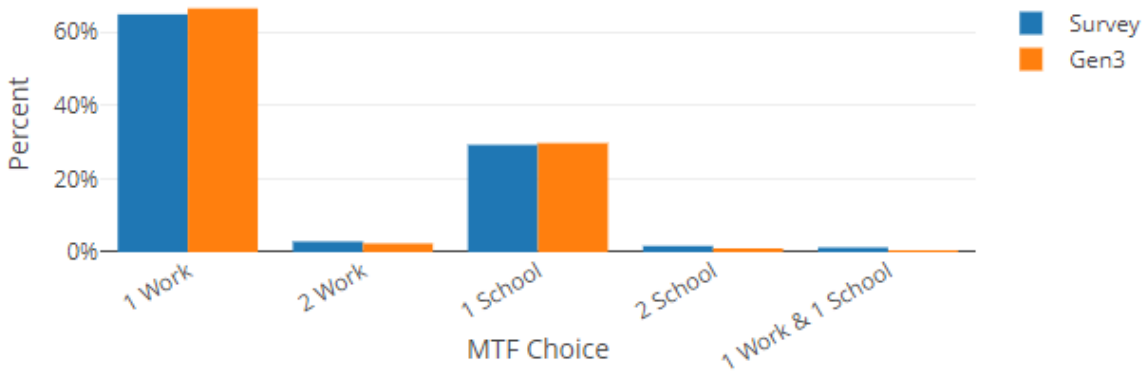


FIGURE 14: MANDATORY TOUR FREQUENCY - ALL PERSON TYPES

The joint tour frequency model predicts the number and purpose of tours in which two or more household members travel together for the entire tour. The model is applied to households in which there are at least two members with an active (Mandatory or Non-Mandatory) daily activity pattern. The model was transferred from the MTC donor model. It has not been calibrated to RTS/MTS/MTS data; as shown in Figure 15 the model under-estimates the 1 shopping tour alternative and tends to over-estimate alternatives with 2 joint tours. This is likely contributing to the relatively higher rates of travel in the model as compared to survey data, as shown in Table 2. This model will be further calibrated in Phase 2.

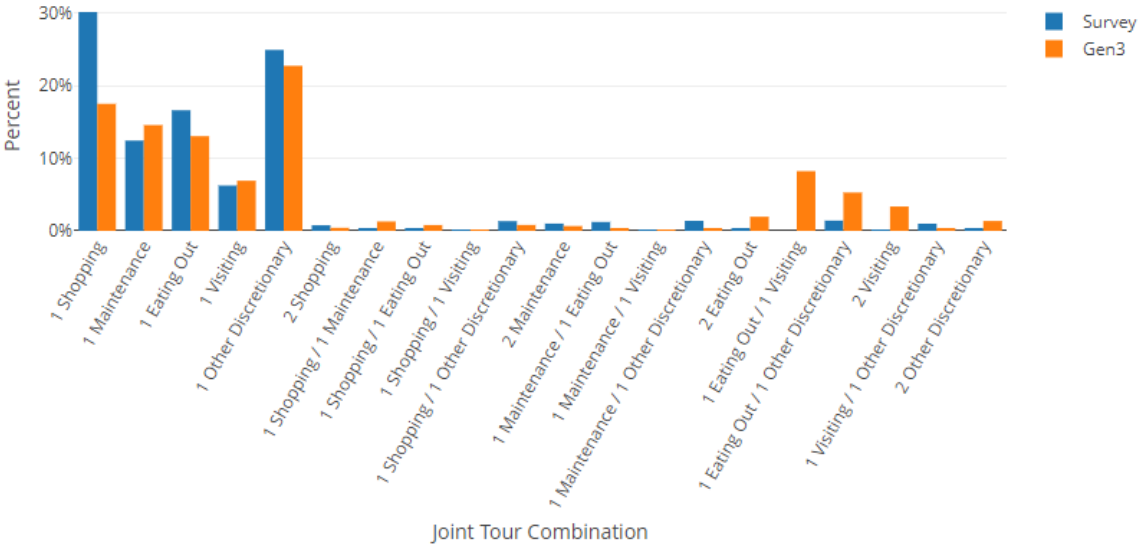


FIGURE 15: JOINT TOUR FREQUENCY COMPARISON

After joint tours are generated, a model is run for each joint tour to predict its composition - adults only, children only, or mixed adults plus children. Figure 16 shows the joint tour composition from RTS/MTS/MTS data compared to the Gen3 Phase 1 Model. The model clearly over-predicts the share of joint tours made by only children as compared to survey data. This model will be further calibrated in Phase 2.

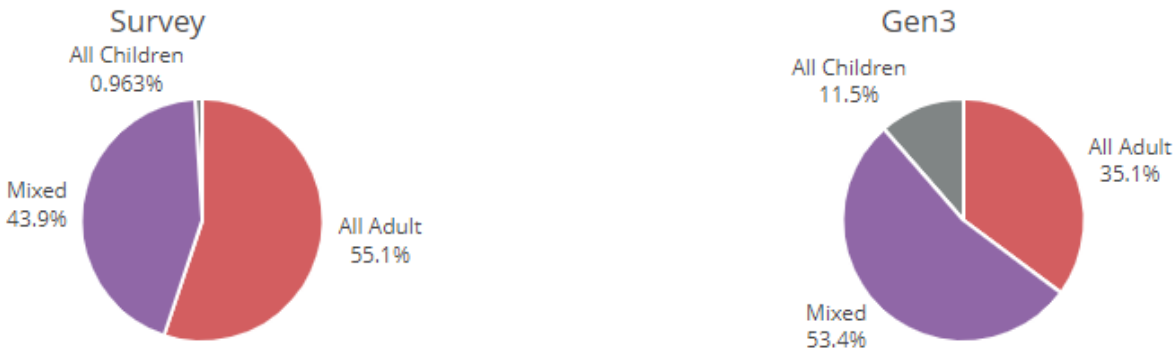


FIGURE 16: JOINT TOUR PARTY COMPOSITION

Once joint tours are generated and their composition predicted, a model runs at the person level to determine whether active household members in households with joint tours participate in the joint tour. This is a simulation-based model which runs iteratively until the composition constraints are met; for example, if the tour composition is mixed, the model cycles through household members until at least one adult and one child choose to participate in the tour. Figure 17 shows a frequency distribution of estimated versus observed joint tours by number of household members participating in the tour. It indicates that the model tends to over-estimate the party size for joint tours. This may be due to the error in the tour purpose or composition models shown above; if necessary, the model will be calibrated further in Phase 2.

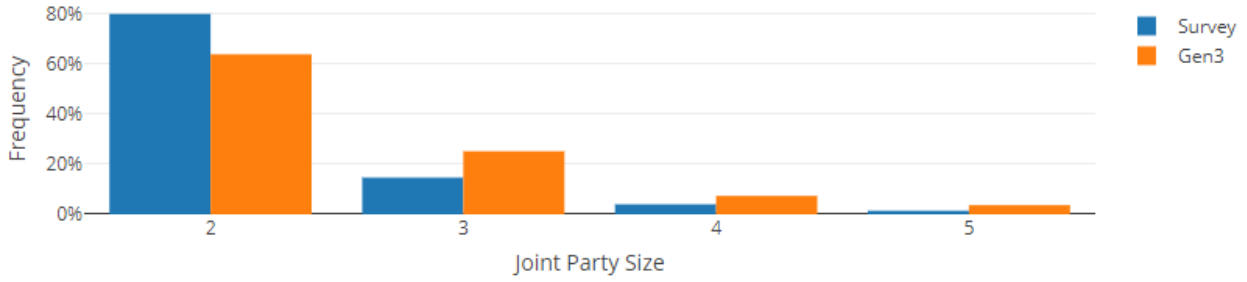


FIGURE 17: JOINT TOURS BY NUMBER OF HOUSEHOLD MEMBERS

The individual non-mandatory tour frequency model predicts the number of individual non-mandatory tours by purpose (escorting, shopping, other maintenance, visiting/social, eating out, and other discretionary[8]) for each household member with an active daily activity pattern. Each alternative in the model indicates the number of tours by purpose. In total there are 89 alternatives in the model. After the model runs, the exact number of non-mandatory tours by purpose is selected from a probability distribution generated from observed data.

Because there are so many alternatives in the model, we typically calibrate the tour frequency distribution by number of individual non-mandatory tours by person type. Figure 18 shows the results across all person types. As shown in the table, the share of persons with one or more individual non-mandatory tours is slightly over-estimated. This is consistent with the over-estimate of persons with a Non-Mandatory daily activity pattern shown in Figure 13. Further calibration of the Coordinated Daily Activity Pattern model should reduce this over-estimate.

Overall, the estimated total tour rate across all active persons by person type (Figure 19) closely follows observed data.

[8] Other maintenance refers to activities like personal business and medical appointments. Other discretionary refers to attendance at sporting events, religious activities, and other types of discretionary activities not included in social/recreational or eating out.

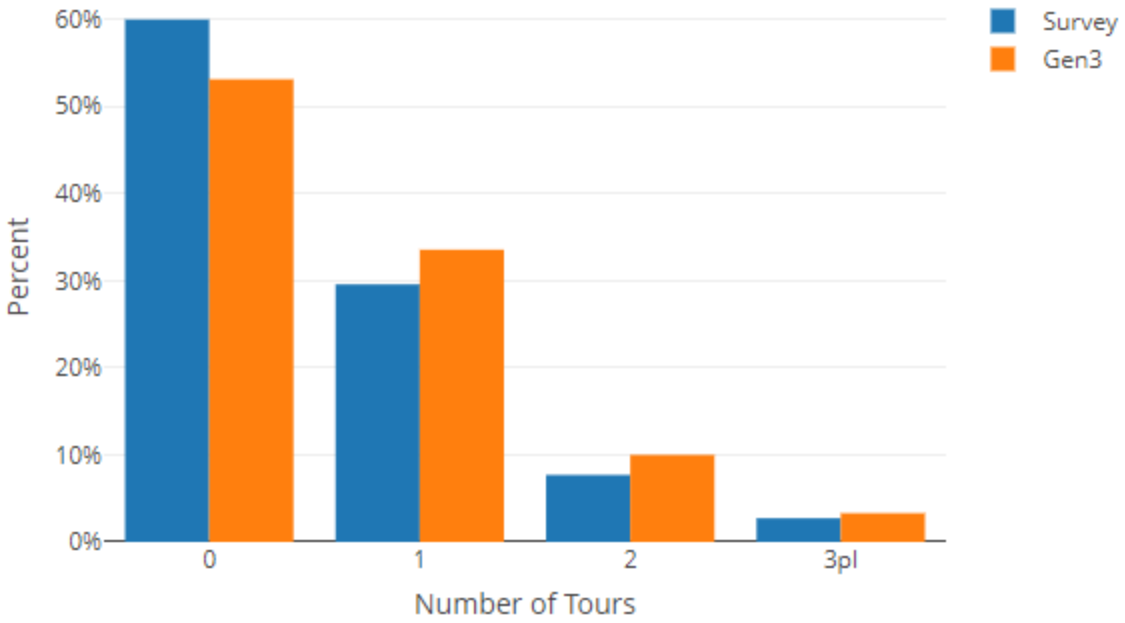


FIGURE 18: INDIVIDUAL NON-MANDATORY TOUR FREQUENCY - ALL PERSON TYPES

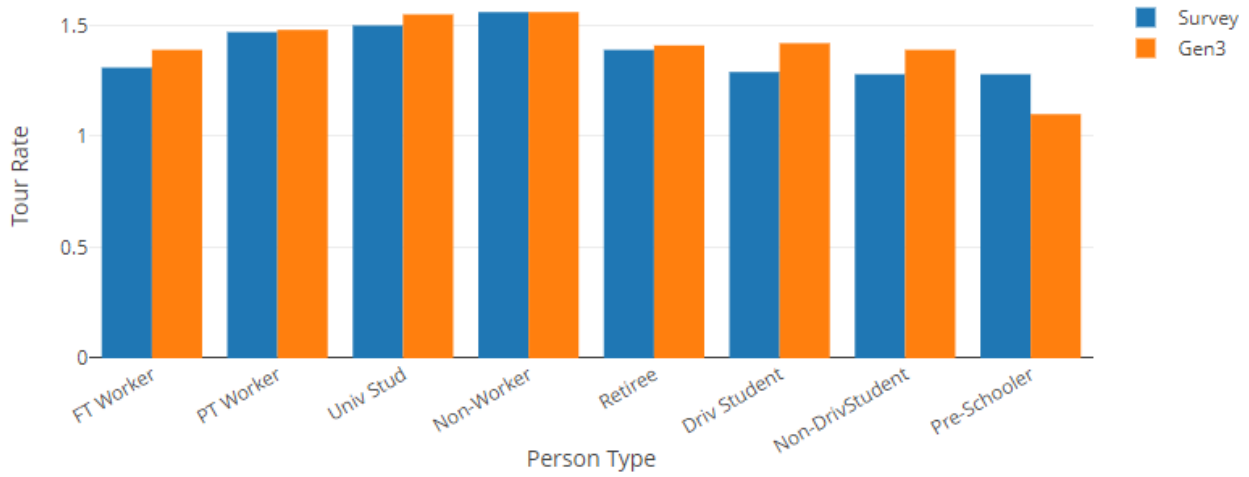


FIGURE 19: TOUR RATES - ONLY ACTIVE PERSONS

Tour Destination Choice Models

After tours are generated, a primary destination TAZ is chosen for each tour. The tour primary destination choice models were estimated from RTS/MTS/MTS data and implemented in the Gen3 Phase 1 Model. Figure 20 shows the overall estimated versus observed tour length frequency distribution for joint and individual non-mandatory tours. The estimated and observed tour length frequency distributions match quite closely. Table 7 shows the estimated versus observed average tour length in miles by grouped purpose. In this table, shopping and other maintenance tours are grouped into "Maintenance" while visiting/social, eating out, and other discretionary tours are grouped into "Discretionary". As shown in the table, the estimated average tour lengths for all purposes are very close to observed. Individual discretionary and at-work subtours have the biggest discrepancy in tour length. However, since VMT is over-estimated by the Phase 1 model, correction of these two discrepancies are not a high priority calibration task for Phase 2.

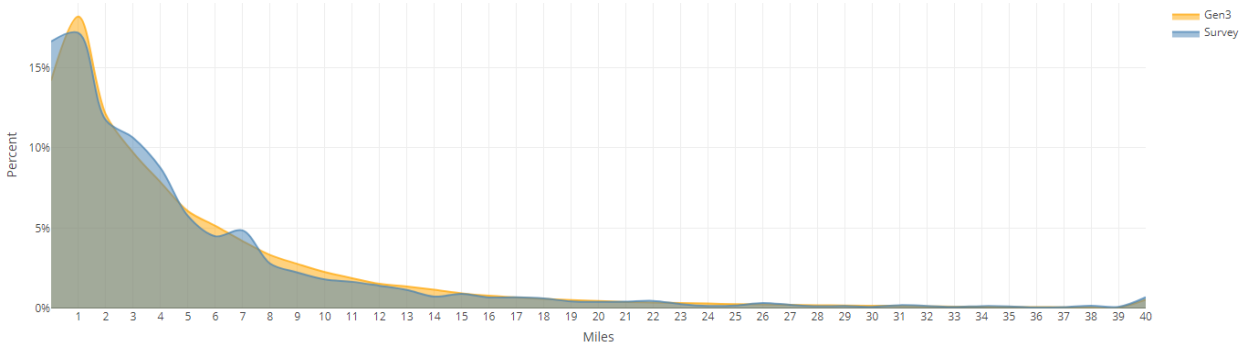


FIGURE 20: NON-MANDATORY TOUR LENGTH FREQUENCY DISTRIBUTION - ALL PURPOSES

Purpose	Observed	Estimated	Difference	Percent Difference
Escorting	4.2	4.2	0.0	-1.0%
Individual Maintenance	5.6	5.6	0.0	-0.7%
Individual Discretionary	6.4	6.0	-0.4	-6.2%
Joint Maintenance	6.8	7.1	0.3	4.1%
Joint Discretionary	7.0	7.2	0.2	3.1%
At-Work Subtours	5.4	5.0	-0.4	-7.2%
Total	5.7	5.8	0.1	2.1%

TABLE 7: AVERAGE NON-MANDATORY TOUR LENGTHS (MILES)

Tour Time of Day Choice Models

Tour time of day choice models predict the outbound and inbound time period of each tour in 30-minute time windows. These models were estimated using SEMCOG data. No calibration on the models has been performed for MWCOG. The estimated versus observed departure time distribution for all tours is shown in Figure 21. The estimated versus observed arrival time distribution for all tours is shown in Figure 22, and the estimated versus observed duration distribution is shown in Figure 23. Overall, the figures show a reasonably close match to observed data. Figure 41 through Figure 67 in Appendix A shows tour departure, arrival, and duration distributions by purpose. Many purposes show a reasonable match to observed data. The university purpose has the most error compared to observed data. This purpose and some of the non-mandatory purposes should be considered for calibration in Phase 2.

Tour departures and arrivals were aggregated to skim periods and are shown in Figure 24 and Figure 25. For the purposes of these figures, the night period has been broken out into pre-3 AM and post-3 AM (Night 1: 3 AM to 6 AM, Night 2: 7 PM to 3 AM)), to be consistent with the earliest start time of tours (3:00 AM to 3:30 AM). The figures show a slight under-estimation of tours in the AM peak period and a corresponding over-estimation of tours in the period after the PM peak.

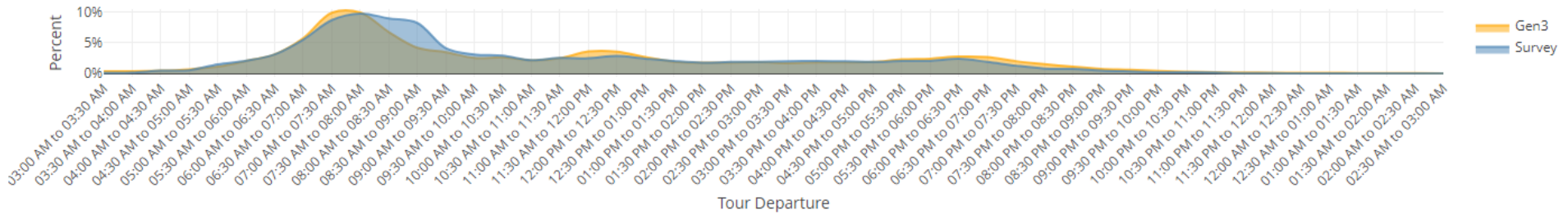


FIGURE 21: TOUR DEPARTURE PROFILE (30 MIN BINS)

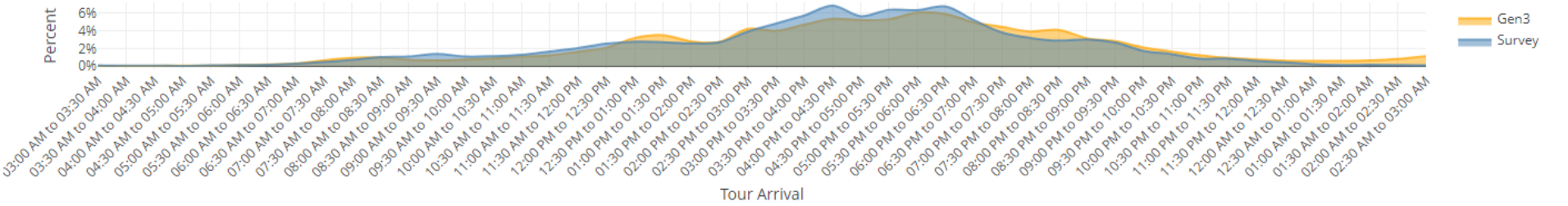


FIGURE 22: TOUR ARRIVAL PROFILE (30 MIN BINS)

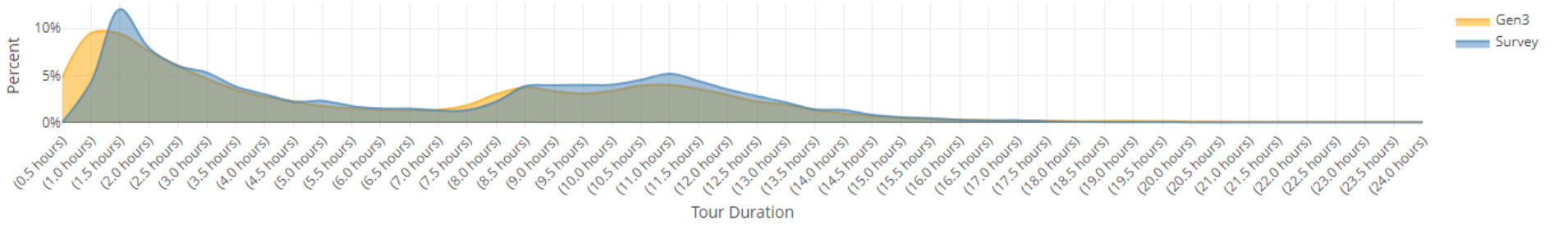


FIGURE 23: TOUR DURATION PROFILE (30 MIN BINS)

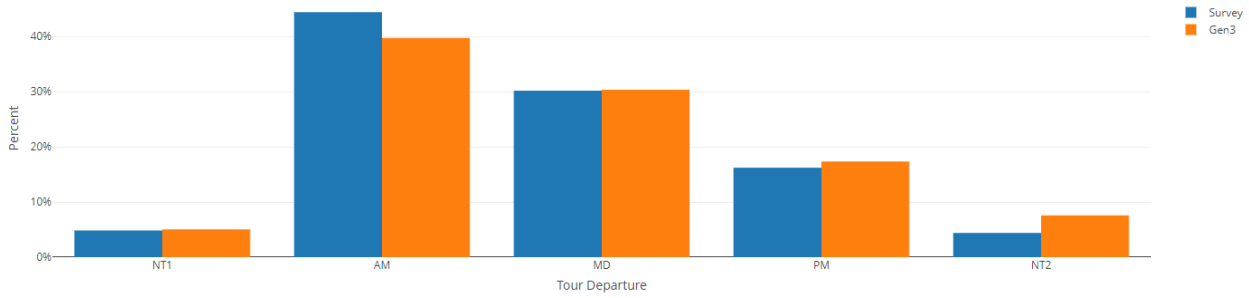


FIGURE 24: TOUR DEPARTURE (AGGREGATE TIME PERIODS, ALL PURPOSES)

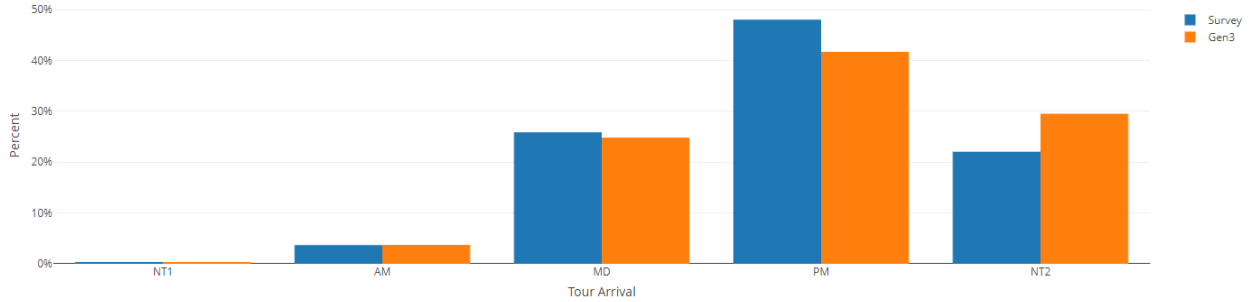


FIGURE 25: TOUR ARRIVAL (AGGREGATE TIME PERIODS, ALL PURPOSES)

Tour Mode Choice

The tour mode choice models predict the primary tour mode for each tour. For calibration purposes, we aggregate the transit modes (bus, metrorail, bus+metrorail, commuter rail) by access modes (walk, park-and-ride (PNR), and kiss-and-ride (KNR)), and we aggregate ride-hailing modes (taxi, Transportation Networking Company (TNC)-single, and TNC-shared) into a single ride-hail mode. Tour mode choice models are calibrated by tour purpose and auto sufficiency (0 autos, autos<workers, autos >= workers) for each of these aggregated modes, setting drive alone to the base mode.

The share of estimated versus observed tours by mode is shown in Figure 26. Overall, the model matches the observed shares very closely. Table 26 through Table 32 in Appendix B shows tour mode choice calibration results by tour purpose, auto sufficiency, and tour mode.

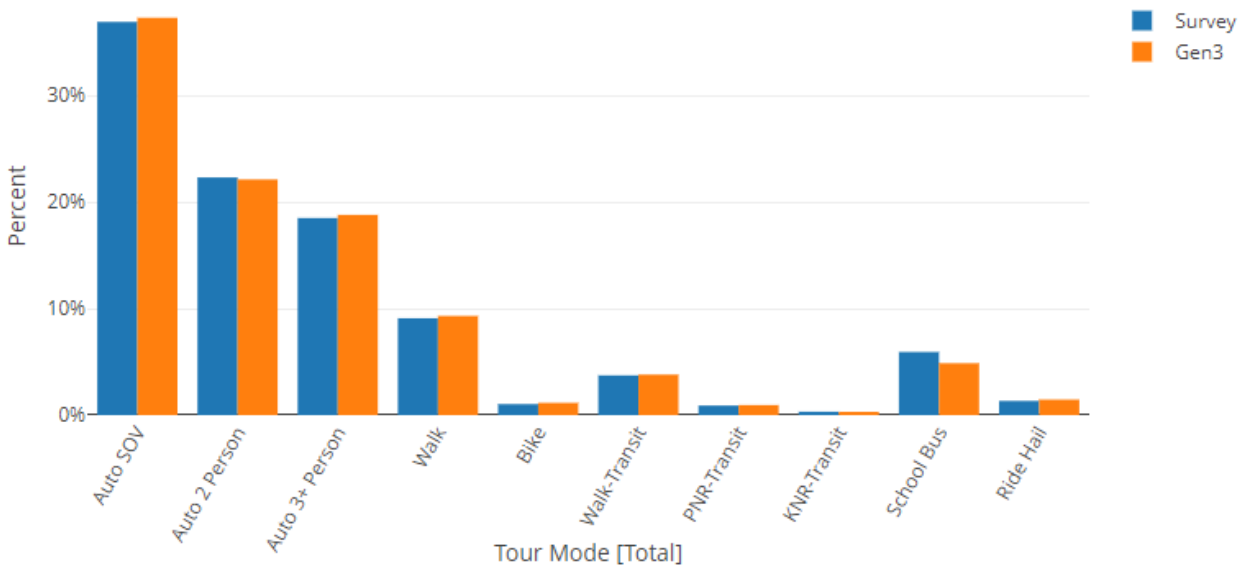


FIGURE 26: TOUR MODE CHOICE - ALL PURPOSES

The stop frequency model predicts number of stops by direction on each tour. The stop frequency model is calibrated by tour purpose. As shown in Figure 27, the estimated share of tours by number of stops per tour matches observed data quite well.

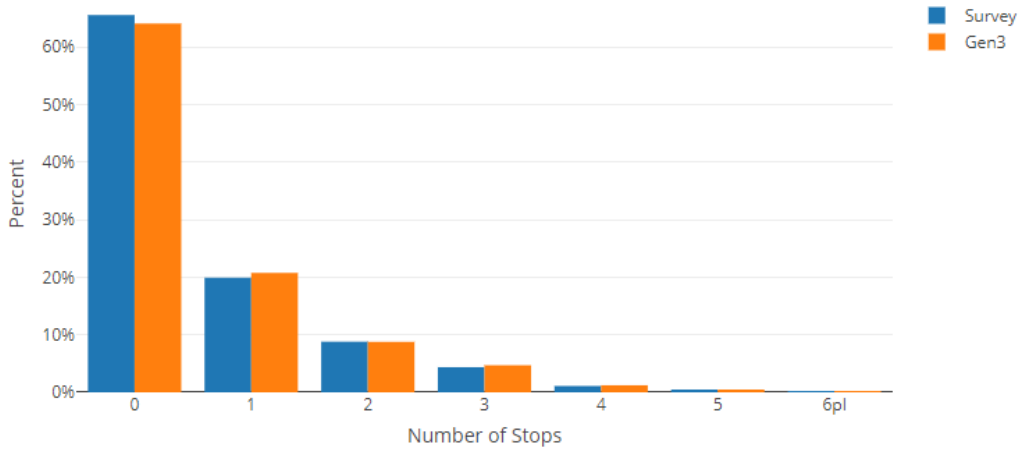


FIGURE 27: STOP FREQUENCY - TOTAL

Stop and Trip Level Models

Stop and trip level models include stop purpose, stop departure/arrival time, stop location, and trip mode.

The stop purpose model attributes each stop with a purpose. This model is a probability table generated from observed RTS/MTS/MTS data. Therefore, we do not show the purpose distribution of intermediate stops in our calibration summaries. However, we have confirmed that this model is working as expected.

The stop location choice model predicts the TAZ of each intermediate stop on the tour. The model was transferred from the MTC donor model. It has not been calibrated to RTS/MTS/MTS data. Typically, we compare the out-of-direction distance for each modeled stop to the survey to determine goodness of fit. Out-of-direction distance is defined as

$$Distance_{ik} + Distance_{kj} - Distance_{ij}$$

where:

i is the last known origin location. For the first stop in outbound direction, the last known origin location is the tour origin. For subsequent stops, it is location of last stop in order from the origin to the primary destination.

k is the stop location

j is the tour primary destination for outbound stops and the tour anchor location (home or work for at-work subtours) for inbound stops

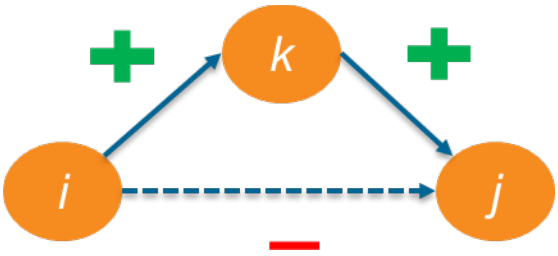


FIGURE 28: STOP OUT-OF-DIRECTION DISTANCE

Figure 28 shows a diagram of each leg in the stop out-of-direction distance calculation. Figure 29 shows the estimated versus observed out-of-direction distance for intermediate stops. the out-of-direction distance is somewhat over-estimated compared to survey data. As shown in Table 8, the stop out-of-direction distance is under-estimated for the University and School purposes, and over-estimated for Individual and Joint Maintenance purposes. Overall, the out-

of-direction distance is 7.7% over-estimated in the Gen3 Phase 1 Model. Further calibration in Phase 2 could improve the VMT over-estimate in the Phase 1 model.

Stop Location

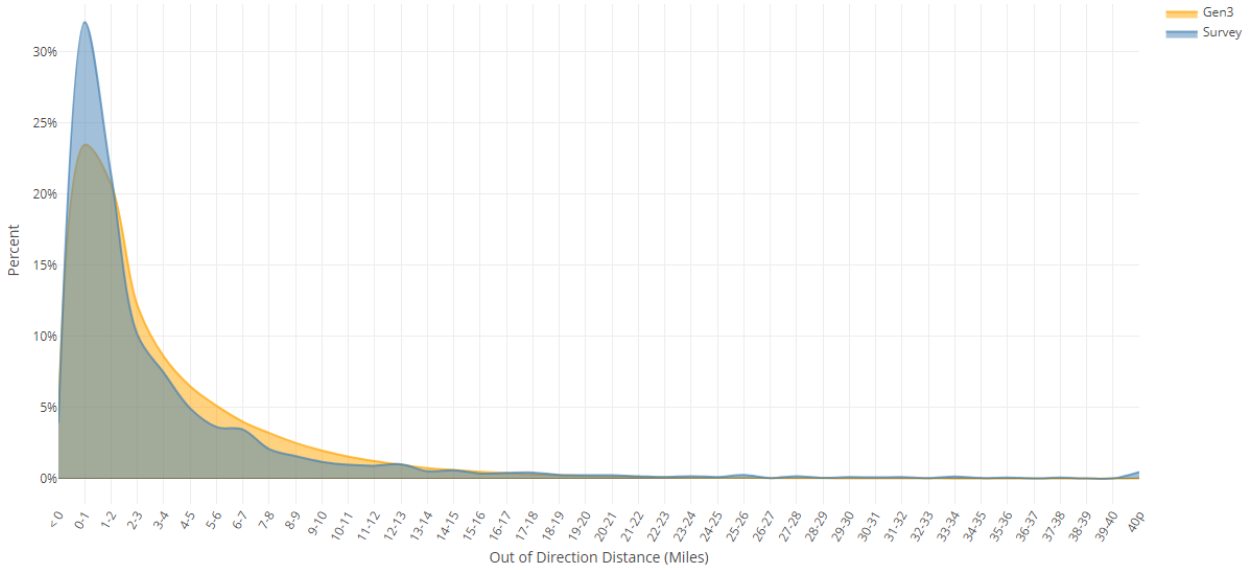


FIGURE 29: STOP LOCATION - OUT OF DIRECTION DISTANCE (ALL PURPOSES)

Purpose	Observed	Estimated	Difference	Percent Difference
Work	3.4	3.5	0.0	1.5%
University	4.3	3.7	-0.6	-14.8%
School	4.4	3.6	-0.9	-19.3%
Escorting	3.3	3.6	0.2	6.6%
Individual Maintenance	3.2	3.5	0.4	11.4%
Individual Discretionary	3.4	3.6	0.2	5.3%
Joint Maintenance	3.2	3.7	0.5	15.9%
Joint Discretionary	3.4	3.6	0.2	6.0%
At-Work Subtours	2.1	2.2	0.1	4.7%
Total	3.2	3.5	0.3	7.7%

TABLE 8: AVERAGE STOP OUT OF DIRECTION DISTANCE (MILES)

The stop departure/arrival time choice model predicts the 30-minute departure period for each stop in the outbound direction, and the arrival period for each stop in the inbound direction. This model is also a probability table generated from observed RTS/MTS/MTS data. The model is constrained by the tour departure and arrival model, therefore the goodness-of-fit of the model is dependent upon the goodness-of-fit of tour scheduling. As shown in Figure 30 and Figure 31, we see a similar pattern to tour departure and arrival scheduling; the trips departing and arriving in the evening period are over-estimated, and trips departing in the AM period appear to be under-estimated.

Trip Time of Day

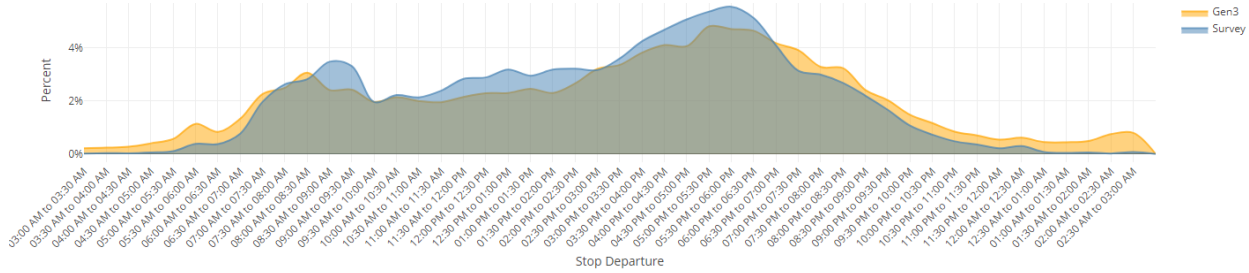


FIGURE 30: STOP DEPARTURE PROFILE (30 MIN BINS)

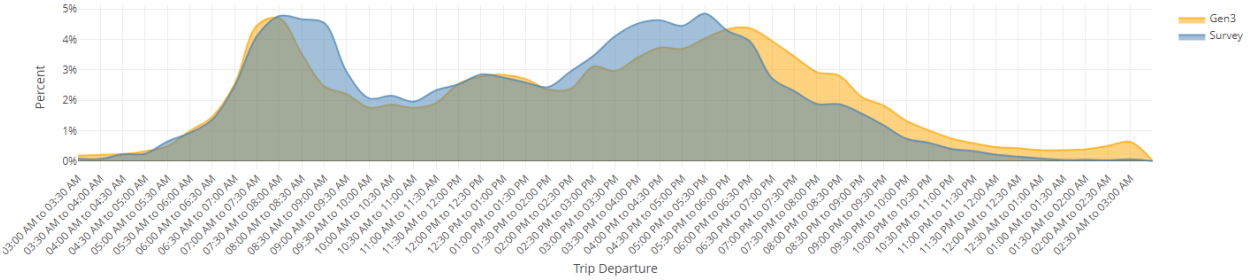


FIGURE 31: TRIP DEPARTURE PROFILE (30 MIN BINS)

Trip mode choice models predict the trip mode for each trip on the tour. The trip mode is constrained by the tour mode, according to the rules used to code tour mode from the reported trips by mode on each tour. Trip mode choice is calibrated by adjusting alternative-specific constants for each trip mode by tour purpose and tour mode. Figure 32 shows the overall calibration results across all tour purposes and tour modes. The model closely replicates the survey distribution of trips by trip mode. School bus is slightly under-estimated in the model; this

is possibly correlated with an under-estimate of school tours. Otherwise the distribution is quite close.

Trip Mode Choice

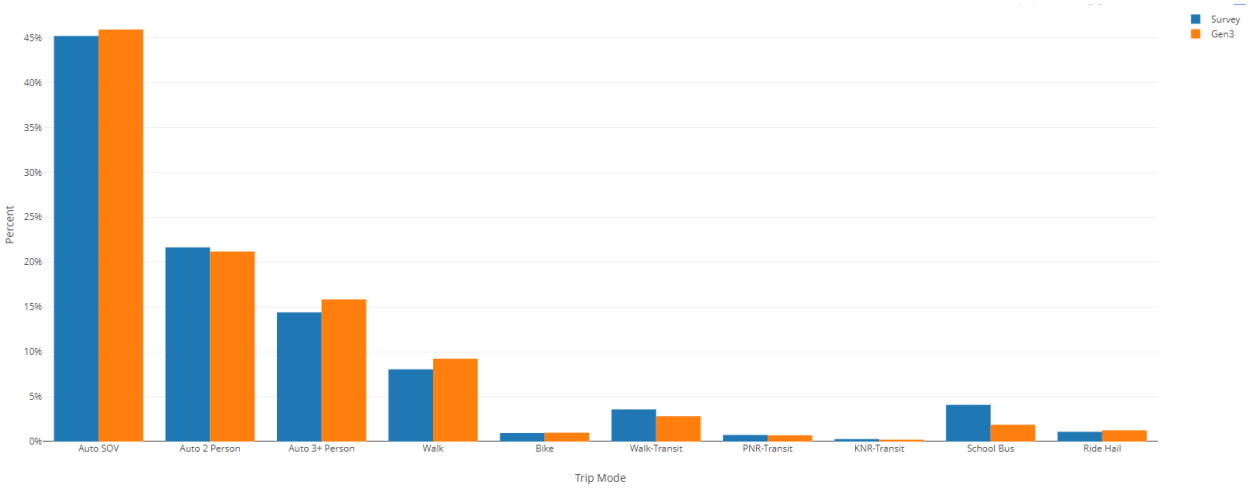


FIGURE 32: TRIP MODE CHOICE - ALL PURPOSES

3.0 MODEL VALIDATION

The model validation process tests the model's predictive capabilities by comparing the outputs from highway and transit assignment with the observed data. The model parameters are adjusted until the model outputs falls within an acceptable range of error. The model validation includes, on the highway side, comparing estimated traffic volume and vehicle miles traveled (VMT) from the model with observed traffic counts from state DOTs and observed VMT data from the Highway Performance Monitoring System (HPMS), and on the transit side, comparing estimated transit boardings from the model with observed transit ridership. This chapter presents the results from the Phase 1 model validation.

3.1 HIGHWAY VALIDATION

The highway model validation process involved an iterative process where the Gen3 (Phase 1) Model would be run, and then the resulting load-links highway network file would be processed using a set of post-processing scripts written in Cube, and the summary results would be tabulated in a spreadsheet to compare against 2018 traffic counts and similar validation measures for the MWCOG's Gen2/Version 2.4 Travel Model. These iterative run results were presented to MWCOG in bi-weekly check-in meetings to discuss strategies for Gen3 Model improvements. Those iterative and interim run results are not included in this report. Instead, this report focuses on presenting the highway validation results from the final December 9, 2021 run, which was deemed as the last run of the Gen3 Model in Phase 1 of the ActivitySim development project. Please note that the December 9, 2021, model run used the congested 4th iteration skims from a previous run, and thus it was not a full model run that runs through all the speed feedback loops.

There were five Cube scripts that were run on the Gen3 Model highway output network (i4_Assign_Output.net) to prepare highway validation statistics. Those Cube scripts, referenced and documented in Appendix C, were originally developed by MWCOG staff and were later modified to accommodate the changes in the Gen3 network's link attributes and the new 2018 traffic count files.

Several highway validation measures were summarized using the Cube scripts, first to check the Gen3 Model performance, and to check how well Gen3 Model (Phase 1 version) compares with the trip-based Gen2 Model (Ver. 2.4) in terms of year-2018 validation performance. More specifically, the following highway validation measures were tabulated:

- Comparison of model estimated vs. observed Vehicle miles traveled (VMT) for links whose 2018 observed traffic counts are available, cross-tabulated by six area types and six facility types defined in the model, and a comparison with the TPB's Gen2/Ver. 2.4

year-2018 model validation (Table 9). The estimated-to-observed (E/O) ratios for daily VMT by facility type are based on a sample of 7,887 directional highway links with daily traffic counts available in 2018.

- Comparison of model estimated traffic volumes vs. 2018 observed traffic counts, cross-tabulated by twenty-two jurisdictions and six facility types (based on 7,887 directional links with traffic counts) and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 10)
- Comparison of model estimated traffic volumes vs. 2018 observed traffic counts, cross-tabulated by thirty-five screenlines and six facility types and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 11)
- Comparison of model estimated VMT vs. 2018 observed VMT based on a subset of network links where traffic counts were available, cross-tabulated by six area types and six facility types, and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 12)
- Comparison of model estimated VMT vs. 2018 observed VMT based on a subset of network links where traffic counts were available, cross-tabulated by twenty-two jurisdictions and six facility types, and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 13)
- Comparison of model estimated VMT vs. 2018 observed VMT based on broader set of network links that are part of the HPMS, cross-tabulated by twenty-two jurisdictions and six facility types (for model estimates only), and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 14)
- Comparison of Percent Root Mean Square Error (RMSE) statistic by six facility types defined in the model, and a comparison with the TPB's Gen2/Ver. 2.4 Model validation (Table 15)
- Breakdown of model estimated VMT, cross-tabulated by four time periods and six highway user classes defined in the Gen3 Model (Table 16)

These summary tables reveal that the Gen3 Model is overpredicting highway VMT by approximately 9% when the full model region is considered (Table 14). In specific jurisdictions, the Gen3 Model shows much higher highway VMT, such as 23% over prediction in DC, 11% over in Montgomery County, and 16% over in Loudoun County. In terms of facility type, the Gen3 Model is overpredicting by 8% for freeways, overpredicting by 10% for major arterials, and overpredicting by 26% for minor arterials.

The tabular results presented above for the 35 screenlines (Table 11) were also reviewed on several maps to explore the Gen3 Model performance across different corridors within the context of the various jurisdictions in the modeled area. These are illustrated in Figure 34 and in

Figure 33 (inset map for DC area) for jurisdictions included in the modeled region,Figure 35 for screenlines performance using a five-color map theme. A red screen line reflects overestimation by more than 25%, an orange screen line reflects overestimation in the range of 11 to 25%, a green screen line reflects reasonable match within plus-minus 10%, a blue screen line reflects underestimation in the range of 11 to 25%, and a purple screen line reflects underestimation by at least 25%. These color-coded screenlines are displayed in Figure 32 and Figure 35 for results from the Gen2 Model (TPB Ver. 2.4)9 on the left-hand side and for results from the Gen3 Model (Phase 1) on the right-hand side for side-by-side comparison.

The screenline plots reveal that there are several screenlines that are red and orange, illustrating the geographic context of overestimation in the Gen3 Model. The red screenlines are mostly around the northwest part of the modeled region such as screenline #25 along the Montgomery County/Frederick County border line in Maryland, screenline #26 along the Howard/Montgomery County line in Maryland, screenline #31 along the Frederick/Carroll County line in Maryland, screenline #32 along the Loudoun/Clarke County line in Virginia and Loudoun/Jefferson County line in Virginia-West Virginia border, and screenline #37 along the Loudoun/Fauquier County line in Virginia. Similarly, there are overestimations in screenline crossing traffic volumes from the Gen3 Model, albeit at a smaller scale (shown in orange screenlines), across several screenlines that capture travel interactions of the core COG region with several outer counties in Virginia, and with coastal counties in Maryland (Anne Arundel, Calvert, and St. Mary's).

The inset map for the Gen3 Model reveals two red screenlines (screenlines 2 and 4) across the inner and outer cordons in northwest/northeast parts of the District of Columbia. The screenline along the Potomac River (screenline #20) is also orange, reflecting traffic overestimation from and to DC at a smaller scale in the Gen3 Model. Overall, the Gen3 Model shows slightly worse validation performance across selected screenlines as compared to the Gen2 Model (TPB Ver. 2.4).

In addition, several scatterplots were prepared to review the screenline validation results by facility type. These scatterplots are illustrated in Figure 36 for Freeways, in Figure 37 for Major Arterials, in Figure 38 for Minor Arterials, and in Figure 39 for Collectors. These scatterplots reveal that a majority of the data points are above the 45-degree line (line of perfect agreement), reflecting the overall traffic overestimation in the Gen3 Model.

[9] Seifu, Meseret, and Sanghyeon Ko. Memorandum to Feng Xie. "Year-2018 Validation of TPB Version 2.4 Travel Model." Memorandum, August 17, 2021

TABLE 9: ESTIMATED VOLUME VS. OBSERVED COUNT - BY AREA AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)

Estimate_2018

	Facility Type						
Area Type	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	1,804,160	6,460,150	2,631,131	855,450	1,384,315	0	13,135,206
2	9,749,233	13,017,114	7,380,128	1,232,479	1,966,235	0	33,345,189
3	11,780,318	5,971,043	5,057,311	1,037,929	2,754,711	0	26,601,312
4	5,951,017	4,989,029	5,062,578	1,097,839	1,021,041	0	18,121,504
5	8,711,796	5,857,373	3,393,839	941,196	1,575,055	24,597	20,503,856
6	2,893,121	4,061,801	4,861,315	541,758	692,906	0	13,050,901
TOTAL	40,889,645	40,356,510	28,386,302	5,706,651	9,394,263	24,597	124,757,968

Observed_2018

	Facility Type						
Area Type	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	1,745,200	4,391,351	1,934,323	591,430	1,181,644	0	9,843,948
2	9,752,001	11,625,001	6,756,020	1,195,356	1,938,278	0	31,266,656
3	11,738,247	5,975,279	5,316,416	1,348,806	3,005,924	0	27,384,672
4	5,481,925	4,394,496	5,029,521	1,232,249	994,126	0	17,132,317
5	8,114,330	5,197,788	3,206,771	1,095,634	1,429,586	33,910	19,078,019
6	2,433,186	3,526,925	3,334,674	590,830	683,728	0	10,569,343
TOTAL	39,264,889	35,110,840	25,577,725	6,054,305	9,233,286	33,910	115,274,955

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate_2018

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1,718,325	4,951,321	1,955,125	562,856	1,141,350	0	10,328,977
2	10,056,454	11,746,836	6,528,792	1,007,303	1,710,320	0	31,049,705
3	11,926,794	5,805,601	4,905,735	943,872	2,584,924	0	26,166,926
4	6,063,603	4,834,260	4,877,647	978,263	985,255	0	17,739,028
5	8,409,449	5,816,796	3,290,968	867,947	1,456,726	32,997	19,874,883
6	2,974,481	4,263,866	4,543,332	505,193	657,843	0	12,944,715
TOTAL	41,149,106	37,418,680	26,101,599	4,865,434	8,536,418	32,997	118,104,234

Observed_2018

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1,807,200	4,416,351	1,934,323	591,430	1,181,644	0	9,930,948
2	9,997,501	11,647,501	6,756,020	1,194,806	1,938,278	0	31,534,106
3	11,738,247	5,975,279	5,316,416	1,348,806	3,005,924	0	27,384,672
4	5,565,925	4,394,496	5,029,521	1,229,568	994,126	0	17,213,636
5	8,114,330	5,197,788	3,206,771	1,106,244	1,429,586	33,910	19,088,629
6	2,433,186	3,522,305	3,334,674	588,724	683,728	0	10,562,617
TOTAL	39,656,389	35,153,720	25,577,725	6,059,578	9,233,286	33,910	115,714,608

Continued

Model Run:	**Gen3 i4 (12-9-2021)**

Estimate/Observed Ratio

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1.03	1.47	1.36	1.45	1.17	-	1.33
2	1.00	1.12	1.09	1.03	1.01	-	1.07
3	1.00	1.00	0.95	0.77	0.92	-	0.97
4	1.09	1.14	1.01	0.89	1.03	-	1.06
5	1.07	1.13	1.06	0.86	1.10	0.73	1.07
6	1.19	1.15	1.46	0.92	1.01	-	1.23
TOTAL	1.04	1.15	1.11	0.94	1.02	0.73	1.08

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate/Observed Ratio

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	0.95	1.12	1.01	0.95	0.97	-	1.04
2	1.01	1.01	0.97	0.84	0.88	-	0.98
3	1.02	0.97	0.92	0.70	0.86	-	0.96
4	1.09	1.10	0.97	0.80	0.99	-	1.03
5	1.04	1.12	1.03	0.78	1.02	0.97	1.04
6	1.22	1.21	1.36	0.86	0.96	-	1.23
TOTAL	1.04	1.06	1.02	0.80	0.92	0.97	1.02

TABLE 10: ESTIMATED VOLUME VS. OBSERVED COUNT - BY JURISDICTION AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)

Estimate_2018

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	478,766	9,549,734	4,831,537	1,368,792	2,842,745	0	19,071,574
Montgomery County	6,291,385	7,489,030	2,176,456	409,176	707,713	0	17,073,760
Prince George's County	6,536,886	4,677,986	2,351,740	574,894	2,565,011	0	16,706,517
Arlington County	2,493,385	1,212,244	1,048,185	210,364	69,670	0	5,033,848
City of Alexandria	1,070,042	648,309	763,829	70,928	0	0	2,553,108
Fairfax County	9,402,832	5,165,724	7,302,619	1,059,550	333,907	0	23,264,632
Loudoun County	249,686	779,689	1,368,138	625,735	258,777	0	3,282,025
Prince William County	2,075,230	1,367,871	2,492,934	374,473	75,320	0	6,385,828
Frederick County	2,275,992	659,368	833,660	170,266	346,727	0	4,286,013
Howard County	2,802,762	758,784	897,508	79,351	1,467,297	0	6,005,702
Anne Arundel County	5,311,527	2,475,960	1,457,014	127,737	727,095	24,597	10,123,930
Charles County	0	1,030,456	343,210	70,166	0	0	1,443,832
Carrol County	77,576	1,064,059	656,774	18,625	0	0	1,817,034
Calvert County	0	623,205	102,383	31,253	0	0	756,841
St. Mary's County	0	405,965	351,963	24,952	0	0	782,880
King George County	0	86,747	133,567	10,821	0	0	231,135
City of Fredericksburg	114,338	471,289	238,561	16,337	0	0	840,525
Stafford County	983,424	386,346	258,240	277,658	0	0	1,905,668
Spotsylvania County	213,639	276,528	138,052	157,492	0	0	785,711
Fauquier County	397,930	530,004	320,633	1,176	0	0	1,249,743
Clarke County	0	250,014	213,576	0	0	0	463,590
Jefferson County	114,243	447,197	105,725	26,904	0	0	694,069
TOTAL	40,889,643	40,356,509	28,386,304	5,706,650	9,394,262	24,597	124,757,965

Continued

Model Run:	**Gen3 i4 (12-9-2021)**

Observed_2018

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	481,972	6,081,116	3,159,238	942,315	2,652,056	0	13,316,697
Montgomery County	5,837,833	6,280,829	1,914,824	465,236	521,680	0	15,020,402
Prince George's County	6,743,686	4,624,064	2,380,776	765,790	2,654,440	0	17,168,756
Arlington County	2,314,850	1,262,600	1,050,884	218,640	57,000	0	4,903,974
City of Alexandria	1,017,000	614,600	713,200	46,400	0	0	2,391,200
Fairfax County	9,207,134	5,561,400	7,519,856	1,149,482	363,000	0	23,800,872
Loudoun County	323,000	717,000	1,048,100	627,788	355,000	0	3,070,888
Prince William County	1,831,000	1,266,000	2,603,476	495,174	70,000	0	6,265,650
Frederick County	2,073,956	585,526	653,228	179,604	334,854	0	3,827,168
Howard County	2,569,256	615,973	795,569	76,588	1,527,194	0	5,584,580
Anne Arundel County	5,236,606	2,439,254	1,436,718	137,644	698,062	33,910	9,982,194
Charles County	0	904,470	358,596	92,470	0	0	1,355,536
Carrol County	72,762	814,288	334,768	20,098	0	0	1,241,916
Calvert County	0	648,136	91,672	39,310	0	0	779,118
St. Mary's County	0	421,988	369,852	24,028	0	0	815,868
King George County	0	98,000	154,900	18,100	0	0	271,000
City of Fredericksburg	117,000	486,000	139,134	35,000	0	0	777,134
Stafford County	835,000	353,000	240,850	423,618	0	0	1,852,468
Spotsylvania County	208,000	306,000	201,600	271,000	0	0	986,600
Fauquier County	299,860	579,300	236,830	1,092	0	0	1,117,082
Clarke County	0	195,000	126,500	0	0	0	321,500
Jefferson County	95,974	256,296	47,154	24,928	0	0	424,352
TOTAL	39,264,889	35,110,840	25,577,725	6,054,305	9,233,286	33,910	115,274,955

Continued

Model Run:	Gen3 i4 (12-9-2021)

Estimate/Observed Ratio

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	0.99	1.57	1.53	1.45	1.07	-	1.43
Montgomery County	1.08	1.19	1.14	0.88	1.36	-	1.14
Prince George's County	0.97	1.01	0.99	0.75	0.97	-	0.97
Arlington County	1.08	0.96	1.00	0.96	1.22	-	1.03
City of Alexandria	1.05	1.05	1.07	1.53	-	-	1.07
Fairfax County	1.02	0.93	0.97	0.92	0.92	-	0.98
Loudoun County	0.77	1.09	1.31	1.00	0.73	-	1.07
Prince William County	1.13	1.08	0.96	0.76	1.08	-	1.02
Frederick County	1.10	1.13	1.28	0.95	1.04	-	1.12
Howard County	1.09	1.23	1.13	1.04	0.96	-	1.08
Anne Arundel County	1.01	1.02	1.01	0.93	1.04	0.73	1.01
Charles County	-	1.14	0.96	0.76	-	-	1.07
Carrol County	1.07	1.31	1.96	0.93	-	-	1.46
Calvert County	-	0.96	1.12	0.80	-	-	0.97
St. Mary's County	-	0.96	0.95	1.04	-	-	0.96
King George County	-	0.89	0.86	0.60	-	-	0.85
City of Fredericksburg	0.98	0.97	1.71	0.47	-	-	1.08
Stafford County	1.18	1.09	1.07	0.66	-	-	1.03
Spotsylvania County	1.03	0.90	0.68	0.58	-	-	0.80
Fauquier County	1.33	0.91	1.35	1.08	-	-	1.12
Clarke County	-	1.28	1.69	-	-	-	1.44
Jefferson County	1.19	1.74	2.24	1.08	-	-	1.64
TOTAL	1.04	1.15	1.11	0.94	1.02	0.73	1.08

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate_2018

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	470,121	7,459,579	3,631,281	922,189	2,344,314	0	14,827,484
Montgomery County	6,005,154	7,053,965	1,975,320	346,134	564,038	0	15,944,611
Prince George's County	5,953,179	4,278,215	2,099,740	497,379	2,494,445	0	15,322,958
Arlington County	2,606,237	1,103,870	950,886	178,361	50,250	0	4,889,604
City of Alexandria	1,106,694	580,963	674,612	60,526	0	0	2,422,795
Fairfax County	9,777,131	5,229,477	7,388,947	1,032,981	354,623	0	23,783,159
Loudoun County	227,589	707,139	1,231,953	552,808	253,090	0	2,972,579
Prince William County	2,181,518	1,430,117	2,392,134	357,191	71,558	0	6,432,518
Frederick County	2,426,138	648,302	777,696	154,713	301,787	0	4,308,636
Howard County	2,836,052	673,690	813,694	61,932	1,333,497	0	5,718,865
Anne Arundel County	5,603,790	2,446,539	1,390,709	111,917	768,816	32,997	10,354,768
Charles County	0	1,023,097	329,657	61,162	0	0	1,413,916
Carrol County	93,957	1,057,803	625,216	14,862	0	0	1,791,838
Calvert County	0	617,094	94,839	30,089	0	0	742,022
St. Mary's County	0	431,601	349,906	23,535	0	0	805,042
King George County	0	97,064	137,468	14,186	0	0	248,718
City of Fredericksburg	110,677	453,737	219,494	15,442	0	0	799,350
Stafford County	1,075,970	473,974	263,678	251,872	0	0	2,065,494
Spotsylvania County	204,661	283,579	133,264	152,510	0	0	774,014
Fauquier County	355,828	621,725	313,964	1,451	0	0	1,292,968
Clarke County	0	255,130	211,257	0	0	0	466,387
Jefferson County	114,409	492,021	95,884	24,194	0	0	726,508
TOTAL	41,149,105	37,418,681	26,101,599	4,865,434	8,536,418	32,997	118,104,234

Continued

Model Run:	Gen2 (TPB Ver. 2.4)						
Observed_2018							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	481,972	6,081,116	3,159,238	940,264	2,652,056	0	13,314,646
Montgomery County	5,837,833	6,280,829	1,914,824	465,236	521,680	0	15,020,402
Prince George's County	6,743,686	4,624,064	2,380,776	776,690	2,654,440	0	17,179,656
Arlington County	2,500,850	1,262,600	1,050,884	218,640	57,000	0	5,089,974
City of Alexandria	1,122,000	662,100	713,200	46,400	0	0	2,543,700
Fairfax County	9,307,634	5,561,400	7,519,856	1,148,302	363,000	0	23,900,192
Loudoun County	323,000	717,000	1,048,100	627,788	355,000	0	3,070,888
Prince William County	1,831,000	1,266,000	2,603,476	495,174	70,000	0	6,265,650
Frederick County	2,073,956	585,526	653,228	178,078	334,854	0	3,825,642
Howard County	2,569,256	615,973	795,569	76,588	1,527,194	0	5,584,580
Anne Arundel County	5,236,606	2,439,254	1,436,718	137,644	698,062	33,910	9,982,194
Charles County	0	904,470	358,596	92,470	0	0	1,355,536
Carrol County	72,762	814,288	334,768	20,098	0	0	1,241,916
Calvert County	0	648,136	91,672	39,310	0	0	779,118
St. Mary's County	0	421,988	369,852	24,028	0	0	815,868
King George County	0	98,000	154,900	18,100	0	0	271,000
City of Fredericksburg	117,000	486,000	139,134	35,000	0	0	777,134
Stafford County	835,000	353,000	240,850	423,618	0	0	1,852,468
Spotsylvania County	208,000	306,000	201,600	271,000	0	0	986,600
Fauquier County	299,860	579,300	236,830	1,092	0	0	1,117,082
Clarke County	0	195,000	126,500	0	0	0	321,500
Jefferson County	95,974	251,676	47,154	24,058	0	0	418,862
TOTAL	39,656,389	35,153,720	25,577,725	6,059,578	9,233,286	33,910	115,714,608

Continued

Model Run:	Gen2 (TPB Ver. 2.4)						
Estimate/Observed Ratio							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	0.98	1.23	1.15	0.98	0.88	-	1.11
Montgomery County	1.03	1.12	1.03	0.74	1.08	-	1.06
Prince George's County	0.88	0.93	0.88	0.64	0.94	-	0.89
Arlington County	1.04	0.87	0.90	0.82	0.88	-	0.96
City of Alexandria	0.99	0.88	0.95	1.30	-	-	0.95
Fairfax County	1.05	0.94	0.98	0.90	0.98	-	1.00
Loudoun County	0.70	0.99	1.18	0.88	0.71	-	0.97
Prince William County	1.19	1.13	0.92	0.72	1.02	-	1.03
Frederick County	1.17	1.11	1.19	0.87	0.90	-	1.13
Howard County	1.10	1.09	1.02	0.81	0.87	-	1.02
Anne Arundel County	1.07	1.00	0.97	0.81	1.10	0.97	1.04
Charles County	-	1.13	0.92	0.66	-	-	1.04
Carrol County	1.29	1.30	1.87	0.74	-	-	1.44
Calvert County	-	0.95	1.03	0.77	-	-	0.95
St. Mary's County	-	1.02	0.95	0.98	-	-	0.99
King George County	-	0.99	0.89	0.78	-	-	0.92
City of Fredericksburg	0.95	0.93	1.58	0.44	-	-	1.03
Stafford County	1.29	1.34	1.09	0.59	-	-	1.11
Spotsylvania County	0.98	0.93	0.66	0.56	-	-	0.78
Fauquier County	1.19	1.07	1.33	1.33	-	-	1.16
Clarke County	-	1.31	1.67	-	-	-	1.45
Jefferson County	1.19	1.95	2.03	1.01	-	-	1.73
TOTAL	1.04	1.06	1.02	0.80	0.92	0.97	1.02

TABLE 11: ESTIMATED VOLUME VS. OBSERVED VOLUME - BY SCREENLINE AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)

Estimate_2018

	Facility Type						
Screenline	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	453,931	163,516	83,610	57,496	0	0	758,552
2	0	738,373	273,127	71,932	150,274	0	1,233,706
3	492,844	214,045	135,129	36,186	0	0	878,204
4	43,583	623,818	242,615	55,181	301,685	0	1,266,882
5	382,929	379,114	356,774	22,996	0	0	1,141,814
6	306,995	844,034	297,811	56,609	283,237	0	1,788,686
7	532,656	225,625	338,421	25,632	44,968	0	1,167,301
8	720,418	539,785	208,819	96,534	344,026	0	1,909,582
9	469,628	336,246	184,542	54,618	0	0	1,045,033
10	180,960	241,300	40,176	159,698	0	0	622,135
11	108,686	115,773	77,018	63,243	0	0	364,720
12	265,726	197,338	130,864	47,246	0	0	641,175
13	288,267	211,178	61,814	0	0	0	561,259
14	214,873	39,239	42,072	4,458	0	0	300,642
15	191,484	89,346	37,585	26,680	0	0	345,096
16	157,798	20,318	36,183	8,054	0	0	222,353
17	224,702	114,713	108,921	46,603	0	0	494,939
18	182,862	142,058	260,604	19,674	84,664	0	689,863
19	213,801	94,883	150,877	118,486	121,344	0	699,390
20	598,740	210,251	0	0	367,339	0	1,176,331
22	803,337	508,334	145,353	106,841	268,398	0	1,832,264
23	134,783	34,880	76,340	5,149	0	0	251,151
24	237,442	117,931	76,181	62,912	0	0	494,466
25	119,348	0	41,108	5,490	0	0	165,946
26	273,579	0	160,365	28,228	105,371	0	567,543

27	284,061	144,910	27,670	6,932	0	0	463,572
28	0	124,625	60,433	30,096	0	0	215,154
31	0	51,949	132,175	10,911	0	0	195,035
32	0	87,431	51,741	0	0	0	139,173
33	240,783	69,300	26,563	0	0	0	336,645
34	0	114,903	47,298	0	0	0	162,200
35	526,287	174,194	55,005	4,672	199,144	0	959,302
36	0	81,766	17,787	0	0	0	99,553
37	0	0	54,516	2,408	0	0	56,923
38	0	124,334	30,755	108,009	0	0	263,098
TOTAL	8,650,503	7,175,510	4,070,252	1,342,974	2,270,450	0	23,509,688

Continued

Model Run:	Gen3 i4 (12-9-2021)

Observed_2018

	Facility Type						
Screenline	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	381,200	227,000	76,584	51,200	0	0	735,984
2	0	452,141	170,879	48,543	134,786	0	806,349
3	473,650	213,000	144,000	52,340	0	0	882,990
4	21,390	394,034	177,454	44,616	176,712	0	814,206
5	451,378	368,400	308,790	26,736	0	0	1,155,304
6	258,996	775,306	306,978	127,048	346,606	0	1,814,934
7	638,528	232,000	342,906	44,200	49,000	0	1,306,634
8	727,526	446,748	219,664	138,738	287,174	0	1,819,850
9	530,728	221,900	181,600	54,450	0	0	988,678
10	206,000	209,000	41,000	104,808	0	0	560,808
11	104,000	129,000	62,976	69,068	0	0	365,044
12	265,536	146,920	85,154	58,590	0	0	556,200
13	282,382	155,494	38,894	0	0	0	476,770
14	236,052	35,130	67,322	10,672	0	0	349,176
15	229,792	92,204	38,370	31,110	0	0	391,476
16	170,620	17,962	41,794	24,896	0	0	255,272
17	263,000	134,800	115,100	49,814	0	0	562,714
18	189,000	198,000	235,800	17,180	117,000	0	756,980
19	218,000	88,000	149,460	159,724	166,000	0	781,184
20	505,664	140,904	0	0	360,490	0	1,007,058
22	866,158	472,096	151,070	203,739	265,138	0	1,958,201
23	111,902	22,622	90,120	20,474	0	0	245,118
24	273,990	116,802	88,182	66,738	0	0	545,712

25	90,880	0	28,476	2,764	0	0	122,120
26	206,542	0	95,956	8,248	72,660	0	383,406
27	210,178	123,144	30,142	9,284	0	0	372,748
28	0	143,154	62,248	33,954	0	0	239,356
31	0	26,630	54,350	6,060	0	0	87,040
32	0	53,000	30,000	0	0	0	83,000
33	196,000	73,000	19,500	0	0	0	288,500
34	0	102,020	27,244	0	0	0	129,264
35	474,626	208,002	78,922	16,664	250,052	0	1,028,266
36	0	46,762	5,494	0	0	0	52,256
37	0	0	29,100	1,082	0	0	30,182
38	0	120,000	67,800	151,418	0	0	339,218
TOTAL	8,583,718	6,185,175	3,663,329	1,634,158	2,225,618	0	22,291,998

Continued

Model Run:	**Gen3 i4 (12-9-2021)**

Estimate/Observed Ratio

	Facility Type						
Screenline	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1.19	0.72	1.09	1.12	-	-	1.03
2	-	1.63	1.60	1.48	1.11	-	1.53
3	1.04	1.00	0.94	0.69	-	-	0.99
4	2.04	1.58	1.37	1.24	1.71	-	1.56
5	0.85	1.03	1.16	0.86	-	-	0.99
6	1.19	1.09	0.97	0.45	0.82	-	0.99
7	0.83	0.97	0.99	0.58	0.92	-	0.89
8	0.99	1.21	0.95	0.70	1.20	-	1.05
9	0.88	1.52	1.02	1.00	-	-	1.06
10	0.88	1.15	0.98	1.52	-	-	1.11
11	1.05	0.90	1.22	0.92	-	-	1.00
12	1.00	1.34	1.54	0.81	-	-	1.15
13	1.02	1.36	1.59	-	-	-	1.18
14	0.91	1.12	0.62	0.42	-	-	0.86
15	0.83	0.97	0.98	0.86	-	-	0.88
16	0.92	1.13	0.87	0.32	-	-	0.87
17	0.85	0.85	0.95	0.94	-	-	0.88
18	0.97	0.72	1.11	1.15	0.72	-	0.91
19	0.98	1.08	1.01	0.74	0.73	-	0.90
20	1.18	1.49	-	-	1.02	-	1.17
22	0.93	1.08	0.96	0.52	1.01	-	0.94
23	1.20	1.54	0.85	0.25	-	-	1.02
24	0.87	1.01	0.86	0.94	-	-	0.91

25	1.31	-	1.44	1.99	-	-	1.36
26	1.32	-	1.67	3.42	1.45	-	1.48
27	1.35	1.18	0.92	0.75	-	-	1.24
28	-	0.87	0.97	0.89	-	-	0.90
31	-	1.95	2.43	1.80	-	-	2.24
32	-	1.65	1.72	-	-	-	1.68
33	1.23	0.95	1.36	-	-	-	1.17
34	-	1.13	1.74	-	-	-	1.25
35	1.11	0.84	0.70	0.28	0.80	-	0.93
36	-	1.75	3.24	-	-	-	1.91
37	-	-	1.87	2.23	-	-	1.89
38	-	1.04	0.45	0.71	-	-	0.78
TOTAL	1.01	1.16	1.11	0.82	1.02	-	1.05

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**
Estimate_2018	

	Facility Type						
Screenline	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	450,102	136,284	72,655	49,060	0	0	708,101
2	0	567,021	184,137	46,026	123,269	0	920,453
3	502,424	205,316	124,503	29,200	0	0	861,443
4	39,832	527,264	183,207	41,207	243,734	0	1,035,244
5	427,375	360,633	340,882	20,114	0	0	1,149,004
6	293,470	836,335	279,358	49,183	275,632	0	1,733,978
7	558,161	234,848	355,374	27,328	53,353	0	1,229,064
8	674,164	519,957	196,638	87,458	329,818	0	1,808,035
9	478,569	321,756	172,170	49,871	0	0	1,022,366
10	172,243	219,681	34,078	142,890	0	0	568,892
11	98,784	106,509	65,774	54,805	0	0	325,872
12	258,487	179,529	116,316	36,100	0	0	590,432
13	270,674	191,757	55,852	0	0	0	518,283
14	218,030	40,367	43,210	4,135	0	0	305,742
15	178,872	82,670	35,286	20,097	0	0	316,925
16	131,514	19,508	35,057	7,260	0	0	193,339
17	274,069	137,902	117,115	46,362	0	0	575,448
18	173,572	151,606	259,804	17,102	88,140	0	690,224
19	178,878	96,243	149,847	103,997	118,365	0	647,330
20	482,577	149,346	0	0	288,802	0	920,725
22	738,259	484,575	137,074	84,128	245,127	0	1,689,163
23	128,452	28,232	65,508	5,670	0	0	227,862

24	241,559	108,284	69,793	53,887	0	0	473,523
25	119,246	0	37,295	5,425	0	0	161,966
26	146,280	0	115,153	13,182	74,782	0	349,397
27	244,399	121,468	22,889	1,070	0	0	389,826
28	0	122,347	55,414	26,502	0	0	204,263
31	0	56,874	120,558	10,054	0	0	187,486
32	0	92,379	53,144	0	0	0	145,523
33	246,424	75,938	23,479	0	0	0	345,841
34	0	116,112	42,201	0	0	0	158,313
35	522,110	176,434	63,505	3,950	213,481	0	979,480
36	0	80,111	12,487	0	0	0	92,598
37	0	0	52,560	1,882	0	0	54,442
38	0	128,814	28,021	98,353	0	0	255,188
TOTAL	8,248,526	6,676,100	3,720,344	1,136,298	2,054,503	0	21,835,771

Continued

Model Run:	Gen2 (TPB Ver. 2.4)						
Observed_2018							
	Facility Type						
Screenline	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	381,200	227,000	76,584	51,200	0	0	735,984
2	0	452,141	170,879	48,543	134,786	0	806,349
3	473,650	213,000	144,000	52,340	0	0	882,990
4	21,390	394,034	177,454	44,616	176,712	0	814,206
5	451,378	368,400	308,790	26,736	0	0	1,155,304
6	258,996	775,306	306,978	127,048	346,606	0	1,814,934
7	638,528	232,000	342,906	44,200	49,000	0	1,306,634
8	727,526	446,748	219,664	138,738	287,174	0	1,819,850
9	530,728	221,900	181,600	54,450	0	0	988,678
10	206,000	209,000	41,000	104,808	0	0	560,808
11	104,000	129,000	62,976	69,068	0	0	365,044
12	265,536	146,920	85,154	58,590	0	0	556,200
13	282,382	155,494	38,894	0	0	0	476,770
14	236,052	35,130	67,322	10,672	0	0	349,176
15	229,792	92,204	38,370	31,110	0	0	391,476
16	170,620	17,962	41,794	24,896	0	0	255,272
17	263,000	134,800	115,100	49,814	0	0	562,714
18	189,000	198,000	235,800	17,180	117,000	0	756,980
19	218,000	88,000	149,460	159,724	166,000	0	781,184
20	505,664	140,904	0	0	360,490	0	1,007,058
22	866,158	472,096	151,070	203,739	265,138	0	1,958,201
23	111,902	22,622	90,120	20,474	0	0	245,118
24	273,990	116,802	88,182	66,738	0	0	545,712

25	90,880	0	28,476	2,764	0	0	122,120
26	206,542	0	95,956	8,248	72,660	0	383,406
27	210,178	123,144	30,142	9,284	0	0	372,748
28	0	143,154	62,248	33,954	0	0	239,356
31	0	26,630	54,350	6,060	0	0	87,040
32	0	53,000	30,000	0	0	0	83,000
33	196,000	73,000	19,500	0	0	0	288,500
34	0	102,020	27,244	0	0	0	129,264
35	474,626	208,002	78,922	16,664	250,052	0	1,028,266
36	0	46,762	5,494	0	0	0	52,256
37	0	0	29,100	1,082	0	0	30,182
38	0	120,000	67,800	151,418	0	0	339,218
TOTAL	8,583,718	6,185,175	3,663,329	1,634,158	2,225,618	0	22,291,998

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate/Observed Ratio

	Facility Type						
Screenline	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1.18	0.60	0.95	0.96	-	-	0.96
2	-	1.25	1.08	0.95	0.91	-	1.14
3	1.06	0.96	0.86	0.56	-	-	0.98
4	1.86	1.34	1.03	0.92	1.38	-	1.27
5	0.95	0.98	1.10	0.75	-	-	0.99
6	1.13	1.08	0.91	0.39	0.80	-	0.96
7	0.87	1.01	1.04	0.62	1.09	-	0.94
8	0.93	1.16	0.90	0.63	1.15	-	0.99
9	0.90	1.45	0.95	0.92	-	-	1.03
10	0.84	1.05	0.83	1.36	-	-	1.01
11	0.95	0.83	1.04	0.79	-	-	0.89
12	0.97	1.22	1.37	0.62	-	-	1.06
13	0.96	1.23	1.44	-	-	-	1.09
14	0.92	1.15	0.64	0.39	-	-	0.88
15	0.78	0.90	0.92	0.65	-	-	0.81
16	0.77	1.09	0.84	0.29	-	-	0.76
17	1.04	1.02	1.02	0.93	-	-	1.02
18	0.92	0.77	1.10	1.00	0.75	-	0.91
19	0.82	1.09	1.00	0.65	0.71	-	0.83
20	0.95	1.06	-	-	0.80	-	0.91
22	0.85	1.03	0.91	0.41	0.92	-	0.86
23	1.15	1.25	0.73	0.28	-	-	0.93
24	0.88	0.93	0.79	0.81	-	-	0.87

25	1.31	-	1.31	1.96	-	-	1.33
26	0.71	-	1.20	1.60	1.03	-	0.91
27	1.16	0.99	0.76	0.12	-	-	1.05
28	-	0.85	0.89	0.78	-	-	0.85
31	-	2.14	2.22	1.66	-	-	2.15
32	-	1.74	1.77	-	-	-	1.75
33	1.26	1.04	1.20	-	-	-	1.20
34	-	1.14	1.55	-	-	-	1.22
35	1.10	0.85	0.80	0.24	0.85	-	0.95
36	-	1.71	2.27	-	-	-	1.77
37	-	-	1.81	1.74	-	-	1.80
38	-	1.07	0.41	0.65	-	-	0.75
TOTAL	0.96	1.08	1.02	0.70	0.92	-	0.98

TABLE 12: ESTIMATED VMT VS. OBSERVED VMT BASED ON LINKS WITH TRAFFIC COUNT - BY AREA AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)

Estimate_2018

	Facility Type						
Area Type	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	578,409	931,010	416,812	129,737	484,324	0	2,540,292
2	5,369,943	3,599,711	1,877,373	317,332	802,794	0	11,967,153
3	8,990,781	2,846,139	2,191,767	586,892	1,712,240	0	16,327,819
4	5,242,353	2,122,810	2,014,473	451,337	768,415	0	10,599,388
5	9,962,169	3,794,538	2,327,190	585,492	1,383,102	26,319	18,078,810
6	6,859,784	5,034,258	6,086,419	549,224	671,546	0	19,201,231
TOTAL	37,003,439	18,328,466	14,914,034	2,620,014	5,822,421	26,319	78,714,693

Observed_2018

	Facility Type						
Area Type	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp	TOTAL
1	554,106	700,612	363,478	93,258	412,572	0	2,124,026
2	5,466,431	3,419,008	1,769,923	362,272	888,596	0	11,906,230
3	8,878,084	2,964,965	2,343,673	785,763	1,927,039	0	16,899,524
4	4,872,291	2,042,296	2,122,981	536,216	787,959	0	10,361,743
5	9,472,552	3,391,423	2,144,360	720,329	1,297,292	36,284	17,062,240
6	6,119,478	4,385,383	4,234,617	665,247	667,139	0	16,071,864
TOTAL	35,362,942	16,903,687	12,979,032	3,163,085	5,980,597	36,284	74,425,627

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate_2018

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	561,248	723,761	325,342	85,290	398,698	0	2,094,339
2	5,522,506	3,274,145	1,685,998	265,135	704,572	0	11,452,356
3	9,154,383	2,795,109	2,125,405	542,975	1,555,152	0	16,173,024
4	5,369,055	2,074,403	1,961,228	402,831	762,046	0	10,569,563
5	9,679,633	3,844,930	2,259,017	525,380	1,292,269	35,307	17,636,536
6	7,072,973	5,425,732	5,711,020	512,596	599,768	0	19,322,089
TOTAL	37,359,798	18,138,080	14,068,010	2,334,207	5,312,505	35,307	77,247,907

Observed_2018

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	566,136	702,612	363,478	93,258	412,572	0	2,138,056
2	5,612,456	3,422,608	1,769,923	362,173	888,596	0	12,055,756
3	8,878,084	2,964,965	2,343,673	785,763	1,927,039	0	16,899,524
4	4,953,771	2,042,296	2,122,981	535,084	787,959	0	10,442,091
5	9,472,552	3,391,423	2,144,360	727,382	1,297,292	36,284	17,069,293
6	6,119,478	4,377,391	4,216,958	660,530	667,139	0	16,041,496
TOTAL	35,602,477	16,901,295	12,961,373	3,164,190	5,980,597	36,284	74,646,216

Continued

Model Run:	Gen3 i4 (12-9-2021)

Estimate/Observed Ratio

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	1.04	1.33	1.15	1.39	1.17	-	1.20
2	0.98	1.05	1.06	0.88	0.90	-	1.01
3	1.01	0.96	0.94	0.75	0.89	-	0.97
4	1.08	1.04	0.95	0.84	0.98	-	1.02
5	1.05	1.12	1.09	0.81	1.07	0.73	1.06
6	1.12	1.15	1.44	0.83	1.01	-	1.19
TOTAL	1.05	1.08	1.15	0.83	0.97	0.73	1.06

Model Run:	Gen2 (TPB Ver. 2.4)

Estimate/Observed Ratio

	Facility Type						
Area Type	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
1	0.99	1.03	0.90	0.91	0.97	-	0.98
2	0.98	0.96	0.95	0.73	0.79	-	0.95
3	1.03	0.94	0.91	0.69	0.81	-	0.96
4	1.08	1.02	0.92	0.75	0.97	-	1.01
5	1.02	1.13	1.05	0.72	1.00	0.97	1.03
6	1.16	1.24	1.35	0.78	0.90	-	1.20
TOTAL	1.05	1.07	1.09	0.74	0.89	0.97	1.03

TABLE 13: ESTIMATED VMT VS. OBSERVED VMT BASED ON LINKS WITH TRAFFIC COUNT - BY JURISDICTION AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)						
Estimate_2018							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	367,155	1,734,140	861,599	232,391	1,125,047	0	4,320,332
Montgomery County	4,820,647	2,380,780	1,288,166	204,837	489,478	0	9,183,908
Prince George's County	5,523,365	1,695,427	793,326	234,341	1,443,903	0	9,690,362
Arlington County	1,342,793	226,004	274,404	46,907	28,565	0	1,918,673
City of Alexandria	513,833	100,656	163,854	15,431	0	0	793,774
Fairfax County	5,085,794	2,002,909	2,785,154	490,471	291,230	0	10,655,558
Loudoun County	295,868	437,605	1,347,089	340,697	61,901	0	2,483,160
Prince William County	1,741,000	735,008	1,181,377	212,908	9,038	0	3,879,331
Frederick County	3,225,689	597,525	728,153	117,184	391,648	0	5,060,199
Howard County	4,433,339	586,031	703,829	65,094	1,145,498	0	6,933,791
Anne Arundel County	6,194,244	1,858,809	1,232,485	156,342	836,113	26,319	10,304,312
Charles County	0	989,256	361,836	33,294	0	0	1,384,386
Carrol County	111,321	1,136,279	935,986	29,003	0	0	2,212,589
Calvert County	0	573,341	109,598	22,351	0	0	705,290
St. Mary's County	0	351,176	396,873	39,881	0	0	787,930
King George County	0	162,463	236,421	29,272	0	0	428,156
City of Fredericksburg	96,576	240,541	92,959	16,444	0	0	446,520
Stafford County	1,117,469	347,383	225,939	151,354	0	0	1,842,145
Spotsylvania County	903,218	267,719	117,127	123,488	0	0	1,411,552
Fauquier County	1,051,888	840,920	523,998	3,354	0	0	2,420,160
Clarke County	0	459,394	346,448	0	0	0	805,842
Jefferson County	179,241	605,099	207,413	54,969	0	0	1,046,722
TOTAL	37,003,440	18,328,465	14,914,034	2,620,013	5,822,421	26,319	78,714,692

Continued

Model Run:	Gen3 i4 (12-9-2021)						
Observed_2018							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	412,474	1,218,645	586,015	169,880	1,132,132	0	3,519,146
Montgomery County	4,534,148	2,040,804	1,106,816	256,033	361,839	0	8,299,640
Prince George's County	5,712,890	1,660,517	822,513	347,177	1,616,326	0	10,159,423
Arlington County	1,236,461	246,777	274,475	53,892	23,370	0	1,834,975
City of Alexandria	492,670	98,492	150,486	9,493	0	0	751,141
Fairfax County	5,043,919	2,376,468	2,872,186	541,372	327,140	0	11,161,085
Loudoun County	371,440	423,440	917,829	342,582	93,100	0	2,148,391
Prince William County	1,527,235	723,541	1,234,559	267,467	8,400	0	3,761,202
Frederick County	2,934,525	462,131	608,632	142,244	392,987	0	4,540,519
Howard County	4,093,734	445,805	590,282	77,457	1,190,753	0	6,398,031
Anne Arundel County	6,026,982	1,797,940	1,137,243	183,912	834,549	36,284	10,016,910
Charles County	0	878,533	321,739	86,071	0	0	1,286,343
Carrol County	104,413	842,768	448,743	29,498	0	0	1,425,422
Calvert County	0	595,850	98,458	29,547	0	0	723,855
St. Mary's County	0	367,828	420,908	38,721	0	0	827,457
King George County	0	179,140	272,020	45,606	0	0	496,766
City of Fredericksburg	98,830	253,930	48,068	35,420	0	0	436,248
Stafford County	936,800	328,800	202,481	231,735	0	0	1,699,816
Spotsylvania County	859,240	301,120	196,529	223,506	0	0	1,580,395
Fauquier County	828,603	934,924	372,260	3,328	0	0	2,139,115
Clarke County	0	355,010	205,973	0	0	0	560,983
Jefferson County	148,575	371,225	90,815	48,145	0	0	658,760
TOTAL	35,362,939	16,903,688	12,979,030	3,163,086	5,980,596	36,284	74,425,623

Continued

Model Run:	Gen3 i4 (12-9-2021)

Estimate/Observed Ratio

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	0.89	1.42	1.47	1.37	0.99	-	1.23
Montgomery County	1.06	1.17	1.16	0.80	1.35	-	1.11
Prince George's County	0.97	1.02	0.96	0.67	0.89	-	0.95
Arlington County	1.09	0.92	1.00	0.87	1.22	-	1.05
City of Alexandria	1.04	1.02	1.09	1.63	-	-	1.06
Fairfax County	1.01	0.84	0.97	0.91	0.89	-	0.95
Loudoun County	0.80	1.03	1.47	0.99	0.66	-	1.16
Prince William County	1.14	1.02	0.96	0.80	1.08	-	1.03
Frederick County	1.10	1.29	1.20	0.82	1.00	-	1.11
Howard County	1.08	1.31	1.19	0.84	0.96	-	1.08
Anne Arundel County	1.03	1.03	1.08	0.85	1.00	0.73	1.03
Charles County	-	1.13	1.12	0.39	-	-	1.08
Carrol County	1.07	1.35	2.09	0.98	-	-	1.55
Calvert County	-	0.96	1.11	0.76	-	-	0.97
St. Mary's County	-	0.95	0.94	1.03	-	-	0.95
King George County	-	0.91	0.87	0.64	-	-	0.86
City of Fredericksburg	0.98	0.95	1.93	0.46	-	-	1.02
Stafford County	1.19	1.06	1.12	0.65	-	-	1.08
Spotsylvania County	1.05	0.89	0.60	0.55	-	-	0.89
Fauquier County	1.27	0.90	1.41	1.01	-	-	1.13
Clarke County	-	1.29	1.68	-	-	-	1.44
Jefferson County	1.21	1.63	2.28	1.14	-	-	1.59
TOTAL	1.05	1.08	1.15	0.83	0.97	0.73	1.06

Continued

Model Run:	Gen2 (TPB Ver. 2.4)

Estimate_2018

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	369,809	1,379,613	657,950	158,499	931,176	0	3,497,047
Montgomery County	4,564,858	2,235,452	1,160,234	169,455	376,331	0	8,506,330
Prince George's County	4,996,171	1,555,240	723,622	207,932	1,392,546	0	8,875,511
Arlington County	1,483,565	207,918	249,923	38,313	20,602	0	2,000,321
City of Alexandria	558,894	91,642	144,658	13,479	0	0	808,673
Fairfax County	5,360,584	2,081,307	2,836,149	474,526	309,122	0	11,061,688
Loudoun County	271,272	396,782	1,211,682	302,351	60,337	0	2,242,424
Prince William County	1,838,937	785,865	1,145,280	210,282	8,587	0	3,988,951
Frederick County	3,500,621	617,564	698,298	108,213	334,841	0	5,259,537
Howard County	4,485,263	527,174	625,825	41,983	980,922	0	6,661,167
Anne Arundel County	6,489,236	1,829,694	1,143,702	134,496	898,041	35,307	10,530,476
Charles County	0	998,821	354,077	29,119	0	0	1,382,017
Carrol County	134,826	1,173,814	892,100	21,326	0	0	2,222,066
Calvert County	0	572,433	104,639	21,717	0	0	698,789
St. Mary's County	0	378,865	395,557	37,964	0	0	812,386
King George County	0	182,983	242,076	39,247	0	0	464,306
City of Fredericksburg	93,508	227,699	84,781	15,525	0	0	421,513
Stafford County	1,221,592	434,444	234,044	135,325	0	0	2,025,405
Spotsylvania County	861,195	269,313	113,565	120,847	0	0	1,364,920
Fauquier County	948,587	1,047,174	513,083	4,165	0	0	2,513,009
Clarke County	0	475,614	345,643	0	0	0	821,257
Jefferson County	180,880	668,669	191,122	49,443	0	0	1,090,114
TOTAL	37,359,798	18,138,080	14,068,010	2,334,207	5,312,505	35,307	77,247,907

Continued

Model Run:	Gen2 (TPB Ver. 2.4)

Observed_2018

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	412,474	1,218,645	586,015	169,101	1,132,132	0	3,518,367
Montgomery County	4,534,148	2,040,804	1,089,157	256,033	361,839	0	8,281,981
Prince George's County	5,712,890	1,660,517	822,513	355,134	1,616,326	0	10,167,380
Arlington County	1,307,606	246,777	274,475	53,892	23,370	0	1,906,120
City of Alexandria	574,960	104,092	150,486	9,493	0	0	839,031
Fairfax County	5,130,019	2,376,468	2,872,186	540,921	327,140	0	11,246,734
Loudoun County	371,440	423,440	917,829	342,582	93,100	0	2,148,391
Prince William County	1,527,235	723,541	1,234,559	267,467	8,400	0	3,761,202
Frederick County	2,934,525	462,131	608,632	139,505	392,987	0	4,537,780
Howard County	4,093,734	445,805	590,282	77,457	1,190,753	0	6,398,031
Anne Arundel County	6,026,982	1,797,940	1,137,243	183,912	834,549	36,284	10,016,910
Charles County	0	878,533	321,739	86,071	0	0	1,286,343
Carrol County	104,413	842,768	448,743	29,498	0	0	1,425,422
Calvert County	0	595,850	98,458	29,547	0	0	723,855
St. Mary's County	0	367,828	420,908	38,721	0	0	827,457
King George County	0	179,140	272,020	45,606	0	0	496,766
City of Fredericksburg	98,830	253,930	48,068	35,420	0	0	436,248
Stafford County	936,800	328,800	202,481	231,735	0	0	1,699,816
Spotsylvania County	859,240	301,120	196,529	223,506	0	0	1,580,395
Fauquier County	828,603	934,924	372,260	3,328	0	0	2,139,115
Clarke County	0	355,010	205,973	0	0	0	560,983
Jefferson County	148,575	363,232	90,815	45,263	0	0	647,885
TOTAL	35,602,474	16,901,295	12,961,371	3,164,192	5,980,596	36,284	74,646,212

Continued

Model Run:	**Gen2 (TPB Ver. 2.4)**

Estimate/Observed Ratio

	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	0.90	1.13	1.12	0.94	0.82	-	0.99
Montgomery County	1.01	1.10	1.07	0.66	1.04	-	1.03
Prince George's County	0.87	0.94	0.88	0.59	0.86	-	0.87
Arlington County	1.13	0.84	0.91	0.71	0.88	-	1.05
City of Alexandria	0.97	0.88	0.96	1.42	-	-	0.96
Fairfax County	1.04	0.88	0.99	0.88	0.94	-	0.98
Loudoun County	0.73	0.94	1.32	0.88	0.65	-	1.04
Prince William County	1.20	1.09	0.93	0.79	1.02	-	1.06
Frederick County	1.19	1.34	1.15	0.78	0.85	-	1.16
Howard County	1.10	1.18	1.06	0.54	0.82	-	1.04
Anne Arundel County	1.08	1.02	1.01	0.73	1.08	0.97	1.05
Charles County	-	1.14	1.10	0.34	-	-	1.07
Carrol County	1.29	1.39	1.99	0.72	-	-	1.56
Calvert County	-	0.96	1.06	0.73	-	-	0.97
St. Mary's County	-	1.03	0.94	0.98	-	-	0.98
King George County	-	1.02	0.89	0.86	-	-	0.93
City of Fredericksburg	0.95	0.90	1.76	0.44	-	-	0.97
Stafford County	1.30	1.32	1.16	0.58	-	-	1.19
Spotsylvania County	1.00	0.89	0.58	0.54	-	-	0.86
Fauquier County	1.14	1.12	1.38	1.25	-	-	1.17
Clarke County	-	1.34	1.68	-	-	-	1.46
Jefferson County	1.22	1.84	2.10	1.09	-	-	1.68
TOTAL	1.05	1.07	1.09	0.74	0.89	0.97	1.03

TABLE 14:ESTIMATED VMT VS. OBSERVED VMT BASED ON 2018 HPMS - BY JURISDICTION AND FACILITY TYPE

Model Run:	Gen3 i4 (12-9-2021)						
Estimate_2018							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	712,790	4,276,365	2,695,347	784,557	1,720,947	30132	10,220,138
Montgomery County	9,086,727	7,112,327	4,004,092	1,094,132	725,992	235487	22,258,757
Prince George's County	10,311,925	5,525,761	3,426,030	1,731,488	3,422,350	358270	24,775,824
Arlington County	2,444,670	863,116	690,347	149,587	79,868	49352	4,276,940
City of Alexandria	1,043,016	512,995	613,209	93,636	0	65259	2,328,115
Fairfax County	11,815,977	6,222,660	6,403,104	1,393,566	912,464	493231	27,241,002
Loudoun County	1,073,567	1,975,696	3,126,431	1,492,890	506,594	95700	8,270,878
Prince William County	3,689,085	1,973,736	3,276,149	936,922	56,811	166690	10,099,393
Frederick County	4,609,053	937,420	1,980,369	651,892	795,624	62917	9,037,275
Howard County	6,351,569	1,123,073	2,099,837	450,993	1,975,753	8106	12,009,331
Anne Arundel County	8,947,890	3,034,756	2,411,638	560,080	984,882	38,797	15,978,043
Charles County	0	2,068,049	925,144	248,596	0	0	3,241,789
Carrol County	123,680	2,095,761	2,158,158	80,040	0	0	4,457,639
Calvert County	0	1,344,572	220,200	110,766	0	0	1,675,538
St. Mary's County	0	1,104,384	871,063	90,772	0	0	2,066,219
King George County	0	272,913	436,425	69,869	0	0	779,207
City of Fredericksburg	448,055	309,243	112,007	22,758	0	25463	917,526
Stafford County	2,432,337	765,631	507,593	528,276	0	44386	4,278,223
Spotsylvania County	1,101,035	696,466	257,425	373,791	0	17389	2,446,106
Fauquier County	1,172,076	1,392,173	906,428	100,589	0	6762	3,578,028
Clarke County	0	561,550	500,338	1705	0	0	1,063,593
Jefferson County	179,241	920,618	273,295	79,998	0	0	1,453,152
TOTAL	65,542,693	45,089,265	37,894,629	11,046,903	11,181,285	1,697,941	172,452,716

Continued

Model Run:	Gen2 (TPB Ver. 2.4)						
Estimate_2018							
	Facility Type						
Jurisdiction	**Freeway**	**Major Arterial**	**Minor Arterial**	**Collector**	**Expressway**	**Ramp**	**TOTAL**
District of Columbia	713,268	3,386,779	2,052,551	548,705	1,432,729	26099	8,160,131
Montgomery County	8,667,885	6,735,537	3,652,111	919,300	569,848	249583	20,794,264
Prince George's County	9,305,130	5,071,141	3,107,022	1,469,671	3,333,355	373121	22,659,440
Arlington County	2,470,928	786,848	628,008	123,699	57,379	42351	4,109,213
City of Alexandria	1,010,756	454,702	547,543	72,134	0	55516	2,140,651
Fairfax County	12,422,916	6,391,769	6,498,215	1,338,941	968,512	491414	28,111,767
Loudoun County	997,054	1,750,955	2,816,484	1,298,665	498,564	87887	7,449,609
Prince William County	3,753,081	2,128,959	3,161,907	897,143	53,940	167616	10,162,646
Frederick County	4,978,507	925,129	1,850,831	583,525	663,601	65097	9,066,690
Howard County	6,399,660	1,017,248	1,884,492	356,241	1,761,847	7066	11,426,554
Anne Arundel County	9,240,211	3,001,527	2,271,344	440,555	1,056,076	48,882	16,058,595
Charles County	0	2,095,407	894,006	247,646	0	0	3,237,059
Carrol County	150,427	2,147,488	2,023,583	60,159	0	0	4,381,657
Calvert County	0	1,337,727	208,388	106,820	0	0	1,652,935
St. Mary's County	0	1,184,770	863,878	85,981	0	0	2,134,629
King George County	0	302,644	447,432	85,769	0	0	835,845
City of Fredericksburg	445,000	293,463	103,114	22,102	0	30590	894,269
Stafford County	2,658,398	982,220	530,852	494,009	0	51083	4,716,562
Spotsylvania County	1,043,082	699,938	249,681	359,648	0	24071	2,376,420
Fauquier County	1,053,192	1,714,568	924,027	101,092	0	9581	3,802,460
Clarke County	0	571,320	509,779	1015	0	0	1,082,114
Jefferson County	180,880	1,007,444	248,435	68,531	0	0	1,505,290
TOTAL	65,490,375	43,987,583	35,473,683	9,681,351	10,395,851	1,729,957	166,758,800

Continued

Comparison:	Observed vs. Gen3 i4 (12-9-2021) vs. Gen2 (TPB Ver. 2.4)				
	VMT based on 2018 HPMS				
Jurisdiction	**Observed**	**Gen3**	**TPB 2.4**	**Gen3 E/O Ratio**	**TPB 2.4 E/O Ratio**
District of Columbia	8,410,547	10,220,138	8,160,131	1.22	0.97
Montgomery County	20,844,658	22,258,757	20,794,264	1.07	1.00
Prince George's County	25,320,822	24,775,824	22,659,440	0.98	0.89
Arlington County	4,115,600	4,276,940	4,109,213	1.04	1.00
City of Alexandria	1,851,663	2,328,115	2,140,651	1.26	1.16
Fairfax County	28,284,350	27,241,002	28,111,767	0.96	0.99
Loudoun County	7,342,782	8,270,878	7,449,609	1.13	1.01
Prince William County	10,300,396	10,099,393	10,162,646	0.98	0.99
Frederick County	8,391,370	9,037,275	9,066,690	1.08	1.08
Howard County	11,526,986	12,009,331	11,426,554	1.04	0.99
Anne Arundel County	16,518,082	15,978,043	16,058,595	0.97	0.97
Charles County	3,426,164	3,241,789	3,237,059	0.95	0.94
Carrol County	3,408,904	4,457,639	4,381,657	1.31	1.29
Calvert County	2,019,452	1,675,538	1,652,935	0.83	0.82
St. Mary's County	2,367,534	2,066,219	2,134,629	0.87	0.90
King George County	932,207	779,207	835,845	0.84	0.90
City of Fredericksburg	990,749	917,526	894,269	0.93	0.90
Stafford County	4,358,421	4,278,223	4,716,562	0.98	1.08
Spotsylvania County	3,774,287	2,446,106	2,376,420	0.65	0.63
Fauquier County	3,686,566	3,578,028	3,802,460	0.97	1.03
Clarke County	827,733	1,063,593	1,082,114	1.28	1.31
Jefferson County	1,069,310	1,453,152	1,505,290	1.36	1.41
TOTAL	169,768,582	172,452,716	166,758,800	1.02	0.98

TABLE 15: PERCENT RMSE - BY FACILITY TYPE, AREA TYPE, AND JURISDICTION

Model Run:	Gen3 i4 (12-9-2021)			
By Facility Type				
Facility Type	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
Freeway	671	127,069,268,594	39,264,889	23.52
Major Arterial	2,066	122,252,201,454	35,108,530	45.27
Minor Arterial	3,337	60,321,009,305	25,577,725	55.47
Collector	1,544	14,662,136,225	6,047,224	78.68
Expressway	244	44,270,696,487	9,183,535	35.79
Ramp	2	43,444,872	33,910	27.49
TOTAL	7,864	368,618,756,937	115,215,813	46.73
By Area Type				
Area Type	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
1	753	63,262,930,646	9,794,197	70.47
2	1,899	100,282,332,051	31,265,556	44.14
3	1,266	78,665,745,204	27,384,672	36.44
4	1,112	42,198,758,406	17,129,636	39.99
5	1,259	56,250,887,264	19,077,729	44.11
6	1,575	27,958,103,366	10,564,023	62.82
TOTAL	7,864	368,618,756,937	115,215,813	46.73

Continued

Model Run:	Gen3 i4 (12-9-2021)			
By Jurisdiction				
Jurisdiction	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
District of Columbia	1,251	95,489,734,872	13,264,895	82.4
Montgomery County	837	42,157,717,051	15,020,402	39.55
Prince George's County	822	44,842,353,901	17,168,756	35.36
Arlington County	344	15,587,976,939	4,903,974	47.22
City of Alexandria	132	4,217,549,649	2,391,200	31.2
Fairfax County	1,508	71,729,454,420	23,799,142	43.7
Loudoun County	338	9,142,919,726	3,070,888	57.24
Prince William County	445	13,018,499,267	6,265,650	38.41
Frederick County	369	7,836,926,282	3,824,738	44.46
Howard County	222	16,659,492,918	5,584,580	34.44
Anne Arundel County	453	23,428,819,047	9,982,194	32.64
Charles County	172	3,663,256,299	1,355,536	58.56
Carrol County	174	6,192,768,811	1,241,916	83.58
Calvert County	86	426,938,681	779,118	24.59
St. Mary's County	120	527,808,318	815,868	30.85
King George County	50	212,857,185	271,000	38.07
City of Fredericksburg	44	2,020,016,182	777,134	38.36
Stafford County	148	5,021,739,051	1,852,468	46.54
Spotsylvania County	96	1,630,508,890	986,600	40.1
Fauquier County	134	1,617,839,062	1,117,082	41.68
Clarke County	38	876,017,723	321,500	56.75
Jefferson County	81	2,317,562,663	421,172	102.87
TOTAL	7,864	368,618,756,937	115,215,813	46.73

Continued

Model Run:	Gen2 (TPB Ver. 2.4)			
By Facility Type				
Facility Type	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
Freeway	689	135,692,208,852	39,656,389	24.38
Major Arterial	2,067	90,728,041,228	35,153,720	38.96
Minor Arterial	3,337	46,148,009,579	25,577,725	48.52
Collector	1,549	13,935,041,614	6,059,578	76.67
Expressway	245	45,443,476,576	9,233,286	36.14
Ramp	2	969,224	33,910	4.11
TOTAL	7,889	331,947,747,073	115,714,608	44.22

By Area Type				
Area Type	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
1	758	41,911,902,448	9,930,948	56.76
2	1,915	89,786,180,741	31,534,106	41.58
3	1,266	74,713,025,539	27,384,672	35.51
4	1,113	53,971,192,359	17,213,636	45.03
5	1,261	44,274,223,304	19,088,629	39.14
6	1,576	27,291,222,682	10,562,617	62.09
TOTAL	7,889	331,947,747,073	115,714,608	44.22

Continued

Model Run:	Gen2 (TPB Ver. 2.4)			
By Jurisdiction				
Jurisdiction	**No, Obs**	**Sum Diff Sq**	**Sum Obs Count**	**Pct_RMSE**
District of Columbia	1,252	59,007,798,010	13,314,646	64.55
Montgomery County	837	23,488,356,162	15,020,402	29.52
Prince George's County	824	51,341,119,349	17,179,656	37.86
Arlington County	354	19,261,273,000	5,089,974	51.3
City of Alexandria	140	5,316,358,369	2,543,700	33.92
Fairfax County	1,511	72,930,598,156	23,900,192	43.92
Loudoun County	338	8,330,598,324	3,070,888	54.64
Prince William County	445	16,799,820,303	6,265,650	43.64
Frederick County	371	9,308,007,423	3,825,642	48.57
Howard County	222	14,221,822,585	5,584,580	31.82
Anne Arundel County	453	23,286,173,151	9,982,194	32.54
Charles County	172	3,914,551,720	1,355,536	60.53
Carrol County	174	5,796,688,306	1,241,916	80.87
Calvert County	86	361,101,735	779,118	22.62
St. Mary's County	120	521,017,941	815,868	30.65
King George County	50	146,620,596	271,000	31.59
City of Fredericksburg	44	2,029,780,660	777,134	38.46
Stafford County	148	8,942,261,110	1,852,468	62.1
Spotsylvania County	96	1,764,014,540	986,600	41.71
Fauquier County	134	1,122,216,902	1,117,082	34.71
Clarke County	38	928,963,139	321,500	58.44
Jefferson County	80	3,128,605,592	418,862	119.44
TOTAL	7,889	331,947,747,073	115,714,608	44.22

TABLE 16: ESTIMATED 2018 VMT - BY TIME PERIOD AND USER CLASS

	SOV	HV2	HV3	CV	TRK	APX	Total
AM	25,062,444	4,718,434	1,547,671	2,745,474	2,809,639	352,491	37,236,153
PM	34,387,009	9,273,529	3,389,639	4,895,311	1,884,868	388,047	54,218,403
MD	28,966,154	7,992,016	2,543,276	4,797,334	5,909,483	548,427	50,756,690
NT	32,539,404	7,648,637	3,308,164	2,214,459	1,695,667	222,010	47,628,341
Total	120,955,011	29,632,616	10,788,750	14,652,578	12,299,657	1,510,975	189,839,587

	SOV	HV2	HV3	CV	TRK	APX	Total
AM	67.30%	12.70%	4.20%	7.40%	7.50%	0.90%	100.00%
PM	63.40%	17.10%	6.30%	9.00%	3.50%	0.70%	100.00%
MD	57.10%	15.70%	5.00%	9.50%	11.60%	1.10%	100.00%
NT	68.30%	16.10%	6.90%	4.60%	3.60%	0.50%	100.00%
Total	63.70%	15.60%	5.70%	7.70%	6.50%	0.80%	100.00%

User classes:

SOV: Single-occupant vehicle

HV2: High-occupant vehicle, 2 occupants

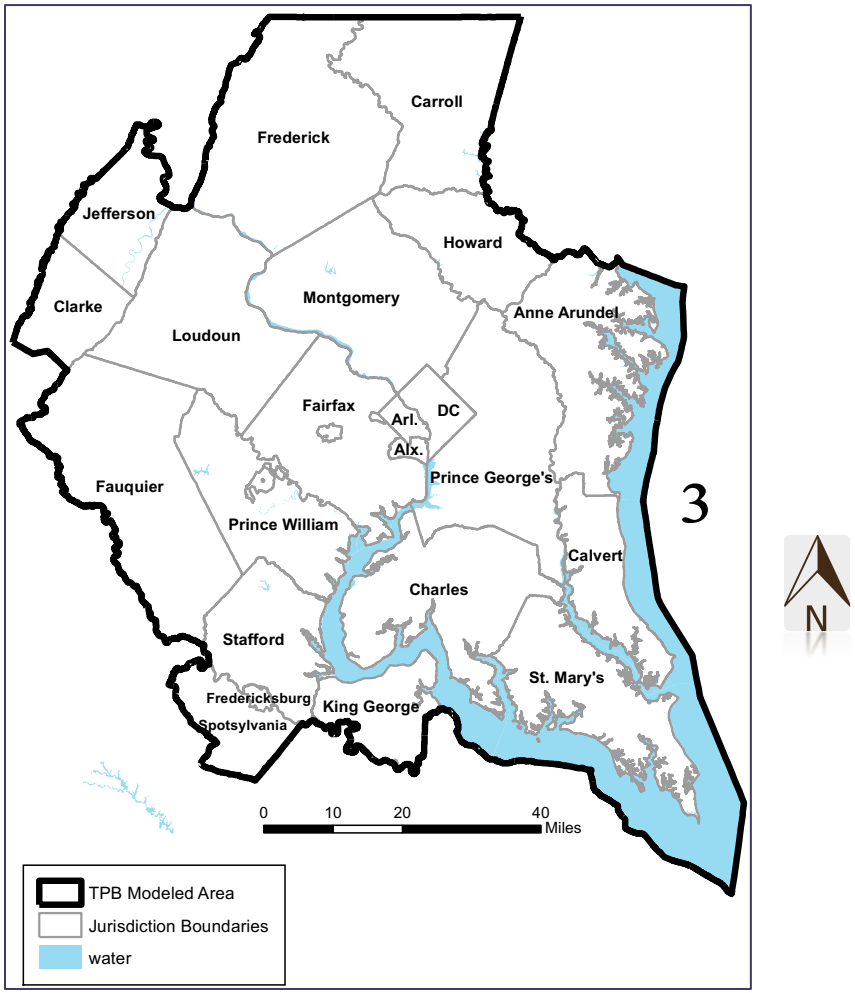
HV3: High-occupant vehicle, 3+ occupants

CV: Commercial vehicles

TRK: Trucks

APX: Airport passenger auto person vehicles

FIGURE 33: MAP OF MODELED AREA COUNTY AND MUNICIPAL JURISDICTIONS



Note: Only the northern half of Spotsylvania Co., Virginia is included in the modeled area.

FIGURE 34: MAP OF SCREENLINE VALIDATION PERFORMANCE – MODELED REGION

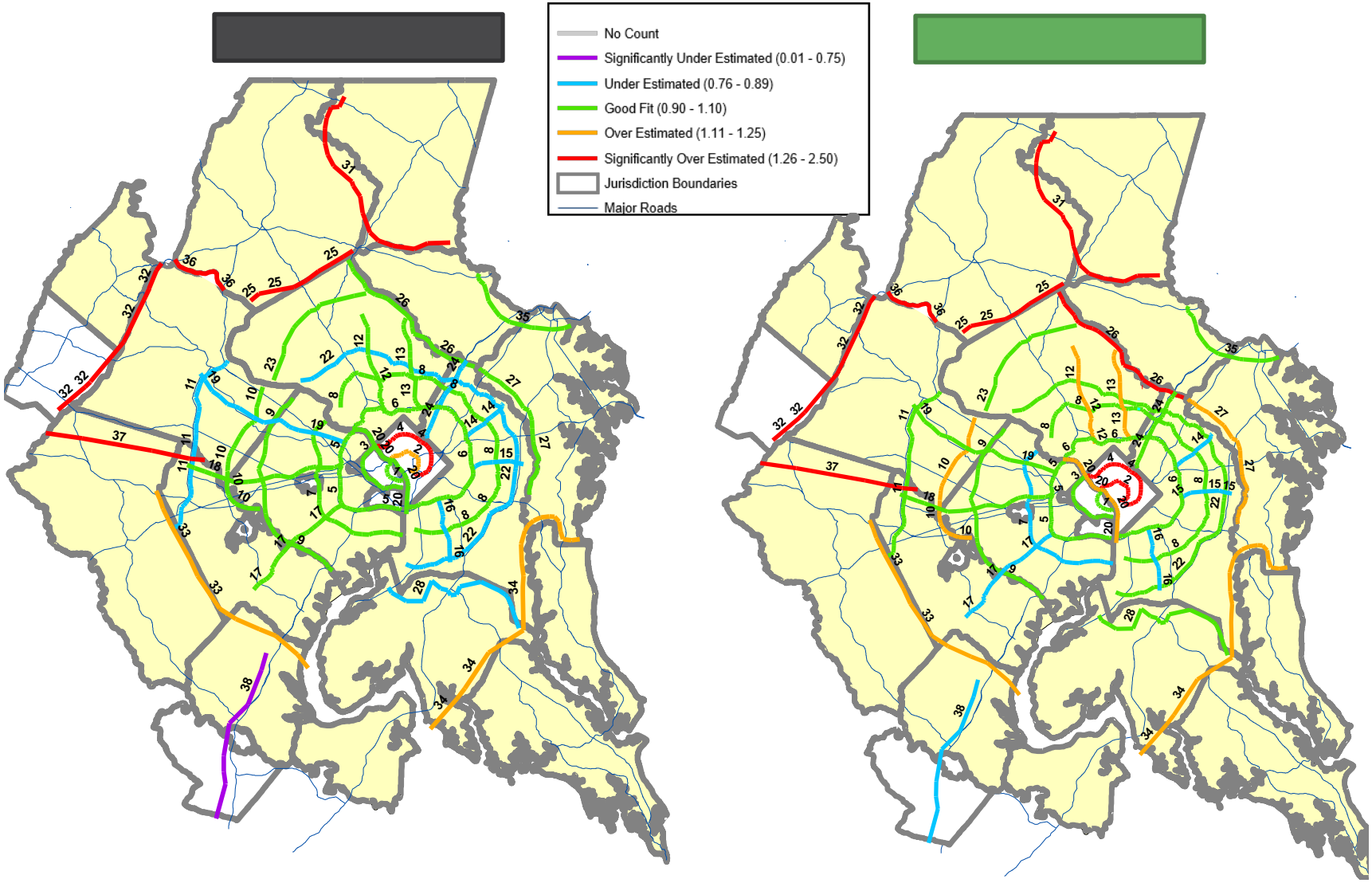


FIGURE 35: MAP OF SCREENLINE VALIDATION PERFORMANCE – DC AREA

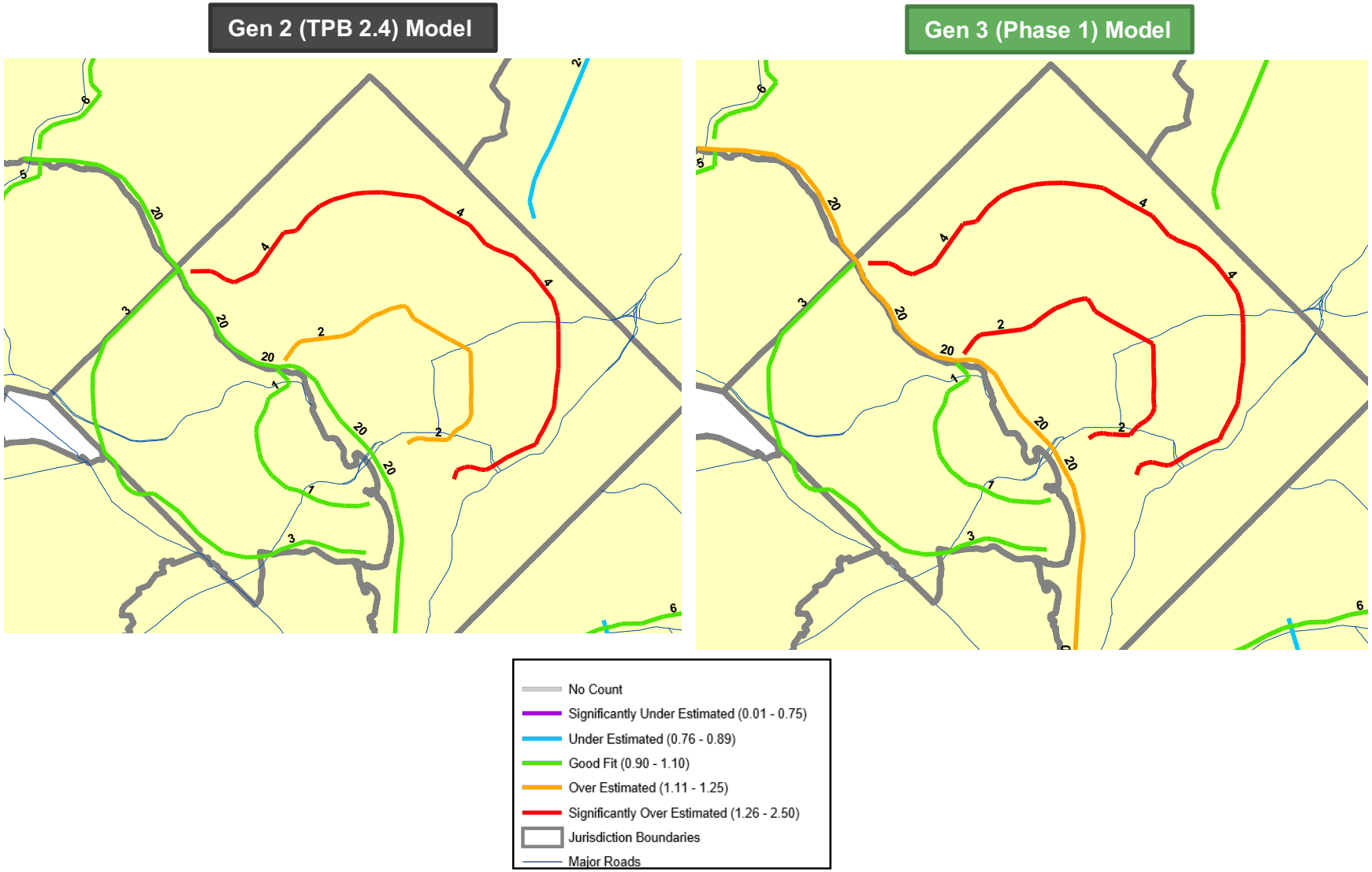


FIGURE 36: SCATTERPLOT OF SCREENLINE VALIDATION – FREEWAYS

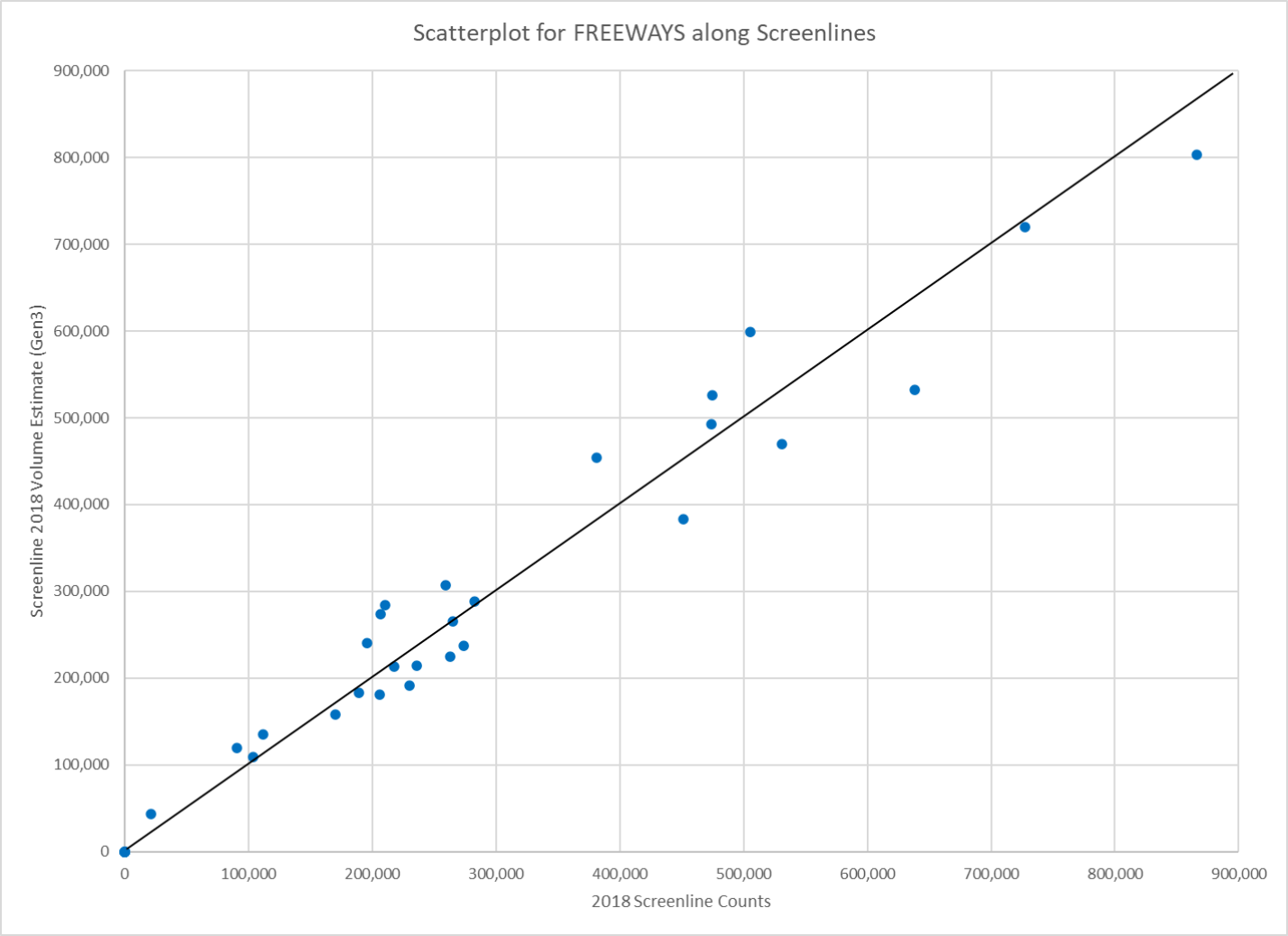


FIGURE 37: SCATTERPLOT OF SCREENLINE VALIDATION – MAJOR ARTERIALS

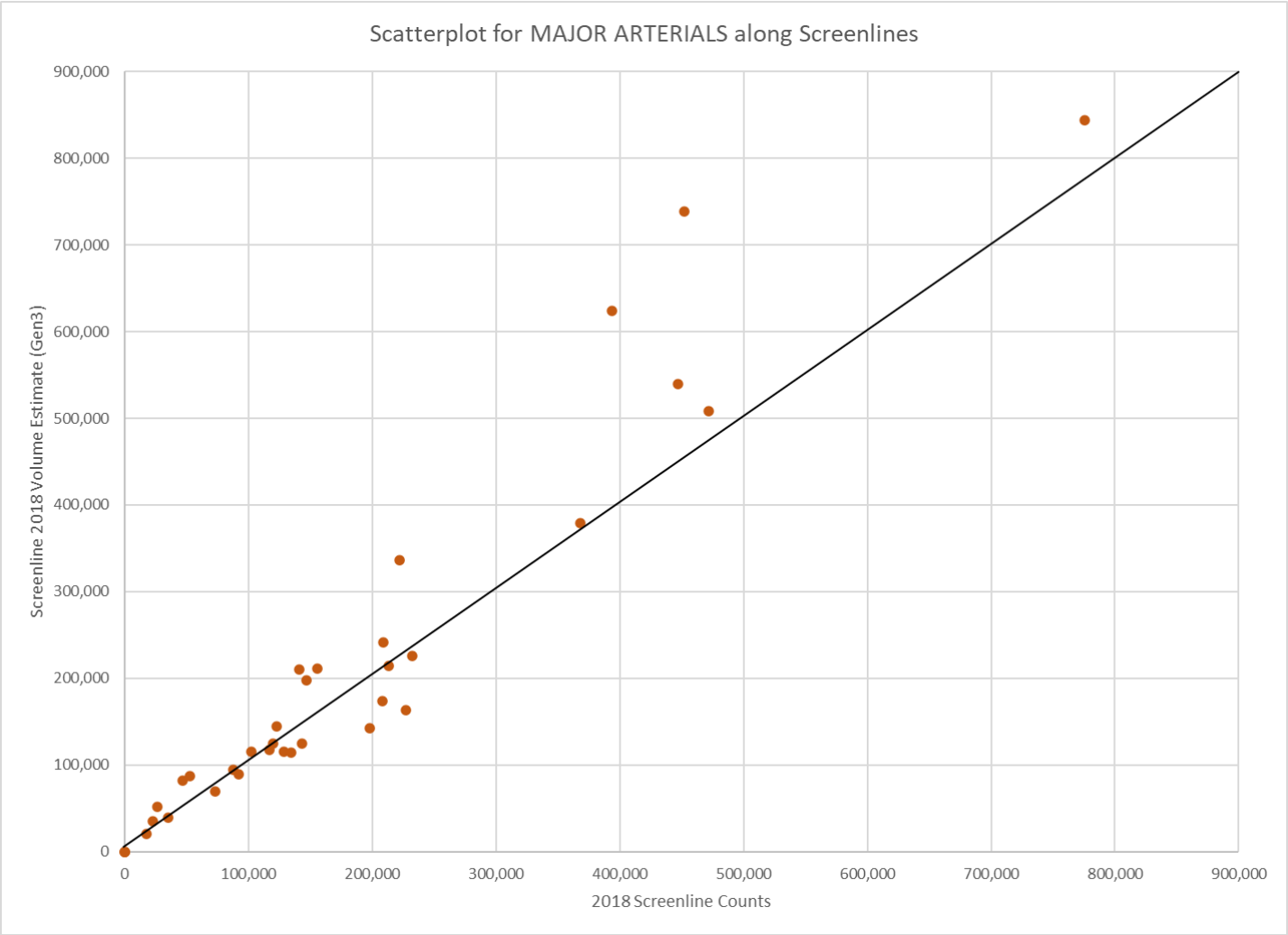


FIGURE 38: SCATTERPLOT OF SCREENLINE VALIDATION – MINOR ARTERIALS

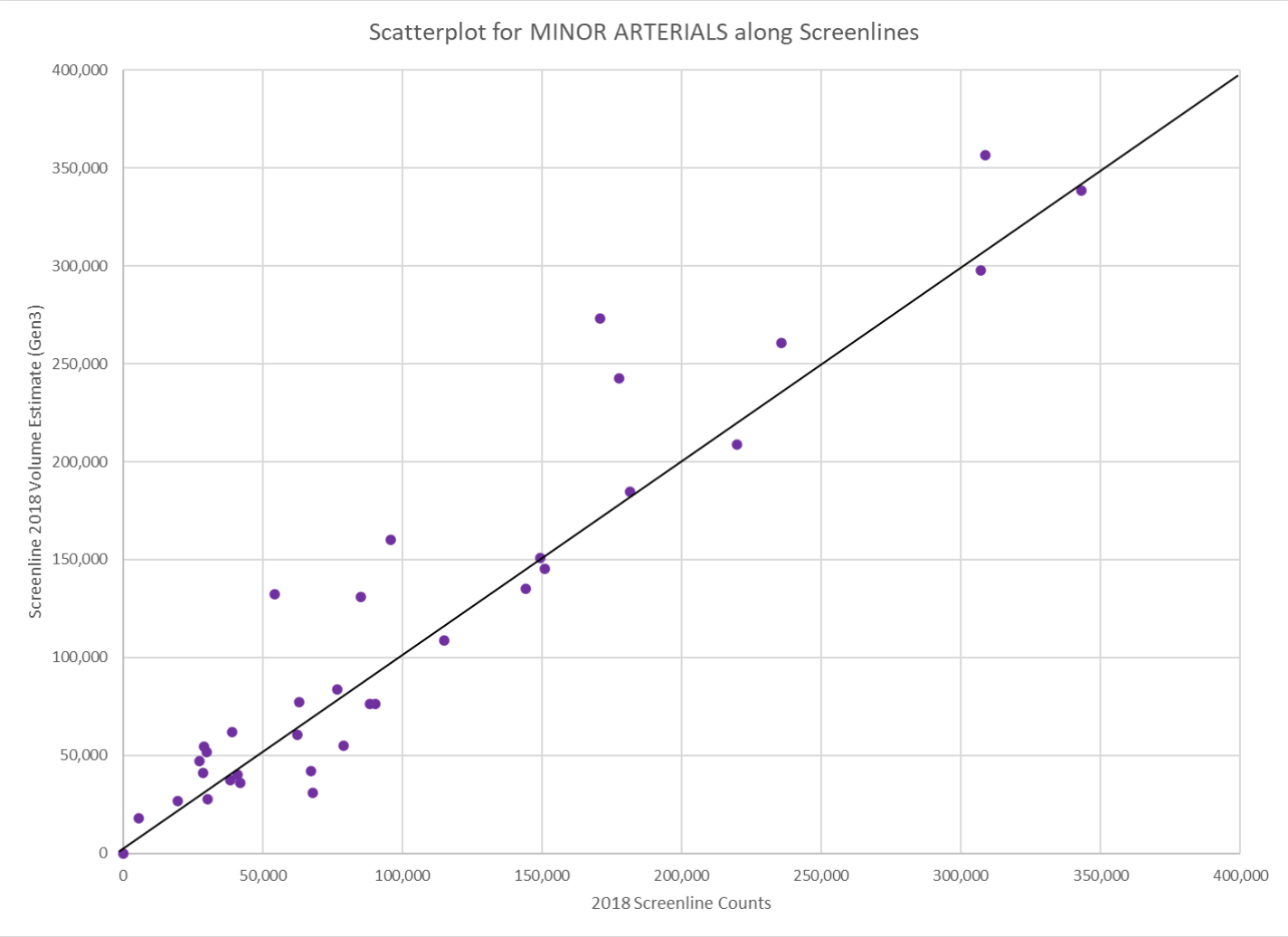
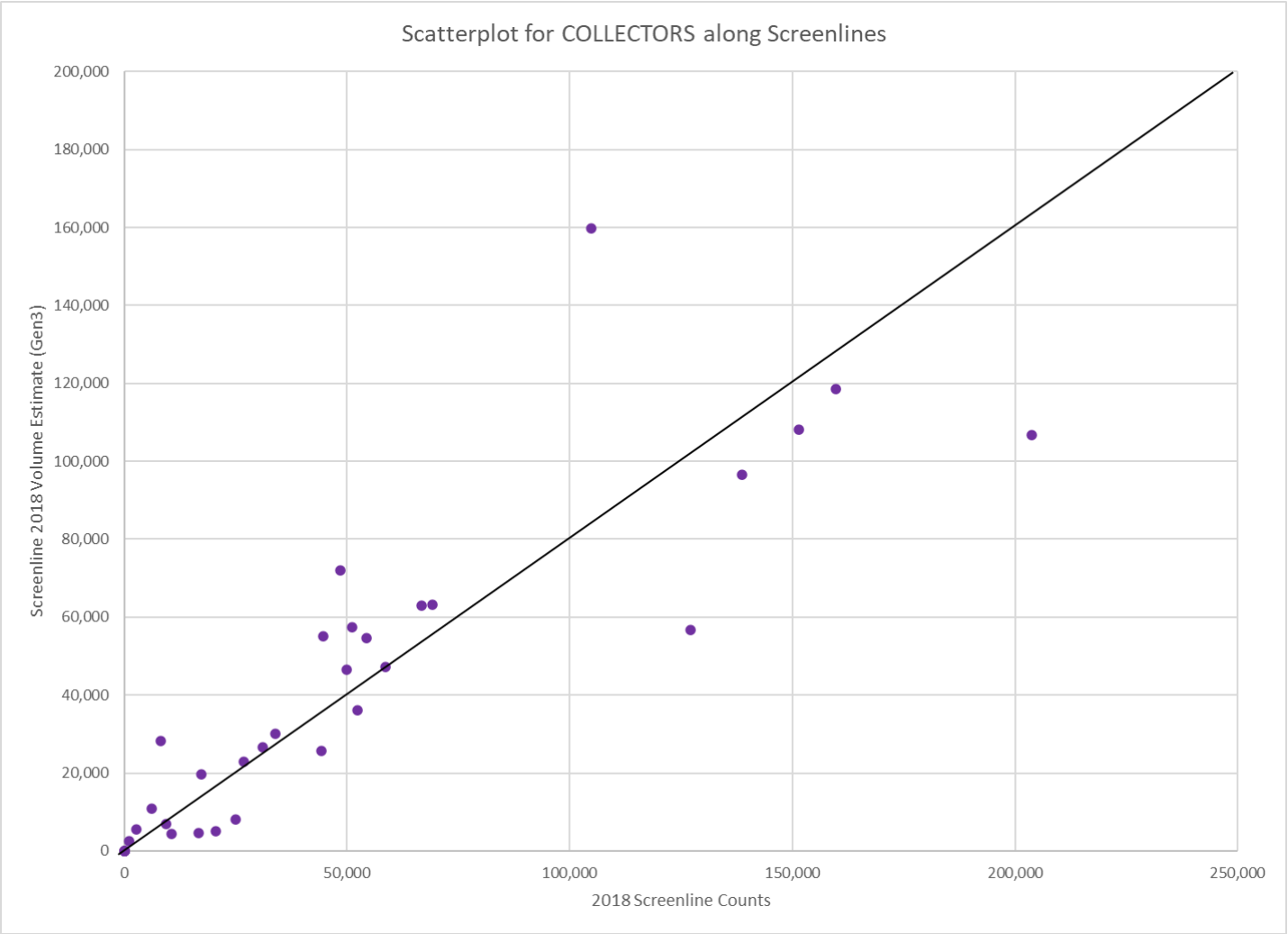


FIGURE 39: SCATTERPLOT OF SCREENLINE VALIDATION – COLLECTORS



3.2 TRANSIT VALIDATION

The transit validation process also involved an iterative process where the Gen3 (Phase 1) Model was run, and then the resulting series of 144 transit output database files was processed using a set of post-processing scripts first written in Python and later in Jupyter Notebook, and then the summary results were tabulated in a spreadsheet to compare against 2018 transit boardings and also to compare against similar validation measures for the MWCOG's Gen2/Ver. 2.4 Model. These iterative run results were presented to MWCOG in bi-weekly check-in meetings to discuss strategies for Gen3 Model improvements. Those iterative and interim run results are not included in this report. Instead, this report focuses on presenting the transit validation results from the final December 9, 2021 run, which was deemed as the finalrun of the Gen3 Model in Phase 1 of the ActivitySim development project. As noted, this run utilized the 4th iteration skims from a previous run, rather than the results achieved after running the calibrated utility files through a full 4 iterations with feedback.

The Gen2/Ver. 2.4 Model conducts transit assignment using trip tables in production-attraction (P-A) format for two time-of-day periods (peak and off peak). The Gen3 Model conducts transit assignment using trip tables in origin-destination (O-D) format for four time-of-day periods (AM, midday, PM, and night).

This December 9, 2021 run generated the following 144 transit output database files:

- Link Volume Files (a total of 72 *LINKVOL.DBF files)
    - All Bus Mode (20 DBFs)
        - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
            - Drive Access-Walk Egress
            - Walk Access-Drive Egress
            - K&R Access-Walk Egress
            - Walk Access-K&R Egress
            - Walk Access-Walk Egress
    - Bus and Metrorail Modes (20 DBFs)
        - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
            - Drive Access-Walk Egress

                - Walk Access-Drive Egress
                - K&R Access-Walk Egress
                - Walk Access-K&R Egress
                - Walk Access-Walk Egress
        - Commuter Rail Mode (12 DBFs)
            - By Four Time Periods (AM, Midday, Night, and PM) and three access-egress mode combinations
                - Drive Access-Walk Egress
                - Walk Access-Drive Egress
                - Walk Access-Walk Egress
        - Metrorail Mode (20 DBFs)
            - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
                - Drive Access-Walk Egress
                - Walk Access-Drive Egress
                - K&R Access-Walk Egress
                - Walk Access-K&R Egress
                - Walk Access-Walk Egress
- Stop to Stop Volume Files (a total of 72 *S2Svol.DBF files)
    - All Bus Mode (20 DBFs)
        - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
            - Drive Access-Walk Egress
            - Walk Access-Drive Egress
            - K&R Access-Walk Egress
            - Walk Access-K&R Egress
            - Walk Access-Walk Egress
    - Bus and Metrorail Modes (20 DBFs)

        - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
            - Drive Access-Walk Egress
            - Walk Access-Drive Egress
            - K&R Access-Walk Egress
            - Walk Access-K&R Egress
            - Walk Access-Walk Egress
    - Commuter Rail Mode (12 DBFs)
        - By Four Time Periods (AM, Midday, Night, and PM) and three access-egress mode combinations
            - Drive Access-Walk Egress
            - Walk Access-Drive Egress
            - Walk Access-Walk Egress
    - Metrorail Mode (20 DBFs)
        - By Four Time Periods (AM, Midday, Night, and PM) and five access-egress mode combinations
            - Drive Access-Walk Egress
            - Walk Access-Drive Egress
            - K&R Access-Walk Egress
            - Walk Access-K&R Egress
            - Walk Access-Walk Egress

These transit output DBF files were processed initially using a set of Python scripts and later using two Jupyter Notebook scripts to prepare validation statistics. These Python and Jupyter Notebook scripts are referenced and documented in (7.0 Appendix C). COG staff later compared the transit validation statistics generated from the Jupyter Notebook scripts and those from the latest LineSum program (Version 7.5.1) and found that they matched. LineSum is a TRANSIMS based program created by AECOM that COG staff uses to create transit summaries for the Gen2 Models.

Several transit validation measures were summarized to check Gen3 Model performance on the transit network side. More specifically, the following transit validation measures were tabulated:

- Comparison of model estimated transit boardings vs. 2018 observed transit boardings by Mode (Table 17)
- Comparison of model estimated transit boardings vs. 2018 observed transit boardings by transit operator (Table 18)
- Comparison of model estimated station entries vs. 2018 observed station entries by 21 station groups (Table 19)
- Comparison of model estimated Metrorail through trips vs. 2018 observed Metrorail through trips by 21 station groups (Table 20 and Figure 40)

These validation results reveal that the Gen3 Model is predicting transit travel conditions reasonably well as there is a relatively closer match to observed data and overestimates transit ridership overall by only 9%. The comparison of boardings by mode (Table 17) reveal that the Gen3 Model underestimates bus boardings by 7% when all of the bus modes in the region are combined. However, individual bus modes such as Express Metrobus and Local Metrobus are underestimated by 9% and 16%, respectively. For commuter rail, the Gen3 Model underestimates boardings by 23% and for Metrorail it overestimates by 27%. However, the Metrorail overestimation is partly due to the fact that the observed Metrorail boardings are actually station entries and do not include transfers.

The comparison of Metrorail station entries (Table 19) are based on the Gen3 Model's stop-to-stop output files that provide through ridership estimates between each station pair that don't include transfers. Consequently, summary totals reflect station entries, which is more comparable to the observed data that represent station entries as well and don't include transfers. This comparison (Table 19) shows close match for Red Line and Orange/Blue Line station groups, 7% underestimation and 4% overestimation, respectively. The Blue/Yellow Line station groups, the Silver Line station groups, and the Green Line station groups show significantly off from the observed totals, 21%, 18%, and 15% underestimation, respectively. It should be mentioned that the station groups have been defined by the COG staff and documented in the last validation memorandum[10].

The comparison of through trips between the 21 station groups (Table 20 and Figure 40) show wide range of underestimations and overestimations when the estimate/observed ratios are reviewed. However, the actual differences were relatively small. Of the 441 station pair combinations, only 53 station pairs show absolute differences over 1,000 riders, which is 12% of all the station pairs.

[10] Seifu, Meseret, and Sanghyeon Ko. Memorandum to Feng Xie. "Year-2018 Validation of TPB Version 2.4 Travel Model." Memorandum, August 17, 2021

TABLE 17: COMPARISON OF BOARDINGS BY MODE

	2018 Daily Boarding and Alighting Estimates (Gen3 Model)											
Mode	All Bus: Sum of ONA	All Bus: Sum of OFFB	Bus & Metrorail: Sum of ONA	Bus & Metrorail: Sum of OFFB	Metrorail: Sum of ONA	Metrorail: Sum of OFFB	Commuter Rail: Sum of ONA	Commuter Rail: Sum of OFFB	Combined: Sum of ONA	Combined: Sum of OFFB	2018 Observed Boardings	Ratio E/O for Boardings
1	272,749	272,750	43,475	43,476	0	0	2,824	2,824	319,049	319,050	381,637	0.84
2	13,831	13,831	7,282	7,282	0	0	206	206	21,319	21,319	23,472	0.91
3	0	0	117,685	117,685	617,009	617,009	32,759	32,759	767,453	767,453*	605,909*	1.27
4	0	0	0	0	0	0	44,565	44,565	44,565	44,565	57,989	0.77
6	121,782	121,782	30,491	30,491	0	0	1,942	1,942	154,216	154,216	150,554	1.02
7	827	827	925	925	0	0	79	79	1,831	1,831	3,583	0.51
8	24,684	24,684	2,420	2,420	0	0	632	632	27,736	27,736	5,500	5.04

9	18,424	18,425	4,184	4,184	0	0	159	159	22,767	22,768	21,438	1.06
10	0	0	0	0	0	0	0	0	0	0		n/a
1, 2, 6, 7, 8, and 9	452,298	452,299	88,778	88,778	0	0	5,842	5,842	546,917	546,919	586,184	0.93
ALL	452,298	452,299	206,463	206,463	617,009	617,009	83,166	83,166	1,358,935	1,358,937	1,250,082	1.09

NOTE:

*Observed data is station entries and does not include transfers, whereas the Metrorail estimate includes transfers. Hence, the comparison is not exactly consistent.

MODE NAMES:

1: Local Metrobus
2: Express Metrobus
3: Metrorail
4: Commuter Rail
5: Light Rail Transit (LRT, none in 2018)
6: Other Local Bus in the WMATA Area
7: Other Express Bus in the WMATA Area
8: Other Local Bus beyond the WMATA Area
9: Other Express Bus beyond the WMATA Area
10: Bus Rapid Transit and Streetcar
1, 2, 6, 7, 8, and 9: All Bus

OBSERVED DATA SOURCES:

- Bus boardings data from October 2018 – Obtained from transit agencies by COG. Extracted from COG's Regional Transportation Data Clearinghouse (RTDC)
- Metrorail - Data from Model Ver. 2.4 Validation Memo, Table B-1
- Commuter Rail boardings - MARC and VRE onboard surveys and October 2018 ridership data

TABLE 18: COMPARISON OF BOARDINGS BY OPERATOR

	2018 Daily Boardings and Alightings Estimates (Gen3 Model)											
Operator	All Bus: Sum of ONA	All Bus: Sum of OFFB	Bus & Metrorail: Sum of ONA	Bus & Metrorail: Sum of OFFB	Metrorail: Sum of ONA	Metrorail: Sum of OFFB	Commuter Rail: Sum of ONA	Commuter Rail: Sum of OFFB	Combined: Sum of ONA	Combined: Sum of OFFB	2018 Observed Boardings	Ratio E/O for Boardings
1	0	0	117,685	117,685	617,009	617,009	32,759	32,759	767,453	767,453*	605,909*	1.27
2	0	0	0	0	0	0	14,041	14,041	14,041	14,041	18,491	0.76
3	0	0	0	0	0	0	30,524	30,524	30,524	30,524	39,498	0.77
11	390,535	390,535	73,830	73,831	0	0	4,651	4,651	469,016	469,017		n/a
12	21,101	21,101	10,266	10,266	0	0	315	315	31,682	31,682		n/a
13	7,029	7,029	464	464	0	0	221	221	7,714	7,714	16,885	0.46
14	21,652	21,652	2,093	2,093	0	0	526	526	24,270	24,270		n/a
15	11,981	11,981	2,125	2,125	0	0	129	129	14,235	14,235		n/a
61	0	0	0	0	0	0	0	0				

NOTE:

*Observed data is station entries and does not include transfers, whereas the Metrorail estimate includes transfers. Hence, the comparison is not exactly consistent.

OPERATOR NAMES:

1: Metrorail
2: AMTRAK/VRE
3: MARC
11: ART/DASH/FF Con./PG/ Ride On/WMATA
12: DASH/FF Con./WMATA
13: DC Circular
14: Annapolis/ Culvert County/Carroll County/FairF City Bus/ GM Shuttle/Loudon County Local/Saint Mary/TransIT/VANGO
15: Flyer/ Loudon County Commuter/MARTZ/Maryland Commuter
61: DC OKLAH

OBSERVED DATA SOURCE:

- Bus boardings data from October 2018 - RTDC data
- Metrorail - Data from Model Ver. 2.4 Validation Memo, Table B-1
- Commuter Rail boardings - MARC and VRE onboard surveys and October 2018 ridership data

TABLE 19: COMPARISON OF STATION ENTRIES BY METRORAIL STATION GROUP

		2018 Daily Entries (Gen3 Model, S2Svol Files)					
Station Group	Station Group Name	Bus & Metrorail: Sum of VOL	Metrorail: Sum of VOL	Commuter Rail: Sum of VOL	Combined: Sum of VOL	2018 Observed Station Entries (Data from Validation Memo, Table B-2)	Ratio E/O
1	Red Line - "A" route MD outside Beltway	5,068	15,022	619	20,709	26,664	0.78
2	Red Line - "A" route MD inside Beltway	3,855	19,166	485	23,506	21,583	1.09
3	Red Line - "A" route DC non-core	1,694	17,204	221	19,119	20,577	0.93
4	Red Line - DC core	12,833	94,092	12,029	118,954	127,659	0.93
5	Red Line - "B" route DC non-core	2,807	12,969	1,518	17,294	21,519	0.8
6	Red Line - "B" route MD	4,341	17,291	1,278	22,910	21,244	1.08
7	Green Line - "E" route MD	2,151	11,368	917	14,436	16,020	0.9
8	Green Line - "E" route DC non-core	863	14,575	218	15,656	21,396	0.73
9	Green Line - DC core	4,030	29,430	1,996	35,456	36,365	0.98
10	Green Line - "F" route DC non-core	2,164	13,430	549	16,143	21,840	0.74
11	Green Line - "F" route MD	2,259	11,083	166	13,508	16,184	0.83
12	Blue/Yellow Line - VA Fairfax	3,090	10,163	110	13,363	14,964	0.89
13	Blue/Yellow Line - VA Alexandria	2,454	8,998	916	12,368	12,592	0.98

14	Blue/Yellow Line - VA Core	9,188	19,513	721	29,422	42,396	0.69
15	Orange Line - VA Fairfax	2,332	5,150	74	7,556	14,855	0.51
16	Orange Line - VA Arlington non-core	5,498	31,529	498	37,525	27,054	1.39
17	Orange/Blue Line - VA/DC core	12,237	80,325	2,061	94,623	92,125	1.03
18	Orange/Blue Line - DC non-core	1,115	8,351	391	9,857	10,774	0.91
19	Orange Line - DC/MD	2,363	8,003	1,271	11,637	12,275	0.95
20	Blue Line - DC/MD	1,631	12,781	80	14,492	12,604	1.15
21	Silver Line - Phase I & Phase 2	3,836	8,541	138	12,515	15,219	0.82
	Total Red Line Ridership				222,492	239,246	0.93
	Total Green Line Ridership				95,199	111,805	0.85
	Total Blue/Yellow Line Ridership				55,153	69,952	0.79
	Total Orange/Blue Line Ridership				175,690	169,687	1.04
	Total Silver Line Ridership				12,515	15,219	0.82
	Grand Total				561,049	605,909	0.93

TABLE 20: METRORAIL STATION GROUP TO STATION GROUP THROUGH TRIPS

2018 Boardings Estimate - COMBINED

Sta. Grp.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	5,227	3,048	769	6,003	198	225	131	165	698	272	83	100	143	416	1
2	3,076	4,522	1,994	6,006	410	488	259	297	602	395	278	308	214	665	2
3	837	2,085	1,400	8,009	263	394	157	256	701	318	167	154	192	503	1
4	5,689	6,136	7,829	31,122	7,987	8,798	4,381	4,557	4,505	3,774	3,197	2,718	1,435	4,194	1
5	209	387	261	8,177	686	1,113	416	411	859	282	143	135	182	598	1
6	230	506	363	9,284	1,037	2,926	617	419	1,249	384	82	137	220	833	1
7	131	263	161	4,560	397	636	1,941	764	2,208	463	91	95	145	603	
8	171	319	248	4,442	455	421	861	799	3,051	565	200	124	203	827	
9	653	611	725	4,963	920	1,239	1,748	2,846	2,858	2,216	1,914	1,331	1,088	3,281	3
10	274	362	258	3,507	289	398	530	615	2,108	1,284	912	260	321	1,039	
11	84	310	143	3,682	121	88	106	222	2,101	954	838	44	190	812	
12	104	335	156	2,496	156	133	85	124	1,476	261	45	528	1,241	1,124	
13	154	249	168	1,568	211	228	146	226	1,330	366	167	1,238	1,020	1,362	
14	418	735	519	4,400	625	793	527	742	3,403	1,096	695	1,211	1,569	2,737	2
15	177	286	95	1,378	89	134	30	56	351	98	35	38	76	246	3
16	786	1,116	1,022	5,757	765	839	388	600	1,522	791	517	584	572	1,364	9
17	1,874	1,671	2,213	9,348	2,335	3,481	1,433	2,150	3,609	3,117	2,679	3,925	2,301	6,147	2
18	110	160	118	1,252	111	146	84	135	838	182	124	153	156	486	1
19	113	192	99	1,813	90	116	60	138	1,066	145	45	46	137	462	
20	116	252	126	2,598	100	84	86	159	1,188	187	72	76	145	753	
21	414	403	239	1,315	218	411	118	136	358	163	92	136	141	304	3
COLSUM	20,847	23,948	18,906	121,680	17,463	23,091	14,104	15,817	36,081	17,313	12,376	13,341	11,691	28,756	7

Continued

2018 Observed - Station Group to Station Group Through Trips (Source: WMATA TRACE Data for Average Weekday in October 2018)

Sta. Grp.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1
1	3,440	4,150	1,479	11,888	303	87	162	153	1,035	500	245	80	162	702	8
2	4,101	1,885	2,381	8,708	376	83	199	230	469	389	414	157	137	576	1
3	1,514	2,389	1,971	9,917	594	347	213	214	530	440	240	155	158	532	1
4	11,630	8,472	9,754	33,474	8,986	10,236	3,985	4,591	3,235	3,304	3,600	2,423	1,866	5,773	2,
5	307	390	644	9,110	2,164	1,811	750	1,620	1,043	1,026	472	145	168	694	1
6	81	64	337	10,405	1,803	2,061	638	732	1,143	608	286	110	188	808	1
7	172	205	237	4,167	746	653	1,246	1,985	2,748	817	382	88	143	764	6
8	162	209	202	4,450	1,644	696	2,036	1,721	2,980	1,976	925	225	388	1,398	1
9	1,017	462	531	3,550	1,037	1,117	2,645	2,939	2,359	2,448	2,720	2,010	1,694	5,240	7
10	487	399	466	3,341	1,027	590	806	1,991	2,394	2,002	1,488	354	305	1,250	2
11	261	438	262	3,491	506	293	382	932	2,616	1,454	858	110	138	1,033	9
12	76	149	161	2,360	138	112	87	212	2,039	353	106	697	990	3,222	7
13	160	128	153	1,788	153	186	127	364	1,673	286	123	997	770	2,165	1
14	701	566	552	5,888	720	803	745	1,402	5,230	1,277	1,049	3,319	2,293	5,878	7
15	78	99	134	2,766	133	97	59	109	768	262	86	70	117	706	5
16	258	242	277	4,066	318	325	177	298	866	422	243	283	349	1,091	1,
17	2,117	940	1,278	7,034	1,514	1,851	1,500	1,383	2,510	1,792	2,552	4,105	3,235	9,662	7,
18	114	175	251	1,315	268	136	121	445	619	204	124	120	153	623	1
19	132	209	197	1,561	229	117	58	361	1,166	415	233	85	115	649	1
20	154	301	238	1,905	317	176	127	485	1,110	374	129	107	129	703	6
21	107	106	163	2,348	177	158	123	184	644	275	163	128	193	671	2
COLSUM	27,070	21,979	21,668	133,533	23,154	21,935	16,185	22,352	37,176	20,621	16,436	15,767	13,688	44,140	15,

Continued

2018 Estimate/Observed (E/O) Ratio for Station Group to Station Group Through Trips

Sta. Grp.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	1.52	0.73	0.52	0.5	0.65	2.58	0.81	1.08	0.67	0.54	0.34	1.25	0.88	0.59	2
2	0.75	2.4	0.84	0.69	1.09	5.85	1.3	1.29	1.28	1.02	0.67	1.97	1.57	1.16	2
3	0.55	0.87	0.71	0.81	0.44	1.14	0.74	1.19	1.32	0.72	0.7	0.99	1.21	0.94	0
4	0.49	0.72	0.8	0.93	0.89	0.86	1.1	0.99	1.39	1.14	0.89	1.12	0.77	0.73	0
5	0.68	0.99	0.41	0.9	0.32	0.61	0.55	0.25	0.82	0.27	0.3	0.93	1.09	0.86	0
6	2.85	7.88	1.08	0.89	0.58	1.42	0.97	0.57	1.09	0.63	0.29	1.24	1.17	1.03	1
7	0.76	1.28	0.68	1.09	0.53	0.97	1.56	0.38	0.8	0.57	0.24	1.08	1.01	0.79	0
8	1.06	1.53	1.23	1	0.28	0.61	0.42	0.46	1.02	0.29	0.22	0.55	0.52	0.59	0
9	0.64	1.32	1.37	1.4	0.89	1.11	0.66	0.97	1.21	0.91	0.7	0.66	0.64	0.63	0
10	0.56	0.91	0.55	1.05	0.28	0.67	0.66	0.31	0.88	0.64	0.61	0.73	1.05	0.83	0
11	0.32	0.71	0.55	1.05	0.24	0.3	0.28	0.24	0.8	0.66	0.98	0.4	1.38	0.79	0
12	1.36	2.24	0.97	1.06	1.13	1.19	0.98	0.59	0.72	0.74	0.43	0.76	1.25	0.35	0
13	0.96	1.94	1.1	0.88	1.38	1.23	1.15	0.62	0.79	1.28	1.36	1.24	1.33	0.63	0
14	0.6	1.3	0.94	0.75	0.87	0.99	0.71	0.53	0.65	0.86	0.66	0.36	0.68	0.47	0
15	2.26	2.89	0.71	0.5	0.67	1.38	0.51	0.51	0.46	0.37	0.41	0.54	0.65	0.35	0
16	3.05	4.61	3.69	1.42	2.4	2.58	2.19	2.02	1.76	1.88	2.13	2.07	1.64	1.25	0
17	0.89	1.78	1.73	1.33	1.54	1.88	0.96	1.55	1.44	1.74	1.05	0.96	0.71	0.64	0
18	0.96	0.91	0.47	0.95	0.41	1.07	0.7	0.3	1.35	0.89	1	1.28	1.02	0.78	1
19	0.86	0.92	0.5	1.16	0.39	0.99	1.04	0.38	0.91	0.35	0.19	0.54	1.19	0.71	0
20	0.75	0.84	0.53	1.36	0.32	0.48	0.68	0.33	1.07	0.5	0.56	0.71	1.13	1.07	0
21	3.86	3.81	1.47	0.56	1.23	2.6	0.96	0.74	0.56	0.59	0.57	1.06	0.73	0.45	1
COLSUM	0.77	1.09	0.87	0.91	0.75	1.05	0.87	0.71	0.97	0.84	0.75	0.85	0.85	0.65	0

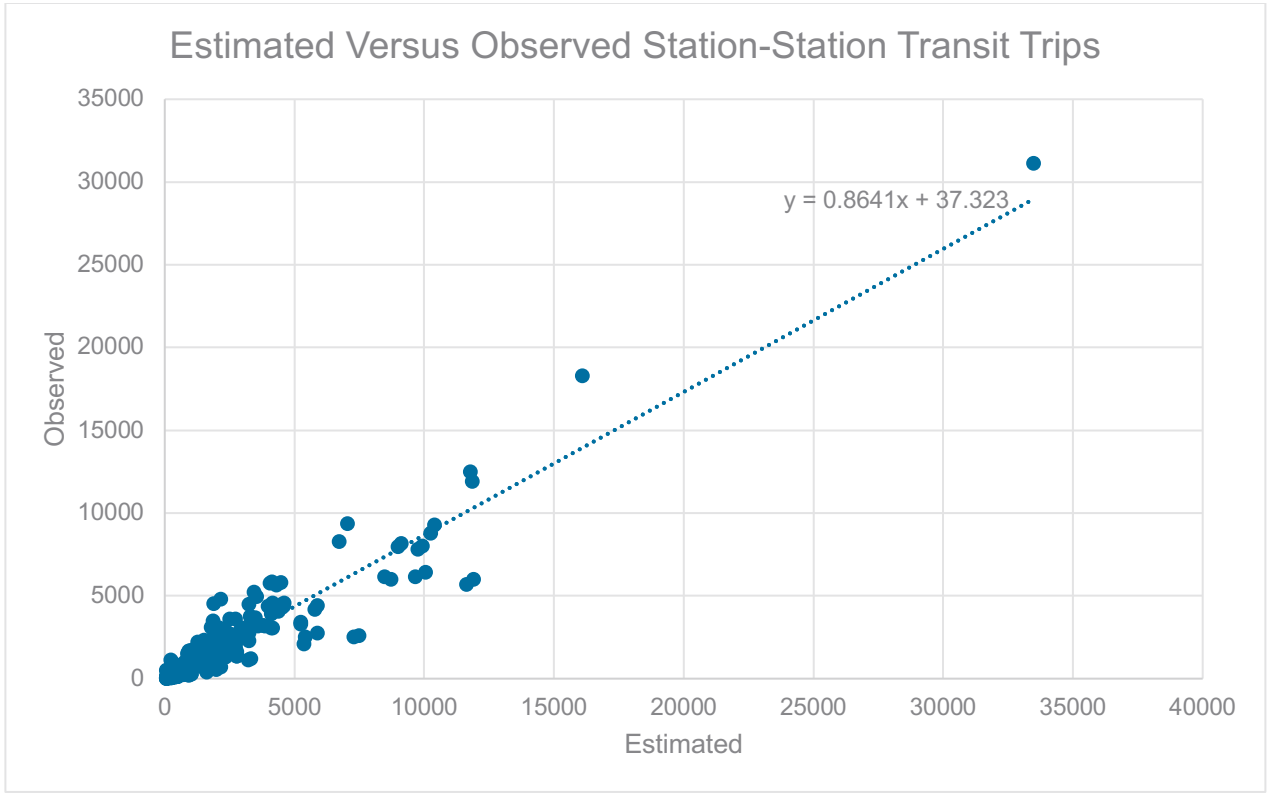


FIGURE 40: ESTIMATED VERSUS OBSERVED STATION-STATION TRANSIT TRIPS

3.3 TRIP FLOW VALIDATION

The trip flow validation process involved a review of the Gen3 Model outputs in terms of person trip flows between 22 jurisdictions and how they compare with the 2017-2018 Regional Travel Survey (RTS) conducted by the COG. This review was prepared in spreadsheets, namely TripFlowAnalysis.xlsx and TripFlows_Jurisdiction_Dec9_2021.xlsx, using pivot analysis. The following results have been summarized:

- Total Trip Flows for all modes and all trip purposes as observed in the RTS (Table 21)
- Total Trip Flows for all Modes and all trip purposes as estimated in the Gen3 Model (Table 22)
- Percent Difference in Total Trip Flows between Gen3 Model and RTS (Table 23)
- Comparison of Total Trip Flows going to, from and within DC between Gen3 Model and RTS by Tour Purpose (Table 24)
- Comparison of Total Trip Flows going to, from and within DC between Gen3 Model and RTS by Trip Mode (Table 25)

The results reveal that the Gen3 model is overestimating trip flows by approximately seven percent overall. The trip flows from several jurisdictions in the core of the modeled area (such as DC, Prince George's County, City of Alexandria, Prince William County) are 10-22 percent over the observed RTS data, Also, the trip flows from several jurisdictions in the periphery of the modeled area (such as Howard County in Maryland, City of Fredericksburg in Virginia, Spotsylvania, Fauquier and Clarke counties in Virginia) are over the observed RTS data by 29 percent or less.

The results in Table 24 and Table 25 reveal that the Gen3 model is underestimating overall mandatory tours (relatively less to DC or within DC) and overestimating overall non-mandatory tours. The sub tour frequency is also overestimated that is likely contributing to high traffic within the DC area. Also, the tour/trip mode choice model in the Gen3 model is overestimating auto mode overall and significantly to the DC area and within the DC area.

TABLE 21: TOTAL TRIP FLOWS FOR ALL MODES AND ALL TRIP PURPOSES IN THE REGIONAL TRAVEL SURVEY (RTS)

Jurisdiction	DC	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Frederick	Howard	Anne Arundel	Charles	Carroll	Calvert	St. Mary's	King George	Fredericksburg	Stafford	Spotsylvania	Fauquier	Clarke	Jefferson	Total
DC	1,834,098	192,702	219,462	86,714	28,088	106,808	11,428	17,025	3,596	12,209	16,979	12,239	271	4,946	2,948	101	518	3,303	895	502	212	592	2,555,634
Montgomery	188,399	2,761,244	98,077	18,492	2,958	55,630	13,258	3,633	40,333	33,548	20,255	2,703	6,232	885	237	0	0	0	246	50	0	1,220	3,247,399
Prince George's	221,963	98,641	1,679,589	18,808	22,712	35,635	3,245	3,290	2,832	33,836	78,084	42,444	1,578	13,646	2,629	0	3	1,250	0	387	0	45	2,260,618
Arlington	86,610	15,941	19,772	531,987	52,654	133,631	9,967	11,760	521	685	1,954	2,634	22	378	162	531	13	4,448	648	115	1,135	0	875,567
Alexandria	29,271	2,286	23,602	52,803	296,459	88,756	2,120	7,464	0	171	1,538	541	26	257	47	0	101	1,734	604	27	0	51	507,860
Fairfax	105,027	57,920	29,091	135,899	92,857	3,042,856	181,551	138,651	1,413	954	11,150	4,445	1,150	73	2,096	86	1,075	11,727	854	5,818	1,138	1,000	3,826,832
Loudoun	10,958	12,639	4,660	8,997	2,307	179,938	881,735	25,195	5,582	620	232	0	170	0	0	0	316	1,368	0	3,982	4,994	3,910	1,147,603
Prince William	17,624	4,557	3,941	12,565	8,070	134,150	25,462	1,082,558	160	310	338	36	0	215	0	465	2,383	20,401	3,774	13,355	0	108	1,330,472
Frederick	2,595	40,151	1,985	1,757	0	2,878	5,496	269	653,329	5,393	4,954	1,339	20,363	0	0	0	0	135	0	0	69	3,659	744,371
Howard	14,035	30,970	33,897	435	225	1,055	758	300	5,590	736,008	61,388	150	15,584	456	31	0	0	0	0	0	0	0	900,880
Anne Arundel	16,205	22,741	77,394	2,810	1,387	7,541	115	664	5,663	64,377	1,428,092	3,710	4,042	6,939	625	0	27	95	57	0	0	6	1,642,489
Charles	11,764	2,809	42,245	2,444	1,641	2,765	21	36	318	150	2,879	354,937	552	3,611	12,948	3,910	0	118	0	0	0	0	443,148
Carroll	169	6,125	1,775	22	0	1,150	255	0	19,762	15,133	3,783	552	397,151	0	0	0	0	0	0	0	0	372	446,247
Calvert	4,749	178	13,596	256	257	281	0	0	0	434	7,440	3,592	22	213,107	12,102	0	0	215	0	0	0	0	256,229
St. Mary's	2,787	409	2,452	35	47	2,135	700	0	0	0	1,219	12,101	0	10,647	379,601	393	0	0	0	0	0	0	412,527
King George	101	0	0	175	0	162	0	465	0	0	0	4,156	0	0	393	53,613	4,129	1,137	2,958	0	0	0	67,288
Fredericksburg	117	117	338	268	76	416	58	1,165	203	0	0	0	0	0	0	4,656	67,745	23,734	30,252	530	0	0	129,676
Stafford	3,140	321	675	3,842	629	11,759	338	18,076	0	0	0	118	0	0	0	1,606	24,739	282,311	24,992	210	0	0	372,757
Spotsylvania	1,687	0	0	649	0	1,916	604	3,660	0	0	151	0	0	0	0	2,485	29,699	26,151	172,198	72	0	0	239,271
Fauquier	518	67	446	160	27	6,259	3,428	13,170	0	0	0	0	0	0	0	0	25	543	72	104,467	1,376	0	130,558
Clarke	212	0	0	1,033	0	1,090	4,941	0	359	0	0	0	0	0	0	0	0	0	0	904	24,414	924	33,877
Jefferson	271	1,507	0	0	0	1,308	3,662	0	2,907	338	0	0	0	0	0	0	0	0	0	0	239	119,120	129,353
Total	2,552,299	3,251,327	2,252,998	880,150	510,397	3,818,120	1,149,141	1,327,380	742,568	904,163	1,640,435	445,698	447,163	255,161	413,818	67,846	130,773	378,668	237,549	130,420	33,577	131,006	21,700,656

TABLE 22: TOTAL TRIP FLOWS FOR ALL MODES AND ALL TRIP PURPOSES IN THE GEN3 MODEL

Jurisdiction	DC	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Frederick	Howard	Anne Arundel	Charles	Carroll	Calvert	St. Mary's	King George	Fredericksburg	Stafford	Spotsylvania	Fauquier	Clarke	Jefferson	Total
DC	2,064,468	259,629	396,343	143,770	49,196	127,427	8,454	16,817	2,474	11,818	18,778	15,314	1,109	4,869	1,975	414	228	2,362	769	768	82	245	3,127,309
Montgomery	258,805	2,518,425	172,088	26,906	6,727	67,624	10,306	3,974	35,793	58,404	17,642	1,299	10,239	804	214	46	46	386	97	348	103	1,105	3,191,381
Prince George's	387,067	173,434	1,710,762	27,740	22,575	39,907	1,595	3,486	1,093	49,729	94,503	48,923	905	13,209	4,215	568	37	453	127	137	17	57	2,580,539
Arlington	140,564	26,517	28,490	432,646	74,987	168,396	5,685	9,974	462	879	1,733	2,437	127	512	265	54	98	1,277	297	527	48	139	896,114
Alexandria	47,390	6,499	22,841	73,389	241,676	146,944	1,767	8,846	107	247	848	3,511	29	418	302	58	106	1,284	276	215	17	37	556,807
Fairfax	126,931	66,943	40,164	164,780	143,618	2,907,640	182,426	161,351	1,838	1,928	2,326	5,119	358	848	595	325	702	8,514	1,686	7,164	808	1,213	3,827,277
Loudoun	10,471	10,639	1,812	5,903	1,996	178,447	942,114	24,082	10,762	416	294	110	266	32	25	13	49	269	67	4,390	3,681	6,895	1,202,733
Prince William	20,127	4,843	3,787	10,208	8,126	154,188	24,049	1,256,836	285	183	320	438	35	97	68	620	2,039	26,681	3,188	23,629	499	260	1,540,506
Frederick	3,368	33,953	1,252	581	182	2,433	10,471	299	693,329	7,152	1,195	17	25,110	13	10	0	4	16	9	110	402	6,499	786,405
Howard	13,336	56,990	49,132	1,070	319	2,253	384	134	7,273	813,868	84,705	202	18,238	193	56	5	3	19	4	18	20	184	1,048,406
Anne Arundel	21,498	17,775	91,235	2,093	1,043	2,665	230	229	881	85,491	1,474,513	1,709	1,635	9,211	380	47	10	50	13	20	4	51	1,710,783
Charles	16,938	1,713	44,679	2,956	3,453	5,641	156	531	21	312	1,934	332,345	13	4,545	12,936	2,955	105	217	174	18	1	4	431,647
Carroll	1,430	9,999	1,087	186	36	533	274	42	25,213	17,289	2,018	10	423,182	6	2	0	0	5	3	8	12	151	481,486
Calvert	5,755	1,020	11,508	725	534	1,168	44	115	17	282	9,214	4,372	11	186,450	12,740	75	16	24	21	6	0	0	234,097
St. Mary's	2,270	332	3,773	319	362	820	38	76	10	79	491	12,461	2	12,744	300,961	855	74	91	111	10	0	3	335,882
King George	487	65	510	70	72	382	13	572	0	11	65	2,844	1	80	846	45,218	2,497	3,577	2,301	88	0	1	59,700
Fredericksburg	358	82	62	143	106	744	52	1,781	2	3	10	118	1	15	81	2,478	65,601	34,597	39,393	840	3	2	146,472
Stafford	3,398	607	586	1,460	1,235	8,617	375	25,049	18	44	56	223	11	25	100	3,656	34,398	282,815	23,613	4,926	10	10	391,232
Spotsylvania	981	155	146	344	242	1,671	100	2,717	6	10	20	167	5	19	99	2,220	39,462	23,829	207,032	849	6	3	280,083
Fauquier	1,082	470	183	589	241	7,450	4,361	22,760	123	26	23	22	6	6	8	93	990	4,747	891	123,335	483	105	167,994
Clarke	121	116	19	50	31	928	3,417	550	399	22	7	0	19	1	1	0	5	12	7	474	24,366	3,719	34,264
Jefferson	464	1,175	80	186	50	1,399	6,422	285	6,299	213	88	6	184	0	3	0	2	7	4	114	3,702	138,765	159,448
Total	3,127,309	3,191,381	2,580,539	896,114	556,807	3,827,277	1,202,733	1,540,506	786,405	1,048,406	1,710,783	431,647	481,486	234,097	335,882	59,700	146,472	391,232	280,083	167,994	34,264	159,448	23,190,565

TABLE 23: PERCENT DIFFERENCE IN TOTAL TRIP FLOWS BETWEEN GEN3 MODEL AND RTS

Jurisdiction	DC	Montgomery	Prince George's	Arlington	Alexandria	Fairfax	Loudoun	Prince William	Frederick	Howard	Anne Arundel	Charles	Carroll	Calvert	St. Mary's	King George	Fredericksburg	Stafford	Spotsylvania	Fauquier	Clarke	Jefferson	Total
DC	13%	35%	81%	66%	75%	19%	-26%	-1%	-31%	-3%	11%	25%	308%	-2%	-33%	312%	-56%	-28%	-14%	53%	-61%	-59%	22%
Montgomery	37%	-9%	75%	46%	127%	22%	-22%	9%	-11%	74%	-13%	-52%	64%	-9%	-10%				-61%	600%		-9%	-2%
Prince George's	74%	76%	2%	47%	-1%	12%	-51%	6%	-61%	47%	21%	15%	-43%	-3%	60%		1154%	-64%		-65%		27%	14%
Arlington	62%	66%	44%	-19%	42%	26%	-43%	-15%	-11%	28%	-11%	-7%	476%	35%	63%	-90%	639%	-71%	-54%	357%	-96%		2%
Alexandria	62%	184%	-3%	39%	-18%	66%	-17%	19%		45%	-45%	549%	12%	62%	543%		5%	-26%	-54%	691%		-28%	10%
Fairfax	21%	16%	38%	21%	55%	-4%	0%	16%	30%	102%	-79%	15%	-69%	1056%	-72%	278%	-35%	-27%	97%	23%	-29%	21%	0%
Loudoun	-4%	-16%	-61%	-34%	-13%	-1%	7%	-4%	93%	-33%	27%		56%				-84%	-80%		10%	-26%	76%	5%
Prince William	14%	6%	-4%	-19%	1%	15%	-6%	16%	78%	-41%	-5%	1128%		-55%		33%	-14%	31%	-16%	77%		140%	16%
Frederick	30%	-15%	-37%	-67%		-15%	91%	11%	6%	33%	-76%	-99%	23%					-88%			481%	78%	6%
Howard	-5%	84%	45%	146%	42%	114%	-49%	-55%	30%	11%	38%	35%	17%	-58%	84%								16%
Anne Arundel	33%	-22%	18%	-26%	-25%	-65%	100%	-66%	-84%	33%	3%	-54%	-60%	33%	-39%		-63%	-47%	-77%			771%	4%
Charles	44%	-39%	6%	21%	110%	104%	641%	1388%	-93%	108%	-33%	-6%	-98%	26%	0%	-24%		84%					-3%
Carroll	748%	63%	-39%	744%		-54%	7%		28%	14%	-47%	-98%	7%									-59%	8%
Calvert	21%	472%	-15%	183%	107%	316%				-35%	24%	22%	-51%	-13%	5%			-89%					-9%
St. Mary's	-19%	-19%	54%	824%	671%	-62%	-95%				-60%	3%		20%	-21%	117%							-19%
King George	384%			-60%		136%		23%				-32%			115%	-16%	-40%	215%	-22%				-11%
Fredericksburg	205%	-30%	-82%	-47%	39%	79%	-10%	53%	-99%							-47%	-3%	46%	30%	59%			13%
Stafford	8%	89%	-13%	-62%	96%	-27%	11%	39%				89%				128%	39%	0%	-6%	2242%			5%
Spotsylvania	-42%			-47%		-13%	-83%	-26%			-87%					-11%	33%	-9%	20%	1083%			17%
Fauquier	109%	607%	-59%	267%	786%	19%	27%	73%									3829%	774%	1141%	18%	-65%		29%
Clarke	-43%			-95%		-15%	-31%		11%											-48%	0%	302%	1%
Jefferson	71%	-22%				7%	75%		117%	-37%											1446%	16%	23%
Total	23%	-2%	15%	2%	9%	0%	5%	16%	6%	16%	4%	-3%	8%	-8%	-19%	-12%	12%	3%	18%	29%	2%	22%	7%

TABLE 24: PERCENT AND ABSOLUTE DIFFERENCE IN TOTAL TRIP FLOWS BETWEEN GEN3 MODEL AND RTS BY TOUR PURPOSE

	Percentage Difference				Absolute Difference			
	Region	To DC	From DC	Intra DC	Region	To DC	From DC	Intra DC
Work	-11%	0%	0%	-12%	-819,000	-1,000	2,000	-75,000
School	-19%	-28%	-28%	-39%	-490,000	-55,000	-55,000	-65,000
University	2%	79%	80%	82%	10,000	48,000	49,000	42,000
Escort	12%	-23%	-23%	-32%	-200,000	-32,000	-32,000	-38,000
Shopping	24%	128%	131%	108%	620,000	219,000	222,000	147,000
Other Maintenance	36%	56%	56%	30%	607,000	96,000	97,000	39,000
Eat out	57%	85%	82%	64%	513,000	76,000	75,000	48,000
Social	77%	58%	55%	23%	448,000	39,000	38,000	12,000
Other Discretionary	11%	13%	11%	5%	300,000	39,000	33,000	11,000
At Work	46%	54%	52%	46%	500,000	143,000	142,000	108,000
Total	7%	23%	22%	13%	1,500,000	575,000	571,000	230,000

TABLE 25:PERCENT AND ABSOLUTE DIFFERENCE IN TRIPS GOING TO, FROM AND WITHIN DC BETWEEN GEN3 MODEL AND RTS BY TRIP MODE

	Percentage Difference				Absolute Difference			
	Region	To DC	From DC	Intra DC	Region	To DC	From DC	Intra DC
SOV	10%	76%	73%	84%	958,000	508,000	495,000	300,000
HOV2	4%	32%	35%	26%	200,000	108,000	115,000	51,000
HOV3+	19%	71%	73%	40%	576,000	134,000	139,000	52,000
Walk	19%	-9%	-9%	-9%	335,000	-57,000	-60,000	-63,000
Bike	9%	-45%	-46%	-53%	18,000	-42,000	-43,000	-44,000
Wtransit	-19%	-15%	-14%	-24%	-148,000	-60,000	-56,000	-71,000
PNR	0%	-19%	-5%	139%	-	-12,000	-3,000	7,000
KNR	-17%	-6%	-34%	27%	-10,000	-1,000	-10,000	1,000
School Bus	-53%	128%	84%	68%	-490,000	17,000	11,000	7,000
Taxi	21%	-20%	-19%	-12%	50,000	-19,000	-17,000	-8,000
Total	7%	23%	22%	13%	1,500,000	575,000	571,000	230,000

4.0 CONCLUSIONS

The Gen3 Phase 1 Model calibration and validation results presented in this document reflect that, overall, the Gen3 Phase 1 Model reasonably matches household travel survey and traffic/transit boarding count data with a few exceptions after estimation of several model components and a few rounds of model calibration. The model tends to over-estimate traffic, particularly in outlying parts of the region and in the District of Columbia. The model matches total transit ridership fairly well, though Metrorail ridership is over-estimated and commuter rail modes are under-estimated. We have the following recommendations for Phase 2 based on these results.

- We recommend estimation of the auto ownership model, in the hopes of improving the under-estimation of 0-auto households in the District of Columbia. We will summarize estimated versus observed 0-auto households at the county and tract level and assess the need for additional geographic calibration after implementation of the estimated auto ownership model.
- We may further calibrate day pattern shares for pre-school students in Phase 2. We may also further calibrate the Coordinated Daily Activity Pattern model to address the overestimation of the share of persons with one or more individual non-mandatory tours.
- We will calibrate the joint tour frequency model and composition model to improve the goodness-of-fit by tour purpose and households by number of joint tours. We will calibrate the joint tour composition model to compensate for the Phase 1 model generation of too many children-only tours.
- We will summarize work and school location choice and non-mandatory tour destination choice model results by origin and destination jurisdiction and compare to observed data to assess the need for jurisdiction-level alternative-specific constants. These may be necessary to improve the goodness-of-fit of screenlines.
- We will calibrate the time of day choice models that have been borrowed from the SEMCOG ABM to increase the share of tours in the AM peak period and decrease the number of tours in the evening period. We will also consider calibrating the tour time of day choice models for university and some of the non-mandatory purposes in Phase 2.
- We will further calibrate the stop location choice model to decrease the stop rate per tour.
- We will estimate the trip mode choice models to ensure consistent parameters with tour mode choice estimation and calibrate the models to observed data. After implementation and calibration of trip mode choice, and implementation and calibration of other models,

we will re-assess transit validation results and the need for further adjustments. We will create summaries of transit trips by mode and trip length to better understand the need for further adjustments. Given its role and impact on transit mode share in the region, we will especially look to improve Metrorail validation.

- Since modeled VMT is a key input in greenhouse gas (GHG) and criterial pollutant modeling in EPA's MOVES model, we will evaluate the impacts of recommended calibration steps above on highway validation (Table 14) to ensure that estimated versus observed VMT validation improves at the jurisdiction level (e.g., District of Columbia, Alexandria, and Loudoun County).

We also plan on estimating the coordinated daily activity pattern model, the mandatory tour frequency model, and the non-mandatory tour frequency model, if COG staff has the availability to lead the estimation. Although re-estimation of these models is not likely to significantly affect model validation, the incorporation of COG-specific variables and telecommute frequency participation will improve the sensitivity of the models to inputs and assumptions. After Phase 2 calibration and validation, sensitivity tests will be re-run and the model system will be fully documented in a model user's guide and model development report.

5.0 APPENDIX A: TOUR TIME OF DAY CHOICE DISTRIBUTIONS BY PURPOSE

FIGURE 41: WORK TOUR DEPARTURE PROFILE (30 MIN BINS)

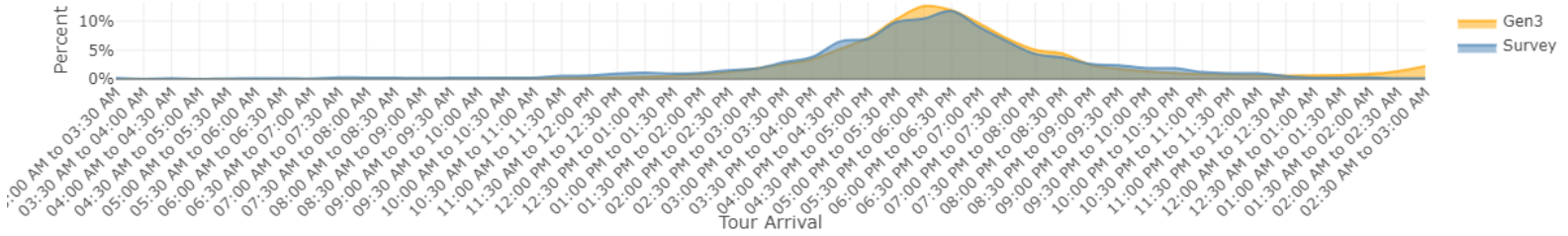


FIGURE 42: WORK TOUR ARRIVAL PROFILE (30 MIN BINS)

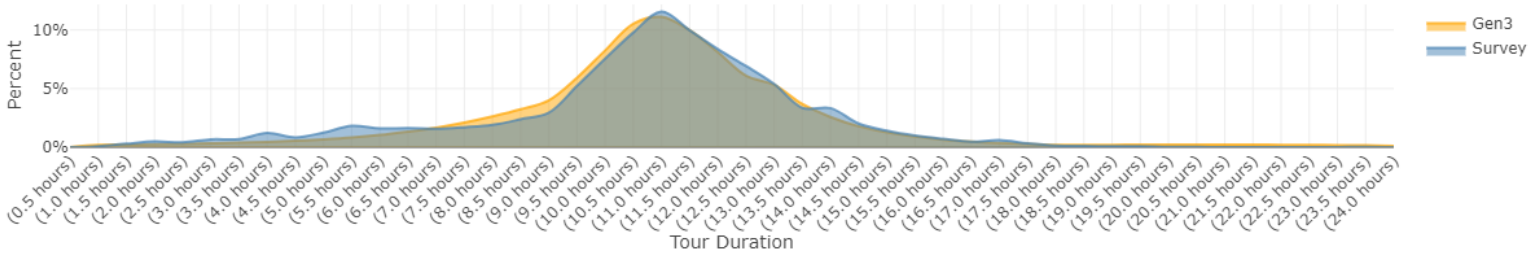


FIGURE 43: WORK TOUR DURATION PROFILE (30 MIN BINS)

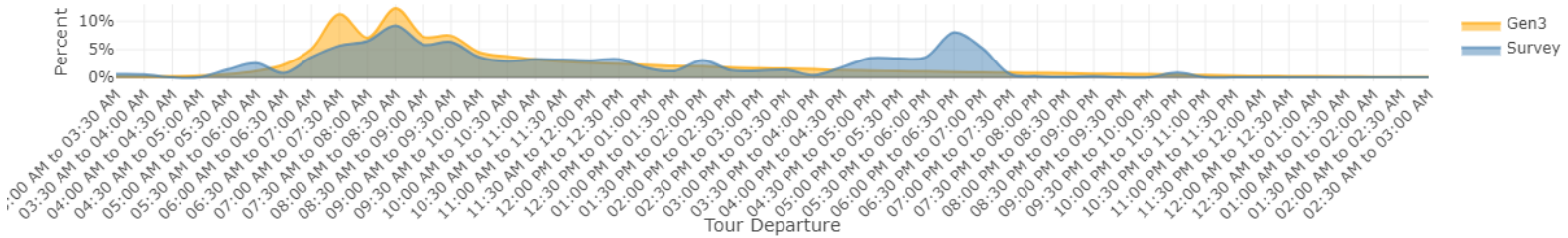


FIGURE 44: UNIVERSITY TOUR DEPARTURE PROFILE (30 MIN BINS)

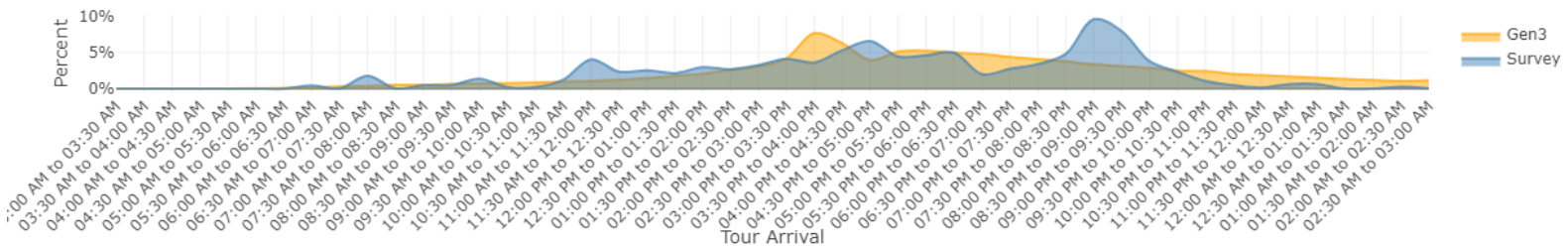


FIGURE 45: UNIVERSITY TOUR ARRIVAL PROFILE (30 MIN BINS)

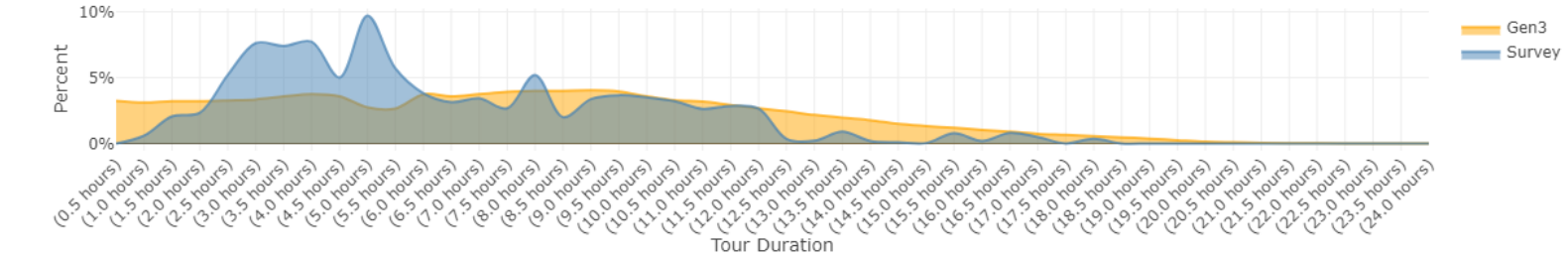


FIGURE 46: UNIVERSITY TOUR DURATION PROFILE (30 MIN BINS)

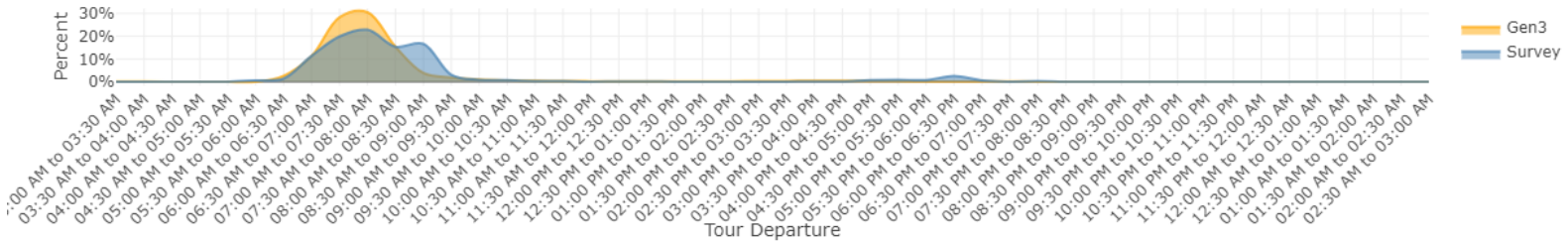


FIGURE 47: SCHOOL TOUR DEPARTURE PROFILE (30 MIN BINS)

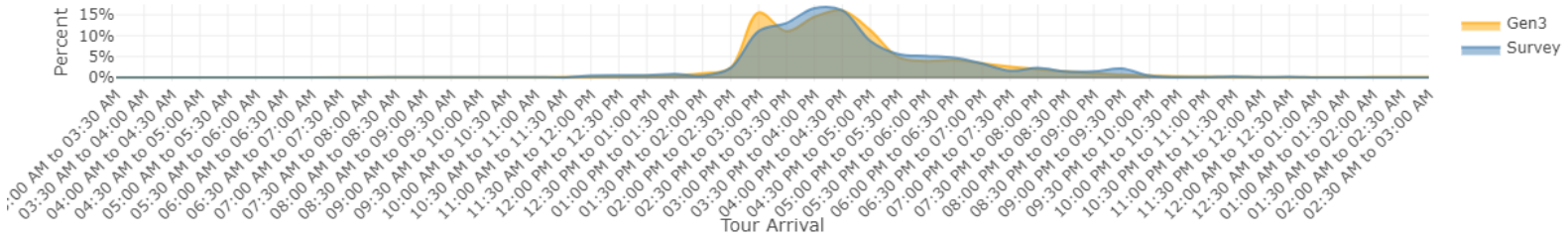


FIGURE 48: SCHOOL TOUR ARRIVAL PROFILE (30 MIN BINS)

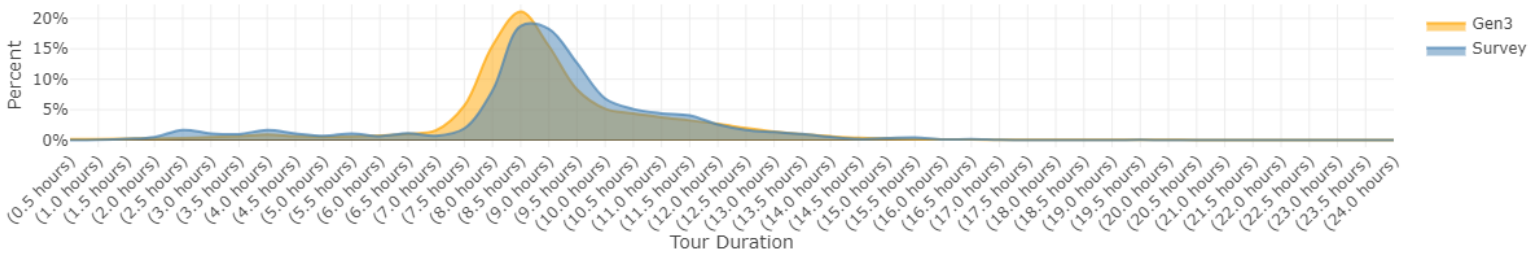


FIGURE 49: SCHOOL TOUR DURATION PROFILE (30 MIN BINS)

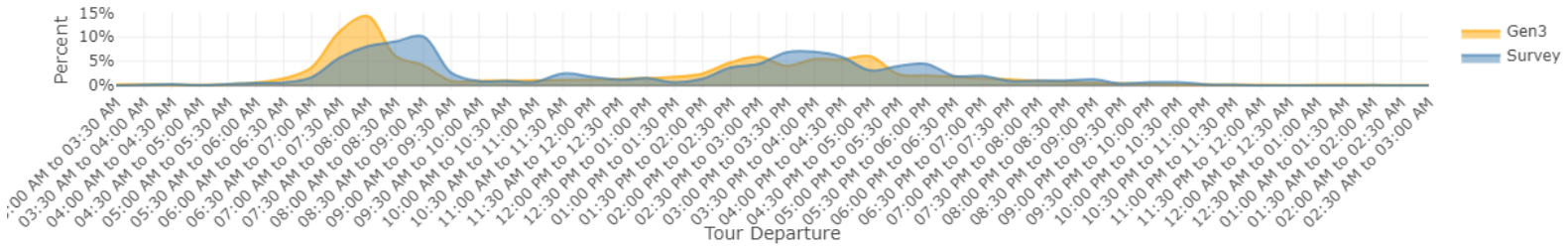


FIGURE 50: ESCORTING TOUR DEPARTURE PROFILE (30 MIN BINS)

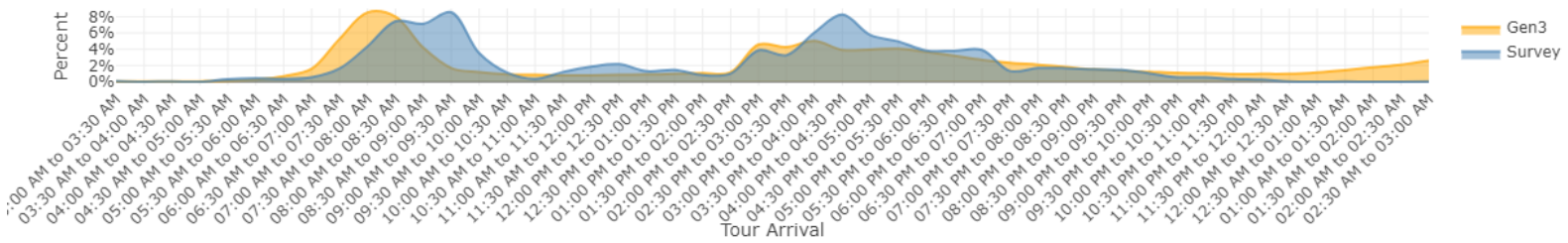


FIGURE 51: ESCORTING TOUR ARRIVAL PROFILE (30 MIN BINS)

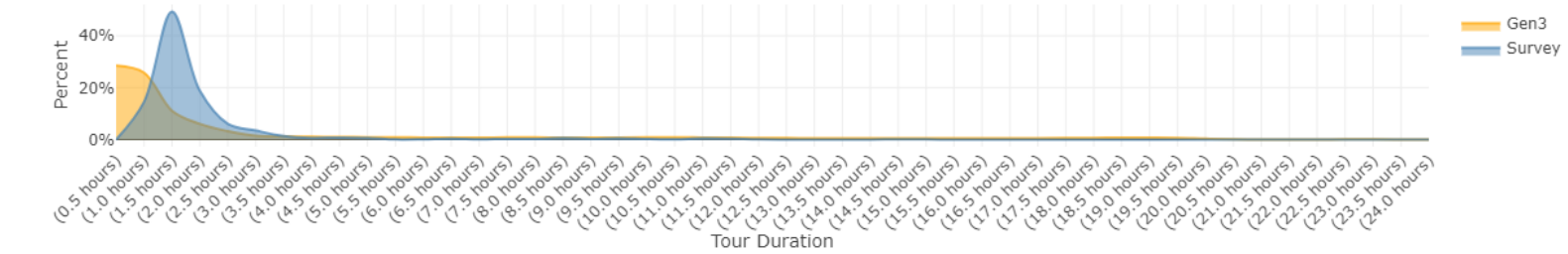


FIGURE 52: ESCORTING TOUR DURATION PROFILE (30 MIN BINS)

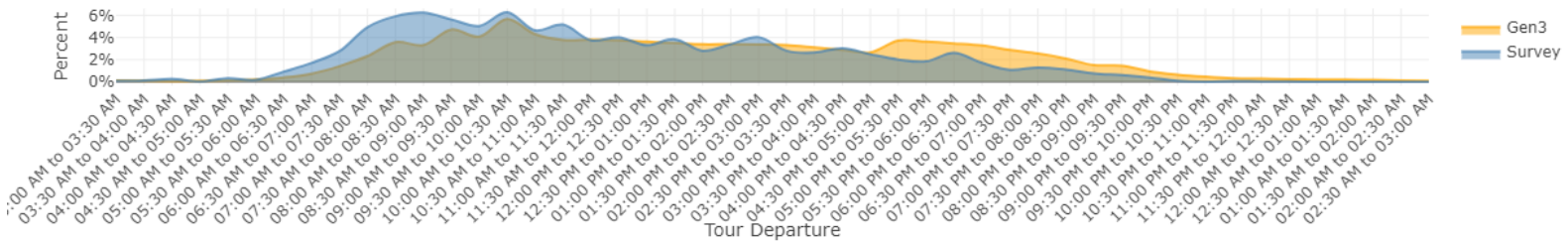


FIGURE 53: INDIVIDUAL MAINTENANCE TOUR DEPARTURE PROFILE (30 MIN BINS)

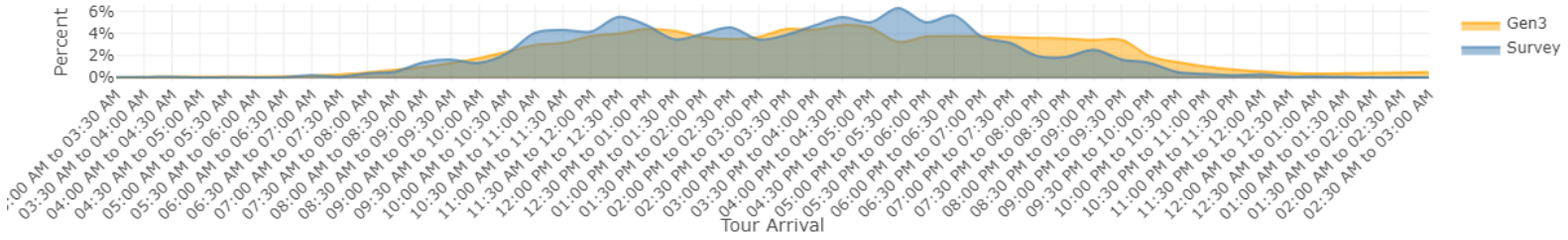


FIGURE 54: INDIVIDUAL MAINTENANCE TOUR ARRIVAL PROFILE (30 MIN BINS)

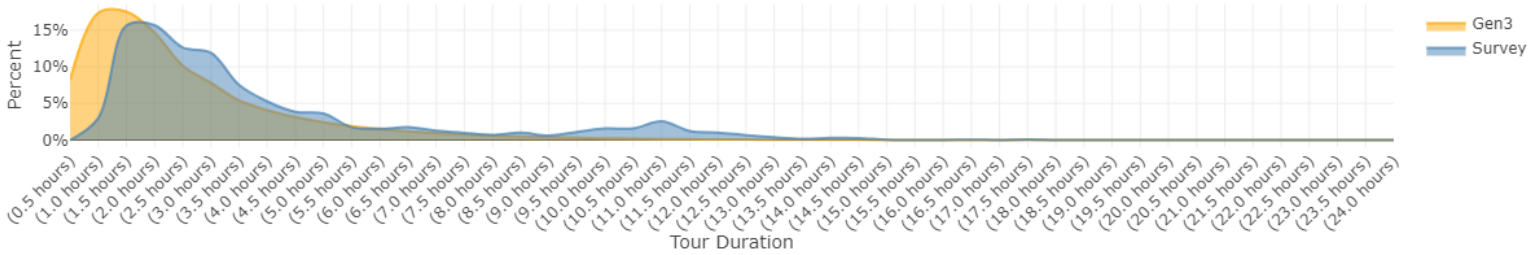


FIGURE 55: INDIVIDUAL MAINTENANCE TOUR DURATION PROFILE (30 MIN BINS)

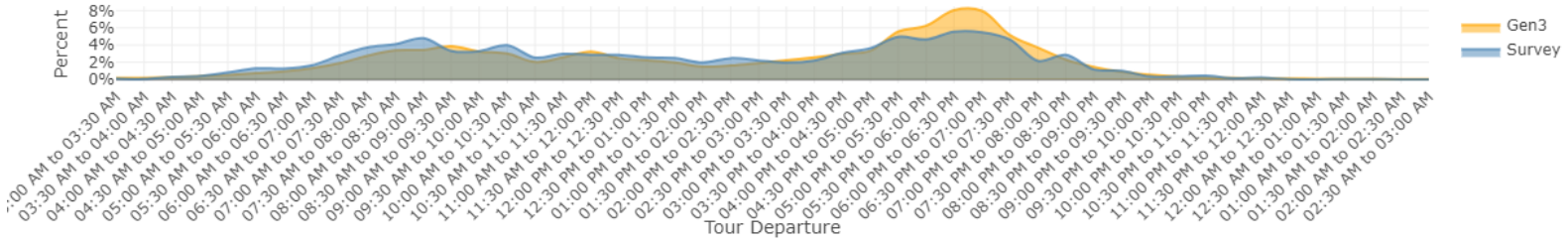


FIGURE 56: INDIVIDUAL DISCRETIONARY TOUR DEPARTURE PROFILE (30 MIN BINS)

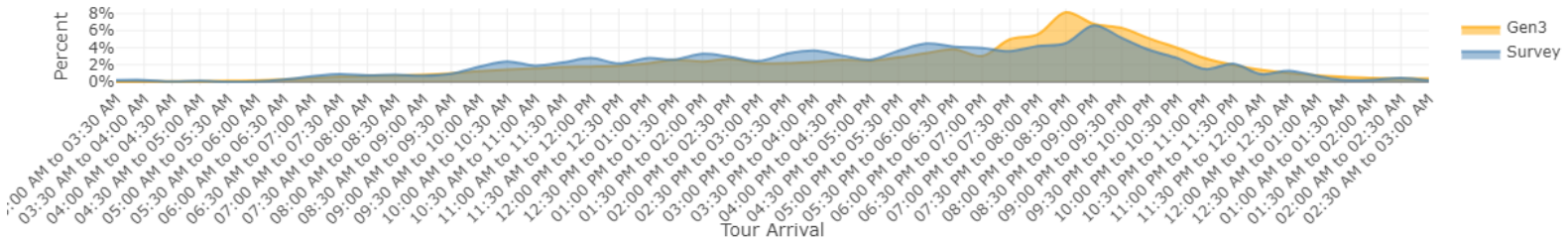


FIGURE 57: INDIVIDUAL DISCRETIONARY TOUR ARRIVAL PROFILE (30 MIN BINS)

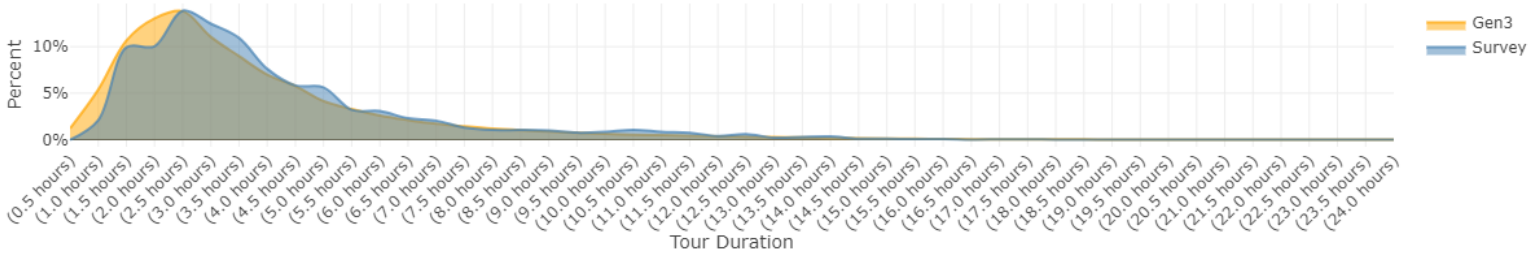


FIGURE 58: INDIVIDUAL DISCRETIONARY TOUR DURATION PROFILE (30 MIN BINS)

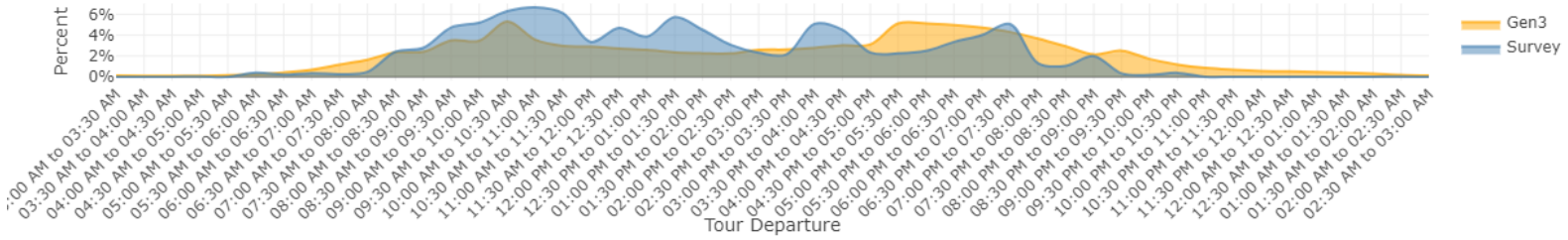


FIGURE 59: JOINT MAINTENANCE TOUR DEPARTURE PROFILE (30 MIN BINS)

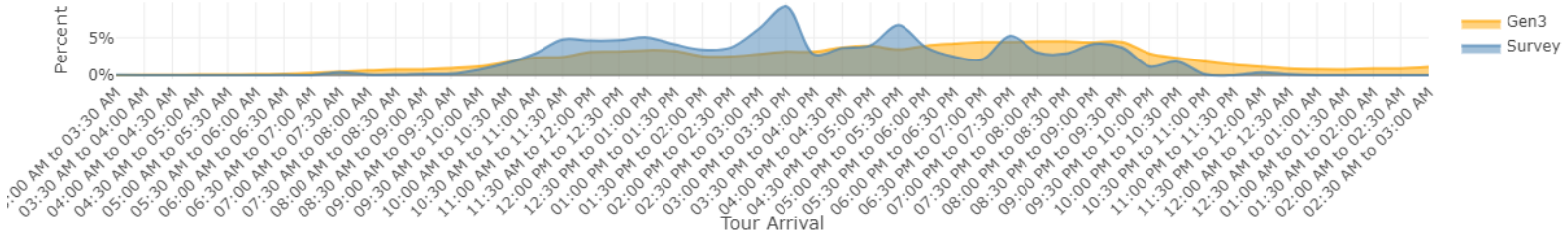


FIGURE 60: JOINT MAINTENANCE TOUR ARRIVAL PROFILE (30 MIN BINS)

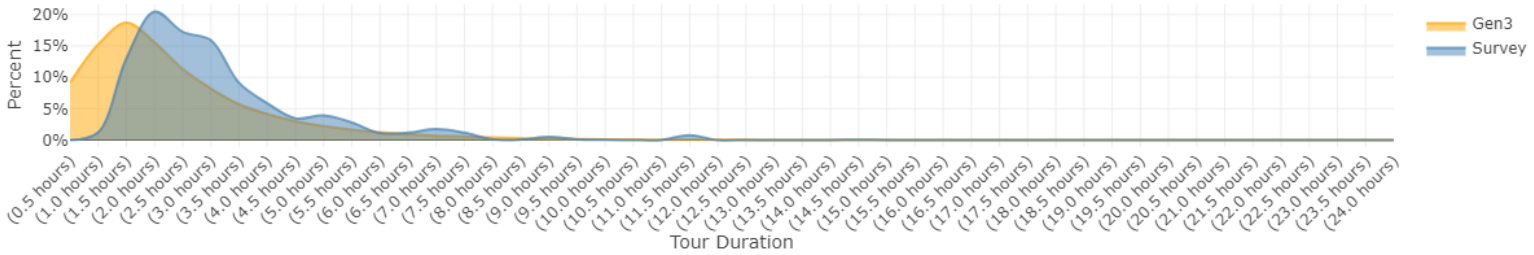


FIGURE 61: JOINT MAINTENANCE TOUR DURATION PROFILE (30 MIN BINS)

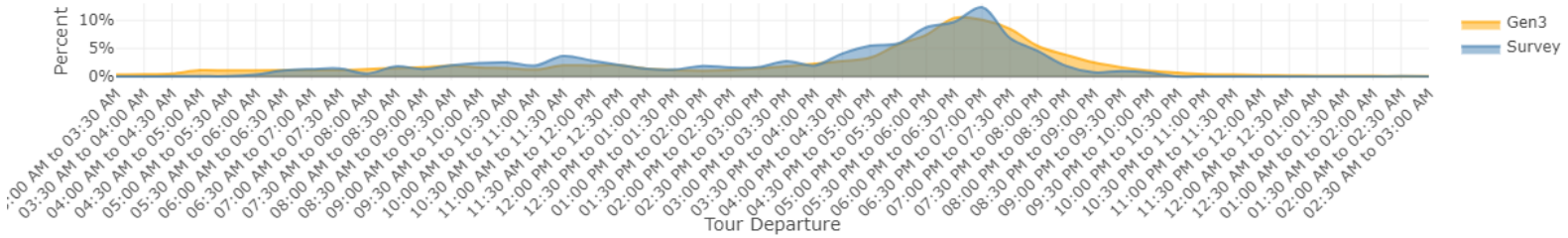


FIGURE 62: JOINT DISCRETIONARY TOUR DEPARTURE PROFILE (30 MIN BINS)

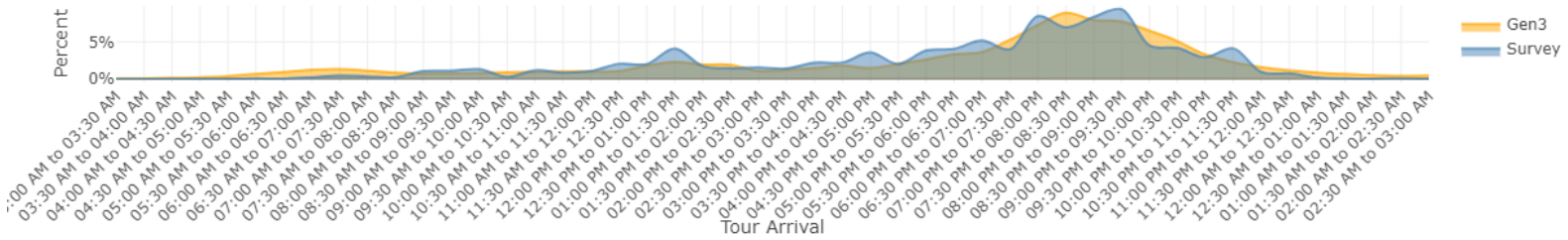


FIGURE 63: JOINT DISCRETIONARY TOUR ARRIVAL PROFILE (30 MIN BINS)

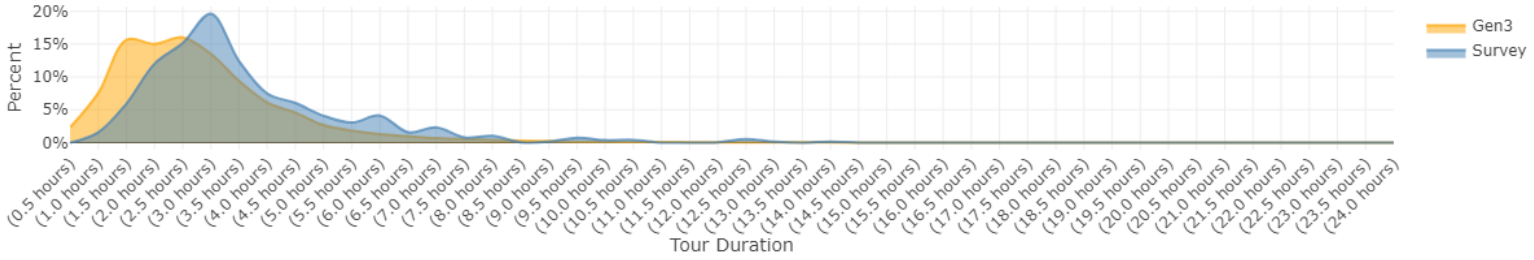


FIGURE 64: JOINT DISCRETIONARY TOUR DURATION PROFILE (30 MIN BINS)

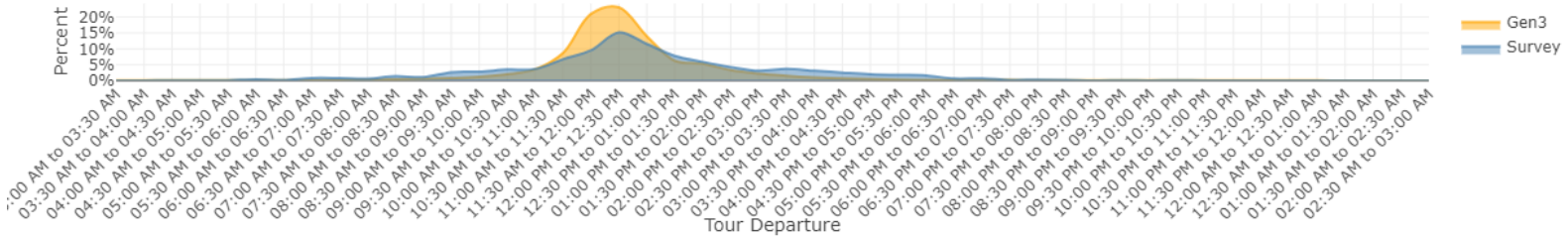


FIGURE 65: AT-WORK SUBTOUR DEPARTURE PROFILE (30 MIN BINS)

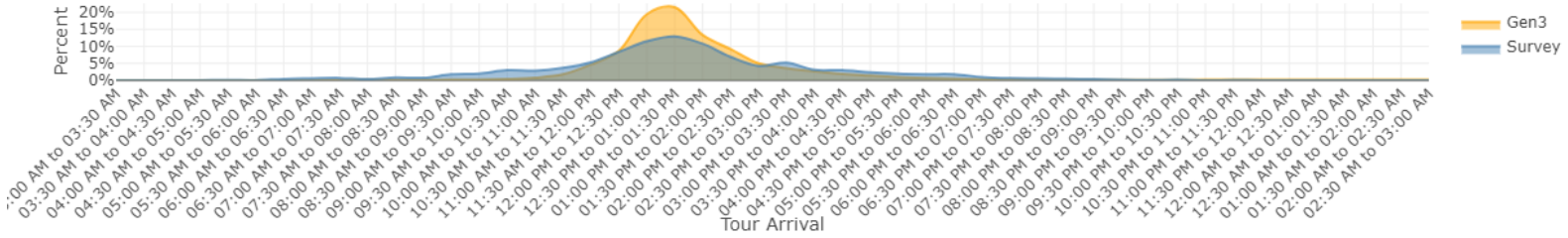


FIGURE 66: AT-WORK SUBTOUR ARRIVAL PROFILE (30 MIN BINS)

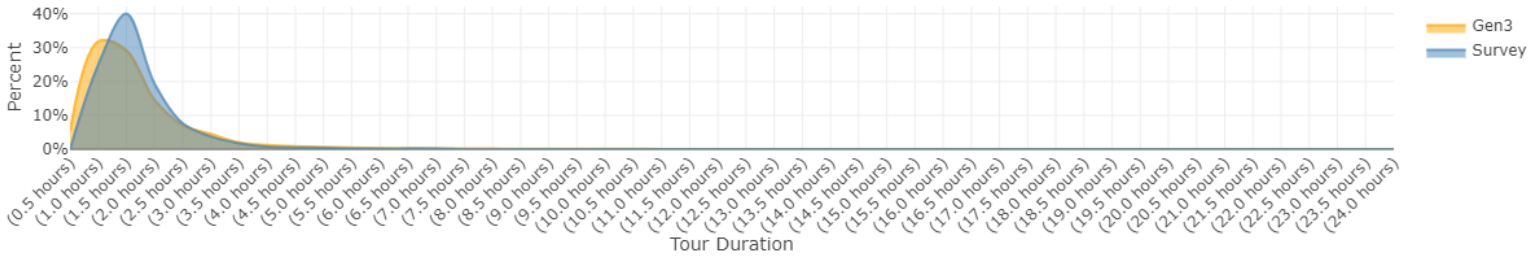


FIGURE 67: AT-WORK SUBTOUR DURATION PROFILE (30 MIN BINS)

6.0 APPENDIX B: TOUR MODE CHOICE CALIBRATION RESULTS

TABLE 26: WORK TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	871	2,186	1,315	151%
sov	auto_deficient	139,004	138,505	(499)	0%
sov	auto_sufficient	1,484,510	1,484,392	(118)	0%
sr2	no_auto	1,061	1,021	(40)	-4%
sr2	auto_deficient	51,424	51,474	50	0%
sr2	auto_sufficient	294,526	294,464	(62)	0%
sr3p	no_auto	2,041	1,969	(72)	-4%
sr3p	auto_deficient	22,843	22,918	75	0%
sr3p	auto_sufficient	130,742	130,783	41	0%
walk	no_auto	8,998	8,825	(173)	-2%
walk	auto_deficient	34,963	35,124	161	0%
walk	auto_sufficient	53,207	52,866	(341)	-1%
bike	no_auto	5,077	4,938	(139)	-3%
bike	auto_deficient	20,097	20,134	37	0%
bike	auto_sufficient	15,521	15,598	77	0%
walk_transit	no_auto	44,317	43,515	(802)	-2%
walk_transit	auto_deficient	74,438	74,629	191	0%
walk_transit	auto_sufficient				0%

		72,796	73,082	286	
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	12,428	12,351	(77)	-1%
pnr_transit	auto_sufficient	71,709	71,722	13	0%
knr_transit	no_auto	1,781	1,753	(28)	-2%
knr_transit	auto_deficient	10,602	10,619	17	0%
knr_transit	auto_sufficient	9,419	9,515	96	1%
taxi	no_auto	7,523	7,464	(59)	-1%
taxi	auto_deficient	15,601	15,649	48	0%
taxi	auto_sufficient	9,871	9,876	5	0%
tnc_single	no_auto	7,523	7,464	(59)	-1%
tnc_single	auto_deficient	15,601	15,649	48	0%
tnc_single	auto_sufficient	9,871	9,876	5	0%
tnc_shared	no_auto	7,523	7,464	(59)	-1%
tnc_shared	auto_deficient	15,601	15,649	48	0%
tnc_shared	auto_sufficient	9,871	9,876	5	0%
all	no_auto	71,670	71,670	-	0%
all	auto_deficient	381,402	381,402	-	0%
all	auto_sufficient	2,142,299	2,142,299	-	0%

TABLE 27: UNIVERSITY TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto	Observed	Estimated	Difference	Percent

	Sufficiency	Tours	Tours		Difference
sov	no_auto	-	1,711	1,711	0%
sov	auto_deficient	8,326	8,299	(27)	0%
sov	auto_sufficient	66,479	66,412	(67)	0%
sr2	no_auto	500	381	(119)	-24%
sr2	auto_deficient	7,908	7,866	(42)	-1%
sr2	auto_sufficient	26,208	26,247	39	0%
sr3p	no_auto	1,418	1,505	87	6%
sr3p	auto_deficient	3,959	3,990	31	1%
sr3p	auto_sufficient	25,336	25,340	4	0%
walk	no_auto	15,645	14,814	(831)	-5%
walk	auto_deficient	735	784	49	7%
walk	auto_sufficient	9,582	9,619	37	0%
bike	no_auto	1,104	979	(125)	-11%
bike	auto_deficient	376	351	(25)	-7%
bike	auto_sufficient	2,287	2,278	(9)	0%
walk_transit	no_auto	8,993	8,588	(405)	-5%
walk_transit	auto_deficient	2,810	2,794	(16)	-1%
walk_transit	auto_sufficient	7,521	7,495	(26)	0%
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	1,255	1,299	44	4%
pnr_transit	auto_sufficient	246	268	22	9%
knr_transit	no_auto	-	-	-	0%

knr_transit	auto_deficient	161	144	(17)	-11%
knr_transit	auto_sufficient	93	93	-	0%
taxi	no_auto	6,361	6,041	(320)	-5%
taxi	auto_deficient	479	485	6	1%
taxi	auto_sufficient	1,619	1,619	-	0%
tnc_single	no_auto	6,361	6,041	(320)	-5%
tnc_single	auto_deficient	479	485	6	1%
tnc_single	auto_sufficient	1,619	1,619	-	0%
tnc_shared	no_auto	6,361	6,041	(320)	-5%
tnc_shared	auto_deficient	479	485	6	1%
tnc_shared	auto_sufficient	1,619	1,619	-	0%
all	no_auto	34,021	34,021	-	0%
all	auto_deficient	26,010	26,010	-	0%
all	auto_sufficient	139,371	139,371	-	0%

TABLE 28: SCHOOL TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	-	41	41	0%
sov	auto_deficient	3,546	1,351	(2,195)	-62%
sov	auto_sufficient	23,920	14,742	(9,178)	-38%
sr2	no_auto				0%

		-	-	-	
sr2	auto_deficient	20,799	21,206	407	2%
sr2	auto_sufficient	149,181	150,464	1,283	1%
sr3p	no_auto	669	649	(20)	-3%
sr3p	auto_deficient	30,287	30,897	610	2%
sr3p	auto_sufficient	284,341	286,505	2,164	1%
walk	no_auto	10,504	10,536	32	0%
walk	auto_deficient	18,719	19,124	405	2%
walk	auto_sufficient	102,024	103,134	1,110	1%
bike	no_auto	-	-	-	0%
bike	auto_deficient	3,641	3,670	29	1%
bike	auto_sufficient	7,684	7,866	182	2%
walk_transit	no_auto	9,653	9,660	7	0%
walk_transit	auto_deficient	2,528	2,567	39	2%
walk_transit	auto_sufficient	9,817	9,814	(3)	0%
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	-	-	-	0%
pnr_transit	auto_sufficient	54	41	(13)	-24%
knr_transit	no_auto	429	402	(27)	-6%
knr_transit	auto_deficient	67	52	(15)	-22%
knr_transit	auto_sufficient	1,138	1,165	27	2%
taxi	no_auto	421	412	(9)	-2%
taxi	auto_deficient	152	155	3	2%

taxi	auto_sufficient	2,246	2,268	22	1%
tnc_single	no_auto	421	412	(9)	-2%
tnc_single	auto_deficient	152	155	3	2%
tnc_single	auto_sufficient	2,246	2,268	22	1%
tnc_shared	no_auto	421	412	(9)	-2%
tnc_shared	auto_deficient	152	155	3	2%
tnc_shared	auto_sufficient	2,246	2,268	22	1%
schoolbus	no_auto	14,654	14,629	(25)	0%
schoolbus	auto_deficient	36,374	37,093	719	2%
schoolbus	auto_sufficient	558,697	563,103	4,406	1%
all	no_auto	36,330	36,330	-	0%
all	auto_deficient	116,113	116,113	-	0%
all	auto_sufficient	1,139,103	1,139,103	-	0%

TABLE 29: INDIVIDUAL MAINTENANCE TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	1,600	103	(1,497)	-94%
sov	auto_deficient	37,345	39,825	2,480	7%
sov	auto_sufficient	846,174	871,319	25,145	3%
sr2	no_auto	6,830	7,175	345	5%
sr2	auto_deficient	82,331	81,443	(888)	-1%
sr2	auto_sufficient	645,174	637,082	(8,092)	-1%
sr3p	no_auto	11,385	11,567	182	2%
sr3p	auto_deficient	58,859	58,536	(323)	-1%
sr3p	auto_sufficient	578,064	570,021	(8,043)	-1%
walk	no_auto	35,297	34,680	(617)	-2%
walk	auto_deficient	31,105	30,196	(909)	-3%
walk	auto_sufficient	211,613	207,474	(4,139)	-2%
bike	no_auto	1,787	1,856	69	4%
bike	auto_deficient	1,186	1,289	103	9%
bike	auto_sufficient	13,707	13,485	(222)	-2%
walk_transit	no_auto	42,947	44,454	1,507	4%
walk_transit	auto_deficient	4,288	4,206	(82)	-2%
walk_transit	auto_sufficient	25,200	24,804	(396)	-2%
pnr_transit	no_auto	-	-	-	0%

pnr_transit	auto_deficient	346	-	(346)	-100%
pnr_transit	auto_sufficient	1,208	-	(1,208)	-100%
knr_transit	no_auto	30	-	(30)	-100%
knr_transit	auto_deficient	26	-	(26)	-100%
knr_transit	auto_sufficient	2,993	-	(2,993)	-100%
taxi	no_auto	8,248	8,289	41	0%
taxi	auto_deficient	989	979	(10)	-1%
taxi	auto_sufficient	8,248	8,196	(52)	-1%
tnc_single	no_auto	8,248	8,289	41	0%
tnc_single	auto_deficient	989	979	(10)	-1%
tnc_single	auto_sufficient	8,248	8,196	(52)	-1%
tnc_shared	no_auto	8,248	8,289	41	0%
tnc_shared	auto_deficient	989	979	(10)	-1%
tnc_shared	auto_sufficient	8,248	8,196	(52)	-1%
all	no_auto	108,124	108,124	-	0%
all	auto_deficient	216,474	216,474	-	0%
all	auto_sufficient	2,332,381	2,332,381	-	0%

TABLE 30: INDIVIDUAL DISCRETIONARY TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	3,508	753	(2,755)	-79%
sov	auto_deficient	38,289	39,093	804	2%
sov	auto_sufficient	733,800	733,660	(140)	0%
sr2	no_auto	8,711	8,887	176	2%
sr2	auto_deficient	39,126	39,619	493	1%
sr2	auto_sufficient	274,313	274,433	120	0%
sr3p	no_auto	7,331	7,206	(125)	-2%
sr3p	auto_deficient	19,480	19,701	221	1%
sr3p	auto_sufficient	254,788	254,598	(190)	0%
walk	no_auto	29,566	29,732	166	1%
walk	auto_deficient	21,508	21,639	131	1%
walk	auto_sufficient	99,870	99,742	(128)	0%
bike	no_auto	2,982	3,474	492	16%
bike	auto_deficient	2,489	2,433	(56)	-2%
bike	auto_sufficient	16,779	16,845	66	0%
walk_transit	no_auto	36,189	37,835	1,646	5%
walk_transit	auto_deficient	6,838	7,000	162	2%
walk_transit	auto_sufficient	12,381	12,381	-	0%
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	1,250	-	(1,250)	-100%

pnr_transit	auto_sufficient	2,694	2,536	(158)	-6%
knr_transit	no_auto	447	474	27	6%
knr_transit	auto_deficient	531	-	(531)	-100%
knr_transit	auto_sufficient	3,255	3,732	477	15%
taxi	no_auto	13,317	13,691	374	3%
taxi	auto_deficient	6,716	6,742	26	0%
taxi	auto_sufficient	18,378	18,330	(48)	0%
tnc_single	no_auto	13,317	13,691	374	3%
tnc_single	auto_deficient	6,716	6,742	26	0%
tnc_single	auto_sufficient	18,378	18,330	(48)	0%
tnc_shared	no_auto	13,317	13,691	374	3%
tnc_shared	auto_deficient	6,716	6,742	26	0%
tnc_shared	auto_sufficient	18,378	18,330	(48)	0%
all	no_auto	102,052	102,052	-	0%
all	auto_deficient	136,227	136,227	-	0%
all	auto_sufficient	1,416,258	1,416,258	-	0%

TABLE 31: JOINT TOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	-	-	-	0%
sov	auto_deficient	-	-	-	0%
sov	auto_sufficient	-	-	-	0%
sr2	no_auto	223	227	4	2%
sr2	auto_deficient	25,656	16,258	(9,398)	-37%
sr2	auto_sufficient	276,827	271,608	(5,219)	-2%
sr3p	no_auto	2,824	2,897	73	3%
sr3p	auto_deficient	3,851	8,464	4,613	120%
sr3p	auto_sufficient	121,193	126,845	5,652	5%
walk	no_auto	4,330	4,134	(196)	-5%
walk	auto_deficient	3,356	5,959	2,603	78%
walk	auto_sufficient	22,460	22,814	354	2%
bike	no_auto	-	-	-	0%
bike	auto_deficient	735	1,495	760	103%
bike	auto_sufficient	1,247	1,299	52	4%
walk_transit	no_auto	2,014	2,124	110	5%
walk_transit	auto_deficient	90	186	96	107%
walk_transit	auto_sufficient	2,125	2,155	30	1%
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	66	196	130	197%

pnr_transit	auto_sufficient	872	-	(872)	-100%
knr_transit	no_auto	-	-	-	0%
knr_transit	auto_deficient	40	-	(40)	-100%
knr_transit	auto_sufficient	34	-	(34)	-100%
taxi	no_auto	145	155	10	7%
taxi	auto_deficient	1,114	2,351	1,237	111%
taxi	auto_sufficient	1,972	2,010	38	2%
tnc_single	no_auto	145	155	10	7%
tnc_single	auto_deficient	1,114	2,351	1,237	111%
tnc_single	auto_sufficient	1,972	2,010	38	2%
tnc_shared	no_auto	145	155	10	7%
tnc_shared	auto_deficient	1,114	2,351	1,237	111%
tnc_shared	auto_sufficient	1,972	2,010	38	2%
schoolbus	no_auto	-	-	-	0%
schoolbus	auto_deficient	-		-	0%
schoolbus	auto_sufficient	-	-	-	0%
all	no_auto	9,536	9,536	-	0%
all	auto_deficient	34,907	34,907	-	0%
all	auto_sufficient	426,732	426,732	-	0%

TABLE 32: AT-WORK SUBTOUR MODE CHOICE CALIBRATION SUMMARY

Mode	Auto Sufficiency	Observed Tours	Estimated Tours	Difference	Percent Difference
sov	no_auto	388	639	251	65%
sov	auto_deficient	28,594	20,990	(7,604)	-27%
sov	auto_sufficient	380,562	382,165	1,603	0%
sr2	no_auto	564	732	168	30%
sr2	auto_deficient	11,692	13,175	1,483	13%
sr2	auto_sufficient	69,411	69,557	146	0%
sr3p	no_auto	301	464	163	54%
sr3p	auto_deficient	6,245	6,845	600	10%
sr3p	auto_sufficient	35,163	35,392	229	1%
walk	no_auto	10,830	9,897	(933)	-9%
walk	auto_deficient	39,256	44,474	5,218	13%
walk	auto_sufficient	113,002	110,804	(2,198)	-2%
bike	no_auto	84	113	29	35%
bike	auto_deficient	4,011	3,742	(269)	-7%
bike	auto_sufficient	541	546	5	1%
walk_transit	no_auto	1,093	1,268	175	16%
walk_transit	auto_deficient	3,292	3,897	605	18%
walk_transit	auto_sufficient	6,117	6,000	(117)	-2%
pnr_transit	no_auto	-	-	-	0%
pnr_transit	auto_deficient	-	31	31	0%

pnr_transit	auto_sufficient	86	52	(34)	-40%
knr_transit	no_auto	228	-	(228)	-100%
knr_transit	auto_deficient	390	-	(390)	-100%
knr_transit	auto_sufficient	1,113	1,722	609	55%
taxi	no_auto	894	1,268	374	42%
taxi	auto_deficient	2,604	2,928	324	12%
taxi	auto_sufficient	21,964	21,722	(242)	-1%
tnc_single	no_auto	894	1,268	374	42%
tnc_single	auto_deficient	2,604	2,928	324	12%
tnc_single	auto_sufficient	21,964	21,722	(242)	-1%
tnc_shared	no_auto	894	1,268	374	42%
tnc_shared	auto_deficient	2,604	2,928	324	12%
tnc_shared	auto_sufficient	21,964	21,722	(242)	-1%
all	no_auto	14,381	14,381	-	0%
all	auto_deficient	96,082	96,082	-	0%
all	auto_sufficient	627,959	627,959	-	0%

7.0 APPENDIX C: VALIDATION SUMMARY SCRIPTS

HIGHWAY VALIDATION SCRIPTS

Script Files	Input Files	Output Files	Comments
1. Summarize_Est_Obs_Volume_Daily.s 2. RMSE_Calc.s 3. **Summarize_Est_Obs_Volume_Period.s** 4. **Mrg_i4_Assign_output_2018AAWDT.s** 5. Summarize_2018_ScreenLines.s	i4_Assign_Output.net i4_Assign_Output.dbf zonehwy.net LOVABHOVAB2018.txt Daily_Counts_2018.csv Screen_2018.csv HOV_Links.txt period_counts_2018.csv	Main output files reviewed: Summarize_Est_Obs_Volume_daily.rpt Summarize_2018_Screenlines.rpt RMSE_Calc.rpt RMSE_Calc.txt Other secondary output files not reviewed: Create_CountNet.rpt Daily_Est_Obs_2018.net data.csv hovvol.asc HVolsAddedtoLOVLnk.net TPPL.PRJ voya.VAR voya0003.PRN ZONEHWY_2018Counts.file Summarize_Est_Obs_Volume_period.rpt Mrg_i4_Assign_Output_2018AAWDT.rpt	Used for processing of all interim and final run results. The scripts were run in sequence as listed. All input, output, script and the post-processed files and spreadsheets are in the project BOX folder.

TRANSIT VALIDATION SCRIPTS

Script Files	Input Files	Output Files	Comments
1. Transit Validation Summaries.ipynb 2. VMT Summaries.ipynb	72 *LINKVOL.DBF files 72 *S2Svol.DBF files Station_Group.csv Mode_Name.csv Operator_Name.csv Station_Name.csv	Transit_assign_paste.csv	Used for processing the final run. Processing time is very fast. All input, output, script and the post-processed files and spreadsheets are in the project BOX folder.
main1.py main2.py modes.py operators.py parallel_run_setup.py stations.py summary_produce.py csv_create.py	72 *LINKVOL.DBF files 72 *S2Svol.DBF files \reference_files\ Station_Group.csv Mode_Name.csv Operator_Name.csv Station_Name.csv	Full_report.xlsx \reports\ report_1.csv to report_13.csv (thirteen csv files)	main1.py and main2.py was run to generate output files. The other python scripts worked as supporting scripts for the main two script files. Used for processing interim run results. Processing time is very slow. All input, output, script and the post-processed files and spreadsheets are in the project BOX folder.

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