

FRESNO COUNCIL OF GOVERNMENTS ACTIVITY-BASED MODEL UPDATE





FRESNO COUNCIL OF GOVERNMENTS

FRESNO COUNCIL OF GOVERNMENTS ACTIVITY- BASED MODEL UPDATE



Fresno AB Model Update Report:

Fresno Council of Governments Activity-Based Model Update

Report Prepared by:

RSG

Report Prepared for:

Fresno Council of Governments

**For additional information regarding this report, or for questions about
permission or use of findings contained therein, please contact:**

RSG (Headquarters)
55 Railroad Row, Suite 200
White River Junction, VT 05001
(802) 295-4999
www.rsginc.com

© 2025 RSG



CONTENTS

1.0 INTRODUCTION	7
2.0 MODEL DESIGN	9
2.1 OVERVIEW.....	9
2.2 INPUT PREPARATION.....	12
SETUP SCENARIO DIRECTORY	12
CREATE SCENARIO NETWORKS	12
GENERATE NON-MOTORIZED SKIMS.....	13
GENERATE EXTERNAL DEMAND	14
GENERATE TRANSIT STOPS FILE	15
GENERATE INTERSECTION DENSITY FILE.....	16
GENERATE TRUCK MODEL SOCIO-ECONOMIC FILE	16
GENERATE INTERNAL-EXTERNAL (IXXI) WORKER FRACTIONS	17
2.3 NETWORK SKIMMING.....	17
HIGHWAY.....	18
TRANSIT.....	19
2.4 TRAVEL DEMAND.....	20
RESIDENT MODEL (DAYSIM).....	20
TRUCK MODEL.....	30
AUXILIARY DEMAND.....	30
2.5 ASSIGNMENT PREPARATION.....	30
HIGHWAY.....	31
TRANSIT.....	31

NON-MOTORIZED	32
2.6 NETWORK ASSIGNMENT	32
HIGHWAY.....	32
TRANSIT.....	33
NON-MOTORIZED	33
2.7 FEEDBACK.....	33
2.8 REPORTING.....	33
DAYSIM.....	34
HIGHWAY ASSIGNMENT	34
TRANSIT ASSIGNMENT	35
NON-MOTORIZED ASSIGNMENTS	35
2.9 ENHANCEMENTS TO THE 2023 BASE YEAR MODEL	35
UPDATES TO THE MODEL DATA AND PARAMETERS.....	35
UPDATES TO THE SYNTHETIC POPULATION.....	36
3.0 CALIBRATION & VALIDATION.....	37
3.1 CALIBRATION	37
DATA	37
DAYSIM CALIBRATION SUMMARIES.....	40
3.2 MODEL VALIDATION	66
VALIDATION DATA.....	67
HIGHWAY VALIDATION.....	68
TRANSIT VALIDATION	78
3.3 SUMMARY.....	81
4.0 SENSITIVITY TESTS	82
4.1 CHANGE IN AUTO OPERATING COST (AOC)	82
MODEL SETUP	83
RESULTS	83
4.2 CHANGE IN TRANSIT FARE	86
MODEL SETUP	86
RESULTS	86
4.3 NEW TRANSIT SERVICE.....	89
MODEL SETUP	90
RESULTS	90
4.4 TRANSIT FREQUENCY	91
MODEL SETUP	92
RESULTS	92
4.5 NEW EMPLOYMENT.....	92
MODEL SETUP	93
RESULTS	93
4.6 SUMMARY.....	94
5.0 FRESNO ABM USER'S GUIDE.....	95
5.1 SOFTWARE REQUIREMENTS	95

CUBE VOYAGER	95
PYTHON - ANACONDA 2.....	95
R SOFTWARE	95
5.2 SETUP ABM	95
SYSTEM SETUP	95
MODEL SETUP	97
5.3 RUN ABM.....	97
5.4 MASTER DIRECTORY STRUCTURE	103
5.5 INPUTS.....	104
DAYSIM	104
5.6 OUTPUTS.....	121
DAYSIM	121
NETWORK SKIMS	134
ASSIGNMENT RESULTS.....	136
REPORTS AND SUMMARIES	152
APPENDIX A. DAYSIM CALIBRATION SUMMARIES	154
APPENDIX B. SYNTHETIC POPULATION	160
APPENDIX C. DAYSIM INPUT FILES	173
INPUT MICRO-ZONE FILE.....	173
TRANSIT STOPS FILE	174
INTERSECTIONS FILE	176
OPENSPACE AND PARKS FILE	176
FUTURE YEAR DAYSIM INPUTS	187
APPENDIX D. DAYSIM CONFIGURATION.....	189
APPENDIX E. TELECOMMUTE SHARES	215
APPENDIX F. CATALOG KEYS.....	219

LIST OF FIGURES

FIGURE 1: MODEL PROCESS FLOW	10
FIGURE 2: TRANSIT STOPS FILE FORMAT.....	16
FIGURE 3: DAYSIM SUB-MODELS	22
FIGURE 4: BUFFER1 AND BUFFER2 DISTANCE DECAY WEIGHTS.....	25
FIGURE 5: DISTRIBUTION OF HOME TO WORK DISTANCES	44
FIGURE 6. EMPLOYMENT VS WORKERS BY TAZ.....	45
FIGURE 7: MAP OF DISTRICTS.....	47
FIGURE 8: DISTRIBUTION OF HOME TO SCHOOL DISTANCE	48
FIGURE 9: ENROLLMENT VS STUDENTS BY TAZ	49
FIGURE 10. AUTO OWNERSHIP DISTRIBUTION – REGIONAL.....	50
FIGURE 11. TOUR MODE SHARES (TOTAL)	59
FIGURE 12: TIME OF DAY DISTRIBUTION OF WORK ARRIVAL TIMES	61
FIGURE 13: TIME OF DAY DISTRIBUTION OF WORK DEPARTURE TIMES	61
FIGURE 14: TIME OF DAY DISTRIBUTION OF SCHOOL ARRIVAL TIMES	62
FIGURE 15: TIME OF DAY DISTRIBUTION OF SCHOOL DEPARTURE TIMES	62
FIGURE 16: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE ARRIVAL TIMES	63
FIGURE 17: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE DEPARTURE TIMES	63
FIGURE 18: TIME OF DAY DISTRIBUTION OF WORK-BASED ARRIVAL TIMES	64
FIGURE 19: TIME OF DAY DISTRIBUTION OF WORK-BASED DEPARTURE TIMES	64

FIGURE 20: TRIP MODE SHARES (TOTAL)	66
FIGURE 21: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS	70
FIGURE 22: HIGHWAY VALIDATION – SPATIAL PERFORMANCE OF THE FRESNO HIGHWAY	73
FIGURE 23. HIGHWAY VALIDATION – I5 (SOUTH TO NORTH).....	75
FIGURE 24. HIGHWAY VALIDATION – SR33 (SOUTH TO NORTH).....	75
FIGURE 25: HIGHWAY VALIDATION – SR41 (SOUTH TO NORTH)	76
FIGURE 26: HIGHWAY VALIDATION – SR99 (SOUTH TO NORTH)	76
FIGURE 27: HIGHWAY VALIDATION – SR168 (WEST TO EAST).....	77
FIGURE 28: HIGHWAY VALIDATION – SR180 (WEST TO EAST).....	77
FIGURE 29: OBSERVED AND ESTIMATED TRANSIT BOARDINGS	79
FIGURE 30: ESTIMATED AND OBSERVED BOARDINGS BY TRANSIT LINE	81
FIGURE 31: SENSITIVITY TEST - NEW TRANSIT SERVICE	90
FIGURE 32: SENSITIVITY TEST – TRANSIT FREQUENCY	91
FIGURE 33: PYTHON RESOURCE FILE – UPDATE PROGRAM PATH	97
FIGURE 34: MAIN CUBE CATALOG FILE.....	98
FIGURE 35: SCENARIO KEYS SCREEN.....	99
FIGURE 36: STARTING A MODEL RUN IN CUBE	102
FIGURE 37: SPECIFYING RUN DETAILS IN CUBE.....	103
FIGURE 38: FRESNO ABM DIRECTORY STRUCTURE	104
FIGURE 39: COEFFICIENT FILE EXAMPLE	117
FIGURE 40: TOUR LENGTH DISTRIBUTION FOR DISCRETIONARY TRAVEL	155
FIGURE 41: TOUR LENGTH DISTRIBUTION FOR MAINTENANCE TRAVEL	155
FIGURE 42: TOUR LENGTH FREQUENCY DISTRIBUTION FOR ESCORT TRAVEL.....	156
FIGURE 43: TOUR LENGTH FREQUENCY DISTRIBUTION FOR WORK-BASED TRAVEL	156
FIGURE 44: POPULATIONSIM FOLDER STRUCTURE.....	161
FIGURE 45: RUNNING POPULATIONSIM FROM THE CUBE CATALOG	162
FIGURE 46. POPULATIONSIM VALIDATION – BASE YEAR (2023)	171
FIGURE 47. DAYSIM INPUT PREP MODULE.....	175
FIGURE 48. TRANSIT STOPS FILE FORMAT	175
FIGURE 49. DAYSIM CONFIGURATION TELECOMMUTE PARAMETER.....	215
FIGURE 50. TELECOMMUTE ASC ADJUSTMENT	218

LIST OF TABLES

TABLE 1: BIKE FACILITY TYPE IN ALL-STREET NETWORK	13
TABLE 2: PARAMETERS BY BIKE FACILITY TYPE.....	14
TABLE 3: DAYSIM TO TRUCK MODEL EMPLOYMENT CATEGORY CROSSWALK.....	17
TABLE 4: NETWORK ATTRIBUTES FOR TOLLING AND RESTRICTIONS.....	19
TABLE 5. LOGISTIC CURVES PARAMETERS	25
TABLE 6. HIGHWAY ASSIGNMENT TIME PERIODS IN THE FRESNO ABM	31
TABLE 7. OCCUPANCY FACTORS TO CONVERT PERSON TRIPS TO VEHICLE TRIPS	31
TABLE 8. MODEL CALIBRATION DATASETS	38
TABLE 9. POPULATION BY PERSON TYPE	42
TABLE 10. POPULATION BY PERSON TYPE (%).....	42
TABLE 11: NUMBER OF WORKERS BY WORK FROM HOME CLASSIFICATIONS.....	43
TABLE 12. AVERAGE HOME TO WORK DISTANCE (MILES) BY WORKER STATUS	43
TABLE 13. WORKERS BY DISTRICT	46
TABLE 14. AVERAGE HOME TO SCHOOL DISTANCE (MILES) BY STUDENT TYPES.....	48
TABLE 15: TOURS BY PURPOSE	51
TABLE 16. TOUR RATE BY PURPOSE.....	52
TABLE 17. TOURS BY PERSON TYPE	52
TABLE 18. TOUR RATE BY PERSON TYPE.....	53
TABLE 19. TRIPS BY PURPOSE	54
TABLE 20. TRIP RATE BY PURPOSE.....	54
TABLE 21. TRIPS PER TOUR BY PURPOSE.....	55
TABLE 22. TRIPS BY PERSON TYPE	55
TABLE 23. TRIP RATE BY PERSON TYPE.....	56
TABLE 24. AVERAGE TOUR LENGTHS FOR OTHER TOUR PURPOSE	57
TABLE 25. AVERAGE TRIP LENGTHS	60
TABLE 26. MODEL VALIDATION DATASETS	67

TABLE 27. HIGHWAY VALIDATION – REGION	69
TABLE 28. HIGHWAY VALIDATION – BY FACILITY TYPE	71
TABLE 29. HIGHWAY VALIDATION – BY VOLUME GROUP	72
TABLE 30. HIGHWAY VALIDATION – KEY CORRIDORS.....	74
TABLE 31. THE FHWA'S TRANSIT VALIDATION GUIDELINES	78
TABLE 32. TRANSIT SUMMARIES - REGIONAL.....	78
TABLE 33. SENSITIVITY TESTS – AUTO OPERATING COST	82
TABLE 34. AOC SENSITIVITY - TOUR LENGTHS (MILES) BY PURPOSE, PERCENT CHANGE FROM BASE.....	83
TABLE 35. AOC SENSITIVITY - TOUR MODE SHARE, PERCENT CHANGE FROM BASE.....	84
TABLE 36. AOC SENSITIVITY - TRIP MODE SHARE, PERCENT CHANGE FROM BASE.....	85
TABLE 37. AOC SENSITIVITY – REGIONAL VMT, PERCENT CHANGE FROM BASE	86
TABLE 38. SENSITIVITY TESTS – TRANSIT FARE	86
TABLE 39. TRANSIT SENSITIVITY - TOUR MODE SHARE, PERCENT CHANGE FROM BASE.....	87
TABLE 40. TRANSIT FARE SENSITIVITY - TRIP MODE SHARE, PERCENT CHANGE FROM BASE	88
TABLE 41. TRANSIT FARE SENSITIVITY – TRANSIT TRIPS BY HOUSEHOLD INCOME, PERCENT CHANGE FROM BASE	89
TABLE 42. TRANSIT FARE SENSITIVITY – TRANSIT BOARDINGS	89
TABLE 43. SENSITIVITY TEST – NEW BRT SERVICE BOARDINGS, COMPARISON TO BASE	91
TABLE 44. SENSITIVITY TEST – TRANSIT FREQUENCY, COMPARISON TO BASE	92
TABLE 45. SENSITIVITY TEST - EMPLOYMENT CHANGES.....	93
TABLE 46. MAZ EMPLOYMENT CHANGES	93
TABLE 47: CHANGES IN TOTAL VMT AND TRANSIT BOARDINGS.....	94
TABLE 48: NEW CATALOG KEYS	99
TABLE 49: MICRO-ZONE FILE FORMAT.....	105
TABLE 50: HOUSEHOLD FILE FORMAT	107
TABLE 51: PERSON FILE FORMAT	108
TABLE 52: ZONE INDEX FILE FORMAT	111
TABLE 53: WORKERS IXXI FRACTIONS FILE FORMAT	112
TABLE 54: PARK AND RIDE FILE FORMAT	113
TABLE 55: NODE TO NODE DISTANCE FILE FORMAT	114
TABLE 56: INTERSECTION DATA FILE FORMAT	114
TABLE 57: TRANSIT STOPS FILE FORMAT	115
TABLE 58: OPEN SPACE DATA FILE FORMAT	116
TABLE 59: ROSTER COMBINATIONS FILE FORMAT	121
TABLE 60: BUFFERED MICRO-ZONE FILE	122
TABLE 61: TOUR FILE FORMAT	125
TABLE 62: TRIP FILE FORMAT	128
TABLE 63: HOUSEHOLD DAY FILE FORMAT	131
TABLE 64: PERSON DAY FILE FORMAT	132
TABLE 65: HIGHWAY SKIM ATTRIBUTES	134
TABLE 66: TRANSIT SKIM ATTRIBUTES	135
TABLE 67: BIKE SKIM (MAZ) ATTRIBUTES.....	136
TABLE 68: WALK SKIM (MAZ) ATTRIBUTES	136
TABLE 69: WALK SKIM (TAZ) ATTRIBUTES	136
TABLE 70: ATTRIBUTES IN HIGHWAY ASSIGNMENT RESULT	137
TABLE 71: ATTRIBUTES IN TRANSIT ASSIGNMENT RESULTS	146
TABLE 72: ATTRIBUTES IN BIKE ASSIGNMENT RESULTS	148
TABLE 73: ATTRIBUTES IN WALK ASSIGNMENT RESULTS	150
TABLE 74: DAYSIM SUMMARIES OUTPUTS	152
TABLE 75. SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ACS).....	154
TABLE 76: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM).....	154
TABLE 77: DIFFERENCE IN SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM - ACS).....	154
TABLE 78: TOUR MODE SHARES (CCTS)	157
TABLE 79: TOUR MODE SHARES (ABM).....	157
TABLE 80: DIFF IN TOUR MODE SHARES (ABM-CCTS)	158
TABLE 81. TRIP MODE SHARES (CCTS)	158
TABLE 82. TRIP MODE SHARES (ABM).....	159
TABLE 83. TRIP MODE SHARES (ABM-CCTS).....	159
TABLE 84: FILES FOR UPDATING POPULATION DATA	163
TABLE 85. CONTROL DATA SOURCE DESCRIPTION	169
TABLE 86. MAZ SHAPEFILE FIELDS.....	173

TABLE 87. INSTRUCTIONS FOR FUTURE YEAR DAYSIM INPUTS	187
TABLE 88. DAYSIM CONFIGURATION FILE (CONFIGURATION.PROPERTIES)	189

1.0 INTRODUCTION

This report describes updates to the Fresno Council of Governments (Fresno COG) activity-based travel demand model (ABM) to meet existing and evolving transportation planning needs. The new model system is capable of addressing policies such as changes in telecommuting shares, peak hour and daily tolling, TNC modes, and truck restrictions.

The report describes the updated ABM system in detail and also serves as a user's guide for the model system. The ABM uses the DaySim activity-based model platform¹ for resident travel demand integrated with Bentley Cube software², which is primarily used for network models (skimming and assignment) and auxiliary demand models (truck model). The ABM is calibrated to a new base year (2023) using the 2022-2023 Central California Travel Survey (subsequently referred to as the 2023 CCTS). The model system is also validated against 2023 observed data for traffic counts, vehicle miles traveled (VMT), and transit ridership.

This project undertook the following key tasks to update the Fresno activity-based model:

- Implemented the latest version of DaySim activity-based model platform
- Updated input external auto and truck trip tables using 2023 Replica Data
- Developed inputs for a new base year (2023)
- Updated the time and cost parameters in the DaySim tour mode choice model to make the derived value of time by purpose more reasonable
- Activated telecommuting model functionality in DaySim³
- Processed the 2023 CCTS to develop calibration targets
- Calibrated and validated key submodels in the base year model
- Updated the model GitHub repository with the latest model setup⁴

The rest of this report refers to the ABM system as "Fresno ABM" and is organized as follows. The next chapter, Chapter 2, presents an overview of the ABM system. Chapter 3 presents various summaries of outputs from the calibrated and validated model. Chapter 4 discusses the tests examining model sensitivities to land-use and network changes. Chapter 5 provides

¹ <https://github.com/RSGInc/DaySim>

² <https://docs.bentley.com/LiveContent/web/OpenPaths%20Help-v1/en/GUID-912A4C66-0CA7-4F87-BCEE-61A08366389D.html>

³ <https://github.com/RSGInc/DaySim/wiki/Telecommute-Model>

⁴ Fresno ABM GitHub repository maintained by RSG (private and requires RSG permission): https://github.com/RSGInc/FresnoABM/tree/FresnoABM_2023_update

instructions to run the model system. The appendices (A-F) at the end of the report provide supplemental information about various tasks performed during this project.

2.0 MODEL DESIGN

This model update includes updating the model base year from 2019 to 2023 and adding model feature enhancements. As such, the 2023 model design and structure are identical to the 2019 model (except for the enhancements).

Prior to the full model run, if the PopulationSim has not been run before for a new land use or horizon year scenario, it needs to be run as a standalone script first. PopulationSim is currently set up to run in an Anaconda 3 environment using the latest PopulationSim python package. This differs from the Anaconda 2 environment used by the rest of the model. It is recommended to update the python packages and settings used for both PopulationSim and the full model run so both can be run with a single run command. The PopulationSim step can be found inside the 'DaySimInputPrep' module described immediately below to facilitate future integration. The steps for updating the synthetic population controls and targets are outlined in Appendix B.

2.1 OVERVIEW

Figure 1 presents the structure of the new Fresno ABM system showing relationships among different sub-model components.

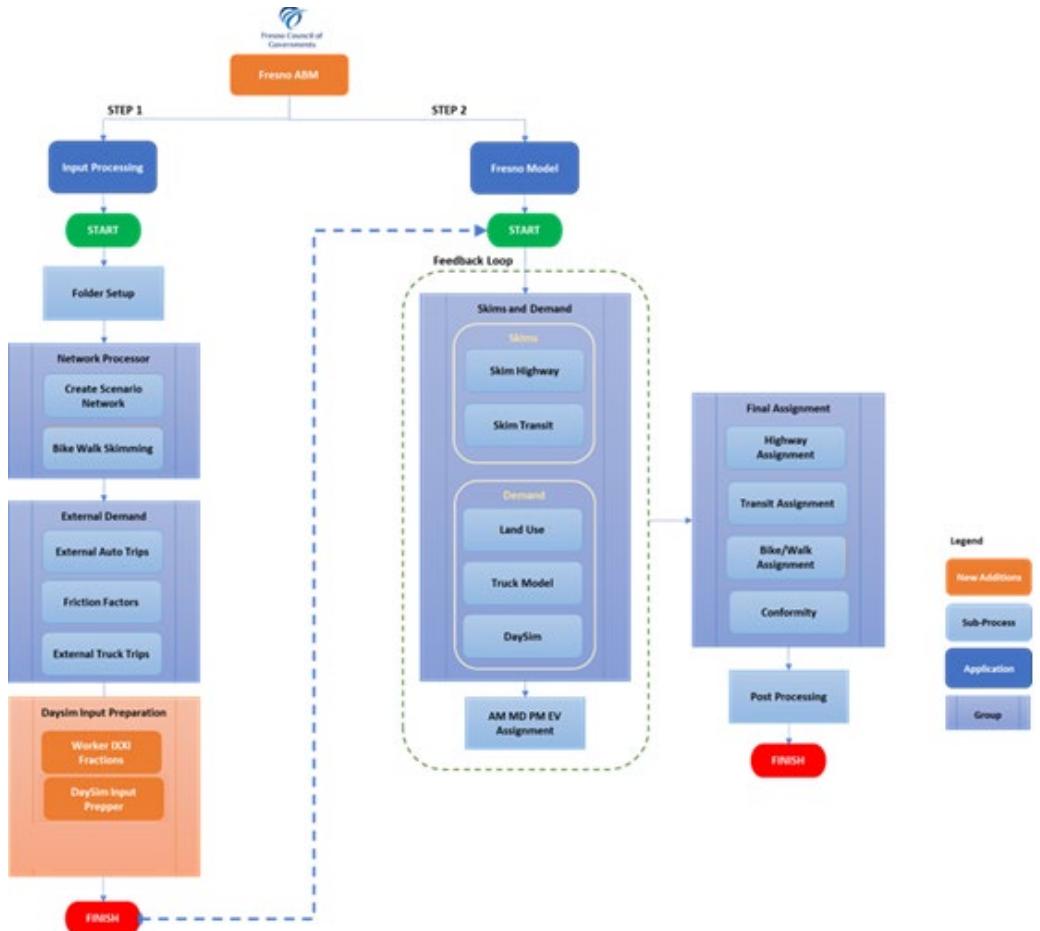


FIGURE 1: MODEL PROCESS FLOW

The ABM consists of two sequential steps: Input Processing and SJV Model. These steps can be launched with a single run command from the Cube catalog. The first step, Input Processing, processes the model network and creates inputs required in the second step, SJV Model, which performs network skimming, demand generation, and assignment in three feedback loops.

The Input Processing step first converts the input CUBE network into scenario specific CUBE network formats (highway, transit, and non-motorized) for network skimming and assignment procedures. As non-motorized assignments are not capacity constrained, re-skimming of bike and walk are not required in every feedback loop. Therefore, an initial set of bike and walk skims are generated to use in every feedback loop. Similarly, this step formats external demand matrices (auto and truck) which are kept static across all feedback loops. Other static inputs specific to DaySim are prepared in the new DaySim Input Preparation Module.

After the networks are prepared in the required format, the second step, SJV Model, runs three feedback loops. Each feedback loop starts with generating highway and transit skims to use in demand models. A set of demand models produces demand for two travel markets in the Fresno County region: resident travel and truck travel. The resident travel demand is generated by DaySim, whereas the truck demand is produced by the truck model, which is retained from the Valley Model Improvement Plan Version 2 (VMIP2) model. The two sets of travel demand, along with the external demand (auto and truck) generated in the first step, input processing, are combined into four time-period specific highway demand matrices with each having OD demand by multiple highway classes based on vehicle type and value of time. Similarly, the transit demand from DaySim is also prepared into four time-period specific transit demand matrices with each having multiple transit assignment classes based on transit sub-mode and access mode. The non-motorized (bike and walk) demand comes from the DaySim model and the corresponding matrices represent daily demand. After the demand matrices are constructed, four highway assignments are run: AM-peak (AM), off-peak (MD), PM-peak (PM), and night (EV). Note that transit and non-motorized assignments are run only once, in the final assignment step after the feedback loops. The link flows from the four highway assignments then inform new link travel times for the next feedback loop.

After the model system runs three feedback loops of skimming, demand, and assignment, a final assignment step runs assignment for all network systems (highway, transit, and non-motorized). The final highway assignment is run for four time periods (AM, MD, PM, and EV) and the transit assignment is performed for peak and off-peak periods. The non-motorized assignments are run for daily demand. After the network assignments, the last step of the model system summarizes the assignment results and produces files/reports to use for analysis.

Note that before running DaySim, a utility called “Buffer Tool” generates a buffered micro-zone file (land-use and accessibility measure for micro-zones) to use in DaySim. Also, a python tool called “population sampler” updates the input synthetic population to oversample households by a factor of 3.0 to reduce the Monte Carlo variance for an individual DaySim model run. If shadow pricing is turned on, the first iteration of the feedback loop will run the DaySim model four times; the first three runs of DaySim produce stable shadow prices that are used as an input for the fourth run, and for the subsequent DaySim runs in iterations two and three.

The Fresno ABM system process is comprised of the following key elements: input preparation, network skimming, demand generation, assignment preparation, assignment preparation, assignment, feedback loop, and reporting. The following sections discuss these processes in more detail.

2.2 INPUT PREPARATION

The first step of the model system, Input Processing, performs all necessary calculations and conversions to prepare networks and other inputs for processes in the second step, Fresno ABM, of the model system. This input preparation process undertakes the following primary tasks that are completed sequentially:

- Setup scenario directory
- Create scenario networks
- Generate non-motorized skims
- Generate external demand
- Generate transit stops file
- Generate intersection density file
- Generate truck model socio-economic (SE) file
- Generate internal-external worker fractions (Optional)
- Generate synthetic population (Optional)

Setup Scenario Directory

When the input processing step is started, it first creates a scenario directory with all necessary sub-folders required at any step of the model system.

Create Scenario Networks

After setting up a scenario directory, the process reads the input all-street highway network in Cube format and transit network from the text-based “.lin” file and processes them to convert into scenario networks. In addition to generating necessary fields, this step filters out minor streets to create a coarser auto network for use in skimming and assignment.

Note that the process of creating the CUBE format highway network does not check for connectivity. The accuracy of the output network is entirely dependent on how well the attributes that are used in the street filtering process are coded in the all-street network. Additionally, a coarser network may miss some streets with substantial traffic, thus causing, on some links, higher model flows than observed traffic counts. A substantial effort was made to track down and resolve such network dysconnectivity and missing link issues during the model validation phase of this project.

Generate Non-Motorized Skims

Since non-motorized network models are not constrained by capacity, non-motorized networks are skinned only once, during network preparation, and non-motorized assignment is run once during the final assignment step after all feedback loops have completed.

The non-motorized skimming procedures use the all-street network and generate distance skims for MAZ OD pairs⁵. The input preparation step creates a separate non-motorized network from the input all-street network and generates one distance skim for each of the two non-motorized modes. The distance skims are generated using a Cube-based shortest path method. The walk distances are based on a distance-based shortest path, whereas the bike distances are based on a shortest path minimizing a generalized cost function that is calculated as equivalent minutes weighted by bike facility class. As shown in Table 1, eight bike facility classes are available in the all-street network. The weights⁶ in bike generalized cost are applied by more aggregated bike facility classes as presented in Table 2.

TABLE 1: BIKE FACILITY TYPE IN ALL-STREET NETWORK

BIKE_FACTYPE	DESCRIPTION
0	Shared Roadway (No Bikeway Designation).
1	Class I Bikeway (Bike Path). Provides a completely separated right of way for the exclusive use of bicycles and pedestrians with crossflow by motorists minimized.
2	Class II Bikeway (Bike Lane). Provides a striped lane for one-way bike travel on a street or highway.
3	Class III Bikeway (Bike Route). Provides for shared use with pedestrian or motor vehicle traffic.
4	Class IV Separated Bikeway (cycle tracks). On-street bicycle facilities that include a vertical physical barrier between the bikeway and moving traffic.
5	Separate highway overcrossings
6	Unpaved Multipurpose Trails

⁵ Auto trips are significantly longer and calculating impedances at a finer detail (MAZ) than TAZ would not be worth adding substantial run time to the model system.

⁶ The parameters are borrowed from SANDAG route choice model, converted from utiles per mile to minutes per mile.

BIKE_FACTYPE	DESCRIPTION
9	Freeways and Ramps (bicycling not permitted)

TABLE 2: PARAMETERS BY BIKE FACILITY TYPE

BIKE FACILITY	WEIGHT (MINS PER MILE) *
No bike facility	6.0
Bike trail	2.0
Bike lane	3.1
Bike route	4.9

*Note: initial parameters were borrowed from SANDAG bike route choice model

The skimming process first strips out all freeway facilities from the all-street network and then calculates a bike generalized cost (BIKE_MINMILE) for each link in the network. As Cube expects skim zones (nodes) to be numbered from 1, the node ids in the resulting non-motorized network are updated to bring MAZ centroids in the beginning and the rest of the nodes start after them. This was done by subtracting 100,000 if node id is greater than 100,000 (MAZ centroids) and adding 100,000 otherwise (street nodes). Both node and link files were updated to reflect the new node id numbering scheme. Now, this updated network is used to generate bike and walk skims using a Cube utility (BUILDPATH) that, for every OD pair, summarizes an attribute on a shortest path based on a user provided cost function, which is the distance for both walk and bike.

Generate External Demand

The ABM system contains two sets of external demand: auto demand and truck demand. These external trip tables were developed using 2023 Fall data from the Replica platform⁷. Trips were extracted from Replica in 3 separate categories: internal-external (IX), external-internal (XI), or external-external (XX). These trip types were defined by their use of an external station link and origin or destination within the Fresno TAZ system. External-external (XX) trip extraction from Replica used a select link methodology on each external station, therefore, this trip list first had to be processed to join the trip entering the county with the trip exiting the county. This was easily done by matching the Replica ActivityID of the trip records. However, since the model

⁷ <https://www.replicahq.com/>

external stations are not a comprehensive list of roadways that enter or exit Fresno County, there were a number of 'one-legged' XX trips. These records were systematically reviewed using the trip origin county and destination county to determine if they should be included in the final XX trip table, and if so, which station to assign them to for the unreported leg.

The trip tables are attributed with their main vehicle type/purpose allowing a designation between passenger vehicle trips and commercial (truck) trips. They are also tagged with their time of day allowing distribution into the model time periods. The Fresno ABM vehicle assignment segments demand by vehicle occupancy classes. This is important for testing managed lane and pricing scenarios based on vehicle occupancy. The Replica trips are reported in vehicle trips without differentiation of vehicle occupancy, so occupancy shares are required to convert them into different occupancy classes. The vehicle occupancy shares were kept the same as the 2019 model and were developed using the 2017 National Household Travel Survey (NHTS). The IXXI sample was selected if either trip origin or destination was within Fresno County. The XX sample was selected if a straight line between trip origin and destination intersected Fresno County. All IX, XI, and XX records were then used to determine vehicle occupancy shares for IXXI trips, which were calculated to be 46.15%, 7.24%, and 46.61% for SOV, HOV2 and HOV3+ respectively. These shares were applied to the total Replica IXXI vehicle trips. The XX trips were all categorized as SOV trips due to the lack of a sufficient sample to calculate the XX occupancy shares.

The trip lists were reformatted into trip origin-destination matrices and adjusted to auto and truck counts at the external stations. The final auto trip matrices segmented by time of day and vehicle occupancy and daily truck trips are static inputs into the model system.

Generate Transit Stops File

The transit stops file is created using the input transit network and is now automated in the input processing step of the model. The module "Scenario Prepper" inside the 'DaySimInputPrep' module contains the process to generate this file. It is run after the network processor. First, the highway network is exported to shapefiles as links and nodes. Next, a python script reads the node shapefile and processes the transit line file to read all the stop nodes with their associated transit mode. This information is joined to the coordinate data of the nodes and exported in the format shown in Figure 2.

The stops file is in the following format:

id	mode	xcoord_p	ycoord_p
1	1	6309142	2167872
2	1	6309117	2166434
3	1	6309112	2165240
4	1	6307677	2165242
5	1	6306517	2165245
6	1	6306529	2166560
7	1	6306503	2167889
8	1	6309149	2169329
9	1	6309154	2170526
10	1	6309171	2171830
11	1	6307831	2173200
12	1	6306543	2173215
13	1	6305216	2173227
14	1	6303896	2173225
15	1	6303887	2174830

FIGURE 2: TRANSIT STOPS FILE FORMAT

Generate Intersection Density File

The intersection file provides the number of roads (links) at an intersection (node). The all-street network in the model is a dual road network where a two-way street is represented as one link for each direction. A two-way road is represented by two links representing to and from direction. Therefore, the all-street network cannot simply be used to calculate number of links at an intersection. First, we need to simplify the network and then process to create the intersection file.

This step in the input prepper reads the exported link file that was created at the beginning of the DaySim Input Prep step and uses a python script to pare the network down to single roadway links. The python script joins this to the node layer and the intersection link counts are saved in the appropriate format as described in section 5.5.

Generate Truck Model Socio-economic File

The truck model requires a socio-economic (SE) data file at the TAZ level with employment categories filled. This data is already available in the MAZ land use data file that is used as an input to DaySim. This step simply aggregates the data to the TAZ level and saves it in the appropriate format for the truck model. This step simplifies the model input preparation as now changes to land use need to be made only in the MAZ land use data file. The employment categories used in the truck model are slightly different than those available in the MAZ land use file. So, a crosswalk, shown in Table 3, is used to reformat these categories.

TABLE 3: DAYSIM TO TRUCK MODEL EMPLOYMENT CATEGORY CROSSWALK

MAZ FIELD (DAYSIM)	TAZ FIELD (TRUCK)
empgov_p	EMPGOV
empind_p	EMPIND
empmed_p	EMPMED
empofc_p	EMPOFC
empret_p	EMPRET
empsvc_p	EMPOTH
empth_p	EMPAGR
emptot_p	TOTEMP

Generate Internal-External (IXXI) Worker Fractions

The IXXI (internal-external and external-internal) worker fractions are zonal share of resident workers working outside Fresno County and zonal share of employment occupied by non-resident workers. These are input into the DaySim model and are generated by summarizing Longitudinal Employer Household Dynamics (LEHD) worker flow data, the latest year available at the time of the model update. This model input only needs to be updated when the base year of the model is changed, or new data is available. This step is optional in the CUBE catalog and can be set to run using the CUBE key “Run_WorkerFrac”.

2.3 NETWORK SKIMMING

The model system generates impedances (skims) for three sets of networks: highway, transit, and non-motorized. The highway and transit skims are (re)generated at the beginning of each feedback loop. The non-motorized skims are generated one-time in the Input Processing step, before the feedback loops.

Highway

The highway skimming process generates 12 skim matrices for four time periods (AM, MD, PM, EV) and three auto modes (drive-alone (DA), shared-ride 2 (SR2), and shared-ride 3+ (SR3)). Each highway skim matrix contains the following impedances in three value of time categories:

- Generalized time (mins)
- Time (mins)
- Distance (miles)
- Cost (dollars)

Note that the highway system reads auto operating cost (AOC) from an input CSV file that contains AOC by scenario years, which is based on 2019 dollars.. To maintain consistency between demand and supply models, before each run, the DaySim configuration file is updated dynamically to reflect the same auto operating cost. This model update included the following features to implement tolling and truck restrictions:

- Network Attributes:
 - Additional network attributes to facilitate tolls and restrictions are summarized in Table 4
- Skimming:
 - Skimming within the feedback loop includes all four time periods
 - Skimmed costs use toll values specific to each time period
 - Each skimming class accommodates the new restrictions for HOV and Truck restricted facilities
- Assignment:
 - Assignment within the feedback loop includes assignment for all four time periods
 - Assignment class definition accommodates the new restrictions for HOV and Truck restricted facilities
 - Each assignment reads in the period-specific toll values as the toll cost (AM sees TOLL_AM, MD sees TOLL_MD, etc.)
 - Final assignment step includes the same improvements as the assignment in the feedback loop

TABLE 4: NETWORK ATTRIBUTES FOR TOLLING AND RESTRICTIONS

NETWORK ATTRIBUTE	VALUE	DESCRIPTION
USE (BASE_USE, IMP1_USE, IMP2_USE)	0	Not used by any vehicle classes
	1	A general purpose lane that can be used by any assignment class
	2	An HOV2+ facility in which only vehicles with occupancy 2 or more are allowed
	3	An HOV3+ facility in which only vehicles with occupancy of 3 or more are allowed
	4	An HOV2+ facility but only in the peak (AM, PM) assignment periods. Will operate as a general-purpose lane in the off-peak (MD, EV) assignment periods
TOLL_{AM, MD, PM, NT}	Dollar value	Toll Value on the link ⁸
TRK_USE	0	Not used by any vehicle classes
	1	Trucks (light, medium, and heavy) are restricted from using the link at all times
	2	Trucks (light, medium, and heavy) are restricted from using the link in the peak periods only (AM, PM)

Transit

The transit skimming process generates 16 skim matrices for two time periods (peak and off-peak), four transit sub-modes (local bus, BRT, light rail and commuter rail), and two access modes (walk and drive). Each transit skim matrix contains the following impedances:

- Transit in-vehicle time (mins)

⁸ The dollar value of the toll is per link. This allows flexibility in coding: for distance based pricing, format the dollar value as price per mile multiplied by link length. For fixed price between ramps, choose one link on the path and set the toll amount.

- Walk access time (mins)
- Walk egress time (mins)
- Transfer walk time (mins)
- Initial wait time (mins)
- Transfer wait time (mins)
- Fare (dollars)
- Boardings
- Transit in-vehicle time for local bus (mins)
- Transit in-vehicle time for express bus (mins)
- Transit in-vehicle time for BRT (mins)

The transit system uses two sets of fare systems: fixed fare and zone-based fare. The fixed fare of \$1 is applied to Fresno Area Express (FAX) and \$0 (free) for Clovis Transit bus routes⁹, whereas the zone-based fare (\$0.75 - \$6.00) is applied to the Fresno County inter-city buses operated by Fresno County Rural Transit Agency (FCRTA)¹⁰.

The non-motorized skimming process generates two Cube matrices for bike and walk distances by MAZ OD pairs. The walk distances are produced in a text format as well for use in the DaySim buffer tool¹¹.

2.4 TRAVEL DEMAND

The model system encompasses three sets of travel demand: resident travel, truck travel, and auxiliary travel. DaySim simulates the internal travel for the Fresno residents. Truck travel within the region is produced by the truck model. Auxiliary demand such as external travel (auto and truck) are provided as inputs in the form of trip tables to the model system.

Resident Model (DaySim)

DaySim is an activity-based (AB) travel demand model. DaySim simulates 24-hour itineraries for individuals with parcel-level spatial resolution and minute-level temporal resolution. DaySim can generate outputs at the level of resolution required as input to dynamic traffic simulation. DaySim's forecasts in all dimensions (activity and travel generation, tours and trip-chaining, destinations, modes, and timing) are sensitive to travel times and costs that vary by mode,

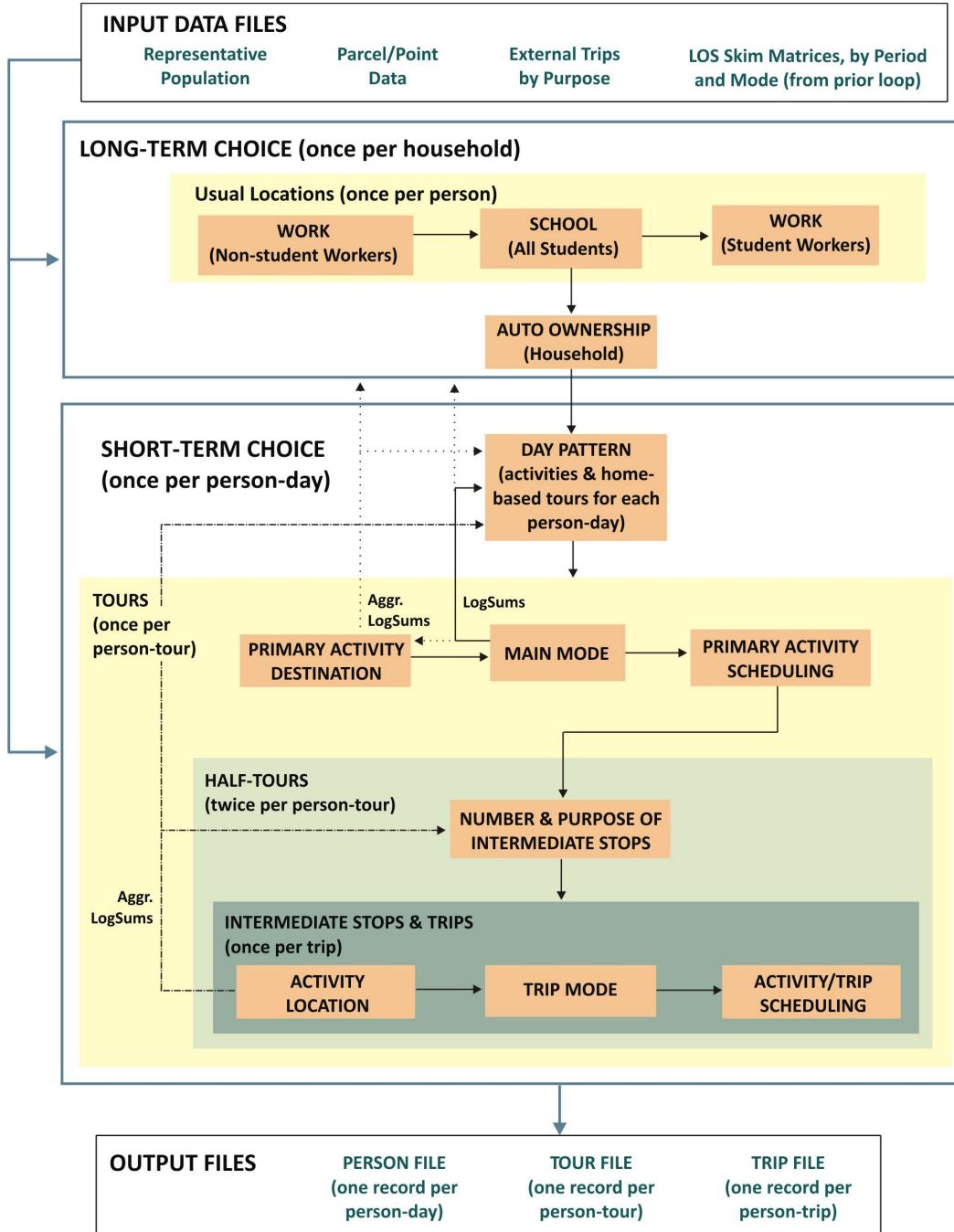
⁹ This is provided in “1_inputs\4_Transit\FC_BASE_TRAN_FAR.FAR”

¹⁰ This is provided in “1_Inputs\4_Transit\fareMatrix.txt”

¹¹ A DaySim input preparation tool that generates a buffered micro-zone file that contains several land-use and accessibility variables.

origin–destination path, and time of day. As a result, DaySim uses the improved network travel costs and times output from a dynamic traffic simulator as inputs. DaySim captures the effects of travel time and cost upon activity and travel choices. These effects are balanced across modes and times of day and are consistent with the econometric theory of nested choice models. DaySim can be used in a distributed manner by running different partitions of the study area population on separate processors and then merging the results.

DaySim comprises several subcomponents and is structured as a series of hierarchical or nested choice models. DaySim's hierarchy places the long-term models at the top of the choice hierarchy and places the short-term models at successively lower levels in the hierarchy. The detailed hierarchy and flow through the model are illustrated in Figure 3.

**FIGURE 3: DAYSIM SUB-MODELS**

The flow generally proceeds in a linear fashion from the long-term models to the short-term models. The choices made in the long-term models influence or constrain the choices made in the lower-level models. For example, household auto ownership affects both day pattern and

tour (and trip) mode choice by including auto ownership variables in those component models. In addition to these direct influences, utilities from lower-level models flow upward to higher-level models. “Logsums” (expected utilities) from tour destination and tour mode choice models affect other short-term models as well as upper-level, longer-term models. Some of the logsums from lower-level models are aggregated for use in the long-term models in order to reduce the computational time required to use fully detailed disaggregate logsums in a complex nesting structure.

This model update included updates to the DaySim code to allow for paid ride share modes such as Uber/Lyft services, which may also be toggled to allow these services to be provided by automated vehicles (AVs). Additionally, the new DaySim code also includes a telecommute sub-model which allows resident workers to make the choice to telecommute (different from working from home and having no out-of-home work location). More details on these parameters can be found in Appendix D.

Buffering and Transit Access Preparation

In DaySim, it is important to have measures not only within a particular micro-zone, but also for the area immediately surrounding each micro-zone. These measures are created by defining a “buffer” area around each micro-zone and counting what lies inside the buffer. These variables can then be used in DaySim, similar to how zonal land use and density variables are used in TAZ-based models, with the advantage that the buffer is defined in exactly the same way for each micro-zone. The buffer variables that DaySim uses include:

- The number of households in the buffer;
- Employment (number of jobs) in the buffer in various employment sectors;
- Enrollment in schools in the buffer, segmented by grade schools and colleges;
- The number of spaces and average price of paid off-street parking in the buffer;
- The number of transit stops within the buffer (segmented by sub-mode, if relevant);
- The number of street intersections in the buffer, segmented by 1-node (dead-end or cul-de-sac), 3-node (T-junction), and 4+node intersections; and

In addition, DaySim also uses the distance from the micro-zone centroid to the nearest transit stop (by transit sub-mode, if relevant), as well as the distance to the nearest open space area while simulating models.

DaySim Buffering Tool

A tool, Buffer Tool, to perform the buffer calculations is implemented in the DaySim component of the model system. This tool calculates all the buffer and transit access variables that DaySim needs, using the following inputs:

- Base micro-zone file
- Street intersections file

- Transit stops file
- Network nodes file (for all streets network based short trip distances)
- Node-to-node shortest path distance file (for all streets network based short trip distances)

Note that it is essential that the buffer measures used in application are consistent with those used for the original model estimation. Thus, when preparing new buffer measures, users should not modify the settings in the buffering tool control file.

Buffer Calculations

As mentioned earlier, buffer variables for a micro-zone are calculated by summing land use variables of all micro-zones within a certain buffer distance of the particular micro-zone. In the past, buffer calculations have used a “flat” buffer, using a certain radius, e.g. $\frac{1}{4}$ mile, and counting everything within that radius and nothing outside the radius. That approach is simple, but has the disadvantages that (a) it weights all opportunities within the buffer the same, whereas in reality the land use that is very close by will tend to have more influence on behavior than the land use at the edge of the buffer, and (b) there can be “cliff effects” if a large development is located near the edge of the buffer. In the latter case, the measures become sensitive to the somewhat arbitrary specification of the buffer size, and to the rules used to deal with micro-zones that straddle the buffer boundary. This tends to add random “noise” to the buffer measures.

The buffering tool can be set to use flat buffering, or a distance-decay buffer, in which each buffered item is weighted according to the distance from the origin micro-zone centroid. There are two options provided for the weighting function: a logistic function and a negative exponential function. The logistic form is recommended because its shape is more representative of typical behavioral models that use logistic functions. The Fresno ABM uses a distance-decay buffering.

The buffering program simultaneously calculates all the buffer variables for two different buffer sizes. The reason for this is that the DaySim choice models use smaller buffers for some variables (e.g. those that represent attractiveness of walk trips), and larger buffers for some other variables (e.g. those that represent attractiveness of bike trips, or more general neighborhood effects).

For distance decay buffering, the user specifies three parameters for each buffer: (1) the distance parameter, (2) the offset parameter, and (3) the slope parameter (the latter two are used only for logistic buffering). The parameters for the logistic curves used for DaySim model estimation and calibration are listed in Table 5. It is necessary that these same parameters be used for model application. The distance decay weights for both buffers are shown in Figure 4.

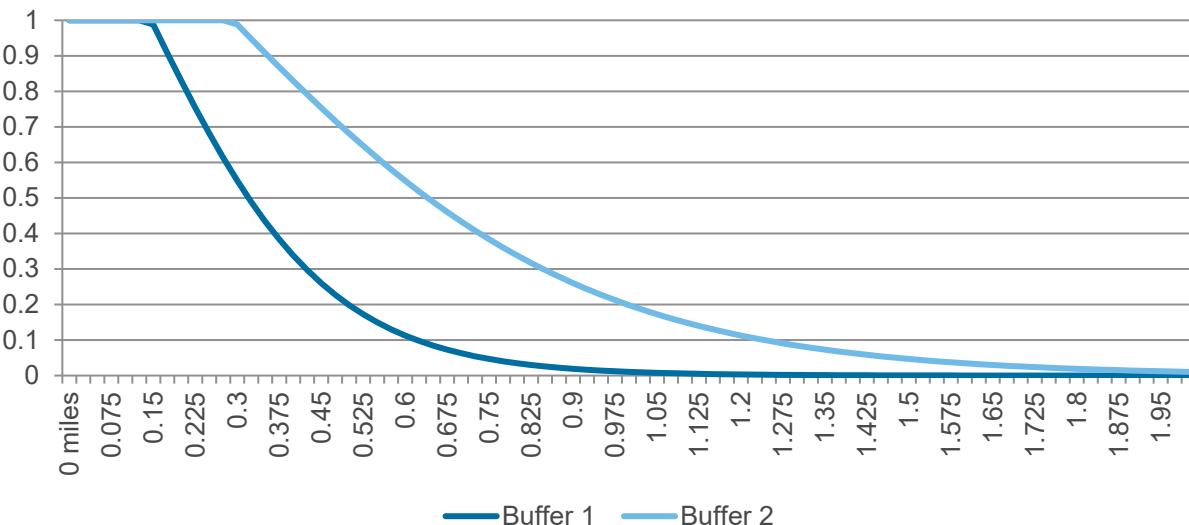
TABLE 5. LOGISTIC CURVES PARAMETERS

PARAMETER	BUFFER 1	BUFFER 2
Inflection	BDIST1 = 660 (ft)	BDIST2 = 1320 (ft)
Offset	BOFFS1 = 2640 (ft)	BOFFS2 = 2640 (ft)
Slope	DECAY1 = 0.76	DECAY2 = 0.76

The equation is:

$$Weight = \min \left(1, \frac{1 + e^{DECAY - 0.5 + \frac{BOFFS}{5280}}}{1 + e^{DECAY(\frac{Distance}{BDIST} - 0.5 - \frac{BOFFS}{5280})}} \right)$$

Distance is the distance, in feet, from the origin micro-zone to any other micro-zone whose calculation is explained in the next paragraph.

**FIGURE 4: BUFFER1 AND BUFFER2 DISTANCE DECAY WEIGHTS**

The buffering program also gives the user three options as to how distances are calculated within the buffering program:

1. Use crow-fly distance between the XY coordinates
2. Use interpolation with a “circuitry surface” around each micro-zone.
3. Use shortest path distance between the nearest all street network nodes.

Note that in option 1, because the buffer distance is calculated using XY coordinates from centroid to centroid for micro-zones, buffering may not be very accurate for micro-zones that are very large compared to the size of the buffer.

Option 3, used in Fresno ABM, provides more accurate distances that take into account obstacles and directness in the street network and is preferable if the required data exists. The following steps are involved in buffering using distance decay weights and all streets network distances:

1. The buffering tool first associates each micro-zone with the nearest network node and creates a micro-zone-node correspondence.
2. Multiple micro-zones may be associated with a single node and so the base micro-zone file is reduced to node level by aggregating data from all micro-zones that are associated with the same node.
3. Other items such as open spaces/parks and transit stops are also associated with the closest network nodes.
4. At this point, buffering calculations are all done at the node level since node-to-node all street network distance are available. For node pairs that are not within 3 miles of each other, Euclidean distance calculated from XY coordinates is used. Buffer variables for a particular node are calculated by obtaining the weighted sum of land-use variables of all the nodes with the chosen buffer distance. The calculation of distance weights has been described earlier.
5. Once the buffer calculations at the node level are complete, the buffer variables are transferred to micro-zones using the micro-zone-node correspondence created in step 1.

It should also be noted that in case of option 3, during the buffering process, two binary files that have information about node-to-node network shortest path distances are output so the DaySim can use them for simulation of short trips.

The following steps are involved in buffering using distance decay weights and XY/Euclidean distance:

1. Calculate distance weights using the logistic decay equation described earlier.
2. Calculate buffer variables for each micro-zone by counting land-use attributes of the surrounding micro-zones by getting their centroid distances (Euclidean) from that of the micro-zone under consideration and weighting by the corresponding distance weights.

Population Sampler

A common problem in the application of activity-based models to small urban areas is the effect of Monte Carlo simulation variance on the interpretation of results. The simulation error is

inversely proportional to the number of decision-makers or agents in the model. For smaller regions like Fresno COG and for cases where the policy of interest is relatively small scale (e.g., a capacity enhancement on a low-volume facility), the simulation error can exceed the sensitivity of the model, confounding the analysis of benefits. To eliminate this problem, the project applied a tool “Population Sampler” that was originally developed for the Bellevue-Kirkland-Redmond region DaySim model to enable oversampling households by geography. Population Sampler reduces the number of feedback iterations required for full model convergence by replicating households whose results are then averaged prior to assignment. The tool is implemented in a Python script and requires specifying the sample rates by zone along with a distribution of households by income and size to ensure that the sampled households are representative of the actual population. For Fresno ABM, the population sampler oversamples households by a factor of 3.0.

DaySim Inputs

This section provides a brief description of inputs required in DaySim model¹².

Micro-zones

The Fresno activity-based model system uses micro-zones as the fundamental spatial unit for generating travel demand. Use of micro-zones improves the sensitivity of the model system to land use, fine-grained urban form and accessibility attributes. However, use of these detailed measures necessitates the preparation of more detailed and larger model input datasets. The micro-zone data input file contains fields that describe the quantities of households, school enrollment by type and employment by industrial sector within quarter mile and half mile buffers. Note that these buffers are based on “all streets” based network accessibilities and employ decay functions that weight closer opportunities more than distant opportunities. In addition, the micro-zone file contains information about urban form and the transportation system on and close to the micro-zone, such as the number of dead-end streets, the proximity of the micro-zone to transit stops, and the price and supply of nearby parking.

Fresno COG provided this file with all the necessary attributes as described in Appendix C

Synthetic Population

The synthetic population is comprised of lists of households and persons that are based on observed or forecasted distributions of socioeconomic attributes and are typically created by sampling detailed Census microdata. These lists function as the basis for all subsequent choice-making simulated in the activity-based model. This project implemented a population

¹² DaySim is an open source activity-based model stored on a GitHub repository: <https://github.com/RSGInc/DaySim>. The repository has a wiki page with extensive documentation describing the model.

synthesizer called “PopulationSim” to generate synthetic population that are input to the Fresno ABM. Details of the procedures and instructions to run the software for the base year (2023) are provided in Appendix B.

Worker IXXI Fractions

Although the modeling area is defined in such a way as to capture as much “internal” travel by regional residents as possible (that is, travel with both origins and destinations within the modeling area), a certain portion of observed regional travel involves either regional residents travelling to destinations outside the modeling area or people who are not regional residents travelling to destinations within the modeling area. As in a traditional trip-based travel demand model system, these travel markets are typically incorporated into the model through the use of internal-external trip tables, which may be either fixed or dynamic.

A distinguishing feature of the DaySim activity-based model system is that, due to the spatial and behavioral detail embedded in the model, it is sensitive to how this internal-external travel affects the choices made by regional residents. A particular focus of this detail is on ensuring that the right numbers of workers are “out-commuting” to employment locations outside the modeling area, and that the right number of regional jobs are being consumed by non-residents “in-commuting” to the region. At present, this is accomplished by using a file (worker IXXI fractions) that contains TAZ-based shares of workers who are in-commuting and out-commuting, which is provided as an external input to the DaySim model system. The shares either can be held fixed or may be updated by deriving updates shares from the trip-based model outputs.

TAZ Indexes

The TAZ index file enables users to flexibly define non-continuous zones numbering systems, and to identify the availability of external and other zones as destination choices, without impacting DaySim performance.

PNR Nodes

The PNR file provides park and ride locations with corresponding capacity and parking cost. The file is prepared by extracting PNR locations from the highway network (node file). For each location, capacity is set to 100 and cost to 0.

Coefficients

A coefficient file provides a list of variables used in the model and corresponding coefficient values and t-statistics. Each Daysim model component is associated with a coefficient file. For the Fresno ABM, the model coefficients are consistent with the 2019 FresnoABM base year and calibrated to match 2023 observed survey data for the Fresno region.

Roster

A key set of inputs to any travel demand forecasting model system are the files that contain the scenario, mode, user-class, and time period-specific measures of network impedance, often referred to as network “skims.” The roster provides users with the ability to flexibly specify the skims that are associated with the different mode, time period and user classes used in the Fresno activity-based models system, without necessitating changes to the core DaySim model code. For example, a user may want to increase the number of time periods used in the model system to better reflect changes in network impedance by detailed time-of-day. In order to implement such an enhancement, a user would first revise the Cube-based network-processing scripts in order to generate the desired skims and would only need to revise the DaySim impedance roster to make DaySim sensitive to this additional detail.

This model update included automating the generation of the Roster file so that it does not need to be manually updated if changing the model year or running future scenarios.

Roster Combinations

The "Roster Combinations" file gives the possible mode/path type combinations used in DaySim. The file has columns that enumerate the 9 modes used in the current model system: walk, bike, single-occupancy vehicle (SOV), high-occupancy vehicles with 2 persons (HOV2), high-occupancy vehicles with 3 or more persons (HOV3), transit, park-and-ride, school-bus, other. The file also has 7 rows that enumerate the path types currently used (full-network, no-tolls, local-bus, light-rail, premium-bus, commuter rail, ferry). The path type “ferry” is used for BRT. The cells are TRUE for valid combinations within DaySim and FALSE otherwise.

Configuration

The configuration file is the main control file for DaySim. The configuration file informs DaySim about inputs/outputs and various model settings. These settings include input/output file names, types and locations, sample rates, DaySim path building weights, and allow users to specify which DaySim model components should be executed.

The ABM system dynamically generates a configuration file before a DaySim run. This process was updated to include parameters for the new DaySim features for teleworking and paid ride share modes. The model system uses two sets of DaySim configuration files: one for running only work and school location choice models and the second for running all choice models in DaySim. In the first feedback loop when shadow pricing is enabled, DaySim is run for four iterations. The first three iterations run only work and school location choice models and, in the end, generate stabilized shadow prices. These shadow prices are used to the fourth DaySim iteration that runs all choice models to produce resident travel in the region. Subsequent iterations (and the first iteration when shadow pricing is disabled) run DaySim only once, using the stable shadow price files that were previously generated.

Shadow Prices

The “shadow_prices.txt” is used to constrain employment and enrollment in a parcel by its actual capacity. Similarly, “park_and_ride_shadow_prices.txt” is used to constrain parking at park and ride locations’ capacity. The shadow prices are intermediate outputs of a DaySim run. They are optional as inputs. However, it is advisable to have starting shadow prices in order to get stable results. Also, having fixed starting shadow prices is helpful in replicating an ABM run with the same inputs. In this model update, the DaySim module was updated to use the stable shadow prices generated in the shadow pricing step in each iteration of the model. If shadow pricing is turned on, the output shadow prices are saved into the model input folder under 1_Inputs\Daysim\09_SeedShadowPrices. Each time DaySim runs, the shadow price files are updated, however, the setup now grabs the stable prices saved in the inputs so each iteration uses the most stable and reliable shadow prices.

Truck Model

The truck model is retained from the VMIP2 model system. The truck model produces a trip table containing truck demand in three truck classes: small (TS), medium (TM), and heavy (TH).

Auxiliary Demand

The auxiliary demand consists of demand external to the model region. Specifically, it consists of external auto demand and external truck demand. The external auto demand for internal-external (IE), external-internal (EI), and external-external (EE) trips by time-period are provided as input trip tables to the model system. The trip tables are created from 2023 Replica data, as described in Section 2.2 Input Preparation.

2.5 ASSIGNMENT PREPARATION

Before performing network assignments, the travel demand in the model system is prepared in formats required in the assignments. Specifically, the resident travel from DaySim is converted into vehicle trips and segmented into highway and transit travel in respective assignment classes. Other components of the model demand, internal truck trips and auxiliary demand, are added with the resident travel demand to create time-period specific Cube matrices.

The resident model, DaySim, generates a list of person trips for the residents and outputs them into a trip file in tab separated values format (_trip.tsv). The person trips are segmented into four time periods (see Table 6) using a trip time calculated based on trip’s position in the corresponding tour chain. The DaySim trip file contains this information in variable “HALF”, which takes value as 1 or 2, indicating if a trip is in first half of the tour or in the second half

respectively. If a trip is present in the first half (leg) of the tour (HALF=1), then the trip time is set to trip's arrival time. Otherwise (HALF=2), trip's departure time is considered as the trip time.

TABLE 6. HIGHWAY ASSIGNMENT TIME PERIODS IN THE FRESNO ABM

TIME PERIOD	DURATION
AM (a.m.)	6 am – 9 am
MD (mid-day)	9 am – 4 pm
PM (p.m.)	4 pm – 7 pm
EV (evening)	7 pm – 6 am

Highway

Person auto trips generated by the resident model (DaySim) are converted into vehicle trips using vehicle occupancy factors for high occupancy auto modes (SR2 and SR3). Table 7 presents the occupancy factors used to convert DaySim person trips to vehicle trips.

TABLE 7. OCCUPANCY FACTORS TO CONVERT PERSON TRIPS TO VEHICLE TRIPS

MODE	OCCUPANCY
Drive-Alone (DA)	1
Share-Ride 2 (SR2)	2
Shared-Ride 3+ (SR3)	3.5

The DaySim vehicle demand is combined with truck demand and the auxiliary demand to construct four time-of-day demand tables for highway assignment. The demand tables are generated in Cube matrix format and contain demand in 13 assignment classes – 9 auto classes (3 auto classes x 3 value of time), one external class (EE), and three truck classes (small, medium, and heavy). Three auto classes are DA, SR2, and SR3.

Transit

DaySim produces transit trips across all times of day in which transit service is provided. The DaySim trip file (_trip.tsv) reports all transit trips as transit and does not classify them by access mode (walk or drive). However, another DaySim output, tour file (_tour.tsv), details tours made by a person and reports transit tours by access mode as well. DaySim calculates trips from the tours made by a person. Therefore, if the tour corresponding to a trip is reported as drive-to-transit then the trip is a drive-to-transit too. To get the tour information to the trips, tour and trip

files are joined by a common identifier (tourid). Presently in the Fresno model, no KNR sub-mode is included in DaySim, thus, all drive-to-transit trips are reported as PNR trips.

The transit trips are aggregated in OD format into two Cube matrices by transit mode (Bus and Rail). Each matrix contains demand in four assignment classes by time-period (peak and off-peak) and access mode (walk and drive).

Non-Motorized

DaySim also produces lists of trips made for non-motorized modes. These trips are aggregated by MAZ OD format and generated a cube matrix that contains demand by two non-motorized modes (walk and bike).

2.6 NETWORK ASSIGNMENT

The model system assigns three sets of travel demand to the model network: highway, transit, and non-motorized. Note that highway and transit assignment procedures are retained from the VMIP2 model system. The project implemented the non-motorized components in the ABM system.

Highway

The highway assignment is a multi-user class equilibrium assignment that builds paths on a generalized cost function with the cost function differentiated by user class. The generalized cost is a function of travel time and cost (toll) and is converted to time using value of time.

The assignment employs a user equilibrium method that is an iterative process to achieve a convergent solution where no travelers on the roadway network can improve travel-times by shifting routes. Throughout each of these iterations, Cube computes network-link flows, which incorporate link-capacity restraint effects and flow-dependent travel-times.

The ABM system runs highway assignment for four time periods (AM, MD, PM, EV) in every feedback loop and for four time periods (Table 6) in the final assignment step. Note that the truck trips are assigned as PCEs by applying factors of 1.5 and 2.0 for medium and heavy trucks respectively. For convergence criteria, the assignments use a gap value of 0.00001 and maximum iterations of 50 for the peak and 20 for the off-peak periods.

Each converged assignment run produces a loaded network (*.NET) that contains assigned flows on the links. The four time-period specific loaded networks are then post-processed and combined into one loaded network containing flows for all four time periods. The post process also exports the flow data into a DBF file.

Transit

The model system uses Cube-based Pathfinder assignment to assign transit demand to the model transit network. The transit demand is assigned by time period (peak and off-peak), sub-mode (bus and rail), and access mode (walk and drive).

Each transit assignment run produces a loaded network file (*.NET) and a DBF file that contains on and off at every transit stop in the model system. In all, the transit assignment step generates 8 files for each of the two outputs – two time periods (peak and off-peak), two sub-modes (bus and rail), and two access modes (walk and drive).

Non-Motorized

This project implemented a new assignment procedure to assign non-motorized demand to a network. For both bike and walk, the daily demand is assigned to a non-motorized network created in the Input Processing step. The bike assignment calculates best path using a generalized cost based on bike facility type, whereas the walk assignment is set up to directly use distance as a generalized cost. As the non-motorized assignments are not capacity restraint, only one iteration is run in each of the two assignments.

Each non-motorized assignment run produces a loaded network with flows on the network links. However, as described in Section 2.2, the non-motorized network contains the re-numbered node ids that are required for skimming and assignment by MAZ. Therefore, the loaded networks are processed to set the node ids back to the original all-street network node ids. The flows in the new loaded networks are also exported into DBF files.

2.7 FEEDBACK

Feedback is used in two primary ways in the Fresno activity-based model system: between iterations within the highway assignment process, and between “system” iterations of the model system in which both the DaySim activity-based demand components and the Cube-based network supply components are executed. The feedback provides new (congested) travel times calculated based on the previous iteration results to the next iteration.

2.8 REPORTING

This project developed several stand-alone report processes to summarize outputs of DaySim and network assignments. These reports are useful to assess model performance and inform model calibration and validation, as well as other analyses.

DaySim

A DaySim run produces multiple outputs describing daily travel for the residents of the model region. The primary outputs are:

- _household.tsv
- _household_day.tsv
- _person.tsv
- _person_day.tsv
- _tour.tsv
- _trip.tsv

A separate set of R scripts summarize these outputs in various excel spreadsheets. The spreadsheets contain tables and charts summarizing different sub-models in DaySim. The spreadsheets are also utilized during calibration and validation of DaySim. These summaries are now automatically produced in the post-processing step and are available to view after the run completes in the scenario folder under “11_DaySim\daysim_summaries” folder.

Highway Assignment

The outputs of the highway assignment are time-period specific flow tables, which are, during a post-process, combined into one flow table. This flow table can be used to report various highway statistics.

This project created a highway validation spreadsheet that takes a combined highway assignment flow table¹³ as input and automatically generates various highway statistics and compares them with the same statistics from observed data (traffic counts). The statistics include:

- Scatter plot of estimated flows and observed counts
- Gap by facility type (also by time of day)
- Gap by volume group
- Root mean squared error

Gap is calculated by taking the difference of estimated traffic volume with the observed count and then dividing it by the observed count.

¹³ A python script generates a combined assignment flow table that is input to the highway validation spreadsheet.

The highway validation spreadsheet is now an automated part of the model setup and run during the post-processing step. The output can be found in the scenario folder under “10_Reportng\validation”.

Transit Assignment

The transit assignment outputs transit boarding tables by period, transit sub-mode and mode access. A python script processes the assignment outputs and reports a summary of daily boardings by transit route. The summary is in a CSV format and is input to a transit validation spreadsheet that generates the following statistics:

- Scatter plot of estimated boardings and observed boardings
- Boarding rate
- Boardings by route

The transit validation spreadsheet is now an automated part of the model setup and run during the post-processing step. The output can be found in the scenario folder under “10_Reportng\validation”.

Non-motorized Assignments

Similar to the highway assignment, the non-motorized assignment outputs walk and bike flows on network links. Two separate validation spreadsheets summarize and compare estimated non-motorized flows with observed counts. Instead of validating every count location separately, the locations are combined and compared in 13 count groups. The groups are created based on the direction of travel and the neighborhood of the location.

2.9 ENHANCEMENTS TO THE 2023 BASE YEAR MODEL

Updates to the Model Data and Parameters

The following updates were introduced to the 2023 base year model without changing the model design.

1. Activated telecommuting model functionality in DaySim (refer to Appendix E).
2. Updated highway network, transit network, and land use data to 2023
3. Updated external demand using 2023 Fall data from Replica, adjusted to 2023 auto and truck counts at the external stations
4. Updated IXXI worker fractions using 2022 LEHD worker flow data, the latest year available at the time of the model update

5. Updated time and cost coefficients (and by extension, the derived value of time) in tour mode choice coefficients because in the 2019 ABM, (1) the coefficients are not sensitive to income, (2) other purposes (shop, meal, personal business, and social recreation) are not sensitive to parking costs, and (3) the derived value of time by purpose is very similar across all purposes. The new coefficients have higher value of time for higher income households, the same sensitivity to parking costs for all non-work purposes, and work purpose value of time 50% higher than that of all other purposes.

Updates to the Synthetic Population

The PopulationSim setup was revised to generate a synthetic population aligned with the 2023 base year. The primary objective of this update was to preserve the integrity of existing input datasets while ensuring demographic relevance. To achieve this, regional distributions derived from the 2023 census data were applied to the control variables, thereby minimizing changes in the original data structure. 2019 PUMS was used as the seed data.

The following steps were undertaken to implement this update:

- **Income Adjustment** – An inflation factor of 1.19¹⁴ was applied to the household adjusted income values in the seed dataset that originates from the 2019 Public Use Microdata Sample (PUMS). The inflation factor was used to approximate 2023 income levels.
- **Data** – RSG downloaded the latest 2023 American Community Survey (ACS) and PUMS data to inform regional control distributions of the resident population, which includes household size, age of head of household, household workers, household income, household presence of children, person age, person occupation. Group quarter population does not have controls by demographic variables other than the total population by the type of group quarters (university, military, and other).
- **Regional Distribution Generation** – A new python script, *createRegionalDistributions.py*, was developed and added to the PopulationSim setup. This script processes the 2023 ACS and PUMS data to generate regional distributions for all existing control variables used in the PopulationSim.
- **Control Adjustment** – Another python script, *adjustControls.py*, was introduced to apply the regional distributions to both TAZ and region level controls. This step ensures that the synthetic population reflects the updated 2023 demographics.

¹⁴ Obtained from CPI inflation calculator - https://www.bls.gov/data/inflation_calculator.htm with year values from 2019 to 2023

3.0 CALIBRATION & VALIDATION

A calibration process adjusts the model to ensure that the model generates demand that reasonably follows the behavior depicted in observed data. The demand is defined as frequency of trips by origin and destination pair. The frequency of trips by OD pair can have different segmentation, e.g., trip mode, time of day, etc. The demand is then loaded on to the network (assignment) to determine the number of trips using each link in the network. For highways, this provides vehicle flows on every link (road) in the highway network and for transit, it generates number of people (boardings) using each transit service.

After a model is calibrated to produce demand that reasonably predicts observed travel behavior in the region, the model is validated to ensure network-level usage of the demand is reasonable. The model validation includes, on the highway side, comparing estimated traffic volume from the model with observed traffic counts, and on the transit side, comparing estimated transit boardings from the model with observed transit ridership.

The rest of this chapter presents model calibration and validation in separate sections. For each, first, the observed data are discussed followed by summaries from a final calibration and validated model run. In the end, a summary of the chapter presents key takeaways from the discussions.

For the 2023 model update, the observed Vehicle Miles Travelled (VMT) was the primary target that guided the calibration and validation process. As such, the calibration of the demand models focused on a few key submodels: the work from home model, the telecommute model, and the day pattern model.

3.1 CALIBRATION

In model calibration, alternative-specific constants (ASCs) and other model parameters are iteratively adjusted until the model generates demand that reasonably matches travel patterns in observed data. Typically, models are calibrated according to the following procedure: first, create comparisons between observed data and estimated model results. Next, calculate ASC adjustments by calculating the natural log of the ratio between the observed value and the estimated value for each alternative. Then, add the adjustments to the ASCs from the previous iteration. Next, run the model with the updated constants.

Data

Table 8 presents a list of datasets utilized to calibrate Fresno ABM.

TABLE 8. MODEL CALIBRATION DATASETS

DATASET	YEAR	PURPOSE
Central California Travel Survey (CCTS)	2022-2023	All DaySim Models
Transit On-Board Survey	2024	Transit Tours/Trips
LEHD Origin-Destination Employment Statistics (LODES)	2022	Worker Flows
5-Year Public Use Microdata Sample (PUMS)	2015-2019	Auto Ownership
1-Year American Community Survey (ACS)	2023	Auto Ownership

The 2022-2023 Central California Travel Survey (CCTS) is the primary dataset used during the calibration. Additional datasets are utilized to inform more accurate information for a particular type of travel. For example, a transit survey provides information about transit travel, thus, informing transit travel targets (tours and trips) in mode choice calibration. The 2022 LEHD Origin-Destination Employment Statistics (LODES) data provides flow of workers, which is used to validate estimated work location choice of Fresno residents. Census (5-year PUMS and 1-year ACS) informed targets for adjusting the auto ownership model in DaySim.

Central California Travel Survey (CCTS)

The 2022-2023 Central California Travel Survey (CCTS) was an effort led by Fresno COG in collaboration with the eight metropolitan planning organizations of the San Joaquin Valley region in California: Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare. The purpose of the study was to gather information about the travel behavior of the residents of the San Joaquin Valley region.

The CCTS collected a rich set of demographic and travel behavior data from 7,406 households with complete responses across the eight-county region, amounting to 19,084 persons and representing 150,012 trips across 42,567 complete person-days. Of the 7,406 households, 1,618 households have a home location in the Fresno County, which are used to support the current model calibration efforts. The study implemented a number of data collection methods including a smartphone app, an online website, and a call-center.

The CCTS sampling plan was based on the 2015-2019 American Community Survey (ACS) 5-year estimates, and the survey was expanded (weighted) to the 2019 ACS Public Use Microdata Sample (PUMS) 1-year data to match the survey data to key household and person demographic variables. To support the 2023 base year model update, targeted refinements were applied to the CCTS survey weights of Fresno households to better represent 2023 travel

conditions, and the survey data was reformatted to support the calibration efforts. The processing and refinement steps were applied in the following order:

- Trips were imputed in the survey data if missing trips were identified. If a person reported being on the trip with another household member, but the trip is not found for the other household member, the trip was imputed for the latter based on the trip information of the former. If an adult reported their child going to school on the survey day, but school trips were not found in the child's travel diary (which is proxy reported by the adult), the school trips were imputed.
- Tours were created based on the trip data in the survey. A tour is a sequence of trips in which the destination of the final trip is the same as the origin of the first trip (typically home). DaySim uses tours to ensure internal consistency of the travel choices (e.g., mode and time) among all trips on a tour.
- Survey variables were re-coded to match DaySim categories.
- Multi-day travel records were converted to single day records by creating a unique household and person identifier for each day to be compatible with DaySim.
- Person weights were scaled to match the distribution of person type (listed in Table 9) of the synthetic population produced by PopulationSim. Household weights were then adjusted to be the average of the scaled person weights of all household members, and day, trip, and tour weights were scaled by the same factor as the person weights. The scaling of the survey to match PopulationSim was necessary for several reasons. First, the survey was weighted against the 2019 ACS, but the survey was conducted from 2022-2023 and the model base year is 2023. The survey needed to be scaled up to represent the 2023 population totals. Second, if the population in the survey and synthetic population are very different for each type of person (e.g., full-time workers), it is more difficult to calibrate the model to survey targets, e.g. if the number of workers in the survey and the synthetic population are very different, it is not possible to calibrate to total work tours and work tours per worker simultaneously.
- Work-from-home and telecommute workers were scaled to match 2023 PUMS work-from-home worker shares by aligning CCTS definitions with Census usual mode of commute definitions as closely as possible. This was necessary because the survey weighting did not control for work-from-home or telecommute workers. To scale the survey data to 2023 PUMS data, survey workers were flagged as working from home if their telecommute frequency is greater than 50%, and their weights are scaled to match Census work-from-home share while keeping the total number of workers by work type (full-time workers, part-time workers, and university student part-time workers) the same.

- Trips external to Fresno County were removed because the resident model captures only the internal-internal trips, while the external demand is handled separately in the model as described in Section 2.4 to avoid double counting of trips.

Transit On-Board Survey

The 2024 transit on-board survey collected demographic and trip information for transit riders. Demographic information includes age, race, gender, household income, home location, work location, worker status, student status, etc. Transit trip information includes trip origin, destination, boarding stop, alighting stop, access mode, egress mode, time, purpose, transit route(s), and fare type. Since the transit on-board survey year (2024) was really close to the base year (2023), the 2024 transit data by each transit operator were not adjusted to 2023.

LEHD Origin-Destination Employment Statistics (LODES)

Commute travel is a very important and significant component of any regional travel. Therefore, in addition to verifying number of workers by work location, it is essential to validate workers by their origin (home) and destination (work) locations. LODES data was used to validate worker flows between home and work districts. The flows are compared at an aggregate level (10 districts) since observed data are likely to show higher variance/error at a more detailed geography.

Public Use Microdata Sample (PUMS) and American Community Survey (ACS)

PUMS and ACS data were used to develop calibration targets for auto ownership. The PUMS data is useful for developing cross-tabulation of auto ownership with household income and with potential drivers (persons aged 16 or over). 5-year PUMS data was used to have a larger sample size for the cross-tabulations. The 1-year ACS data is useful for getting the latest estimates for vehicle ownership. The 2015-2019 PUMS was used to match the seed data used to generate the synthetic population.

DaySim Calibration Summaries

An R-utility summarizes DaySim outputs into statistics that are meaningful and easy to understand. The summaries are prepared by key model components and include work and school location, auto ownership, day pattern, tour/trip destination choice, mode choice, and time of day. The summaries from the final calibrated model are presented in the following sections. Unless otherwise specified, both the CCTS and ABM data include only the study area, i.e., Fresno County.

Synthetic Population

Table 9 and Table 10 compare synthetic population in the ABM with observed data (CCTS) in Fresno County. The population includes both households (in the "HH" columns) and Group

Quarters (in the “GQ” columns). The group quarter population was excluded from the CCTS sampling frame, but it is important to include the group quarter population in the ABM to make sure that travel by all Fresno County residents is captured. The survey weights were scaled to match the person-type distribution in the synthetic population so the weights match perfectly for non-workers. The workers also match very well but are not identical due to a subsequent step to adjust the work-from-home and telecommute workers to match 2023 Census as described above.

TABLE 9. POPULATION BY PERSON TYPE

PERSON TYPE	CCTS HH	ABM HH	CCTS GQ	ABM GQ
Full Time Worker	330,729	330,433	N/A	596
Part Time Worker	56,084	56,290	N/A	563
Retired	110,549	110,549	N/A	1,118
Non-Worker	159,967	159,967	N/A	2,937
University Student	53,900	53,661	N/A	1,853
Student Age 16+	36,122	36,122	N/A	201
Child Age 5-15	182,345	182,345	N/A	98
Child Age 0-4	65,566	65,566	N/A	78
Total	995,262	994,933	N/A	7,444

TABLE 10. POPULATION BY PERSON TYPE (%)

PERSON TYPE	CCTS HH	ABM HH	CCTS GQ	ABM GQ
Full Time Worker	33%	33%	N/A	8%
Part Time Worker	6%	6%	N/A	8%
Retired	11%	11%	N/A	15%
Non-Worker	16%	16%	N/A	39%
University Student	5%	5%	N/A	25%
Student Age 16+	4%	4%	N/A	3%
Child Age 5-15	18%	18%	N/A	1%
Child Age 0-4	7%	7%	N/A	1%
Total	100%	100%	N/A	100%

Work From Home and Telecommute

Workers are classified into three types based on whether they work at their home location: work-from-home workers, telecommute workers, and all other workers. The work location model determines where a worker works and classifies a worker as a work-from-home worker if the work parcel (usual work location) is the same as the home parcel. The telecommute (work at home) model predicts whether a non-work-from-home worker works at home for 3 hours or more on the simulation day and, if so, classifies the worker as a telecommute worker. The rest of the workers are considered out-of-home workers. The work from home and telecommute calibration consists of two main steps. The first step calibrates the models that predicts if a worker works from home or if a worker telecommutes using the work location model and the telecommute model as described above. The second step calibrates the Day Pattern model for each worker type as described later in this section. As presented in Table 11, the number of work from home and telecommute workers in the ABM are within 10% of the respective CCTS workers.

TABLE 11: NUMBER OF WORKERS BY WORK FROM HOME CLASSIFICATIONS

WORKER TYPE	CCTS	ABM	CCTS %	ABM %
Work from home workers	21,017	18,895	5.1%	4.6%
Telecommute workers	86,364	80,755	21.1%	19.5%
All other workers	301,583	314,859	73.7%	76.0%
All Workers	408,964	414,509	100.0%	100.0%

Home to Work Distance

As presented in Table 12, the ABM has an average home to work distance of 8.9 miles compared to 9.4 miles from the CCTS. The estimated distances to work for all worker types are within 10% of the survey data, so the model did not require calibration in the 2023 update. Note that the home-to-work distances are only for the workers of the Fresno County that have work location within the Fresno County.

TABLE 12. AVERAGE HOME TO WORK DISTANCE (MILES) BY WORKER STATUS

WORKER TYPE	CCTS	ABM
Full Time	10.0	9.4
Part Time	7.7	7.1
Other	6.5	7.1

All Workers**9.4****8.9**

Figure 5 compares distributions of home to work distances of workers in the CCTS and the model. The X-axis is distance in miles and the Y-axis is share (%) of workers. Due to relatively lower samples, the observed dataset shows a lumpy distribution. The ABM distribution is smoother and generally follows the observed distributions from the CCTS.

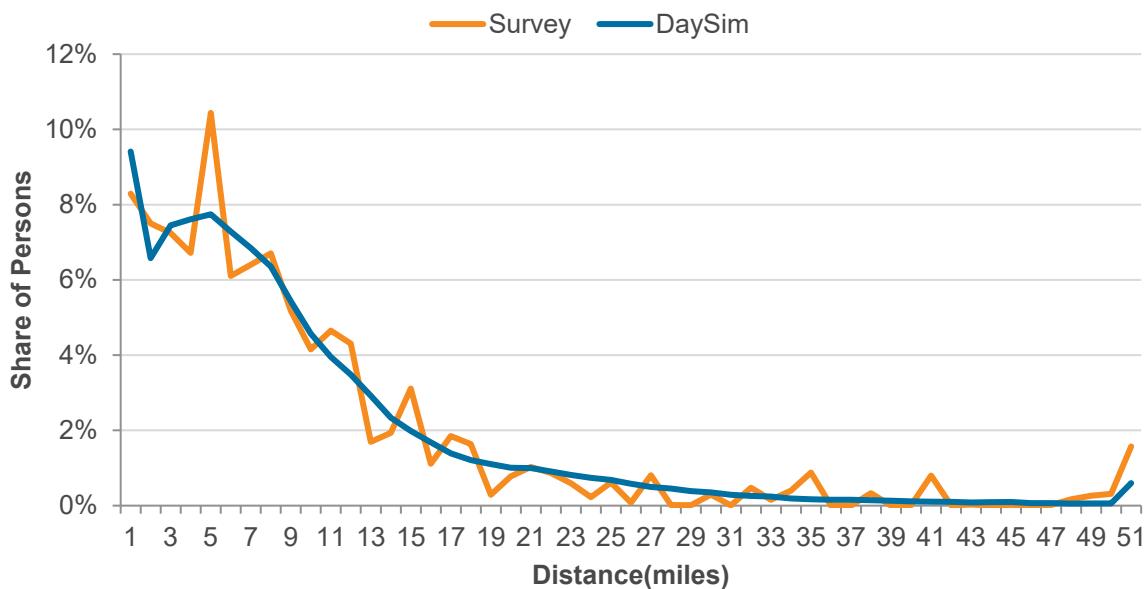


FIGURE 5: DISTRIBUTION OF HOME TO WORK DISTANCES

A comparison of estimated work locations (workers working at a location) and corresponding employment by TAZ, Figure 6, shows a good match with a R-squared value of 0.99. This suggests that the shadow pricing mechanism in DaySim is working well. The shadow pricing iteratively balances number of workers and total employment in a micro-zone. The trendline is below the 45 degree reference line, indicating that there may be slightly fewer workers than zonal employment.

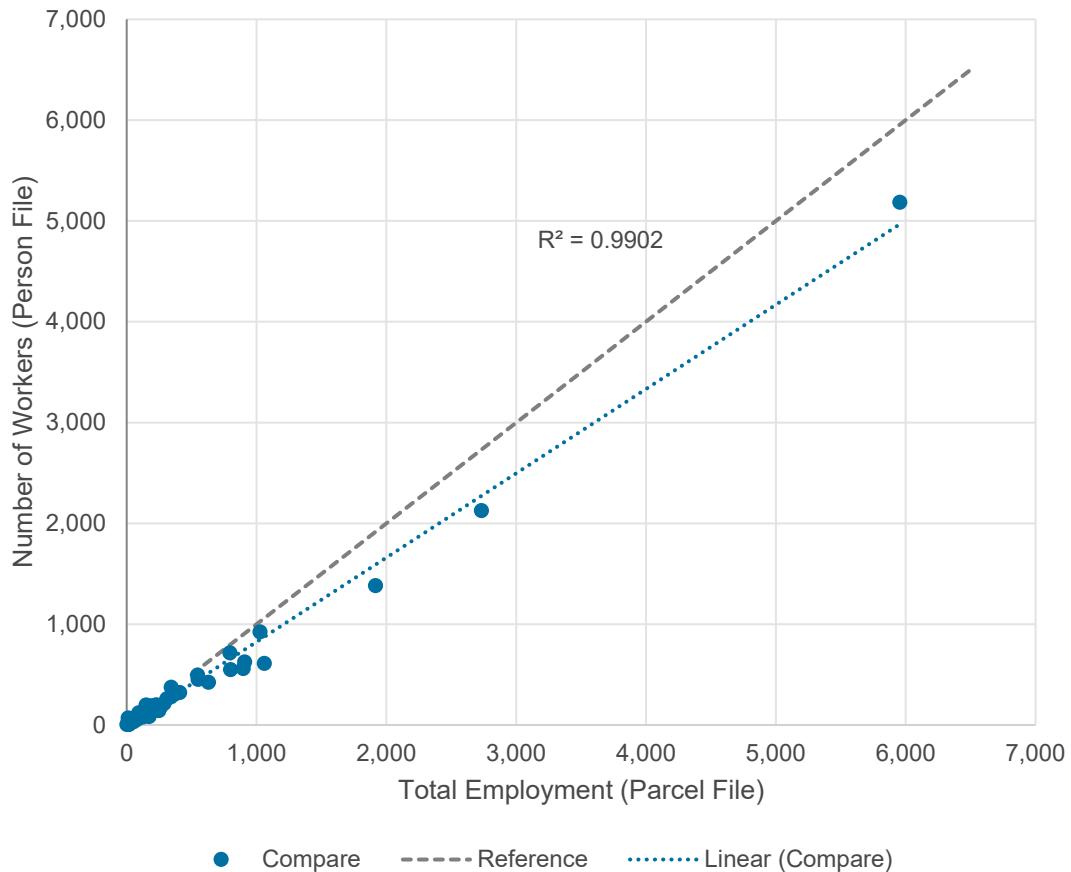


FIGURE 6. EMPLOYMENT VS WORKERS BY TAZ

Table 13 compares the estimated workers working at a location and the corresponding employment and observed workers are at an aggregate geography (10 districts). A map of the districts is shown in Figure 7. The comparison once again confirmed DaySim's ability to balance workers' work location with the available employment. The comparison is extended to compare estimated workers with observed workers from LODES. Note that for comparison observed datasets are scaled to match estimated workers by home district. The number of workers by district generally matches the employment data well, with most districts falling within 10% of the employment data.

TABLE 13. WORKERS BY DISTRICT

WORK DISTRICT	LEHD	EMPLOYMENT	ABM	%DIFF (ABM- EMP/EMP)
1	34,746	35,910	40,695	13%
2	13,032	14,287	11,153	-22%
3	19,844	18,593	20,005	8%
4	31,315	24,299	24,981	3%
5	24,319	25,400	26,074	3%
6	16,505	16,162	15,822	-2%
7	13,970	13,642	13,575	0%
8	44,121	42,375	44,591	5%
9	12,351	13,690	13,300	-3%
10	84,419	90,264	84,427	-6%
TOTAL	294,623	294,623	294,623	0%

NOTES:

LEHD data include workers travelling from out of Fresno

ABM is estimated workers working within the Fresno region only

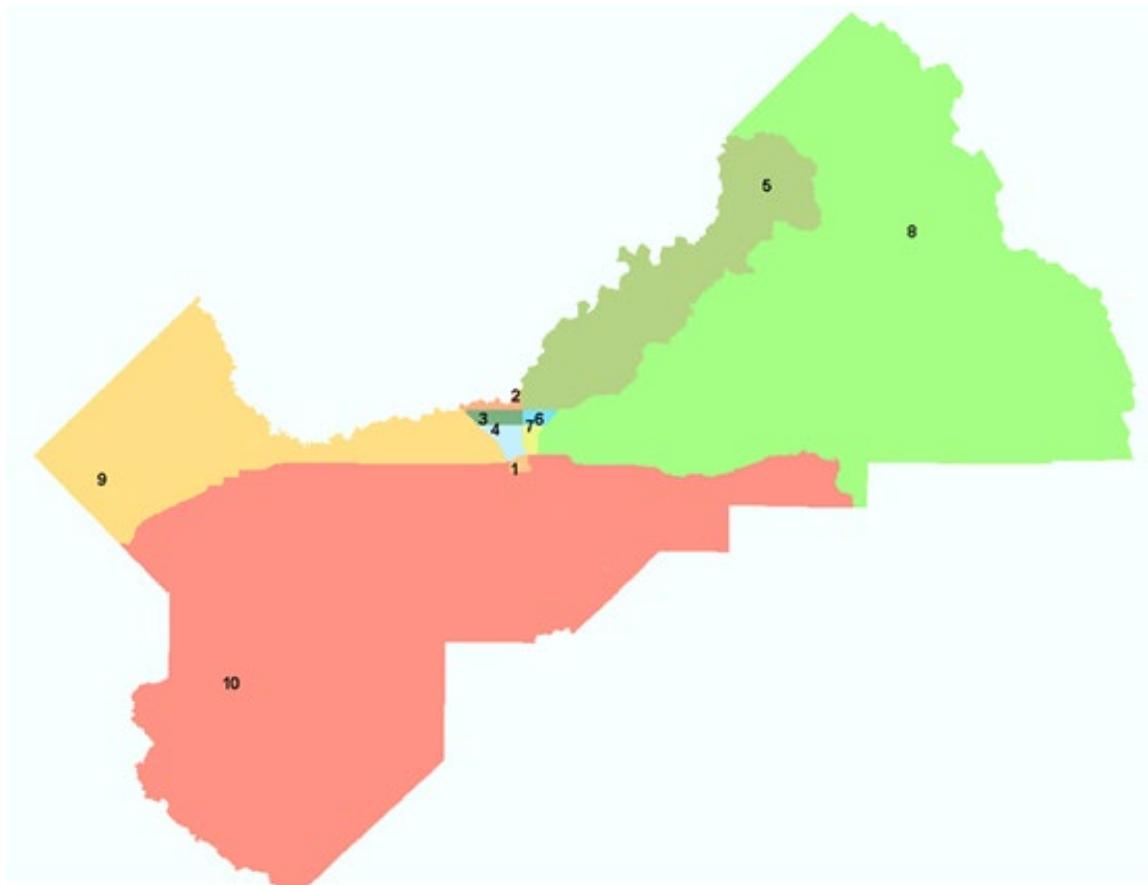


FIGURE 7: MAP OF DISTRICTS

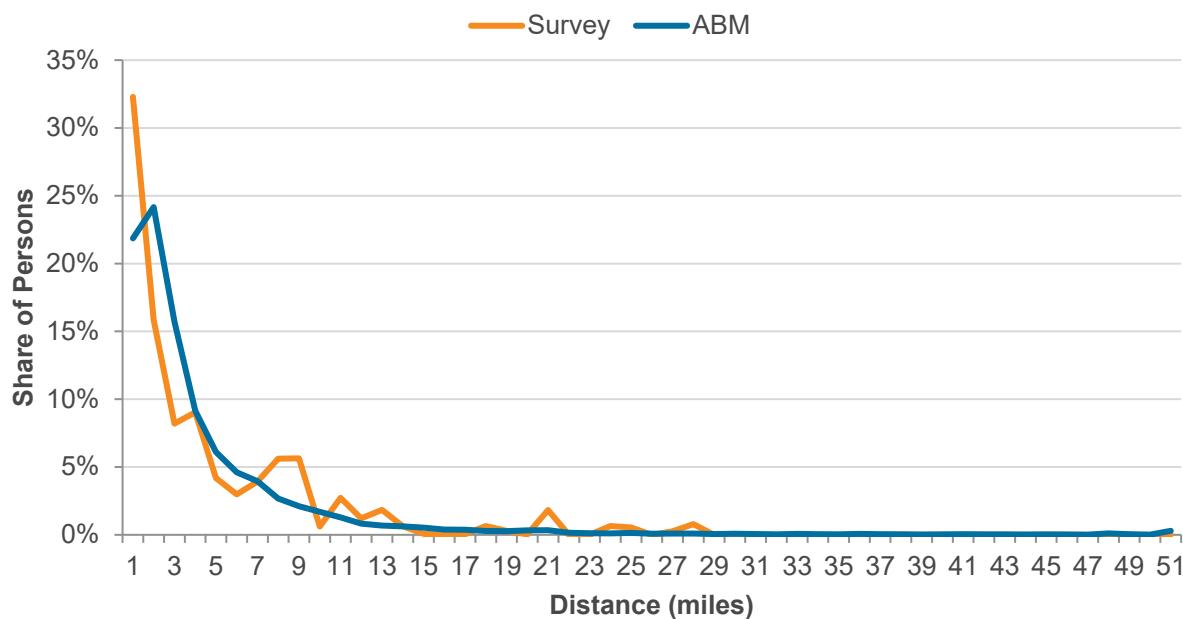
Home to School Distance

The average distance travelled by students to go from home to school is 4.06 miles from the ABM. The CCTS data suggest a slightly higher average distance (4.38 miles), as shown in Table 14. The model did not require calibration as it's within 10% of the survey data.

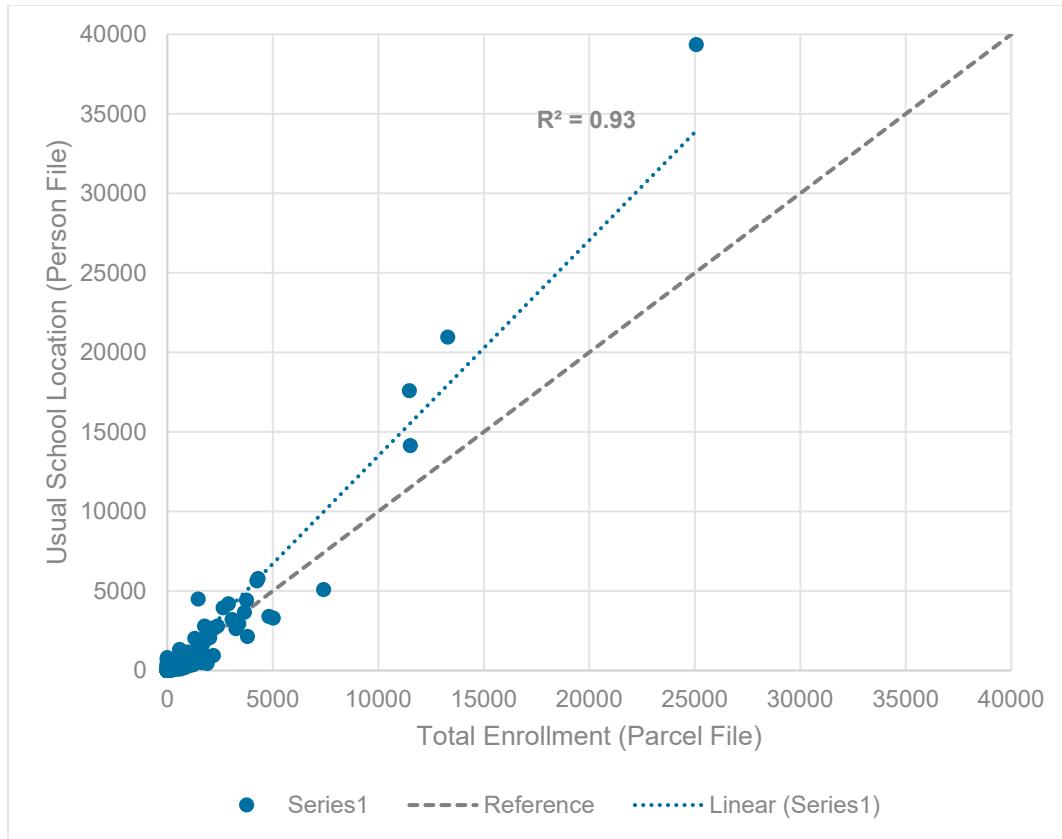
TABLE 14. AVERAGE HOME TO SCHOOL DISTANCE (MILES) BY STUDENT TYPES

STUDENT TYPE	CCTS	ABM
Kids 5 to 15	3.3	2.7
Student 16+	5.5	5.2
University Student	7.7	7.6
Total	4.4	4.1

Figure 8 presents a comparison of observed and estimated frequency distribution of trip lengths between home and school. Because of limited sample size, the survey distribution is not very smooth.

**FIGURE 8: DISTRIBUTION OF HOME TO SCHOOL DISTANCE**

A comparison of estimated school locations with the corresponding enrollment by TAZ exhibits a reasonable match with a R-squared value of 0.93 (Figure 9). The visible overestimation is due to difference in input enrollment (287k) and number of students (294k) in the synthetic population.

**FIGURE 9: ENROLLMENT VS STUDENTS BY TAZ**

Auto Ownership

The auto ownership model predicts the number of vehicles owned by a household. The auto ownership model is structured as a multinomial logit (MNL) with five available alternatives: 0, 1, 2, 3, and 4+. Key variables are the numbers of working adults, non-working adults, students of driving age, children below driving age and income.

The observed distributions of households are developed by first generating distribution by number of drivers and autos owned using the 5-year 2015-2019 PUMS and then scaling it to match households by autos owned at the county level from the 1-year 2023 ACS data. Figure 10 shows that the model matches the observed data reasonably well and did not require calibration.

Detailed summaries of auto-ownership by number of drivers in the household is available in Appendix A.

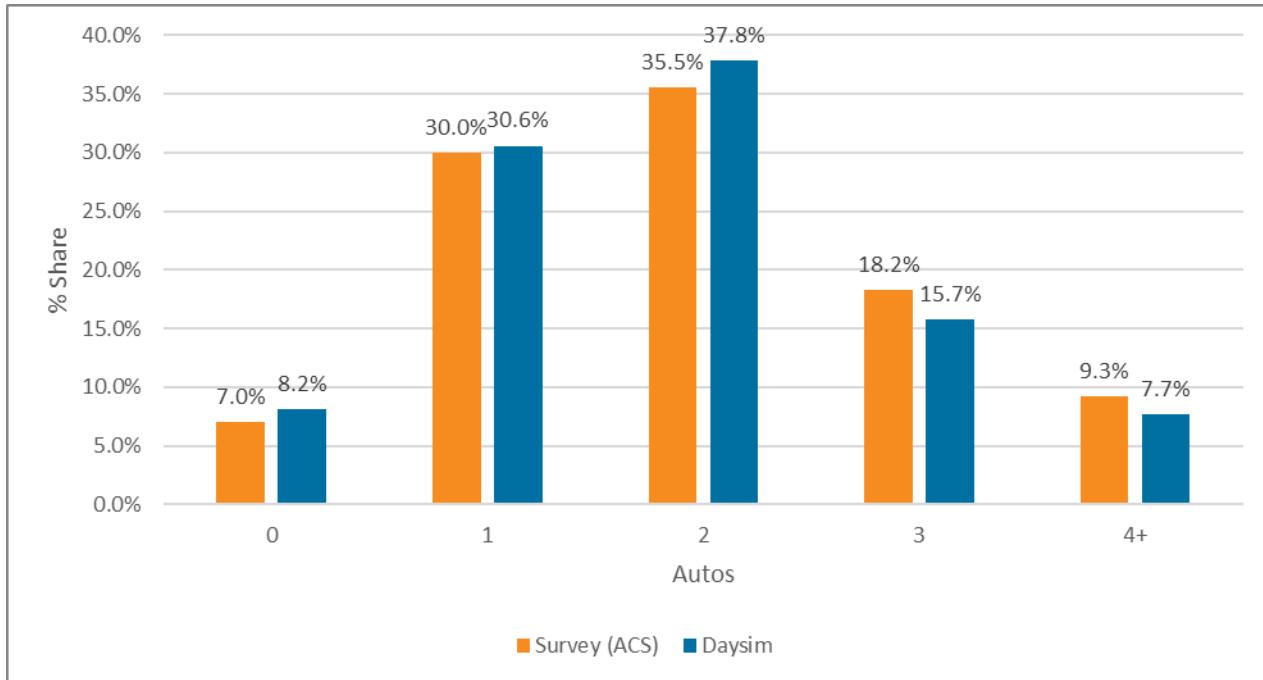


FIGURE 10. AUTO OWNERSHIP DISTRIBUTION – REGIONAL

Day Pattern

Day pattern summaries compare observed and estimated resident travel (tours and trips) by purpose and person type. Table 15 compares distribution of tours by tour purpose in the CCTS and the model in the Fresno County. The work tours were calibrated in the 2023 base year model update by worker type (work from home, telecommute, or other). The rest of the purposes were not calibrated and use the same model parameters as the previous model (2019 base year) as the modeled VMT matches with the observed data reasonably well.

TABLE 15: TOURS BY PURPOSE

TOUR PURPOSE	CCTS	ABM	DIFF (ABM-CCTS)
Work	23%	22%	-1%
School	17%	18%	1%
Escort	15%	15%	0%
Personal Business	11%	11%	0%
Shop	14%	11%	-3%
Meal	6%	4%	-2%
Social/Recreation	11%	12%	1%
Work-based	3%	7%	4%
Total	100%	100%	0.0%

A tour rate is calculated as number of tours divided by number of persons. Table 16 compares tour rates by tour purpose. The CCTS indicates on average 1.36 tours per person in the Fresno County. The work tour rate is under-estimated because the model was calibrated by tour frequency distribution (% of workers with 0, 1, 2+ work tours), but the weighted survey data includes adjustment factors that increases the tour weights (and therefore tour rates) without changing the tour frequency distribution and person weights. The survey was conducted as the region was coming out of the pandemic and there may have been a lot of pent up travel demand for non-mandatory purposes. Since the primary goal is to calibrate the model to match the observed VMT, all non-work tour rates were not calibrated.

TABLE 16. TOUR RATE BY PURPOSE

TOUR PURPOSE	CCTS	ABM	DIFF (ABM-CCTS)
Work	0.31	0.24	-0.07
School	0.23	0.20	-0.03
Escort	0.21	0.16	-0.05
Personal Business	0.15	0.12	-0.03
Shop	0.19	0.12	-0.07
Meal	0.08	0.04	-0.03
Social/Recreation	0.15	0.13	-0.01
Work-based	0.04	0.07	0.03
Total	1.36	1.09	-0.27

Table 17 compares observed and estimated tours by person type. Generally, the tours in the ABM match with the CCTS distribution by person type. Some differences are due to the differences observed by tour purpose. Children aged 0-4 is not shown here because the survey does not collect travel diaries for children aged 4 and under.

TABLE 17. TOURS BY PERSON TYPE

PERSON TYPE	CCTS	ABM	DIFF
Full-Time Worker	43%	37%	-6%
Part-Time Worker	7%	5%	-2%
Retired	8%	10%	2%
Non-Worker	16%	18%	2%
University Student	7%	8%	1%
Student 16+	3%	4%	1%
Child Age 5-15	17%	18%	1%
Total	100%	100%	0%

Table 18 presents a comparison of tour rates by person type. Full-time and part-time workers are under-estimated because the calibration efforts focused on targeted calibration to match VMT and work tour frequency, and the scheduling constraints did not allow for all submodels to be calibrated. All other person types match reasonably well.

TABLE 18. TOUR RATE BY PERSON TYPE

PERSON TYPE	CCTS	ABM	DIFF (ABM-CCTS)
Full-Time Worker	1.64	1.13	-0.51
Part-Time Worker	1.56	0.96	-0.60
Retired	0.94	0.90	-0.04
Non-Worker	1.23	1.12	-0.11
University Student	1.56	1.49	-0.08
Student 16+	0.96	1.12	0.16
Child Age 5-15	1.21	1.03	-0.17
Total	1.36	1.09	-0.27

The distribution of ABM trips by trip purpose matches well with the CCTS data in Fresno County, as shown in Table 19. Trip rates were not calibrated in the 2023 base year model update.

TABLE 19. TRIPS BY PURPOSE

TRIP PURPOSE	CCTS	ABM	DIFF (ABM-CCTS)
Work	10%	13%	2.9%
School	7%	7%	0.1%
Escort	12%	9%	-3.5%
Personal Business	9%	10%	1.0%
Shop	11%	14%	2.6%
Meal	7%	8%	1.1%
Social/Recreation	6%	7%	1.0%
Home	38%	33%	-5.1%
Total	100%	100%	0.0%

As shown in Table 20, according to the CCTS data, a resident of the Fresno County makes 4.01 trips in a day on average. The ABM is under-estimating trip rates (3.05) compared to the survey data because the tour rates are under-estimated as explained above. Note that the model calibration was guided by validation of highway VMT.

TABLE 20. TRIP RATE BY PURPOSE

TRIP PURPOSE	CCTS	ABM	DIFF (ABM-CCTS)
Work	0.39	0.39	-0.01
School	0.27	0.21	-0.06
Escort	0.49	0.26	-0.23
Personal Business	0.35	0.30	-0.05
Shop	0.44	0.41	-0.03
Meal	0.29	0.26	-0.04
Social/Recreation	0.23	0.20	-0.02
Home	1.54	1.02	-0.53
Total	4.01	3.05	-0.96

As indicated in Table 21, the CCTS data suggests, on average, residents of Fresno County make 2.94 trips on a tour. The ABM produces a similar estimate of 2.79 trips per tour for the residents of the Fresno region.

TABLE 21. TRIPS PER TOUR BY PURPOSE

DESTINATION PURPOSE	CCTS	ABM	DIFF (ABM-CCTS)
Work	1.25	1.61	0.36
School	1.17	1.06	-0.11
Escort	2.34	1.63	-0.72
Personal Business	2.34	2.45	0.11
Shop	2.32	3.52	1.20
Meal	3.87	5.97	2.10
Social/Recreation	1.54	1.52	-0.02
Total	2.94	2.79	-0.15

The distribution of model trips by person type categories is similar to the CCTS data, as summarized in Table 22.

TABLE 22. TRIPS BY PERSON TYPE

PERSON TYPE	CCTS	ABM	DIFF
Full-Time Worker	43%	40%	-4%
Part-Time Worker	7%	5%	-1%
Retired	9%	10%	1%
Non-Worker	17%	17%	0%
University Student	7%	9%	2%
Student 16+	2%	4%	1%
Child Age 5-15	14%	16%	2%
Total	100%	100%	0.0%

As presented in Table 23, similar to the tour rate by person type (see Table 18), the County trip rate in the ABM is lower (3.05 trips/person) than the CCTS trip rate (4.05 trips/person). Person type categories too show lower trip rates in the ABM.

TABLE 23. TRIP RATE BY PERSON TYPE

PERSON TYPE	CCTS	ABM	DIFF (ABM-CCTS)
Full-Time Worker	4.90	3.41	-1.50
Part-Time Worker	4.43	2.71	-1.71
Retired	3.16	2.53	-0.64
Non-Worker	3.91	2.96	-0.95
University Student	5.08	4.68	-0.39
Student 16+	2.32	2.77	0.45
Child Age 5-15	2.89	2.45	-0.44
Total	4.01	3.05	-0.96

Other Tour Destination

A comparison of average tour lengths by purpose between the observed (CCTS) and the model data is presented in Table 24. A tour length is calculated as distance between tour origin and primary destination. The comparison includes only non-mandatory tour purposes, as mandatory tour purposes (work and school) have already been discussed before (see Table 12 and Table 14). Due to insufficient sample size for each purpose category, shopping and personal business purposes are aggregated into the Maintenance category, and meal and social/recreational purposes are aggregated into the Discretionary category.

Due to the small sample size in the observed datasets, the tour length frequency distributions are very lumpy (CCTS distributions by purpose is available in Appendix A) which makes it difficult to know the real travel behavior for these tours. Tour destination models were not calibrated in the 2023 base year model update.

TABLE 24. AVERAGE TOUR LENGTHS FOR OTHER TOUR PURPOSE

TOUR PURPOSE	CCTS	ABM
Maintenance	5.4	4.6
Discretionary	4.4	4.4
Escort	4.5	4.1
Work-based	2.7	3.5

Tour Mode Choice

Tour mode is an abstract concept, defined as the main mode of travel used to get from the origin to the primary destination and back. The following 9 tour modes are available in the ABM: drive alone, shared-ride 2, shared-ride 3+, bike, walk, drive-transit, walk-transit, school bus, and TNC. The tour mode is coded in the survey based on a set of rules that are dependent on the combination of trip modes used on the tour. The rules can be summarized as follows:

- Any tour with a transit trip is defined as a transit tour
 - Any transit tour with a PNR-transit trip is defined as a PNR-transit tour
 - Any transit tour with neither a PNR-transit trip or a KNR-transit trip is defined as a walk-transit tour
- Any tour with a bicycle trip is defined as a bicycle tour
- Any tour with an auto trip is defined as an auto tour
 - The highest occupancy mode of all auto trips on the tour is used to set the occupancy of the tour
- Remaining tours are walk tours

A similar set of rules is used in tour mode choice to constrain the availability of trip modes based on tour mode. These rules also influence the accessibilities used to choose the locations of intermediate stops on tours; for example, transit and walk accessibilities are used to choose stop locations on transit tours, rather than auto accessibilities.

After scaling the original CCTS targets to accommodate transit targets from the 2024 transit on-board survey, the CCTS targets are scaled one more time for tour mode calibration. Generally, a tour mode choice calibration aims to adjust the mode choice model so that the distribution of tours by mode is similar to observed share. Therefore, tour mode choice adjustments are made to alternative-specific constants to match observed mode shares. As transit tour targets are calculated directly from a transit on-board survey, the model needs to be calibrated to the same numbers. However, when calibrated using mode shares, the number of transit tours based on

the share of transit mode in the CCTS would result in a different number due to a different value of total tours in the ABM. For example, if a survey says that there are 100 transit tours among 10,000 total tours, then the transit share would be 1%. However, if the model is generating 12,000 total tours, then calibrating the model to the survey transit share of 1% will result in 120 transit tours. Since we want to calibrate the model to match the absolute number of transit tours inferred from the on-board survey, we adjust observed tours by mode, keeping the transit tours constant but scaling other modes to match total tours in the model by purpose and auto sufficiency.

Overall, the tour mode shares in the ABM match the CCTS shares reasonably well (Figure 11). The comparison within the tour purpose categories are available in Appendix A. The CCTS observes an overall tour mode share of 35.6% by drive-alone (SOV) and 25.7% and 25.4% by shared-ride 2 and shared-ride 3, respectively compared to the ABM shares of 35.9%, 25.5% and 27.0%. The non-motorized tour modes (walk and bike) make up for 9.0% of the tours in the region according to the CCTS, compare to 8.3% in the ABM. The newly implemented TNC mode is a very small percent of total mode share. Only 1.3% of the tours in CCTS use some form of transit mode, where most of those transit tours use walk to transit (1.1%) compared to the model share of 1.0% which are almost exclusively walk to transit.

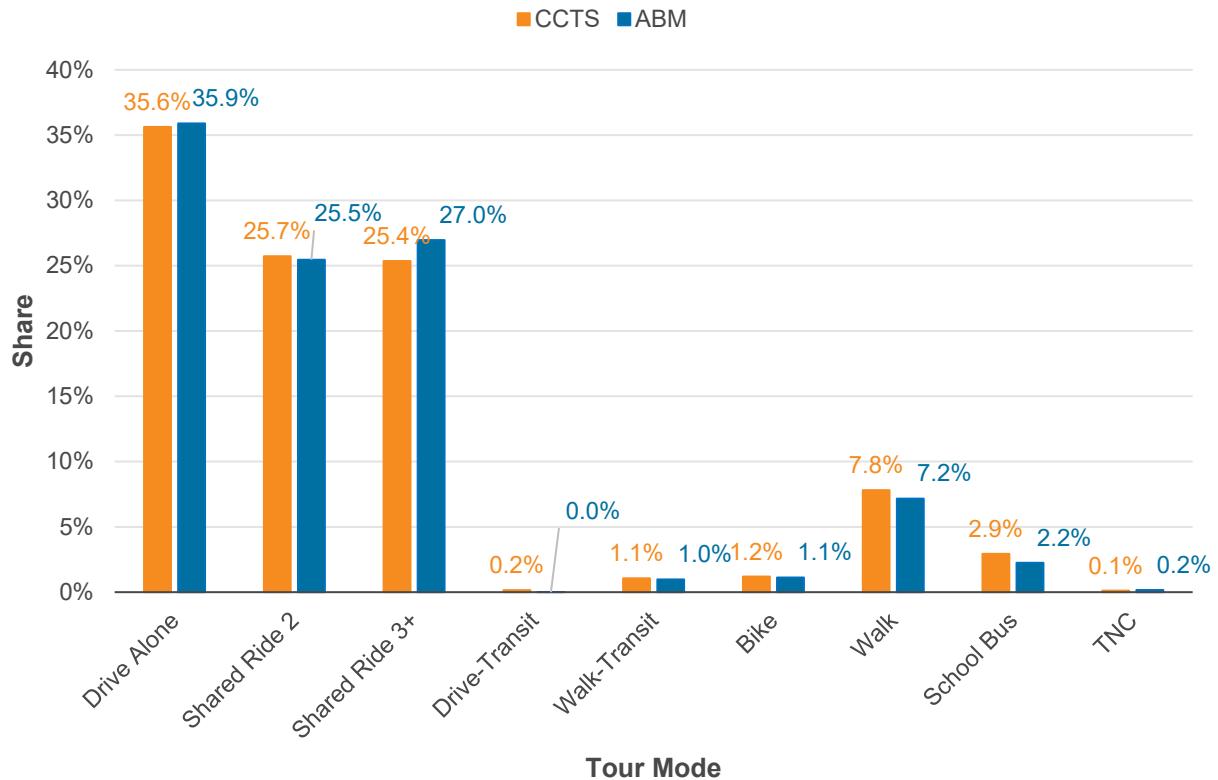


FIGURE 11. TOUR MODE SHARES (TOTAL)

Trip Destination

As presented in Table 25, the CCTS data suggest an average trip length of 4.81 miles regionwide (Fresno). The ABM produces a slightly higher trip length of 5.18 miles. The purpose is based on the destination purpose of the trip, e.g., a trip from work to home is considered to have a “home” trip destination purpose. The model was not calibrated in the 2023 base year model update as the overall model average trip length is within 10% of the survey data.

TABLE 25. AVERAGE TRIP LENGTHS

TRIP PURPOSE	CCTS	ABM
Home	5.0	5.4
Work	7.6	6.6
School	4.2	3.6
Escort	4.2	4.8
Personal Business	5.8	5.5
Shop	3.5	4.8
Meal	3.1	4.6
Social/Recreational	4.3	4.5
Total	4.8	5.2

Tour Time-of-Day

Plots of tour arrival and departure times at primary destination are presented in Figure 12 through Figure 19. The ABM distributions generally match well with the CCTS distribution by purpose, so the tour time-of-days models did not require calibration in the 2023 base year model update.

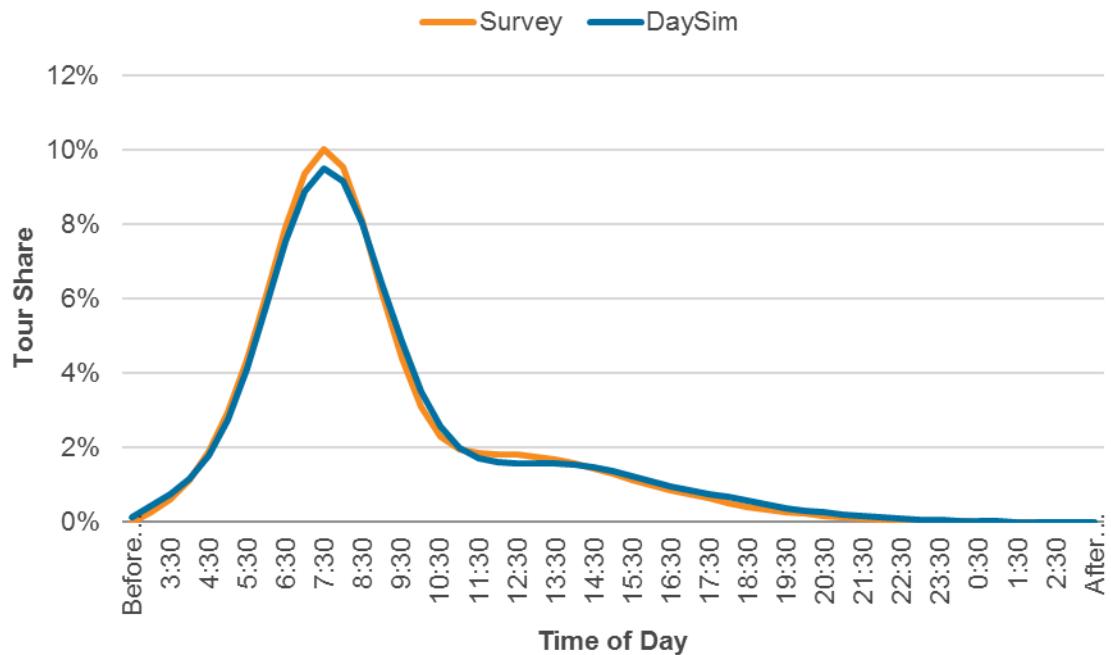


FIGURE 12: TIME OF DAY DISTRIBUTION OF WORK ARRIVAL TIMES

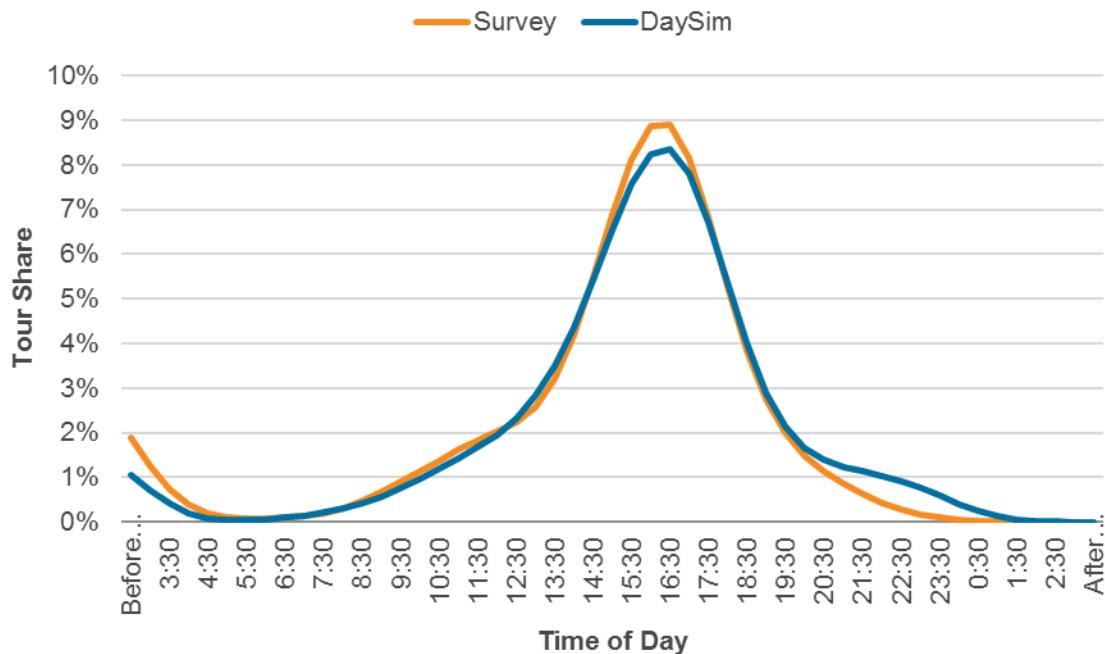


FIGURE 13: TIME OF DAY DISTRIBUTION OF WORK DEPARTURE TIMES

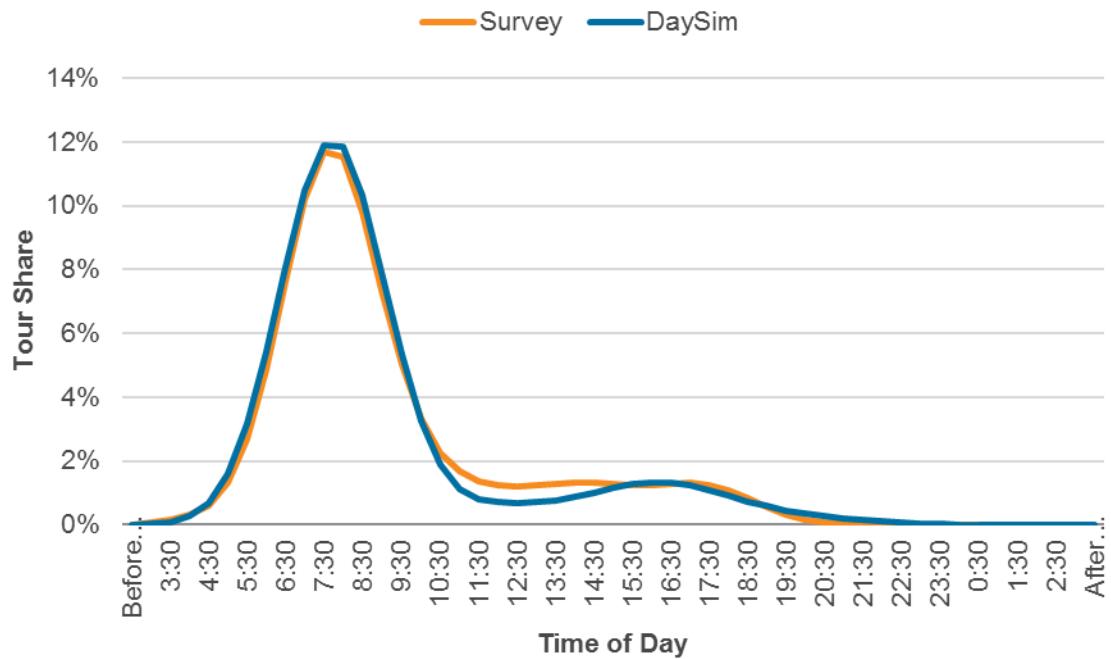


FIGURE 14: TIME OF DAY DISTRIBUTION OF SCHOOL ARRIVAL TIMES

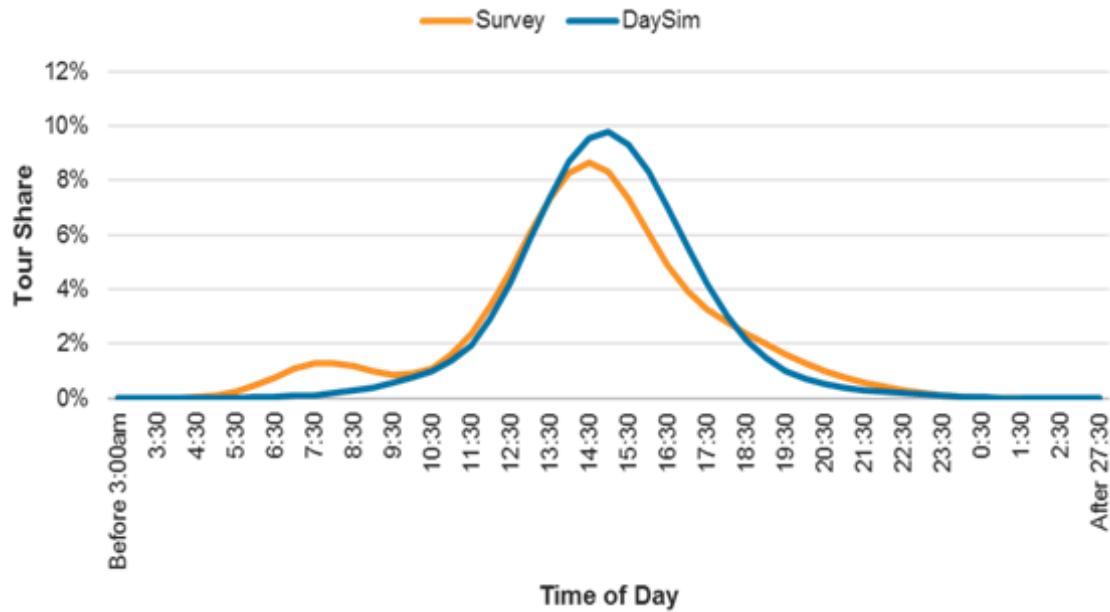


FIGURE 15: TIME OF DAY DISTRIBUTION OF SCHOOL DEPARTURE TIMES

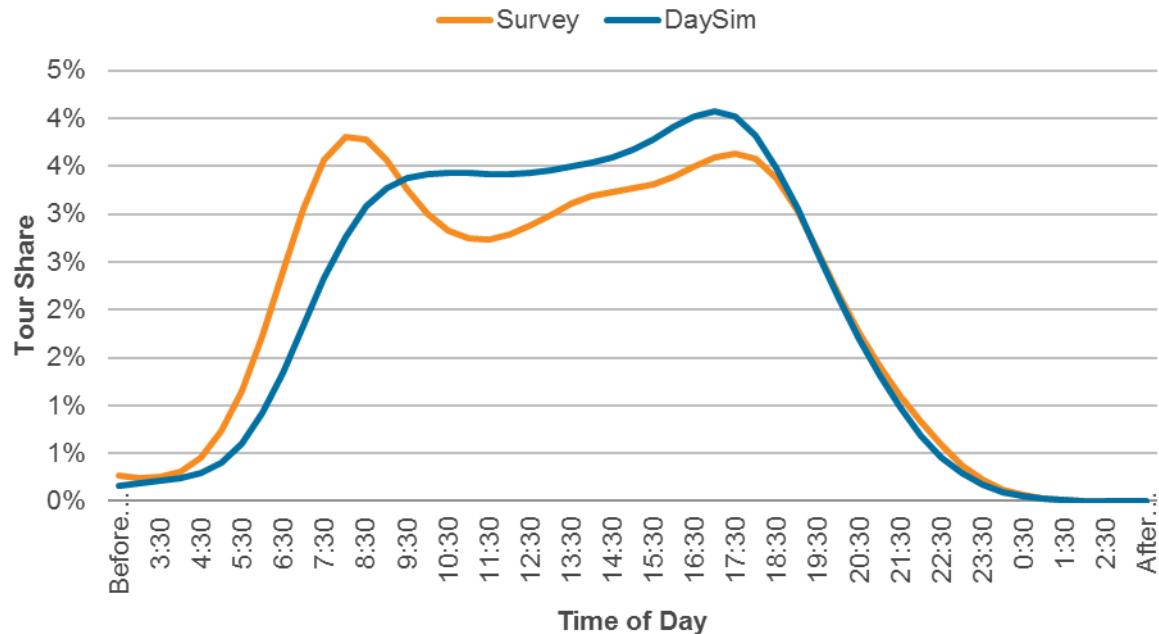


FIGURE 16: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE ARRIVAL TIMES

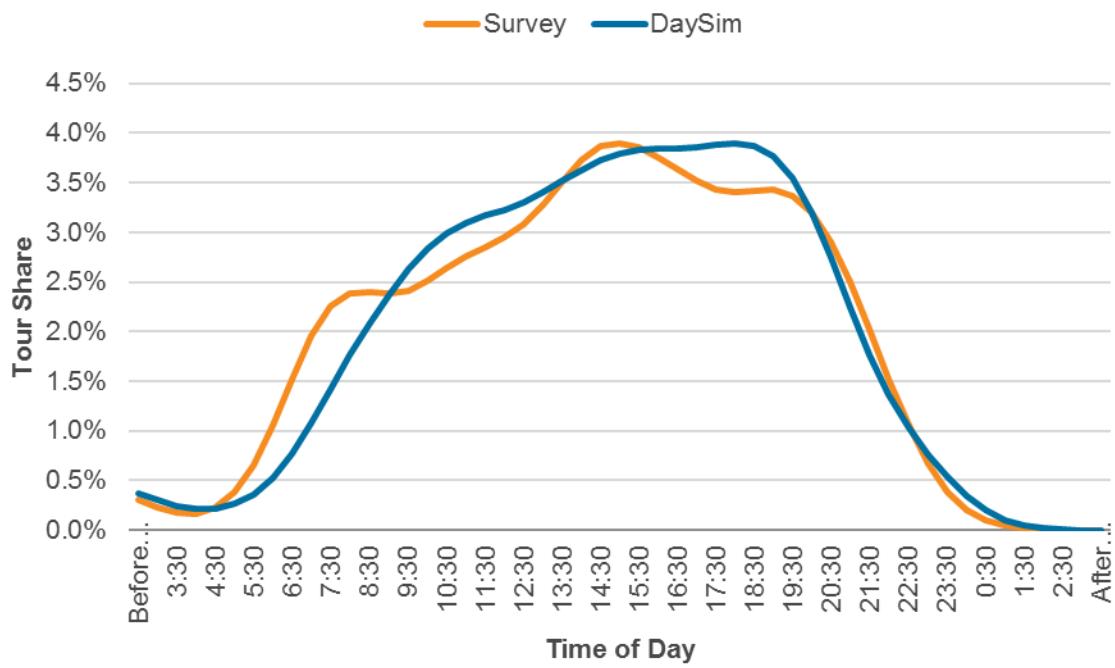


FIGURE 17: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE DEPARTURE TIMES

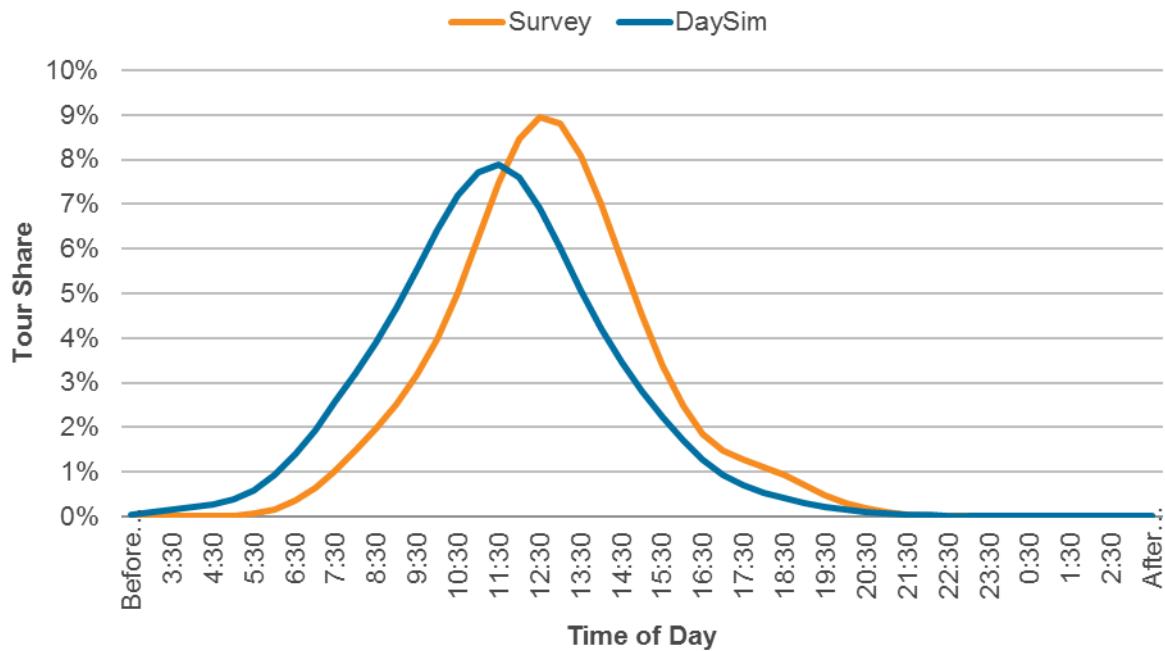


FIGURE 18: TIME OF DAY DISTRIBUTION OF WORK-BASED ARRIVAL TIMES

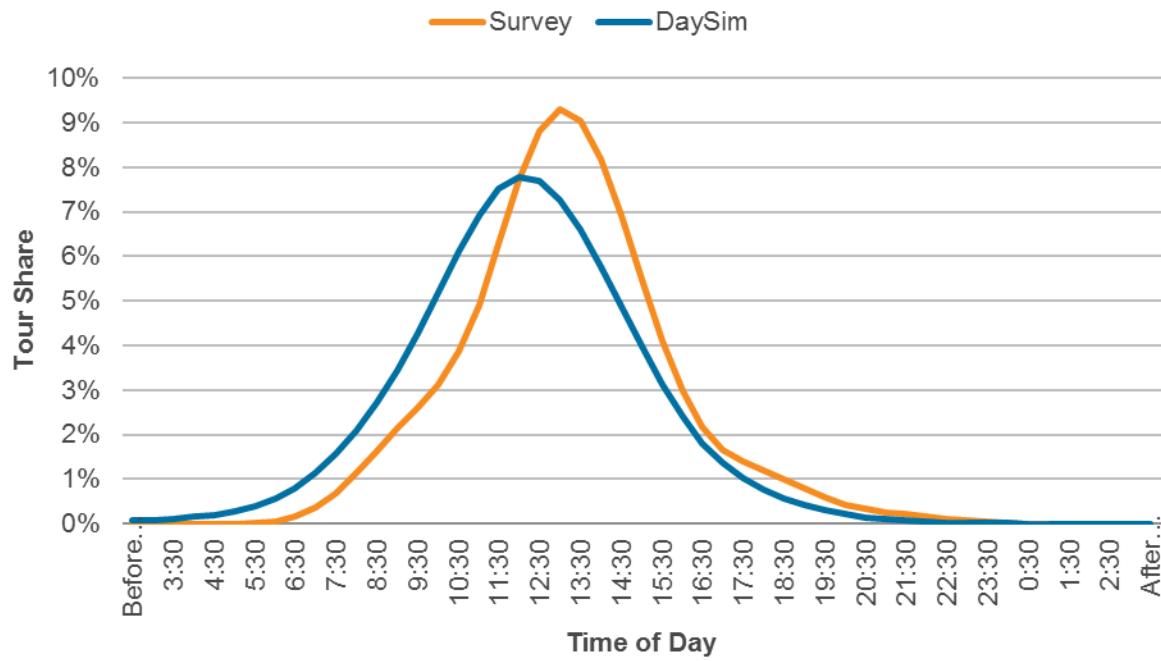


FIGURE 19: TIME OF DAY DISTRIBUTION OF WORK-BASED DEPARTURE TIMES

Trip Mode Choice

Trip mode targets are prepared from the CCTS data and updated with transit trip targets from the 2024 transit on-board survey. Other mode targets are appropriately scaled to keep the total trips by purpose the same, similar to the process described above for creation of tour mode choice targets. This ensures that the absolute number of expanded transit trips from the transit on-board survey is matched in calibration.

The trip mode choice model can be thought of as a ‘mode switching’ model, in which the tour mode constrains which modes are available for trips on tours. The trip mode choice model did not require calibration in the 2023 base year model update.

Overall, the ABM generates a trip mode distribution which is very similar to observed (Figure 20). The trip mode share by purpose distributions can be found in Appendix A. The CCTS data indicate that on an average weekday, 41.0% trips in the Fresno County are drive alone and 43.3% are shared-ride (SR2 and SR3), approximately 1.6% of Fresno County resident trips are made by transit, and 14.1% are made by a non-motorized mode (walk or bike).

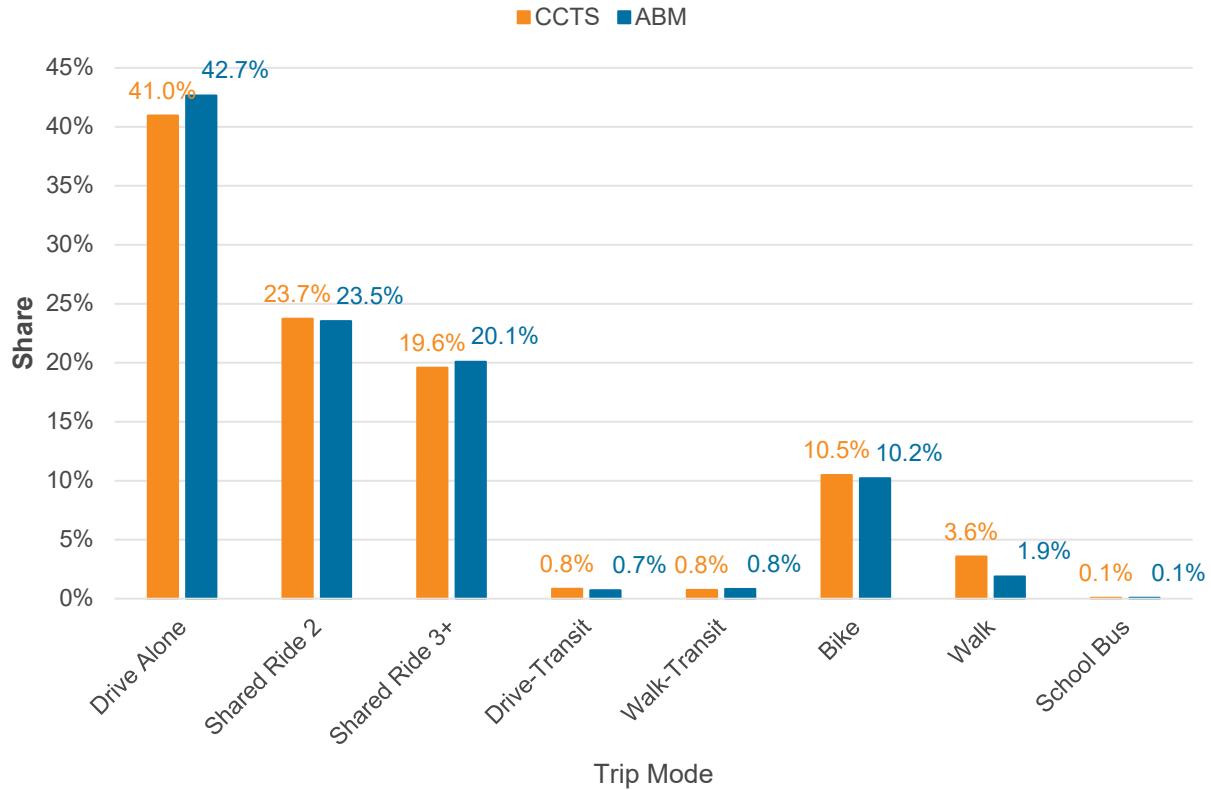


FIGURE 20: TRIP MODE SHARES (TOTAL)

3.2 MODEL VALIDATION

A model validation tests the model's predictive capabilities before it is used to produce forecasts. There are two types of model validation:

- The static validation compares model outputs against independent data that was not used to build the travel model. Model parameters are adjusted until the outputs from model assignment fall within an acceptable range of error to the observed data.
- The dynamic validation involves systematically varying the model inputs to assess the reasonableness of model responses, which is described later in Section 4.0.

In the assignment step, model demand (e.g. trips by time period, mode, and vehicle class\value-of-time) are loaded on to network. In highway assignment, the output includes vehicle flows on every link (road) in the highway network and for transit assignment, the output includes the number of boardings on each route. These are compared to observed traffic counts and observed transit ridership respectively. The two observed datasets (traffic counts and transit

boardings) used in the present model validation are described in the next section, followed by highway, transit, and non-motorized validation summaries.

Note that, if available, model performance is compared against recommended guideline in the FHWA's Travel Model Validation and Reasonableness Checking Manual (Cambridge Systematics, Inc. 2010). However, the latest version of the manual does not recommend any particular threshold to assess reasonableness of model performance. This report does mention the previously recommended thresholds, however, does not strictly follow those in examining validation summaries. The thresholds are included just for informational purpose.

Validation Data

Table 26 presents a list of datasets utilized in the validation of the Fresno ABM.

TABLE 26. MODEL VALIDATION DATASETS

DATASET	YEAR	SOURCE	PURPOSE
Traffic Counts	2023	CalTrans and Fresno COG	Highway Validation
Vehicle Miles Travelled (VMT)	2023	CalTrans Highway Performance Management System (HPMS)	Highway Validation
Transit Ridership	2024	FAX, Clovis Transit, and FCRTA	Transit Validation

Highway

Observed traffic counts are used to validate link-level estimated daily traffic flow generated by a model, whereas the observed vehicle miles travelled (VMT) validates the regionwide network-usage as estimated by the model.

Traffic Counts (CalTrans and local)

The observed traffic counts are assembled from four sources: CalTrans, Fresno COG, Fresno City and Clovis City. The Caltrans traffic census program¹⁵ provides traffic counts on highways (interstates and state routes) in the State of California. These Caltrans traffic counts in year 2023 are downloaded for the Fresno region and in a shapefile format. The count locations (points) in the shapefile are then joined to the model roadway network using a combination of automated and manual review process. The automated process first matched the points in the shapefile to the network links and the manual process reviewed the match and corrected the

¹⁵ <http://www.dot.ca.gov/trafficcops/census/>

joins that appeared incorrect. Also, an appropriate count value (Before AADT or After AADT) is assigned to the joined link in the model network.

Fresno COG provided processed and geocoded traffic counts for freeways from Caltrans and for the other facility types (arterial, collector, local etc.) from the County and the two cities. The traffic counts already had the corresponding model network link for a count. However, during the model validation, several issues related to suspect wrong link match were discovered therefore some traffic counts and network attributes such as speed, lane, and facility type were manually reviewed for their correctness.

VMT

The 2023 observed VMT is obtained from Caltrans Highway Performance Monitoring System (HPMS)¹⁶. Caltrans provide daily vehicle miles of travel for Fresno COG.

Transit

Transit ridership (boardings) by route are compared to the estimated boardings in the model by transit line for transit validation.

Transit Boardings

The transit boardings are assembled from three sources: FAX, Clovis Transit and FCRTA. The three transit agencies provided monthly ridership in 2023 and 2024 for their transit routes.

Ridership data are weekday data (excluding holidays) for May 2024 for FAX, October 2023 to February 2024 for Clovis Transit, and February 2024 for FCRTA.

Highway Validation

The estimated traffic flows from the model and the observed traffic counts are compared in various dimensions, including:

- Region
- Facility Type
- Volume Group
- Key Corridors

Region

The observed traffic count database used in this model validation effort encompass 1,231 links on the highway network. The total traffic across these links amounts to 15.3 million vehicles as

¹⁶ Table 9 in <https://dot.ca.gov/-/media/dot-media/programs/research-innovation-system-information/documents/hpms2023-prd-final.pdf>

shown in Table 27. On the same links, the ABM under-estimates the traffic volume on these links by around 8.3% (14.0 million vehicles). According to the HPMS, on an average weekday in year 2023, the roadway travel in the Fresno region resulted in 23.24 million vehicle miles of travel (VMT). The estimated traffic flows from the ABM produce a daily regionwide VMT value of 22.11 million, within 5% of the observed estimate from the HPMS.

TABLE 27. HIGHWAY VALIDATION – REGION

MEASURE	OBSERVED	ABM	DIFF	% DIFF
Traffic Volume	15,256,975	13,990,168	(1,266,807)	-8.3%
VMT*	23,239,900	22,108,063	(1,131,837)	-4.9%

Note: Observed VMT is from the HPMS estimate of the total VMT in the Fresno region for year 2023

Regionally, the estimated traffic flows are compared with the observed traffic counts by creating a scatter plot, Figure 21. Points in the scatter plot are links where traffic counts are available. A point represents observed traffic count on the X-axis and the corresponding estimated flow on the Y-axis. The scatter plot includes several measures/guidelines assessing accuracy of the model flows with respect to the observed traffic counts.

First, the plot includes a 45-degree line representing a virtual scenario of perfect match between traffic counts and estimated flows. The 45-degree line is useful in quickly identifying overestimation (flow>count) or underestimation (flow<count) of a flow. Highway validation aims to make most points as close to this line as possible. An ideal validation would have all count locations on the 45-degree line. However, a perfect match for all count locations is almost impossible to achieve due to various reasons such as errors in traffic counts, simulation errors in the model, etc. Acknowledging this fact, Caltrans provides recommendations on maximum (high and low) deviations of an estimation flow from the corresponding traffic count value. The scatter plot displays these Caltrans high and low deviations as red and green lines above and below the 45-degree line respectively. Lastly, a linear regressed line of all points is also added to the plot. The slope of the regressed line measures regional match between the estimated flows and the traffic counts - a slope of less than 1 means underestimation regionwide and more than 1 indicates overestimation. The plot also displays a r-squared value representing goodness of fit of all data points.

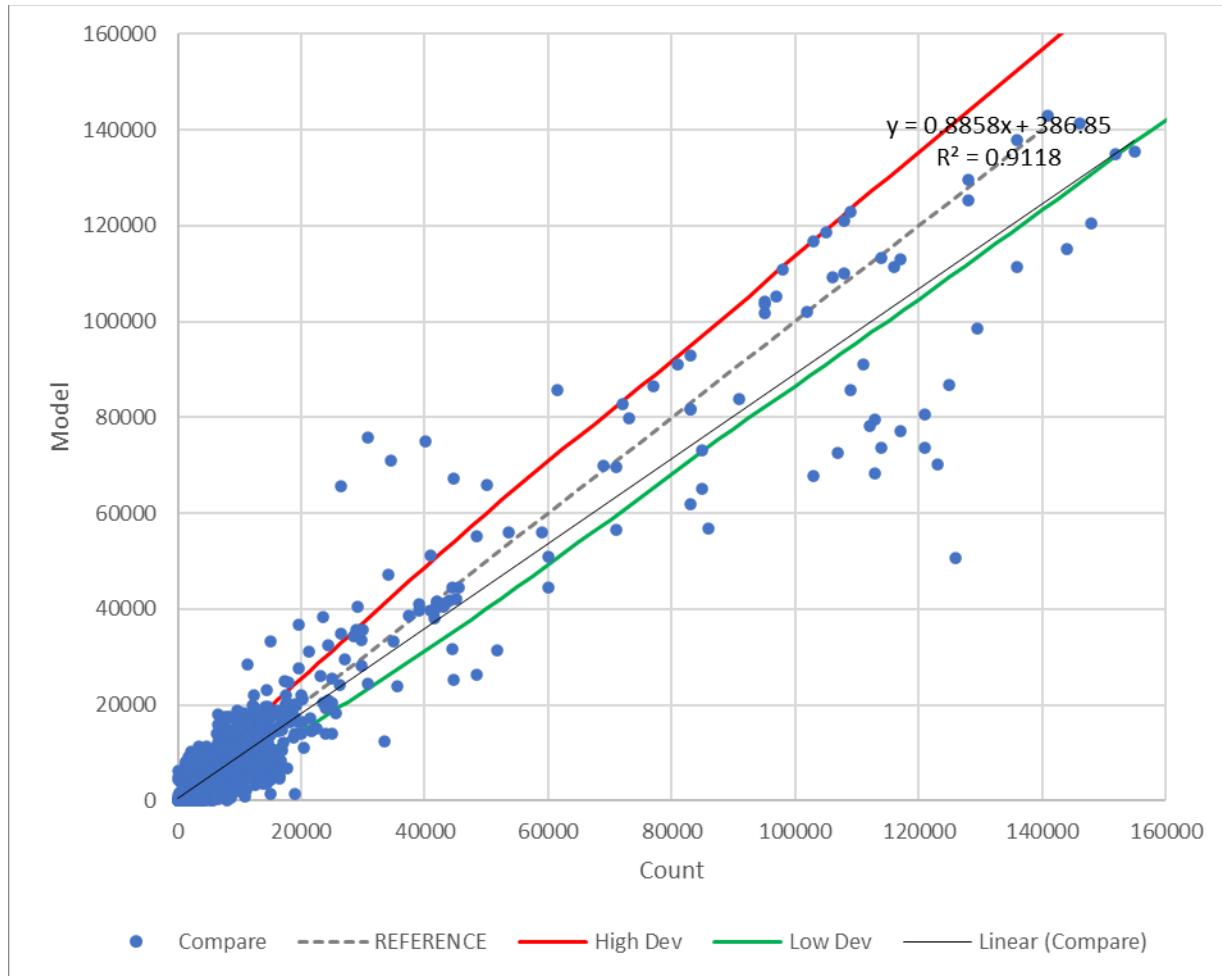


FIGURE 21: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS

As displayed in the scatter plot, the linear regressed line has a slope of 0.89 and R-squared value of 0.91. The r-squared value close to 1.0 indicates that fitted regression line represents the data well.

Facility Type

Table 28 presents a summary of links by facility type. The facilities in the Fresno region are grouped into three categories: freeway, highway, and other (collectors, local roads, ramps). The table also contains the FHWA's guidelines of recommended threshold of difference for each facility type. Overall, the estimated traffic volume from the model matches closely with the total counts on the compared links. The comparison within the facility type exhibits a reasonable match. The model's estimates of traffic volume meet the Caltrans' recommended thresholds for highway and other, while being slightly over the threshold for freeway.

TABLE 28. HIGHWAY VALIDATION – BY FACILITY TYPE

FACILITY TYPE	COUNT	ABM	DIFF	DIFF (%)	*CALTRANS DIFF
Freeway	6,793,500	6,087,074	(706,426)	-10%	7%
Highway, Expressway, Arterial	5,293,730	5,264,214	(29,516)	-1%	15%
Other (Collector, local, ramp, connector)	3,169,745	2,638,880	(530,865)	-17%	25%
Total	15,256,975	13,990,168	(1,266,807)	-8.3%	25%

*Source: FHWA's Travel Model Validation and Reasonableness Checking Manual (Cambridge Systematics, Inc. 2010)

Volume Group

The estimated and observed volumes are compared by the level of volume on the links. Table 29, compares the estimated traffic flows and the traffic counts in 7 volume groups that are formed based on the range of the observed traffic counts. Overall, links with lower volumes show bigger differences and RMSE values. This is not surprising given that these links are more likely to be collectors or arterials and as we discussed before, respective traffic counts are less reliable. The count locations with observed volume less than 60,000 show larger RMSE value than desired. The team reviewed some of these locations and found some network coding issues along SR 180, which were corrected. Beyond that, there weren't any other obvious issues.

TABLE 29. HIGHWAY VALIDATION – BY VOLUME GROUP

VOLUME GROUP	COUNT	ABM	DIFF	DIFF (%)	RMSE	*CALTRANS RMSE
>=0 <1000	49,638	76,959	27,321	55%	244%	60%
>=1000 <2500	318,054	385,869	67,815	21%	125%	47%
>=2500 <5000	944,638	892,496	(52,142)	-6%	62%	36%
>=5000 <10000	2,610,787	2,330,997	(279,790)	-11%	51%	29%
>=10000 <25000	3,448,521	2,969,799	(478,722)	-14%	39%	25%
>=25000 <60000	1,784,337	1,906,054	121,717	7%	38%	22%
>=60000	6,101,000	5,427,994	(673,006)	-11%	23%	21%
ALL	15,256,975	13,990,168	(1,266,807)	-8%	55.3%	40%

* Source: FHWA's Travel Model Validation and Reasonableness Checking Manual (Cambridge Systematics, Inc. 2010)

Key Highway Corridors

Figure 22 presents a spatial distribution of the count locations on the highways in the Fresno region. The color of a point on the map indicates the percent difference between the estimated and observed traffic volume. As shown in the legend, a red means underestimation (<-20%) in the ABM, whereas a green color represents overestimation (>20%). The color becomes darker with increase in overestimation or underestimation. For example, light green indicates overestimation of 20% to 50% and dark green indicates overestimation of more than 50%.

Regionally, it is evident that highways outside the urban areas are generally overestimated in the ABM. That is probably due to the coarser representation of the roadway network in those areas and therefore resulting in missing important streets or incorrect location of the centroid connectors for the zones in those areas. Missing important streets in the roadway network would lead the ABM to re-route the traffic to other major streets and overestimate the volume on these major streets. Incorrect locations of the centroid connectors would load unreasonable demand onto the connected facility, thus resulting in higher estimation of traffic volume on the facility. The roadway network should be reviewed for these issues to improve ABM's performance in those areas.

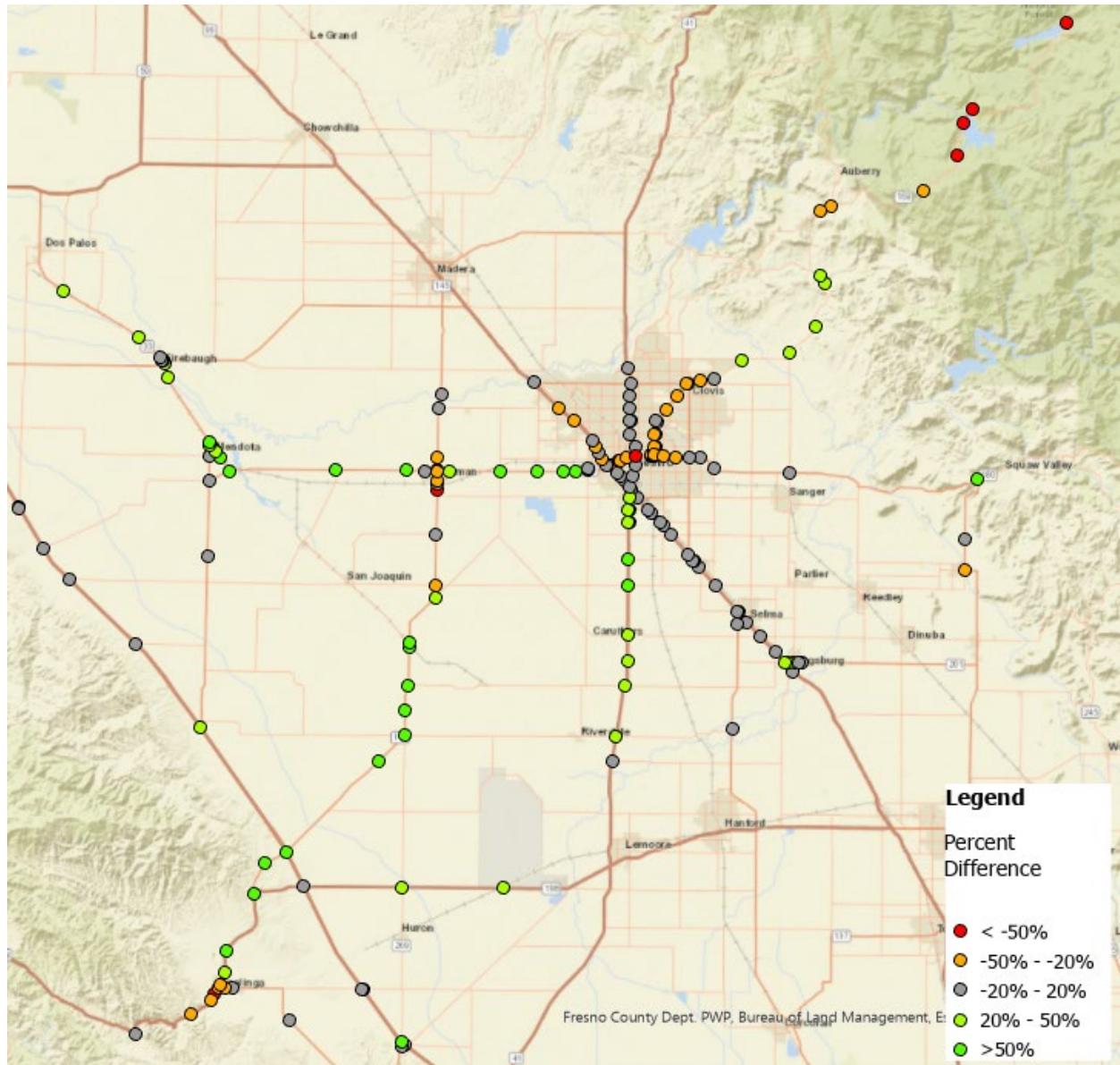


FIGURE 22: HIGHWAY VALIDATION – SPATIAL PERFORMANCE OF THE FRESNO HIGHWAY

Table 30 compares six key high-volume highway corridors in the Fresno region: I5, SR33, SR41, SR99, SR168, and SR180. Most of the highway corridors (I5, SR41, SR99, SR168, SR180) are doing reasonably well with respective percentage difference within 22% of the observed traffic count. Only one highway corridor, SR33, exhibits under performance with an overestimation of 30%. Note that SR33 is also a low volume corridor which makes it relatively difficult to get right.

TABLE 30. HIGHWAY VALIDATION – KEY CORRIDORS

ROUTE	CALTRANS_AADT	ABM_VOL	DIFF	DIFF (%)
5	597,000	575,612	(21,388)	-4%
33	176,350	229,149	52,799	30%
41	1,679,477	1,754,819	75,342	4%
99	3,108,500	3,042,455	(66,045)	-2%
168	728,350	570,445	(157,905)	-22%
180	1,620,750	1,412,976	(207,774)	-13%
Total	7,910,427	7,585,456	(324,971)	-4%

To examine the model's performance along corridors, separate validation plots are prepared for these key highway corridors (see Figure 23 to Figure 28). The plots validate estimated model flows at each count location on the corridor. The count locations are arranged sequentially either from South to North or West to East depending on the corridor's travel direction. Note that the direction of the corridor represents only the order of count locations and not the direction of traffic flow. The traffic flows for both estimated and observed data are aggregates of the two flow directions (A to B and B to A). Each figure contains two solid lines representing the estimated traffic flows and the observed counts for count locations on the corridor. It also includes a dotted line showing percentage difference between the two data. The count locations are placed on the X-axis, whereas traffic volume (in vehicles) is on the primary Y-axis and percentage difference between the estimated and the observed traffic volume is on the secondary Y-axis.

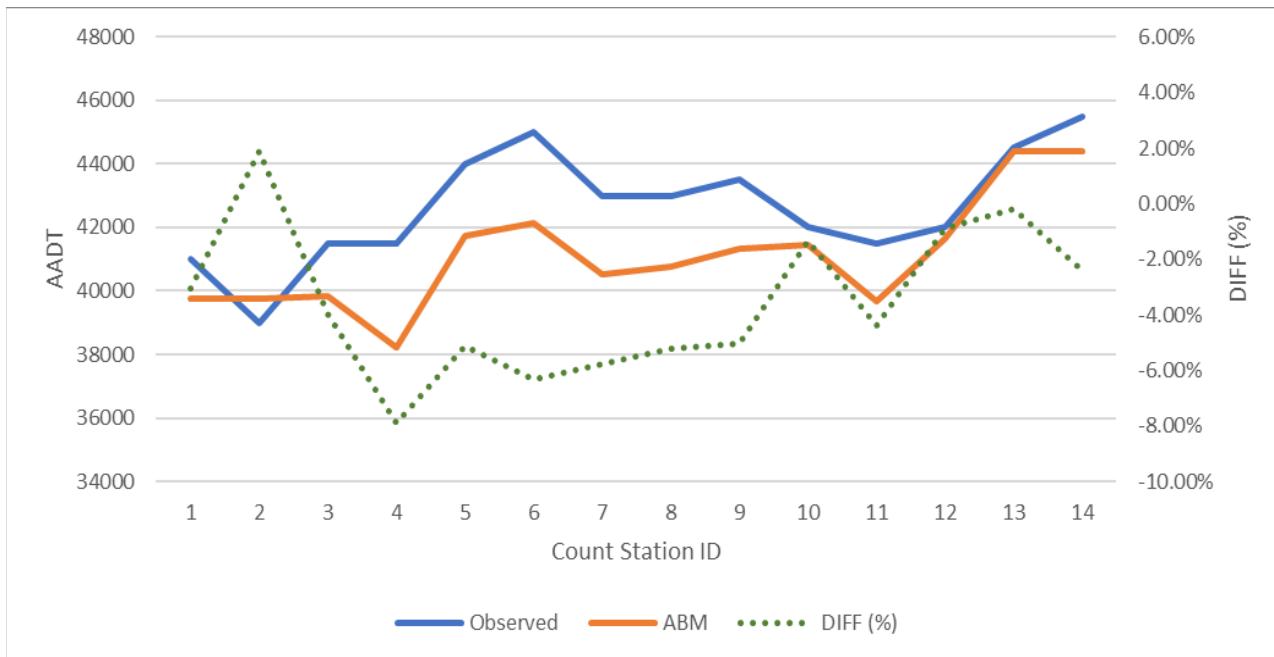


FIGURE 23. HIGHWAY VALIDATION – I5 (SOUTH TO NORTH)

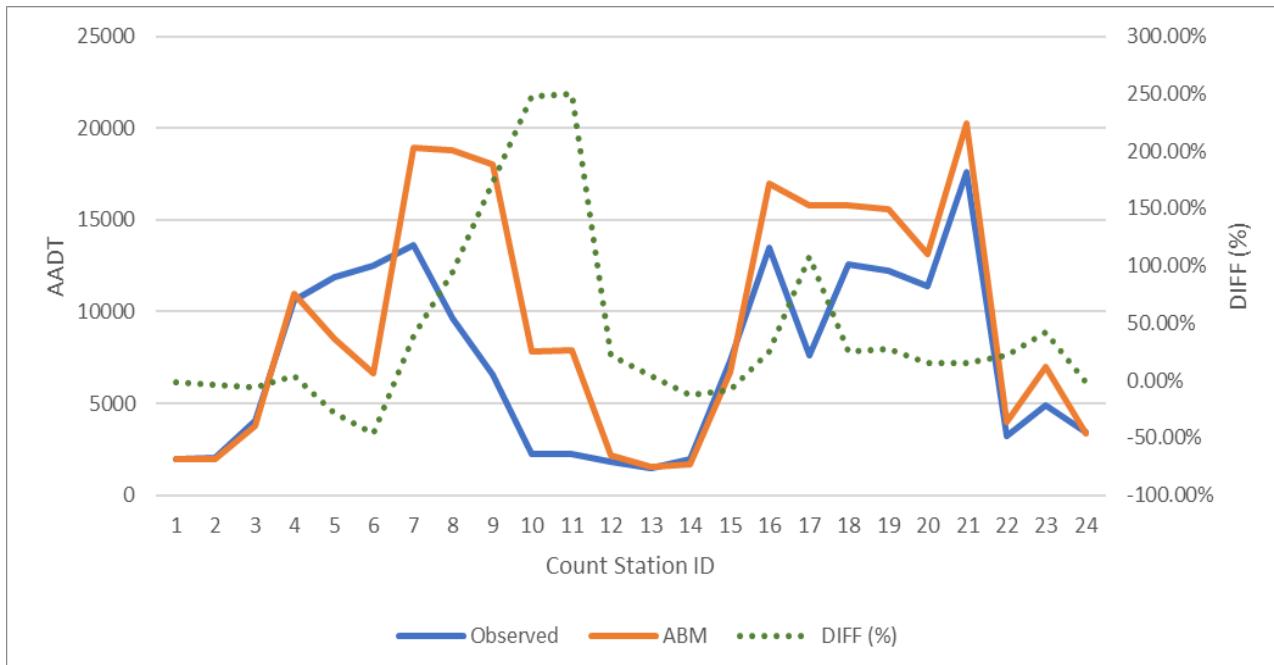
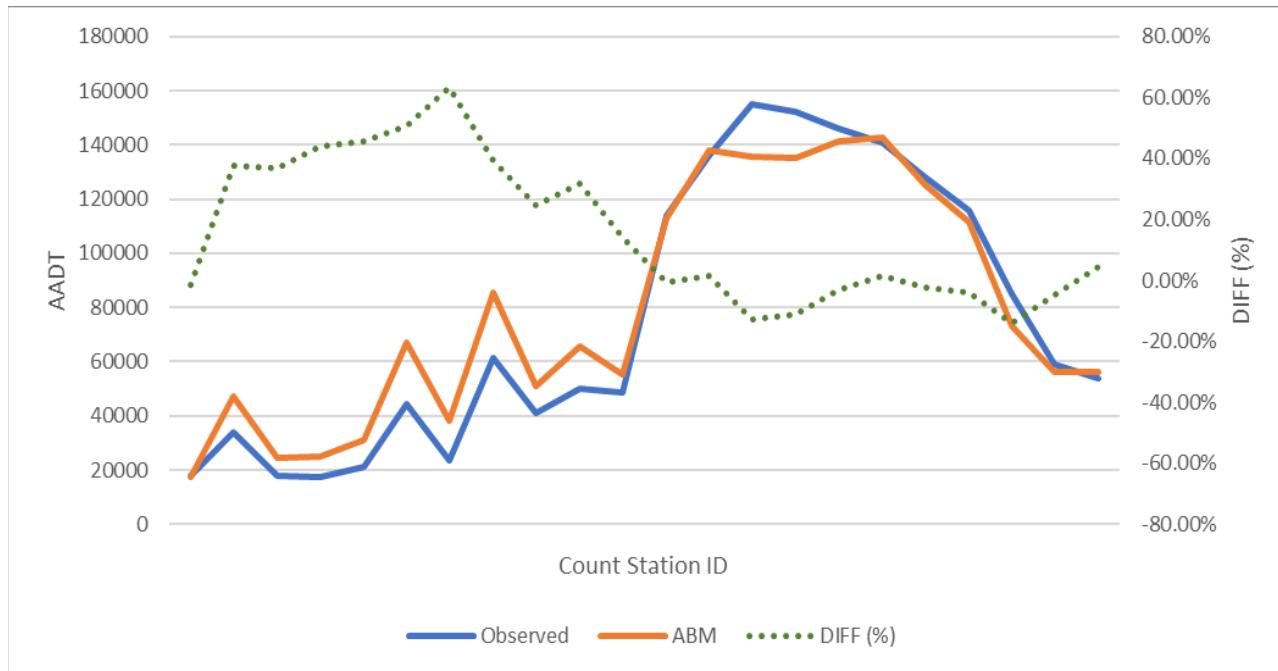
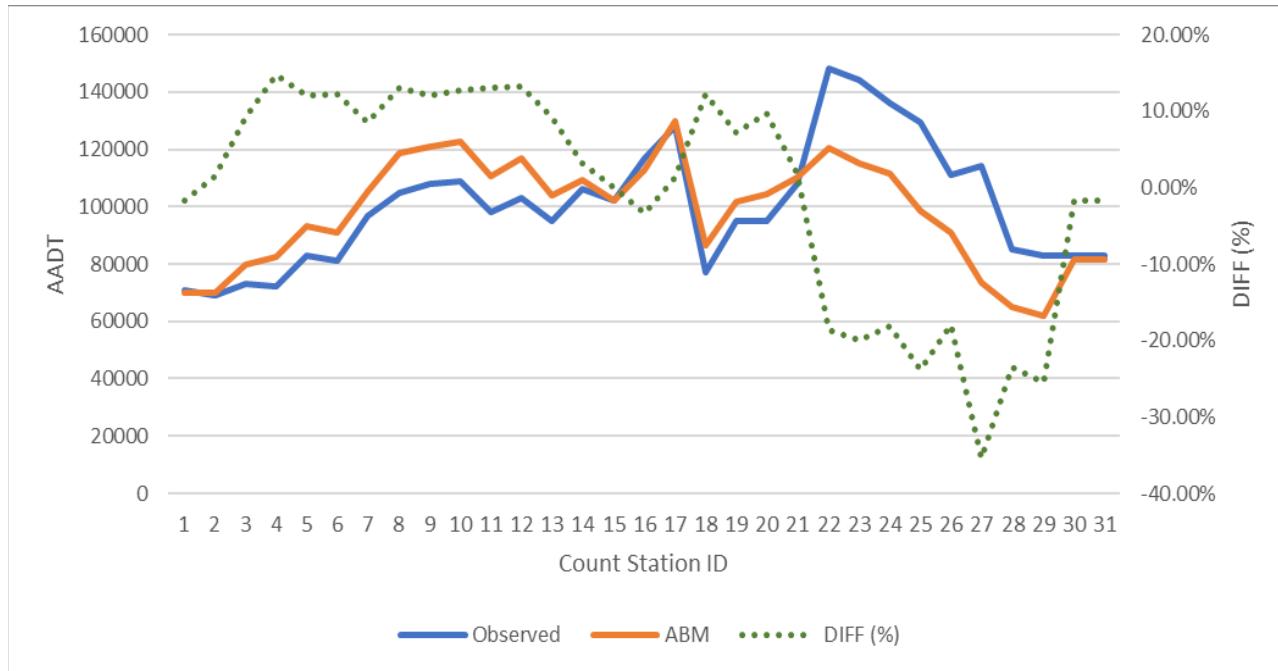


FIGURE 24. HIGHWAY VALIDATION – SR33 (SOUTH TO NORTH)

**FIGURE 25: HIGHWAY VALIDATION – SR41 (SOUTH TO NORTH)****FIGURE 26: HIGHWAY VALIDATION – SR99 (SOUTH TO NORTH)**

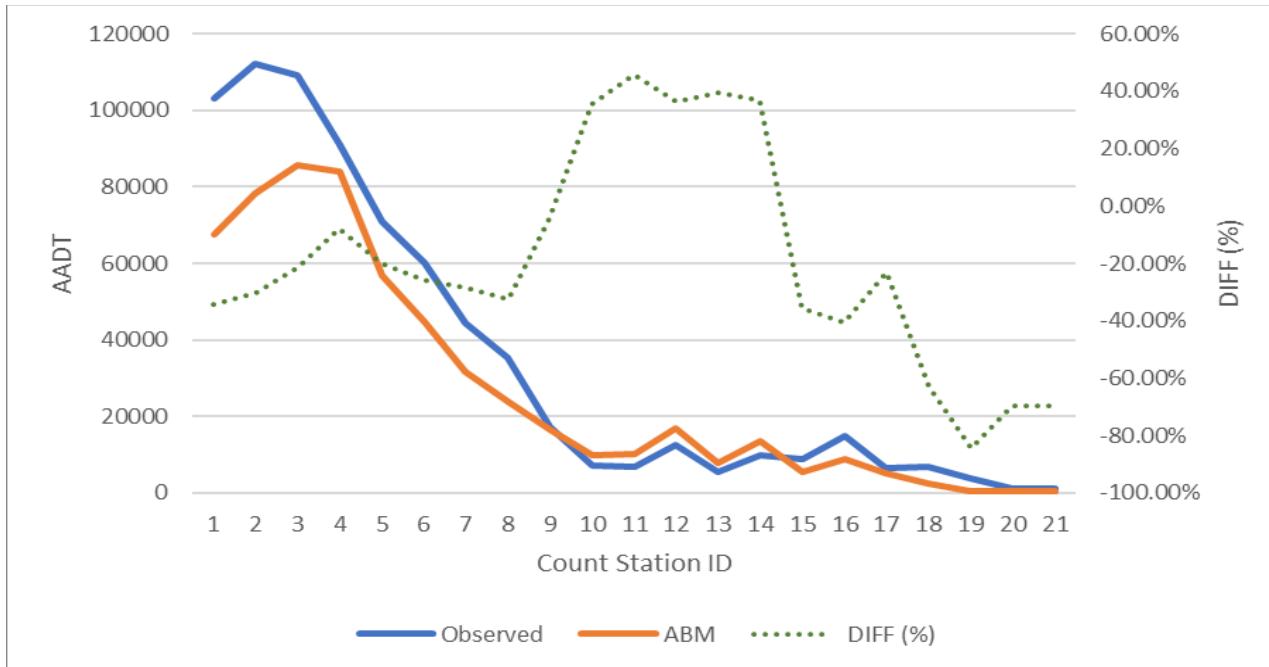


FIGURE 27: HIGHWAY VALIDATION – SR168 (WEST TO EAST)

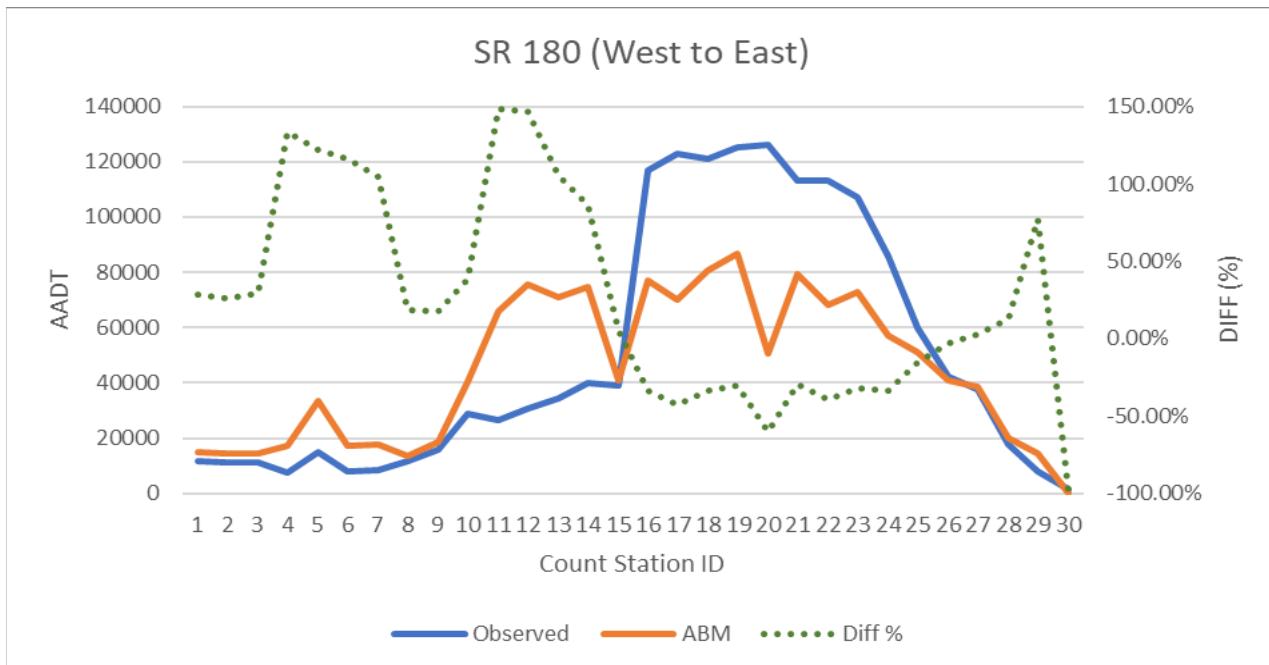


FIGURE 28: HIGHWAY VALIDATION – SR180 (WEST TO EAST)

Transit Validation

Transit ridership produced by the model is compared against the observed ridership. The ridership (boarding) is compared regionally as well as by transit line.

The FHWA previously provided guidelines to check reasonableness of the transit assignment results from a model. The relevant recommended guidelines are presented in Table 31.

TABLE 31. THE FHWA'S TRANSIT VALIDATION GUIDELINES

METRIC	THRESHOLD
Difference between actual counts and model results for a given year by Transit Mode (e.g. light rail, bus, etc.)	+/- 10%

*Source: The Travel Model Validation and Reasonableness Checking Manual, II Second Edition, September 2010.

Region

Regionally, Table 32, the ABM generates transit boardings within 5% of the observed ridership. The model indicates a boarding rate (boardings/trips) of 1.63.

TABLE 32. TRANSIT SUMMARIES - REGIONAL

MEASURE	OBSERVED	ABM	DIFF	% DIFF
Boardings	32,154	33,578	1,424	4%
Trips	-	20,788	-	-
Boarding rate	-	1.62	-	-

Transit Line

A comparison of ridership by transit line examines the model's ability of producing transit ridership by transit line. A scatter plot in Figure 29 shows the relationship between the transit boardings from the ABM and the observed boarding by transit line. The X-axis in the plot represents the observed boardings and the estimated boardings from the model are presented on the Y-axis.

The regression line fitting all data points shows an R-squared value of 0.92 indicating that it is a reasonable fit. This suggests that the model is predicting the transit behavior reasonably well.

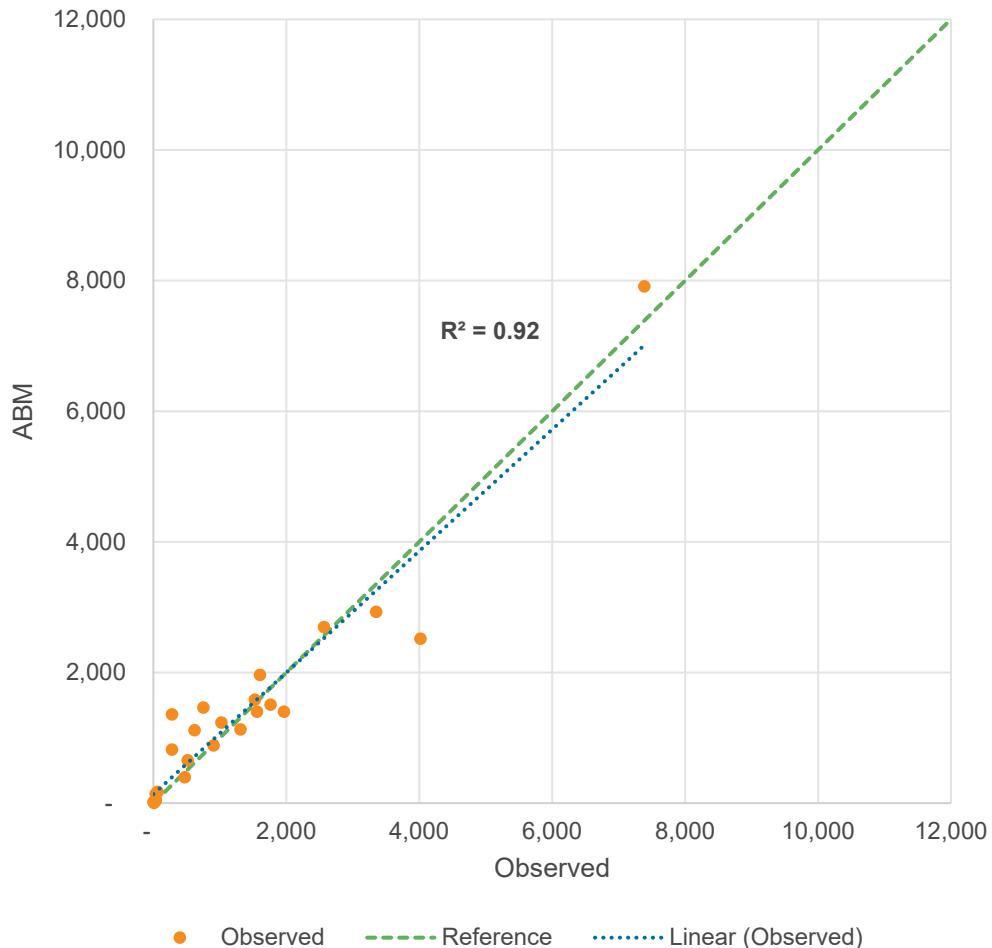


FIGURE 29: OBSERVED AND ESTIMATED TRANSIT BOARDINGS

A comparison of number of boardings by individual transit line is presented in Figure 30. The X-axis is transit line id and the Y-axis is number of boardings. The transit lines are sorted from high observed boarding to low observed boarding. In general, the plot shows a reasonable match across all transit lines, so it was not calibrated in the 2023 base year model update. A significant effort was made to improve transit validations in the previous model update to the 2019 base year. In the previous model update, the Clovis Transit service area was found to have too many zero-auto households, potentially causing the overestimation of ridership on Clovis routes. Additional coefficients were employed to adjust the share of zero auto households in the calibration districts that overlapped the Clovis transit services. The attractiveness of university students to transit was also adjusted in the school tour mode choice coefficients file as many of the over-estimated routes served university locations.

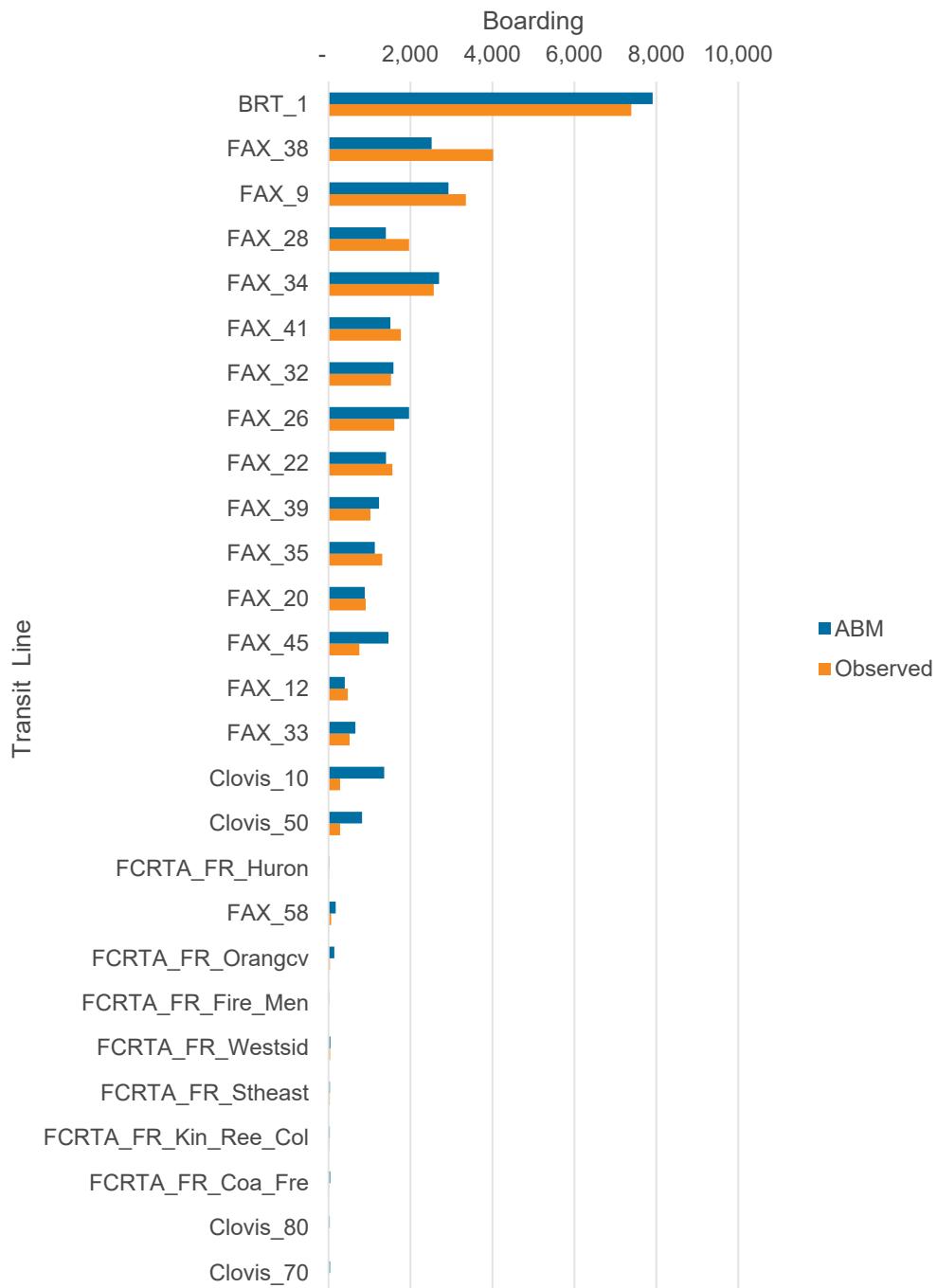


FIGURE 30: ESTIMATED AND OBSERVED BOARDINGS BY TRANSIT LINE

3.3 SUMMARY

The Fresno ABM is reasonably calibrated to match observed travel behavior reported in the 2022-2023 Central California Travel Survey (CCTS).

The model validation also showed reasonable match of estimated volumes with observed traffic counts. However, there are a few areas that still need improvement and shall be addressed in future model development tasks:

- The external travel is informed by the Replica data. However, the model development team spent significant time to quality check and resolve issues when possible while developing external trip tables input to the model. We suspect the external trip tables still contain issues impacting model's performance. Better-quality data for external travel would certainly improve model validation.
- DaySim is calibrated to represent the observed travel behavior primarily in the 2022-2023 CCTS. However, two-thirds of the completed survey samples were collected in 2022, one year earlier than the model base year (2023). While this is typically acceptable and reasonable, especially when data collection spans multiple years, this was a period of rapidly changing travel behavior due to the COVID-19 pandemic. Therefore, it possibly represents outdated or non-normative travel patterns.
- Even though the ABM reasonably predicts VMT travel within an acceptable range, the DaySim model outputs do not consistently match the survey data. This was partly by design as VMT was the primary target and the schedule constraint made a full-scale calibration infeasible. However, future model updates and calibration should take advantage of the availability of the CCTS to improve model calibration and validation.

4.0 SENSITIVITY TESTS

Sensitivity testing assesses the model's sensitivity to changing inputs like fuel prices, transit fares, new land uses, or new infrastructure. During this project, five sets of tests are designed to examine Fresno ABM's sensitivity and include:

1. Auto operating Cost
2. Transit Fare
3. New Transit Service
4. Transit Frequency
5. New Employment

For each test, shadow pricing is either turned on or off depending on the expected effect of the project. For example, small changes in the highway or transit network are not expected to have large effects on work and school location choice. For these types of tests, stable shadow prices from the base run are used. For cases where there are very broad changes in the travel system like changes in auto-operating costs, the shadow pricing loop is turned on to generate shadow prices for the new scenario. The 'model setup' section in each test description will indicate whether or not shadow prices are re-calculated.

4.1 CHANGE IN AUTO OPERATING COST (AOC)

Two model runs, Table 33, examine model's response to change in auto operating cost (AOC): double AOC and half AOC.

TABLE 33. SENSITIVITY TESTS – AUTO OPERATING COST

SENSITIVITY TEST	DESCRIPTION
Double AOC	AOC is 200% of the original AOC
Half AOC	AOC is 50% of the original AOC

The next sections start with describing the process of setting up the ABM for these tests and then discussing the results.

Model Setup

The ABM uses a consistent auto operating cost (AOC) value across the demand (DaySim) and the supply (network assignment) side. Both model systems read an input CSV file¹⁷ that contains auto operating cost (cents per mile) by year.

The AOC value for the 2023 base year is 25.69 cents per mile. For each test, the input CSV file is updated with a new AOC value. For the double AOC test, the AOC value is increased to 51.38 cents per mile and for the half AOC test, the AOC value is decreased to 12.85 cents per mile. Shadow pricing is turned on.

Results

The outputs from the two model runs are compared with the outputs from the base year model run. The sensitivity of the model is measured by change in tour lengths by purpose, tour/trip mode shares, and regional VMT.

Tour Lengths

As expected, Table 34, increase in auto-operating cost by 100% results in shorter tour lengths. That means residents of Fresno County are finding closer activity locations to home due to the higher cost of traveling by car. Work tour lengths decrease the most (-14%) with discretionary tour length following (-9%).

TABLE 34. AOC SENSITIVITY - TOUR LENGTHS (MILES) BY PURPOSE, PERCENT CHANGE FROM BASE

TOUR PURPOSE	DOUBLE AOC	HALF AOC
Work	-14%	11%
School	-8%	5%
Maintenance	-4%	2%
Discretionary	-9%	6%
Escort	-4%	2%
Work-based	-8%	7%

¹⁷ The input CSV file is here: 1_Inputs\6_Static\AutoOperatingCost.csv

Decreasing the auto-operating cost increased tour lengths. The relative response by tour purpose is similar to the results of the double AOC test; work, work-based, and discretionary purposes see the most increase (11%, 7% and 6% respectively) and escort (2%) and maintenance (2%) purpose see the least increase.

Mode Share

As presented in Table 35, the drive alone tour mode sees the most decrease (-8.3%) due to a higher auto operating cost (double AOC). The higher occupancy auto modes show relatively lower sensitivity with shared-ride (SR) 2 losing only 2.4% of the original SR2 tours. The shared-ride 3+ mode even received more tours (0.4%). Mostly travelers switch to non-auto modes to minimize increase cost of travel. All non-auto modes including transit (walk or drive), bike, and walk see an increase in their tours. The results suggest that higher cost of travel pushes travelers to either choose a higher occupancy auto mode or travel by non-auto modes (transit, bike and walk). The TNC mode showed an increase of 11.8%. The TNC costs remained fixed in this sensitivity test suggesting that TNC became more affordable compared to the cost of a private auto in some cases.

TABLE 35. AOC SENSITIVITY - TOUR MODE SHARE, PERCENT CHANGE FROM BASE

TOUR MODE	DOUBLE AOC	HALF AOC
Drive Alone	-8.3%	5.8%
Shared Ride 2	-2.4%	1.7%
Shared Ride 3+	0.4%	-0.1%
Drive-Transit	13.8%	-9.5%
Walk-Transit	9.1%	-4.3%
Bike	12.2%	-5.4%
Walk	5.9%	-2.6%
School Bus	0.1%	-0.3%
TNC	11.8%	-4.9%
Total	-3%	2.2%

Lowering the operating cost (half AOC) results in more tours by auto mode and fewer by non-auto modes. The travelers are making more drive-alone tours (5.8%) because of its lower cost. Even higher occupancy (SR3+) travelers are choosing for a lower occupancy travel (drive-alone or SR2). The non-auto modes generally respond similarly, with bike, walk and transit tour mode shares all decreasing. TNC mode also decreases, suggesting that the reduced auto operating cost makes driving a private auto more affordable than TNC services in some cases.

The change in trip mode shares, Table 36, also exhibit the same behavior as the tour mode shares.

TABLE 36. AOC SENSITIVITY - TRIP MODE SHARE, PERCENT CHANGE FROM BASE

TRIP MODE	DOUBLE AOC	HALF AOC
Drive Alone	-8.2%	5.6%
Shared Ride 2	-1.2%	0.8%
Shared Ride 3+	1.5%	-0.8%
Transit	10.7%	-4.8%
Bike	11.6%	-5.7%
Walk	8.0%	-4.9%
School Bus	0.0%	-0.4%
TNC	12.9%	-4.9%
Total	-2.4%	1.8%

Regional VMT

The regionwide total vehicle miles travelled (VMT), Table 37, responds expectedly to the change in auto operating cost. Doubling the auto operating cost reduce the VMT by 7.1%, whereas halving the cost increase the VMT by 6.4%.

To examine magnitude of the VMT response, a mid-link elasticity value in response to the AOC change are calculated. The ABM is producing elasticities of -0.11 and -0.09 for double AOC and half AOC respectively.

TABLE 37. AOC SENSITIVITY – REGIONAL VMT, PERCENT CHANGE FROM BASE

MEASURE	DOUBLE AOC	HALF AOC
VMT	-7.1%	6.4%
Elasticity	-0.11	-0.09

4.2 CHANGE IN TRANSIT FARE

Two model runs, Table 38, examine model's response to change in transit fare: double transit fare and half transit fare.

TABLE 38. SENSITIVITY TESTS – TRANSIT FARE

SENSITIVITY TEST	DESCRIPTION
Double Transit Fare	Transit fare is 200% of the original fare
Half Transit Fare	Transit fare is 50% of the original fare

The next sections start with describing the process of setting up the ABM for these tests and then discuss the results.

Model Setup

The 2023 base year ABM apply two sets of fare for the transit services in the Fresno County. The first set is a flat fare of \$1 for FAX and \$0 (free) for Clovis transit. The other set is a distance-based fare for the inter-city buses by FCRTA. Both sets of fares are updated in the transit fare sensitivity tests. Shadow pricing is turned off.

Results

The outputs from the two model runs are compared with the outputs from the base year model run. The sensitivity of the model is measured by the change in tour/trip mode shares, transit trips by income groups and regional transit ridership (boardings).

Mode Shares

As presented in Table 39, with double fare, the tours made using transit see a significant decrease due to increase in transit fare. Further, the transit tours that are driving to transit are not affected compared to transit tours walking to transit (-12.7%). This is expected as drive to transit tours are more likely to be mandatory travel and made by travelers that are from relatively higher income households, therefore, such travelers are less sensitive to change in

transit cost. The tours leaving transit are now choosing other modes as the non-transit modes see increase in their respective tours, though the increase is not big due to very low share of transit tours overall (0.3%), as shown in Section 3.1.

With half fare, the walk transit tours increase by 6.5% while driving modes decreased -0.1%. While sensitivity test shows that the drive transit tours decreased by 0.9% despite a decrease in transit fare, this absolute difference between the base scenario and the half fare scenario is so small (0.33 tours) that the number of drive transit tours are essentially the same between these scenarios.

TABLE 39. TRANSIT SENSITIVITY - TOUR MODE SHARE, PERCENT CHANGE FROM BASE

TOUR MODE	DOUBLE FARE	HALF FARE
Drive Alone	0.1%	-0.1%
Shared Ride 2	0.1%	-0.1%
Shared Ride 3+	0.1%	-0.1%
Drive-Transit	-1.7%	-0.9%
Walk-Transit	-11.8%	6.4%
Bike	0.7%	-0.3%
Walk	0.2%	0.0%
School Bus	0.1%	0.0%
TNC	0.2%	-0.3%
Total	0.0%	0.0%

The change in trip mode shares, Table 40, also exhibits the same behavior as the tour mode shares.

TABLE 40. TRANSIT FARE SENSITIVITY - TRIP MODE SHARE, PERCENT CHANGE FROM BASE

TRIP MODE	DOUBLE FARE	HALF FARE
Drive Alone	0.1%	-0.1%
Shared Ride 2	0.1%	-0.1%
Shared Ride 3+	0.1%	-0.1%
Transit	-13.4%	7.5%
Bike	0.7%	-0.3%
Walk	0.1%	-0.02%
School Bus	0.0%	0.0%
TNC	0.8%	-0.1%
Total	0.0%	0.0%

Transit Trips by Household Income

Table 41 examines traveler's sensitivity to change in transit fare by household income. The table looks at transit travelers within 6 household income categories and calculates percentage change in their transit trips due to change in transit fare. For both increase and decrease in transit fare, travelers in lower income categories are the least sensitive to the price change. The sensitivity to the transit fare change increases with increase in average household income. The results make sense as lower income populations may represent more captive riders – those with fewer or no household autos who have fewer choices for travel mode.

TABLE 41. TRANSIT FARE SENSITIVITY – TRANSIT TRIPS BY HOUSEHOLD INCOME, PERCENT CHANGE FROM BASE

HOUSEHOLD INCOME	DOUBLE FARE	HALF FARE
\$0-\$15,000	-10.7%	5.5%
\$15,000-\$35,000	-13.5%	6.6%
\$35,000-\$50,000	-13.0%	7.8%
\$50,000-\$75,000	-14.3%	8.2%
\$75,000-\$100,000	-15.0%	8.0%
\$100,000+	-14.8%	10.3%

Transit Boardings

The regionwide transit ridership, Table 42, responds appropriately to the change in transit fare; doubling the transit fare reduce the ridership by 15.1% and halving the transit fare increase the ridership by 7.6%.

To examine magnitude of the ridership response, a mid-link elasticity value in response to the transit fare change is calculated. The ABM is producing elasticities of -0.24 and -0.11 for double transit fare and half transit fare respectively.

TABLE 42. TRANSIT FARE SENSITIVITY – TRANSIT BOARDINGS

MEASURE	DOUBLE FARE	HALF FARE
Change in Boardings from Base	-14.2%	7.2%
Elasticity	-0.21	-0.11

4.3 NEW TRANSIT SERVICE

To evaluate the model's response to a new transit service, a new transit line is tested as both a local bus and a Bus Rapid Transit (BRT) line. Figure 31 shows the route of the new line.

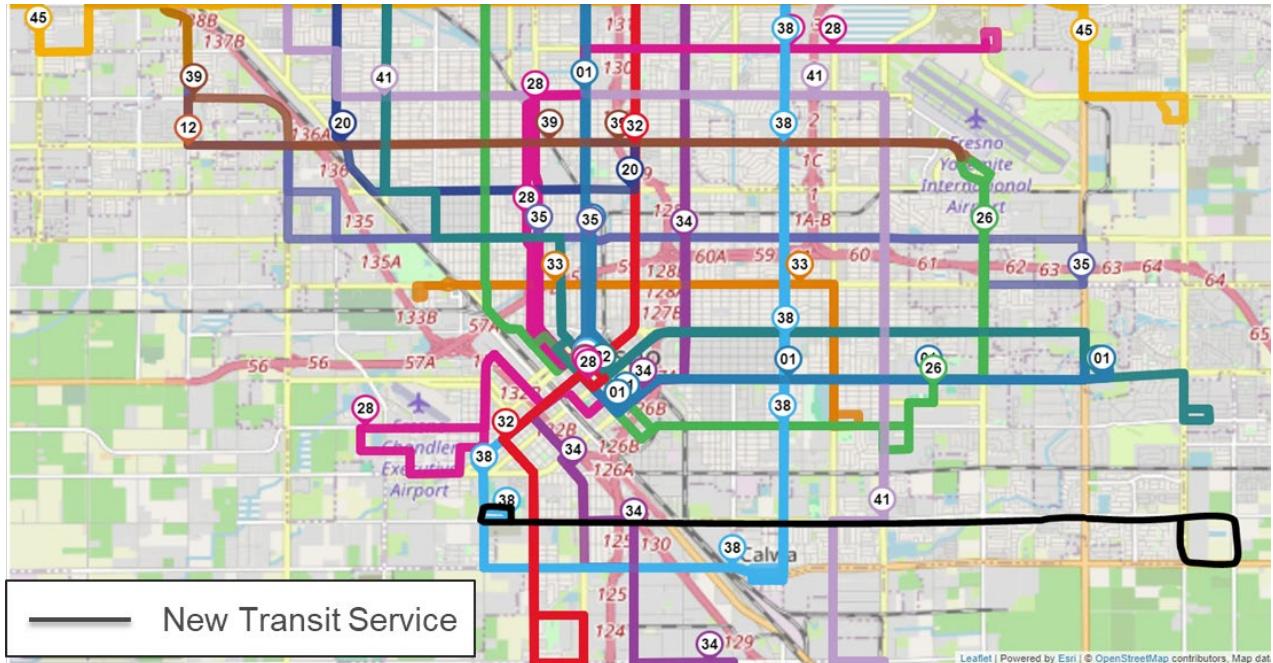


FIGURE 31: SENSITIVITY TEST - NEW TRANSIT SERVICE

Model setup

The new transit line is added to the transit line file (LinFile19.lin) as a FAX service. Two tests are performed, one with the transit mode as local bus, and one with the transit mode as BRT. The local bus is coded with 30 minute peak and off-peak headways with 0.8min dwell times. Local bus stops are every 0.25 mi along the route. The BRT line is coded with 10 minute peak and 15 minute off-peak headways and a dwell time of 0.5 minutes. The BRT is coded with stops every 0.5 mi along the route. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

Addition of the line into the 2023 base year transit system results in a small increase in overall transit boardings (1.9% and 2.6% for the local bus and BRT coding), as summarized in Table 43. The line as a local bus attracts 340 daily riders, while the line as a BRT nearly doubles the ridership (663 daily boardings). In both cases, the increase in systemwide total boardings is higher than the increase in the boardings on the new lines. This indicates that the new line is facilitating trips which transfer to other services as well.

TABLE 43. SENSITIVITY TEST – NEW BRT SERVICE BOARDINGS, COMPARISON TO BASE

LINE CODING	NEW LINE BOARDINGS	TOTAL TRANSIT BOARDINGS	CHANGE IN TOTAL BOARDINGS	TOTAL BOARDINGS PERCENT DIFFERENCE
Local Bus	340	34,232	654	1.9%
BRT	663	34,453	876	2.6%

4.4 TRANSIT FREQUENCY

To evaluate the model's response to changes in transit frequencies, an existing transit line (FAX-41) is tested with half and double its base frequency. Figure 32 shows the route of the selected FAX-41 line.

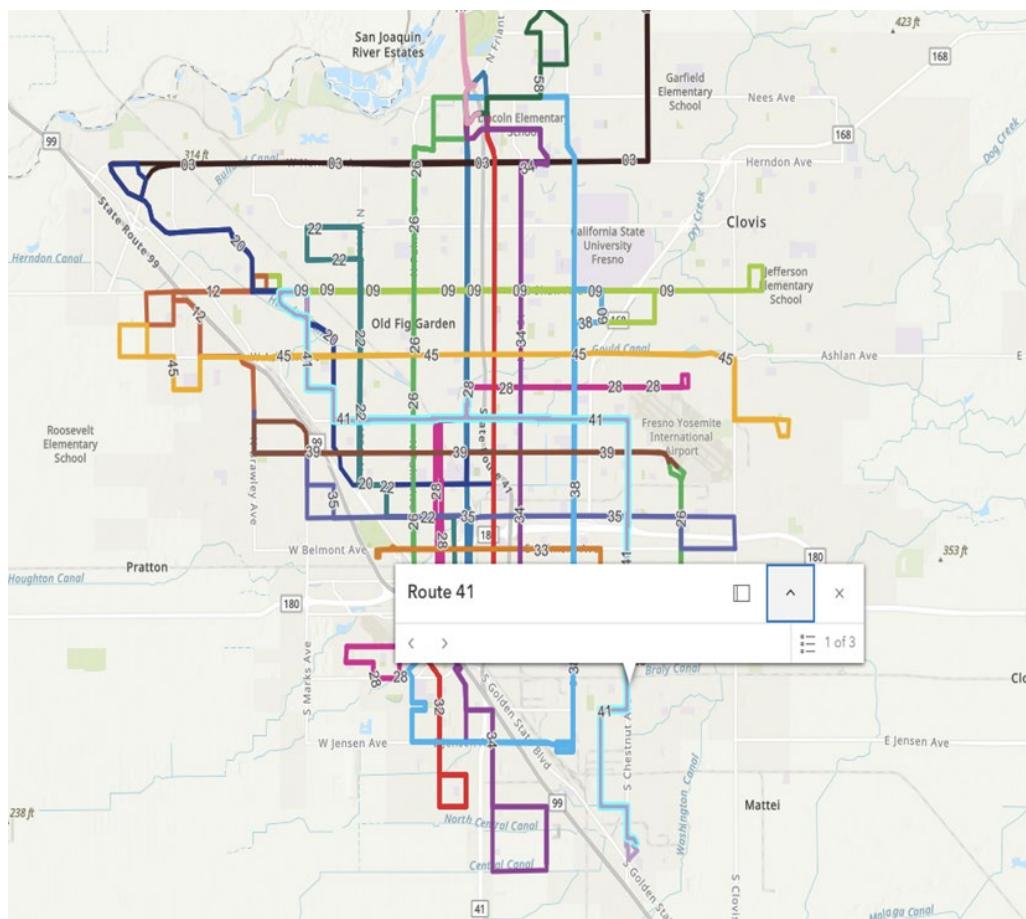


Figure 32: Sensitivity Test – Transit Frequency

Model setup

The frequency of the FAX-41 line is modified in the transit line file (LinFile19.lin). Two tests are performed, one with half (15 mins) its base frequency and another with double (60 mins) the base frequency. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

Reducing the FAX-41 line frequency to 15 minutes in the 2023 base year transit system results in a substantial increase (40%) in line boardings and a small increase (1.7%) in overall transit system boardings. Conversely, increasing the headway to 60 minutes leads to a notable decrease (17%) in line boardings and a slight reduction (0.5%) in total transit boardings.

With the shorter frequency, the FAX-41 line attracts 607 additional riders, while the overall transit system gains only 580 riders, as shown in Table 44. Similarly, with the longer frequency, the line loses 262 riders, whereas the overall system loses only 156 riders. This indicates that a portion of the riders gained or lost on this line are transferring to or from other lines rather than representing net new riders.

To evaluate the magnitude of the ridership response, a mid-link elasticity value with respect to the frequency change is calculated. The ABM produces elasticity values of -0.50 and -0.28 for the half and double frequency scenarios, respectively.

TABLE 44. SENSITIVITY TEST – TRANSIT FREQUENCY, COMPARISON TO BASE

LINE FREQUENCY	FAX 41 BOARDINGS CHANGE	FAX 41 BOARDINGS PERCENT CHANGE	TOTAL TRANSIT BOARDINGS	TOTAL BOARDINGS CHANGE	TOTAL BOARDINGS PERCENT CHANGE	ELASTICITY
0.5X Base	607	40%	34,158	580	1.7%	-0.50
2X Base	-262	-17%	33,422	-156	-0.5%	-0.28

4.5 NEW EMPLOYMENT

Three model runs, Table 45, examine model's response to changes in land-use, specifically employment: employment center, half of the employment center, and 1.5 times the employment center.

TABLE 45. SENSITIVITY TEST - EMPLOYMENT CHANGES

SENSITIVITY TEST	DESCRIPTION
Employment Center	New employment added to base employment
50% Employment Center	50% of the new employment center
150% Employment Center	150% of the new employment center

The next sections start with describing the process of setting up the ABM for these tests and then discuss the results.

Model Setup

In the 2023 base year ABM, changes were made to employment in three Fresno County zones (18739, 19008, and 19010) without redistributing employment to other zones. Table 46 summarizes the employment in these zones for the three sensitivity tests. For the first test, employment was calculated as the sum of base and new employment. The second and third tests used 50% and 150% of the first test's employment, respectively, for the said three zones. Shadow pricing is turned on.

TABLE 46. MAZ EMPLOYMENT CHANGES

MAZ ID	New Employment	Base Employment	Employment Center	50% Emp Center	150% Emp Center
18739	1200	0	1200	600	1800
19008	693	107	800	400	1200
19010	1658	192	1850	925	2775
Total	3551	299	3850	1925	5775

Results

Changes in employment at the three selected zones were tested to evaluate the model's sensitivity to localized employment growth. As expected, vehicle miles traveled (VMT) increased monotonically with higher employment. Compared to the base scenario, total VMT increased by 0.14%, 0.05%, and 0.26% for the Employment Center, 50% Employment Center, and 150%

Employment Center tests, respectively (Table 47). This pattern aligns with expectations, as higher employment levels typically generate additional travel. Total transit boardings increased slightly in all three Employment Center scenarios compared to the base scenario.

TABLE 47: CHANGES IN TOTAL VMT AND TRANSIT BOARDINGS

Measure	Base	Employment Center	50% Emp Center	150% Emp Center
VMT	22,108,063	22,139,276	22,119,962	22,165,644
VMT Diff.	-	31,213	11,899	57,581
VMT Diff (%)	-	0.14%	0.05%	0.26%
Transit Boardings	33,578	33,740	33,624	33,641

4.6 SUMMARY

Five sets of tests are conducted to examine the Fresno ABM's sensitivity. The results of change in these inputs were compared with base scenario and appropriate measures were calculated to analyze change in results. The model is behaving with reasonable sensitivity in these sensitivity tests.

5.0 FRESNO ABM USER'S GUIDE

This chapter describes model setup and steps to run the Fresno ABM for base year 2023. It also describes the structure and content of the model directory.

5.1 SOFTWARE REQUIREMENTS

The instructions are for a machine with Windows operating systems. The following software are required:

Cube Voyager

Cube version 6.5 or greater should be installed on the machine.

Python - Anaconda 2

Anaconda is a python data science platform. It contains a lot of useful python libraries. We are using a python script in our CUBE work flow that would require some python libraries. Instead of installing libraries separately it is better to install an Anaconda package as that would contain all the required libraries.

Latest Anaconda 2 can be downloaded from here:

<https://www.anaconda.com/download/>

Here are instructions on installing Anaconda on windows:

<https://docs.anaconda.com/anaconda/install/windows>

PopulationSim uses Anaconda 3. The installation requirements are provided in Appendix B.

R Software

R v3.4.4 should be installed on the machine. The model uses R to generate summaries for both PopulationSim and DaySim outputs, making it essential for validating the results. This version of R can be downloaded from CRAN website:

<https://cran.r-project.org/bin/windows/base/old/>

5.2 SETUP ABM

System Setup

Once all the required software is installed (5.1 Software Requirements), users need to copy the following files to their respective directories:

OMX DLL

The AB model uses an OMX DLL to convert Cube skims to OMX format, which are then read in DaySim. Users need to copy OMX DLL (“OMXLib.dll”) to the cube voyager installation directory (C:\Program Files\Citilabs\Cube\VOYAGER). The DLL is available under the *App* directory in the model setup.

Python Resource File

The ABM uses a Python script to run the model within the Cube environment. To do so, Cube creates a python resource file (“PYTHON.Rsc”) that primarily contains the python program path. User needs to update that path (see Figure 33) and copy the resource file to the following location:

C:\Users\<username>\AppData\Roaming\Citilabs\Cube\>User

The resource file is available under the *App* directory in the model setup.

```

1  * RSC file for User Program PYTHON
2  *
3  #PYTHON
4
5  &ProgPath=C:\Program Files\Anaconda2\python.exe
6  &ProgDesc=Python Software for Python Programming Language Programs Inclusion
7  &ProgType=1
8  &ProgUI=0
9  &UsePath=0
10
11
12  &FILES
13  1100
14  0,"Script File ***", "* **", 1, PYT, "*****", 1
15  1,"Data File 1 ***", "* **", 1, PYT, "*****", 1
16  2,"Data File 2 ***", "* **", 1, PYT, "*****", 1
17  3,"Data File 3 ***", "* **", 1, PYT, "*****", 1
18  4,"Data File 4 ***", "* **", 1, PYT, "*****", 1
19  5,"Data File 5 ***", "* **", 1, PYT, "*****", 1
20  6,"Data File 6 ***", "* **", 1, PYT, "*****", 1
21  7,"Data File 7 ***", "* **", 1, PYT, "*****", 1
22  8,"Data File 8 ***", "* **", 1, PYT, "*****", 1
23  9,"Data File 9 ***", "* **", 1, PYT, "*****", 1
24 10,"Data File 10 ***", "* **", 1, PYT, "*****", 1
25
26  &PARAM
27  &PARHLP
28  &PAREG
29
30  &OPTION
31
32  &OPTHLP
33
34  &COMLIN
35  Inputs
36  Outputs
37
38  &END

```

FIGURE 33: PYTHON RESOURCE FILE – UPDATE PROGRAM PATH

Model Setup

Additional software packages are required for running the DaySim input preparation steps, summarizing DaySim outputs, and generating validation summaries. These software packages have been provided with the model setup as a 7zip file (software.7z). This should be extracted on the local machine. The folder location should be added to the Cube Catalog Keys “ANACONDA_DIRECTORY” and “R_DIRECTORY”.

5.3 RUN ABM

To run the ABM, open the catalogue file (*Fresno_ABM.cat*) in Cube. A catalogue file is a group of applications (steps) run in a pre-defined order. When opened in Cube, user should see four frames on the left side (see Figure 34): Scenario, Data, App, and Keys.

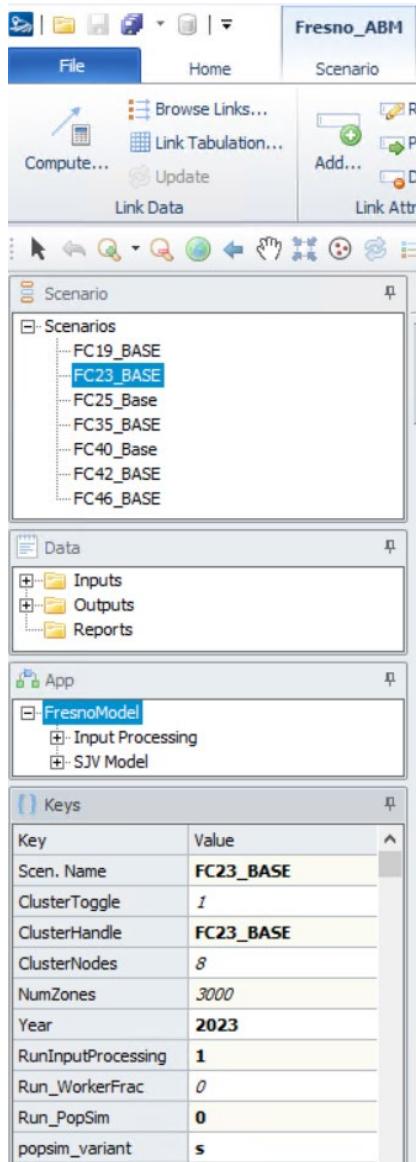


FIGURE 34: MAIN CUBE CATALOG FILE

The *Scenario* frame contains a list of scenarios to pick for the current run. User needs to pick a scenario under this frame. For 2023, user would select FC23_BASE. The *Data* frame contains a list of inputs and outputs. User does not need to do anything here. The *Keys* section contains a list of parameters. When a scenario is selected (double-clicked) a screen will pop-up showing the catalog keys and their values to the user as shown in Figure 35Figure 35: Scenario Keys Screen. Table 47 describes the new keys the added as part of the model update and enhancements. A comprehensive list of catalog keys is provided in Appendix F.

Distribute processing?

ClusterHandle	FC23_BASE
ClusterNodes	8
NumZones	3000
Year	2023
RunInputProcessing	1
Run_WorkerFrac	0
Run_PopSim	0
popsim_variant	5
popsim_scenario	base23
Run_TransitStops	1
Run_IntersectionDensity	1
Run_ShadowPrice	1
RUN_DAYSIM_SUMMARIES	1
Zonal data	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\1_TAZ
Gateway zones	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\2_SED
Master highway network	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\3_High
Year of network scenario	2023
Turn penalties	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\3_High
Truck_BaseMatrix	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\5_Exte
Truck_FutureMatrix	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\1_Inputs\5_Exte
<input type="checkbox"/> Use LOS capacity ranges rather than model VC	
Airbasins	1
Define network to compare	U:\Projects\Clients\FresnoCOG\ModelUpdate_2023\Models\BaseYear\Development\Fresno_Calib_NewHwy_TmnstUpdate_Tele19\Scenarios\TCMO!

FIGURE 35: SCENARIO KEYS SCREEN**TABLE 48: NEW CATALOG KEYS**

KEY	DEFAULT VALUE	DESCRIPTION
RunInputProcessing	1	0 to skip the input processing step. 0 may be selected if a model run does not need to re-generate DaySim inputs, does not have any network updates.
Run_WorkerFrac	0	This step generates the IXXI worker fractions used by DaySim and developed from LEHD Lodes data. This input file only needs to be created for a new model base year
Run_PopSim	0	The PopulationSim setup is run from the Cube Catalog. This step only needs to be run if updates to the synthetic population are needed.
Run_TransitStops	1	In input processing, the transit stops file is generated when this flag is set to 1.

KEY	DEFAULT VALUE	DESCRIPTION
Run_IntersectionDensity	1	In input processing, the intersection density file is generated when this flag is set to 1.
Run_ShadowPrice	1	If set to 1, the first model feedback loop will run DaySim 3 times to generate stable shadow pricing files. These will be saved and used for subsequent DaySim runs
Run_DaySimSummaries	1	After the full model run, the DaySim summaries will automatically be generated when set to 1
Run_Validation	1	After the full model run, the model validation report will automatically be generated when set to 1
HOV2_TOLL_FACTOR	0	Fractional value to be applied to SOV tolls for HOV2 toll value
HOV3_TOLL_FACTOR	0	Fractional value to be applied to SOV tolls for HOV3+ toll value
ANACONDA_DIRECTORY	[path]\software\Anaconda2	Directory where Anaconda2 folder was unzipped
R_DIRECTORY	[path]\software\R	Directory where R folder was unzipped

The *App* section contains one group: FresnoABM. This group includes two steps: Input Processing and SJV Model.

The Fresno AB model is run in one step with the option to skip input processing if needed. The two main modules are:

- Input Processing prepares initial inputs for model to use in feedback loops. The processing includes setting up the working directory, creating model networks, initial skimming, external trips, truck model etc. As bike and walk skimming is performed only once, it is also included in the input processing.
- SJV Model, includes feedback loops and final assignment. A feedback loop start with generating highway and transit skims. After generating external and truck demand, it

runs DaySim. This produces demand matrices by mode and time period. The demand matrices are then assigned on highway and transit networks for AM and MD periods. After three feedback loops, a final assignment of all four periods is performed. Assignment also include bike and walk assignments.

IMPORTANT: Here are sequential steps to run ABM:

1. Open *Fresno_ABM.cat* in Cube.
2. Select a scenario under *Scenarios* section.
3. Update the catalog keys as required for the desired model run.
4. Double click on *FresnoModel* under *App* and click Run on the Home ribbon, as shown in Figure 36.
5. This will bring up a Run Application window. Enter “Run Title” of your choice and click OK, as shown in Figure 37. This will start Cube processing.

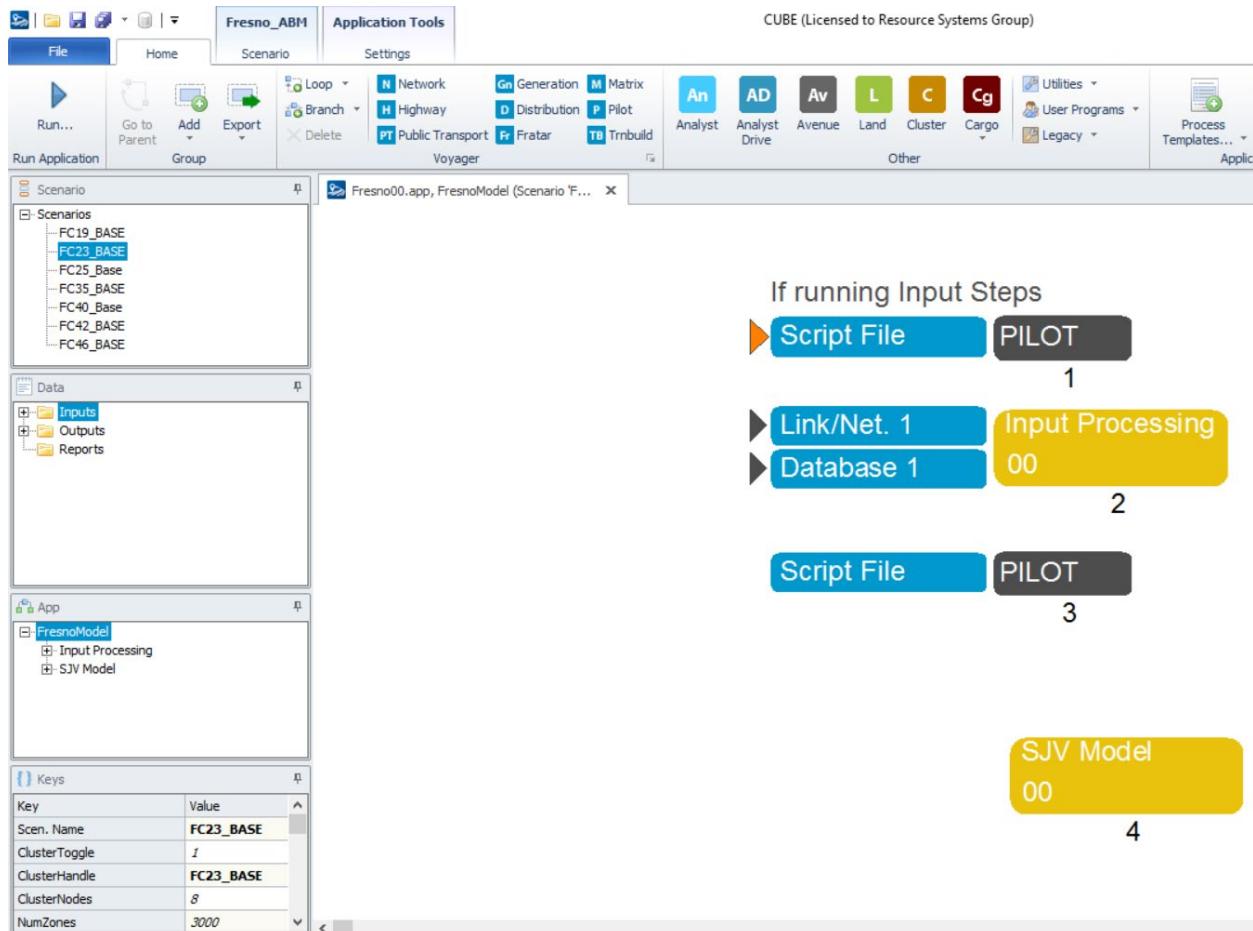


FIGURE 36: STARTING A MODEL RUN IN CUBE

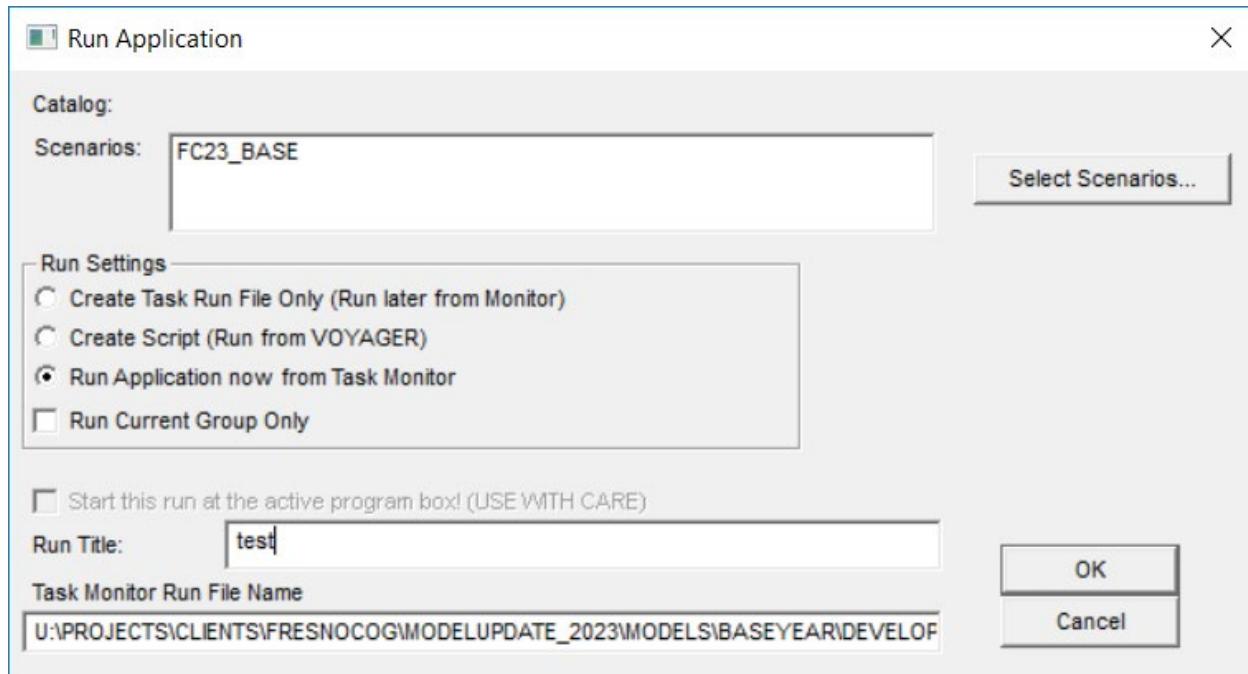


FIGURE 37: SPECIFYING RUN DETAILS IN CUBE

Note: after you click OK, Cube may prompt a message saying that errors have been found while checking for files. Ignore the error and choose “Create Job Anyway”.

5.4 MASTER DIRECTORY STRUCTURE

Figure 38 presents directory structure for the Fresno Activity-Based Model setup. The structure includes initial setup, as well as directories after a model run is finished.

The primary model file linking the entire ABM system is in the root folder and is called as “Fresno_ABM.cat”. This catalogue file is used to view and run the model using Cube Voyager.

The directory “1_Inputs” holds all the input data used by the ABM system. DaySim inputs are also stored in an appropriate sub-directory (8_DaySim) within the inputs directory. The App directory houses cube scripts and other applications (DaySim executable, parcel buffer, summary scripts, and population sampler). The G/S folder contains geodatabase and ArcMap documents.

Once a model run is finished, a new directory *Scenarios* is added to the initial model directory. The output directory (*Scenarios*) contains scenario specific sub-folders (ex. FC23_BASE for

year 2023). The scenario specific folders contain outputs organized by model components. In addition, a temp folder contains intermediate files produced during a scenario run.

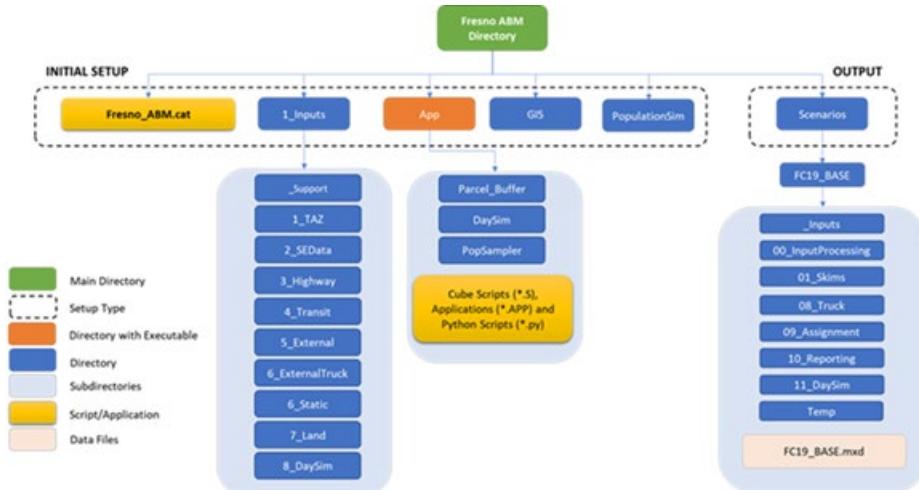


FIGURE 38: FRESNO ABM DIRECTORY STRUCTURE

5.5 INPUTS

This section provides description and structure of input files required in Fresno ABM.

DaySim

This section describes input files required for a DaySim run. The DaySim input files include synthetic population (household and person files), micro-zone land-use, zone index, worker IXXI fraction, PNR nodes, coefficients, roster, roster combinations, and configuration.

Micro-zone Land-use File

The input micro-zone file provides information on location and land-use for micro-zones in the Fresno region. The file is in comma separated value format and is located at "1_Inputs/8_DaySim/02_Parcel/maz_2023_parks.csv". This file is created in-house by Fresno COG. Table 48 presents a list of fields available in the input micro-zone file.

Off-street parking location and pricing information is used in the activity-based model system to influence mode and other choices. Note that this parking information is focused on publicly accessibility off-street locations and does not consider private off-street parking locations (such as those available only to workers in an office building), nor does it consider on-street parking location. Future year parking locations and costs can be easily added to the model system by simply updating the input micro-zone file to identify parking capacity and costs for individual micro-zones. Where data is unavailable or unknown, the parking attributes should be set to 0.

TABLE 49: MICRO-ZONE FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
parcelid	1 – 9999999	The parcel ID number. Values must be unique positive integers, in ascending order. (Gaps are allowed, but not efficient for memory.)
xcoord_p	1-999999999	The x coordinate of the parcel centroid, in integer length units (typically SPF).
ycoord_p	1-999999999	The y coordinate of the parcel centroid, in integer length units (typically SPF).
sqft_p	0-999999999	The area of the parcel, in thousands of square length units (typically sqf, does not need to be an integer)
taz_p	1-9999999	The zone that the parcel is in. Must be a valid zone_id in the “zone” file
block_p	0-9999999	This variable is used to store park area in square feet
hh_p	Real >=0	The number of households residing on a parcel.
stugrad_p	Real >=0	The number of grade school (K-8) students enrolled in schools on a parcel
stuhgh_p	Real >=0	The number of high school (9-12) students enrolled in schools on a parcel. If this is not available separately, then set to 0 & put the number of K-12 students in stugrd_p
stuuni_p	Real >=0	The number of university/college students enrolled in schools on a parcel.
empedu_p	Real >=0	The number of educational employees working on a parcel
empfoo_p	Real >=0	The number of food service employees working on a parcel
empgov_p	Real >=0	The number of government employees working on a parcel
empind_p	Real >=0	The number of industrial employees working on a parcel
empmed_p	Real >=0	The number of medical employees working on a parcel
empofc_p	Real >=0	The number of (other) office employees working on a parcel

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
empret_p	Real >=0	The number of retail employees working on a parcel
empsvc_p	Real >=0	The number of (other) service employees working on a parcel
empoth_p	Real >=0	The number of other sector employees working on a parcel. Typically contains construction, agriculture, mining.
emptot_p	Real >=0	The total number of employees working on a parcel. Should equal the sum of the 9 previous fields.
parkdy_p	Real >=0	The number of paid public off-street parking spaces on a parcel with per day pricing. (May overlap with parkhr_p if have both types of pricing.)
parkhr_p	Real >=0	The number of paid public off-street parking spaces on a parcel with per hour pricing. (May overlap with parkdy_p if have both types of pricing.)
ppricdyp	Real >=0	The average price of public off-street parking spaces on a parcel with per day pricing. (In cents per day)
pprichrp	Real >=0	The average price of public off-street parking spaces on a parcel with per hour pricing. (In cents per hour)

Synthetic Population

DaySim requires household and person files in ASCII delimited format with a header record. The PopulationSim software produces synthetic population in two CSV files: household and person. A python script then converts these files into DaySim format to use in a DaySim run. The Household file is “1_Inputs\8_DaySim\03_Household\Fresno_household.dat” and the person file is “1_Inputs\8_DaySim\03_person\Fresno_person.dat”

Table 49 provides a list of fields available in the household file. Of the variables listed below, only five (hhno, hysize, hhincome, hhparcel, and hhexpfac) are strictly needed by DaySim as inputs on the raw data file. One (hhvehs) is predicted by DaySim. The rest can be computed based on other data files or aren’t currently used in model application. DaySim also adds two variables to the working and output household file (“fraction_with_jobs_outside”, which is a property of the residence zone, and “zone_id” which is DaySim’s internal zone ID corresponding to “hhtaz”).

TABLE 50: HOUSEHOLD FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
hhno	1 - 9999999	The household ID number. Values must be unique positive integers, and should be in ascending order.
hhszie	1 – 99	The number of persons in the household. Must equal the number of person records for the household in the raw person file
hhvehs	0 - 99	The number of autos in the household. (This could be made optional as input, as it is predicted by DaySim.)
hhwks	0 – 99	The number of workers in the household. (This could be made optional as input, as it is computed by DaySim from the person records.)
hhftw	0 – 99	The number of HH members with person type=full-time worker. (This could be optional as input, as it is computed by DaySim.)
hhptw	0 – 99	The number of HH members with person type=part-time worker. (This could be optional as input, as it is computed by DaySim.)
hhret	0 – 99	The number of HH members with person type=retired adult. (This could be optional as input, as it is computed by DaySim.)
hhoad	0 – 99	The number of HH members with person type=other non-working adult. (This could be optional as input, as it is computed by DaySim.)
hhuni	0 – 99	The number of HH members with person type=university student. (This could be optional as input, as it is computed by DaySim.)
hhhsc	0 – 99	The number of HH members with person type=grade school student age 16+. (This could be optional as input, as it is computed by DaySim.)
hh515	0 – 99	The number of HH members with person type=child age 5-15. (This could be optional as input, as it is computed by DaySim.)
hhcu5	0 – 99	The number of HH members with person type=child age 0-4. (This could be optional as input, as it is computed by DaySim.)

hhincome	-1 – 9999999	The household annual income, in integer dollars. (A negative value is interpreted as missing data in DaySim estimation mode.)
hhowrent	1 – 9	Household own versus rent status. (This could be optional as input, as it is not currently used in the DaySim model code.)
hhrestype	1 – 9	Household residence building type. (This could be optional as input, as it is not currently used in the DaySim model code.)
hhparcel	1 – 9999999	The ID of the parcel on which the household lives. Must be a parcel ID found in the raw parcel file.
hhhtaz	1 – 9999999	The ID of the zone in which the household lives. (This could be optional as input, as the Parcel file has the parcel-zone correspondence.)
hhexpfac	Real ≥ 0	The expansion factor for the household – a non-negative real number. (Is typically 1.0 in a synthetic population.)
samptype	0 - 99	The type of sample used. (This could be optional as input, as it is not used in the DaySim model code, but can be useful with survey data in model estimation to identify different sample types.)

Table 50 provides a list of fields available in the person file. Of the variables in the list, only seven (hhno, pno, pptyp, pagey, pgend, pwtyp, pstyp) are needed by DaySim as inputs in the raw data file. Four (pwpcl, pspcl, ptpass and ppaidprk) are predicted by DaySim. The rest are computed based on other data files or aren't currently used in model application and can be coded as -1 by the user. DaySim also adds one variable to the beginning of each record in the output person file ("ID" which is a sequential, unique person ID created by DaySim)

TABLE 51: PERSON FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
hhno	1 - 9999999	The household ID number. Values must be unique positive integers, and should be in ascending order. Must be present in the Household file.

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
pno	1 – 99	The person sequence number within the household. Values must be unique positive integers within a household, and in ascending order from 1 up to “hhszie” on the Household file.
pptyp	1 - 8	Person type (1= full time worker, 2 =part time worker, 3=non-worker age 65+, 4 = other non-working adult, 5 = university student, 6 = grade school student/child age 16+, 7 = child age 5-15, 8 = child age 0-4. (There could be a switch to make this optional and compute it within DaySim for synthetic populations based on ACS PUMS. For other survey data, the coding and rules may be more variable and better done outside DaySim.)
pagey	0 – 99	Age in years (integer)
pgend	1 – 9	Gender (1=male, 2=female, 9=missing data for estimation)
pwtyp	0 - 2	Worker type (0=non-worker, 1=full time worker, 2=part time worker)
pwpcl	-1 - 9999999	Usual work location parcel ID. -1 for none/missing, otherwise must be a valid parcel ID present in the Parcel file.
pwtaz	-1 - 9999999	Usual work location zone ID. (This could be optional as input, as the Parcel file has the parcel-zone correspondence.)
pwautime	-1 - 9999999	The 1-way peak auto travel time between the residence and usual work parcels (a real number of minutes, -1 if no usual work location. Could be optional as input, used as output for calibration.)
pwaudist	-1 - 9999999	The 1-way peak auto travel distance between the residence and usual work parcels (a real number of miles, -1 if no usual work location. Could be optional as input, used as output for calibration.)
pstyp	0 - 2	Worker type (0=non-student, 1=full time student, 2=part time student if known – part-time distinction not used in DaySim code)
pspcl	-1 - 9999999	Usual school location parcel ID. -1 for none/missing, otherwise must be a valid parcel ID present in the Parcel file.

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
pstaz	-1 - 9999999	Usual school location zone ID. (This could be optional as input, as the Parcel file has the parcel-zone correspondence.)
psautime	-1 - 9999999	The 1-way peak auto travel time between the residence and usual school parcels (a real number of minutes, -1 if no usual school location. Could be optional as input, used as output for calibration.)
psaudist	-1 - 9999999	The 1-way peak auto travel distance between the residence and usual school parcels (a real number of miles, -1 if no usual school location. Could be optional as input, used as output for calibration.)
puwmode	-1 – 9	The usual mode used to work. (This is optional, as it is a placeholder for possible models that may be added to DaySim in the future.)
puwarrp	-1 – 9	The usual arrival period at work. (This is optional, as it is a placeholder for possible models that may be added to DaySim in the future.)
puwdepp	-1 – 9	The usual departure period from work. (This is optional, as a placeholder for possible models that may be added to DaySim in the future.)
ptpass	0 – 1	Transit pass ownership (0=no, 1=yes. This is predicted by DaySim, so could be an optional input in application mode.)
ppaidprk	0 – 1	Worker has to pay to park at work (0=no, 1=yes. This is predicted by DaySim, so could be an optional input in application mode.)
pdiary	0 – 1	Survey respondent used their diary? (0=no, 1=yes. This is only relevant for survey data in estimation, so could be optional in application mode.)
pproxy	0 – 1	Survey responses by proxy? (1=no, 2=yes, 3=by mail, 9=missing. This is only relevant for survey data in estimation, so could be optional in application mode.)

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
psexpfac	Real ≥ 0	The expansion factor for the person – a non-negative real number. (In application mode, this could be optional, since it is set equal to hhexpfac)

Zone Index File

This is often referred to as the “taz index” file. Its main purpose is to indicate to DaySim which zone numbers are valid. If there are gaps in the zone numbering (unused zone numbers), then this file is used to set up a mapping from the nominal zone numbers to an internal zone numbering that is used to compress the amount of memory used to store zone-to-zone skim matrices in memory. The file is ASCII delimited with a header record and located at “1_Inputs\8_DaySim\01_TAZ_Index\Fresno_taz_indexes.dat”. Table 51 presents format of the file.

TABLE 52: ZONE INDEX FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
Zone_ID	1 – 9999999	The zone ID number used in the network software that produces skims. Values must be unique positive integers, in ascending order.
Zone_ordinal	1 – 9999999	A zone index number internal to DaySim, which is mapped to Zone_id. Values must be unique positive integers in ascending order. Value will generally begin at 1 with no gaps in numbering, although gaps are allowed.
Dest_eligible	0 or 1	A binary variable indicating whether or not a zone is eligible as a destination in Daysim. Zones that are not eligible as destinations are external zones or special park and ride lot zones.
External	0 – 99	This variable was originally used as a binary variable to indicate external zones, but was not used in the DaySim code, so it is now used to indicate a District mapping of the zones. Including a district mapping is optional – only necessary if ODShadowPricing is used, or other region-specific variables that are District-based

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
xcoord	1 – 9999999	OPTIONAL –only needed if Transit Stop Areas are used for transit skims. The x coordinate of the zone centroid, in integer length units (typically SPF).
ycoord	1 – 9999999	OPTIONAL –only needed if Transit Stop Areas are used for transit skims. The x coordinate of the zone centroid, in integer length units (typically SPF).

Workers IXXI Fractions

This is a file that DaySim uses for the work location model, to set the percent of workers living in each zone that work outside the region, and the percent of jobs in each zone that are filled by workers living outside the region. DaySim does not select a usual workplace or simulate internal home-work tours for the I-X fraction of workers, and makes the X-I fraction of jobs unavailable as usual work locations for region residents. Both fractions tend to be larger towards the edges of modeled regions.

The file is ASCII delimited without a header record and located at "1_Inputs\8_DaySim\05_ixxi\Fresno_worker_ixxifractions.dat". Table 52 presents format of the file.

TABLE 53: WORKERS IXXI FRACTIONS FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
Zone_ID	1 - 9999999	The zone ID number. Values must be unique positive integers, in ascending order. There must be the same number of records in the same order as in the raw Zone file.
Worker_Ix Frac	0.00 - 1.00	The fraction of workers living in the zone that have a usual work location outside the modeled region (not in a destination-eligible zone)
Jobs_XIFr ac	0.00 - 1.00	The fraction of jobs in the zone that are filled by workers living outside of the region (not in a destination-eligible zone)

Park and Ride File

This file is for park and ride lot/path choice in DaySim. It is optional, and not needed if either (a) the park and ride mode is not included in the model for the region, or (b) the park and ride skim matrices are prepared in the network software rather than using the path choice in DaySim.

The file is ASCII delimited with a header record and located at “1_Inputs\8_DaySim\10_ParkAndRide\p_r_Nodes_2023.dat”. Table 53 presents format of the file.

TABLE 54: PARK AND RIDE FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
Node_ID	1 - 9999999	The park and ride node ID number. Values must be unique positive integers, in ascending order.
Zone_ID	1 - 9999999	The zone that the lot is associated in. Must be a zone ID present in the raw Zone file. May be either an internal (destination-eligible zone) or a special park and ride zone, which allows more accurate zone-to-zone skims for park and ride
xcoord	1 – 9999999	The x coordinate of the lot, in integer length units (typically SPF).
ycoord	1 – 9999999	The y coordinate of the lot, in integer length units (typically SPF).
capacity	0 – 9999999	The number of parking spaces in the lot. A value of 0 makes the lot unavailable as a choice option, but can be useful for including a lot as a placeholder for future/alternative scenarios
cost	0 – 9999999	The daily parking cost for the lot, in hundredths of monetary units (typically this is cents)

Node-to-Node Distance File

The node-to-node distance file is an input to the DaySim buffer tool. The ABM Cube process automatically generates maz-to-maz walk skim in a text format as described in Table 54. Other input, INPUT_NODE.csv, required for the buffer tool is also generated by the Cube process. With these two distance related inputs, the buffer tool generates a binary version of the distance file which is then used by DaySim for short trip distance calculations. In addition, the buffer tool generates a maz to node id correspondence, maz_node_{year}.dat, and an index file, {node_distance_file_index.txt} for DaySim to use node to node distance data.

TABLE 55: NODE TO NODE DISTANCE FILE FORMAT

FIELD	DESCRIPTION
RECORD_ID	Record id number
FROM_NODE_ID	Origin node id
TO_NODE_ID	Destination node id
DISTANCE	Shortest path distance in miles

Intersection Data File (Buffer Tool)

This file is an input to the buffer tool that generates buffered micro-zone file for DaySim. A unique measure of urban form that DaySim incorporates is the number of intersections or nodes of different types around a micro-zone. These intersection types include, dead-ends (1 link), T-intersections (3-links), and tradition intersections (4+ links), and help characterize the pattern of urban development.

The intersection data is in a CSV file and resides at

“1_Inputs\8_DaySim\02_Parcel\intersection_2023_nohwys.csv”. Table 55 presents contents of the file.

TABLE 56: INTERSECTION DATA FILE FORMAT

FIELD	DESCRIPTION
Id	Intersection ID number
Links	Number of links associated with node
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet

This file is automatically generated in the input processing step.

Transit Stops File (Buffer Tool)

This file is an input to the buffer tool that generates buffered micro-zone file for DaySim. In addition to using zone-level information on access times to transit, DaySim also incorporates detailed micro-zone-level information on the distance to transit by transit sub-mode. This file is created from transit network by extracting stops on transit routes.

The file is located at “1_Inputs\8_DaySim\02_Parcel\stops_transit_2023.csv”. Table 56 summarizes the contents of this file.

TABLE 57: TRANSIT STOPS FILE FORMAT

FIELD	DESCRIPTION
Id	Transit stop ID number
Mode	Transit sub-mode code 1=local bus 2=express bus 3=commuter rail 4=ferry (BRT) 5=light rail
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet

When developing or updating forecast year or project alternative networks, careful consideration should be given to the location of individual bus stops. In addition to the bus stops located in urban areas of the county, it is also necessary to incorporate bus stop locations for rural transit routes into the model. This fine-grained information is used by DaySim to develop micro-zone-level estimates of access time to transit. Ideally, forecast year transit networks would include a similar level of detail. Forecast year travel model transit network do include information on stop locations as part of the network coding. However, these stop locations are constrained by the coarser travel model roadway networks, and thus may tend to make transit access times appear longer by not including stops that are on major roads included in the roadway network. This file is automatically generated in the input processing module under “DaySim Input Prepper”

Parks/Open Spaces Data Stops File

This file is an input to the buffer tool that generates buffered micro-zone file for DaySim. A unique feature of DaySim is that it incorporates measures of access to publicly accessible open space. Although open space is clearly an attractor of travel for recreational, social and other purposes, typically open space is not included in travel models because the traditional “size” measures used as input to travel models, such as employment and population, are not good indicators of the attractiveness of open space (i.e. a popular park will often have no employment and no population). The open space measures incorporated into DaySim capture the proximity of each micro-zone to the nearest open space, and the amount of open space present in the buffer area around the micro-zone.

The open space park file resides at “1_Inputs\8_DaySim\02_Parcel\openspace_active_fresno.csv”. Contents of the file are presented in Table 57.

TABLE 58: OPEN SPACE DATA FILE FORMAT

FIELD	DESCRIPTION
Id	Open space ID number
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet
Sqft	Open space grid cell size in sq ft

The individual records in the open space file are based on converting a shapefile of regional, publicly accessibility open spaces into a smaller set of open space grid cells.

Appendix C provides details of the procedure to create this input file.

Coefficient Files

Coefficient for each model is a separate text file (.F12 format) that can be edited by the user for calibration purpose. There are a total of 23 files corresponding to all the models described in section 5.9. All coefficient files are in the same directory at 1_Inputs\8_DaySim\07_Coefficients. For example, the person day pattern model coefficient is a file named IndividualPersonDayPatternCoefficients_Nash-v1.8.F12. Figure 39 provides an example of a coefficient file.

```

1  Auto availability auto27.ALO
2  Created by ALOGIT version 4
3  END
4  1 Beta000001 F -3.75488401423
5  2 Beta000002 F -1.43947756024
6  3 Beta000003 F -3.25364812373
7  4 Beta000004 F -4.30330562145
8  5 Beta000005 F -4.05176795548
9  6 Beta000006 F -1.41819142329
10 7 Beta000007 F -1.47531914845
11 8 Beta000008 F -3.13089802675
12 9 Beta000009 F -3.33391748513
13 10 Beta000010 F -0.59233491336
14 11 Beta000011 F -0.30703688340
15 12 Beta000012 F -0.96373295824
16 13 Beta000013 F -2.56166024388
17 14 Beta000014 F -0.55021635237
18 15 Beta000015 F -0.20725368004
19 16 Beta000016 F -0.23469785064
20 18 Beta000018 F 0.29809501011
21 19 Beta000019 F 0.97804158764
22 20 Beta000020 F 0.34302331597
23 22 Beta000022 F -0.56184165791
24 24 Beta000024 F -0.078751777966
25 25 Beta000025 F 0.27622060968
26 26 Beta000026 F 0.07021559821
27 28 Beta000028 F 0.00229947670
28 29 Beta000029 F -0.78751694870
29 31 Beta000031 F 2.66149521117

```

FIGURE 39: COEFFICIENT FILE EXAMPLE

Roster File

The Roster file is a very convenient and flexible way to define which skim matrices are used for all modes/path types and level-of-service (LOS) variables, for all times of day. The roster file is here: “1_Inputs\8_DaySim\06_Roster\roster_mz.csv”.

The Roster file must also be in CSV format and must include the columns listed below and shown in the example below.

- **#variable:** A variable label, as referred to in DaySim code
- **mode:** A mode label, as referred to in the DaySim code and present in the RosterCombinations file
- **path-type:** A path type label, as referred to in the DaySim code, and the mode/path type combination must be TRUE in the RosterCombinations file. In the example, the “walk”, “bike”, “sov”, “hov2” and “hov3” are input only for the “full-network” path type, while separate “transit” skims are input for five different path types.
- **vot-group:** A value of time class, with boundaries set in the configuration file. Valid names are very-low, low, medium, high, very-high, or all.
- **start-minute** and **end-minute:** The time period for which the skim matrix applies, in minutes past midnight. For example, 0-1439 is the entire day, and 360-539 is 6:00 am to

8:59 am. For each variable/mode/path-type/vot-group combination, the skims should cover all minutes from 0 to 1439. An example is the last 5 lines above for toll, for 5 time periods. The last period 1110-179 spans midnight, and is 6:30 pm to 2:59 am.

- **length:** The “zone” system used for the matrix. “maxzone” uses Zone, “transitstop” uses TransitStopArea, “null” just returns a value of 0 instead of reading in a matrix (in which case the “file-type” and “name” columns should also be “null”).
- **file-type:** The format of the file. Valid types are:
 - **text-ij:** Text files with a record for each I-J zone pair that can contain more than 1 skim variable. Column 1 of the text file is always the I zone and column 2 the J zone.
 - **transcad:** Native binary format written by TransCAD-requires a valid TransCAD license to be installed when running.
 - **cube:** Native binary format written by Cube. Requires a valid Cube license to be installed when running.
 - **emme:** Native binary format written to EMME databanks.
 - **visum-binary:** Native binary format written by Visum.
 - **hdf5:** HDF5 format, which can be written by various network packages or converters.
 - **omx:** Open Matrix format (modified HDF5), which can be written by various network packages or converters.
 - **bin:** A custom DaySim binary format, which is fastest to load, but requires pre-processing of the matrices.
 - **null:** Returns a value of 0. (“length” and “name” should also be set to “null”)
- **name:** The matrix file name (plus the table name for HDF5 or OMX files). The directory path is assumed to be the same as for the Roster file. Note that different roster rows may refer to the same file—such as the first four rows in the example using “walkSkim.h5/1”. In that case, the same matrix is used for multiple variables, but only read and stored in memory once. In the example, the toll matrices use the same table number, but different file names for the five time periods.
- **field:** The matrix number on the file for the particular variable. For “text-ij”, it is the column number. For “cube” it is the Cube matrix number.
- **transpose:** This indicates that the origin and destination zones for the matrix should be “switched” and the transpose used. For example, the transpose of the AM peak transit matrices can be used to represent the PM peak period.

- **blend-variable:** This is the variable to use for “short distance blending”. It is only relevant for the walk, bike and auto modes, but not for transit. In practice, this should always be set as “distance”, which is what the DaySim code assumes.
- **blend-path-type:** This is the path type to use for “short distance blending”. If it is set to “null”, then DaySim assumes that the “blend-path-type” is the same as the “path-type” entry on the same row. It would be possible to use a different path type for the same mode if no “distance” matrix was available for “path type”, but in almost all cases, the user should leave this as “null”
- **factor:** This allows one variable to be set as a factored version of another variable. In the example below, “walk” “time” is set to use the same matrix as “walk” “distance”, but with a factor of 20, which assumes a walk speed of 20 minutes per mile. Similarly, “bike” “time” is set to use the same matrix as “bike” “distance”, but with a factor of 6, which assumes a bike speed of 6 minutes per mile. If the entry is “null”, the default factor is 1.0.
- **scaling:** This last setting causes some confusion, so deserves careful explanation. DaySim stores all matrix values in memory as 2-byte unsigned integers, which can take values between 0 and roughly 65,000. Those values are assumed to be hundredths of miles for distance, hundredths of minutes for times, hundredths of dollars (cents) for costs, and hundredths of boardings for transit boardings or transfers. So, the maximum skim values that can be stored in memory are roughly 650 miles, minutes, dollars, or boardings, which is sufficient for regional models. (Any values larger than this are capped at the maximum value.)

In most cases, the input matrices are in units of miles, minutes, or dollars. In that case, “scaling” should be set to TRUE, and DaySim will scale the values by 100 when storing them in memory, and then “unscale” them back to the original units when accessing them from memory. That is done for most of the walk, bike, and auto variables in the example, as well as transit times and boardings (“nboard”).

In the example, the toll and fare matrices were already in units of cents rather than dollars, so no scaling is necessary, and “scaling” is FALSE for those variables. However, the DaySim code assumes that these costs are in dollars, so a factor of 0.1 is necessary to convert the cost in cents to a cost in dollars. In general, the rules are:

In summary, if the matrices are in units of miles, minutes or dollars, the proper setting of “scaling” is “TRUE” and “factor” is “null” (unless converting walk distance to walk time, or a similar conversion).

If the matrices are in cents, or they are already pre-scaled to hundredths of miles or hundredths of minutes, the proper setting of “scaling” is “FALSE” and “factor” is “0.01”.

Roster Combinations File

The RosterCombinations file is used together with the Roster file and tells which mode-path type combinations are valid in the Roster file. A “path type” is essentially a “submode” in DaySim, such as tolled versus non-ttolled networks for auto modes or local bus versus light rail (plus optional bus) networks for transit. The roster combinations file is here: “1_Inputs\8_DaySim\06_Roster\roster_combinations.csv”.

The RosterCombinations file must be in .CSV format and is a matrix where the columns give the valid mode labels for the Roster entries, and the rows give the valid “path type” labels for the Roster entries.

The format is presented in Table 58. A TRUE entry means that the mode/path type combination is valid for the matrix entries in the Roster, and a FALSE entry means that it is not valid. A TRUE entry does not mean that the path type is required, however, so using the file below would not require separate “no-tolls” matrices for the auto modes, or separate “ferry” matrices for transit – but it would allow them.

A few other things to note in this example...

There is a “park-and-ride” mode listed, but that does not require that the user provide skims for park and ride. (That is an option, but DaySim can also use its internal lot/path choice to create park and ride paths from the “sov” and “transit” skims.)

All of the path types are FALSE for the “school-bus” mode. Typically, the school bus mode uses the “hov3” skims in the models, so no separate “school-bus” skims are listed in the Roster.

The “other” mode is basically a placeholder, not currently used in the models. For BKR, we may add a “taxi-uber” mode, but that will use “hov2” skims, so all of the path types could remain FALSE.

Some DaySim users let the network software choose the best transit path, so only use a single path type. In that case, they often list the path type for all of the “transit” skims as “local-bus”, but it would also be possible to list them all as “full-network”, and change the RosterCombinations file so that only the “full-network” row is TRUE under transit, and all of the other rows are FALSE.

A user can add or substituted different path type names, and even different mode names, but that could require substantial corresponding changes to the DaySim code—essentially every call to PathTypeModel includes a mode label and path type label, and that combination must be TRUE in the RosterCombinations file.

TABLE 59: ROSTER COMBINATIONS FILE FORMAT

#	WALK	BIKE	SOV	HOV2	HOV3	TRANSIT	PARK-AND-RIDE	SCHOOL-BUS	OTHER
full-network	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
no-tolls	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
local-bus	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
light-rail	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
premium-bus	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
commute-r-rail	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
ferry	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE

DaySim Configuration File

The configuration file is the main user input control file for DaySim. This file is created automatically before a DaySim run. As mentioned previously, for each feedback loop DaySim is run for four iterations. The first three iterations of DaySim run only long-term choice models (work and school location choice) to get stable shadow prices. The last iteration runs all models (long-term and short-term choice models). In all, each feedback loop generates two sets of properties files under the DaySim folder in a scenario directory: configuration.properties and configuration_shadow_price.properties.

Appendix D describes various settings available to configure a DaySim model run.

5.6 OUTPUTS

DaySim

The outputs generated from a DaySim run are stored inside a scenario folder here: "Scenarios\FC23_BASE\11_DaySim". This section describes all necessary DaySim outputs, including the intermediate outputs generated by the buffer tool which are then used in DaySim.

Buffered Micro-zone File

The buffered micro-zone file is an output from the buffer tool and used in a DaySim run. This is a space-delimited delimited ASCII text format file (.dat) with one row of data per micro-zone and is the primary file used to maintain socioeconomic information. The file begins with several fields identifying the micro-zone and describing the physical location and size of the micro-zone. Then contains fields that describe the quantity of housing, school enrollment, and employment around the micro-zone using logistic distance decay curves with 1/8th mile and quarter mile inflection points. These two distance decay curves with 1/8th and quarter mile inflection points result in

“buffer 1” and “buffer 2” variables respectively which are referred to in the file format table below. In addition, the micro-zone file contains information about urban form and the transportation system on and close to the micro-zone, including the proximity to transit stops and the price and supply of parking.

Table 59 presents a list of fields available in the buffered micro-zone file.

TABLE 60: BUFFERED MICRO-ZONE FILE

FIELD	DESCRIPTION
Id	Micro-zone ID number
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet
sqft_p	Area – square feet
taz_p	TAZ number
lutype_p	Park area (square feet)
hh_p	households on micro-zone
stugrd_p	grade school enrollment on micro-zone
stuhgh_p	high school enrollment on micro-zone
stuuni_p	university enrollment on micro-zone
empedu_p	educational employment on micro-zone
empfoo_p	food employment on micro-zone
empgov_p	government employment on micro-zone
empind_p	industrial employment on micro-zone
empmed_p	medical employment on micro-zone
empofc_p	office employment on micro-zone
empret_p	retail employment on micro-zone
empsvc_p	service employment on micro-zone
empoth_p	other employment on micro-zone

FIELD	DESCRIPTION
emptot_p	total employment on micro-zone
parkdy_p	offstreet daily parking on micro-zone
parkhr_p	offstreet hourly parking on micro-zone
Ppricdyp	offstreet daily parking price
Pprichrp	offstreet hourly parking price
hh_1	households within buffer 1
stugrd_1	grade school enrollment within buffer 1
stuhgh_1	high school enrollment within buffer 1
stuuni_1	university enrollment within buffer 1
empedu_1	educational employment within buffer 1
empfoo_1	food employment within buffer 1
empgov_1	government employment within buffer 1
empind_1	industrial employment within buffer 1
empmed_1	medical employment within buffer 1
empofc_1	office employment within buffer 1
empret_1	retail employment within buffer 1
empsvc_1	service employment within buffer 1
empoth_1	other employment within buffer 1
emptot_1	total employment within buffer 1
parkdy_1	offstreet daily parking within buffer 1
parkhr_1	offstreet hourly parking within buffer 1
ppricdyp	average offstreet daily parking price within buffer 1
pprichrp	average offstreet hourly parking price within buffer 1
nodes1_1	number of single link street nodes (dead ends) within buffer 1

FIELD	DESCRIPTION
nodes3_1	number of three-link street nodes (T-intersections) within buffer 1
nodes4_1	number of 4+ link street nodes (traditional 4-way +) within buffer 1
tstops_1	number of transit stops within buffer 1
nparks_1	number of open space parks within buffer 1
aparks_1	open space area in square feet within buffer 1
hh_2	households within buffer 2
stugrd_2	grade school enrollment within buffer 2
stuhgh_2	high school enrollment within buffer 2
stuuni_2	university enrollment within buffer 2
empedu_2	educational employment within buffer 2
empfoo_2	food employment within buffer 2
empgov_2	government employment within buffer 2
empind_2	industrial employment within buffer 2
empmed_2	medical employment within buffer 2
empofc_2	office employment within buffer 2
empret_2	retail employment within buffer 2
empsvc_2	service employment within buffer 2
empoth_2	other employment within buffer 2
emptot_2	total employment within buffer 2
parkdy_2	offstreet daily parking within buffer 2
parkhr_2	offstreet hourly parking within buffer 2
ppricdy2	average offstreet daily parking price within buffer 2
pprichr2	average offstreet hourly parking price within buffer 2
nodes1_2	number of single link street nodes (dead ends) within buffer 2

FIELD	DESCRIPTION
nodes3_2	number of three-link street nodes (T-intersections) within buffer 2
nodes4_2	number of 4+ link street nodes (traditional 4-way +) within buffer 2
tstops_2	number of transit stops within buffer 2
nparks_2	number of open space parks within buffer 2
aparks_2	open space area in square feet within buffer 2
dist_lbus	distance to nearest local bus stop from micro-zone
dist_ebus	distance to nearest express bus stop from micro-zone
dist_crt	distance to nearest commuter rail stop from micro-zone
dist_fry	distance to nearest ferry stop from micro-zone
dist_lrt	distance to nearest light rail stop from micro-zone
dist_park	distance to nearest park from micro-zone

Tour File (_tour.tsv)

This file has tour-level variables for all persons predicted by a DaySim run. The file is ASCII delimited with a record and is stored here: “Scenarios\FC23_BASE\11_DaySim_tour.tsv”. Table 60 presents a list of fields available in the tour file.

TABLE 61: TOUR FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
id		Internal DaySim record ID
person_id		Internal DaySim record ID
person_day_id		Internal DaySim record ID
hhno	1 - 9999999	The household ID number
pno	1 – 99	The person sequence number within the household

day	1 – 99	The survey day sequence, if using multi-day survey data, or if DaySim were programmed to simulate multiple days per household (which is not a current feature).
tour	1 – 99	The tour sequence within the person-day
jtindex	0 – 99	Links to the sequence number of the tour in the JointTour file records for the HouseholdDay. (Only relevant for the H version of the models.)
parent	0 - 99	If it is a work-based subtour, the “tour” sequence number of the “parent” work tour, otherwise 0.
subtours	0 - 99	For home-based work tours, the number of work-based subtours made from the work activity of that tour.
pdpurp	1 - 9	The tour primary destination purpose (1=work, 2=school, 3=escort, 4=personal business (& medical), 5=shopping, 6=meal, 7=social (& recreation), 8=recreation (H version only) 9=medical (H version only))
tlvorig	0 - 1439	The time leaving the (sub)tour origin, in minutes after midnight (or hours*100+minute for estimation mode)
tardest	0 - 1439	The time arriving at the (sub)tour destination, in minutes after midnight (or hours*100+minute for estimation mode)
tlvdest	0 - 1439	The time leaving the (sub)tour destination, in minutes after midnight (or hours*100+minute for estimation mode)
tarorig	0 - 1439	The time arriving back at the (sub)tour origin, in minutes after midnight (or hours*100+minute for estimation mode)
toadtyp	1 - 5	Tour origin address type (1=home, 2=usual work location, 3=usual school location, 4=other location in region, 5=out of region/missing (survey data only))
tdadtyp	1 - 5	Tour destination address type (1=home, 2=usual work location, 3=usual school location, 4=other location in region, 5=out of region/missing (survey data only))

topcl	-1 - 9999999	Tour origin parcel ID. Must be a valid parcel ID present in the Parcel file.
totaz	-1 - 9999999	Tour origin zone ID. Must be a valid zone ID present in the Zone file.
tdpcl	-1 - 9999999	Tour destination parcel ID. Must be a valid parcel ID present in the Parcel file.
tdtaz	-1 - 9999999	Tour destination zone ID. Must be a valid zone ID present in the Zone file.
tmodotp	1 - 8	Tour main mode type (1=walk, 2=bike, 3=sov, 4=hov 2, 5=hov 3+, 6=walk to transit, 7=park and ride, 8=school bus, 9=TNC, 10=other – survey only)
tpathtp	1 - 8	Tour main mode path type (1=full network, 2=no-toll network, 3=local bus, 4=light rail, 5=premium bus, 6=commuter rail, 7=ferry)
tautotime	-1 - 9999999	The one-way auto travel time between the origin and destination (a real number of minutes)
tautocost	-1 - 9999999	The one-way auto toll cost between the origin and destination (a real number of dollars)
tautodist	-1 - 9999999	The one-way auto travel distance between the origin and destination (a real number of miles)
tripsh1	1 - 99	The number of trips segments on the half tour to the destination.
tripsh2	1 - 99	The number of trips segments on the half tour from the destination.
phtindx1	0 - 99	Links to the sequence number of the first half tour in the PartialHalfTour file records for the HouseholdDay. (Only relevant for the H version of the models.)
phtindx2	0 - 99	Links to the sequence number of the second half tour in the PartialHalfTour file records for the HouseholdDay. (Only relevant for the H version of the models.)

fhtindx1	0 - 99	Links to the sequence number of the first half tour in the FullHalfTour file records for the HouseholdDay. (Only relevant for the H version of the models.)
fhtindx2	0 - 99	Links to the sequence number of the second half tour in the FullHalfTour file records for the HouseholdDay. (Only relevant for the H version of the models.)
toexpfac	Real ≥ 0	The expansion factor for the tour – a non-negative real number. (Is set equal to hhexpfac in application mode)

Trip File

This file is an output from a DaySim run and has trip-level variables for all persons predicted by a DaySim run. The file is ASCII delimited with a record and is stored here:

“Scenarios\FC23_BASE\11_DaySim_trip.tsv”. Table 61 presents a list of fields available in the trip file.

TABLE 62: TRIP FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
Id		Internal DaySim record ID
Tour_id		Internal DaySim record ID
hhno	1 - 9999999	The household ID number. Values must be unique positive integers, and should be in ascending order. Must be present in the Household file.
pno	1 – 99	The person sequence number within the household. Values must be unique positive integers within a household, and match the hhno/pno combinations in the Person file
day	1 – 99	The survey day sequence, if using multi-day survey data, or if DaySim were programmed to simulate multiple days per household (which is not a current feature).
tour	1 – 99	The tour sequence within the person-day. Must match a tour present for the person-day in the Tour file.

half	1 –2	The half tour (1=to the destination, 2=from the destination)
tseg	1 - 99	The trip sequence number within the half tour.
tsvid	1 - 99	Links to a travel survey trip ID (not relevant in application mode)
opurp	0 – 10	The purpose at the trip origin (0=home, 1=work, 2=school, 3=escort, 4=personal business (& medical), 5=shopping, 6=meal, 7=social (& recreation), 8=recreation (H version only) 9=medical (H version only), 10=change mode at a park and ride lot
dpurp	0 – 10	The purpose at the trip destination (0=home, 1=work, 2=school, 3=escort, 4=personal business (& medical), 5=shopping, 6=meal, 7=social (& recreation), 8=recreation (H version only) 9=medical (H version only), 10=change mode at a park and ride lot
oadtyp	1 – 6	Trip origin address type (1=home, 2=usual work location, 3=usual school location, 4=other location in region, 5=out of region/missing (survey data only), 6=inserted change mode location for park and ride
dadtyp	1 – 6	Trip dest. address type (1=home, 2=usual work location, 3=usual school location, 4=other location in region, 5=out of region/missing (survey data only), 6=inserted change mode location for park and ride
opcl	-1 - 9999999	Trip origin parcel ID. Must be a valid parcel ID present in the Parcel file.
otaz	-1 - 9999999	Trip origin zone ID. Must be a valid zone ID present in the Zone file.
dpcl	-1 - 9999999	Trip destination parcel ID. Must be a valid parcel ID present in the Parcel file.
dtaz	-1 - 9999999	Trip destination zone ID. Must be a valid zone ID present in the Zone file.
mode	1 - 8	Trip mode (1=walk, 2=bike, 3=sov, 4=hov 2, 5=hov 3+, 6=walk to transit, 7=park and ride, 8=school bus, 9=TNC, 10=other – survey only)

pathtype	1 - 8	Trip path type (1=full network, 2=no-toll network, 3=local bus, 4=light rail, 5=premium bus, 6=commuter rail, 7=ferry)
dorp	0 - 999	For auto trips, 1=driver, 2=passenger; for transit trips, is set to the total walk access+egress time, in integer minutes
deptm	0 – 1439	The trip departure time, in minutes after midnight (or hours*100+minute for estimation mode)
arrtm	0 – 1439	The trip arrival time, in minutes after midnight (or hours*100+minute for estimation mode)
endacttm	0 – 1439	The end time of the destination activity, in minutes after midnight (or hours*100+minute for estimation mode)
travtime	-1 - 9999999	The travel time by the trip mode and path type (a real number of minutes)
travcost	-1 - 9999999	The travel cost by the trip mode and path type (a real number of dollars)
travdist	-1 - 9999999	The network distance between the trip origin and destination (a real number of miles, SOV distance used for transit trips)
trexpfac	Real ≥ 0	The expansion factor for the trip – a non-negative real number. (Is set equal to hhexpfac in application mode)

Household and Household Day Files

These files are outputs from a DaySim run. The household and household day output files append the model predicted information into the household input files. Household output file is in the same format as the input file in Table 49. The household file is here: “Scenarios\FC23_BASE\11_DaySim_household.tsv”

The household day output file is here:

“Scenarios\FC23_BASE\11_DaySim_household_day.tsv”. Table 62 presents the format of the file. Table 62 presents a list of fields available in the household day file.

TABLE 63: HOUSEHOLD DAY FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
id		Internal DaySim record ID
hhno	1 - 9999999	The household ID number. Values must be unique positive integers, and should be in ascending order. Must be present in the Household file.
day	1 – 99	The survey day sequence, if using multi-day survey data, or if DaySim were programmed to simulate multiple days per household (which is not a current feature).
dow	1 - 7	The day of the week, which is relevant for survey data, but is not currently used in the DaySim models.
jttours	0 - 99	The number of fully joint tour records output for the household. (Is set only in the H version of the DaySim models.)
phtours	0 - 99	The number of partially joint half tour records output for the household. (Is set only in the H version of the DaySim models.)
fhtours	0 - 99	The number of fully joint half tour records output for the household. (Is set only in the H version of the DaySim models.)
hdexpfac	Real ≥ 0	The expansion factor for the household-day – a non-negative real number. (Is set equal to hhexpfac in application mode)

Person and Person Day Files

The person output file is in the same format as the input person file in Table 50. The person file is here: “Scenarios\FC23_BASE\11_DaySim_person.tsv”

The person-day output file has the person-day-level variables from a DaySim run. The file is here: “Scenarios\FC23_BASE\11_DaySim_person_day.tsv”. The format of the file is shown in Table 63.

TABLE 64: PERSON DAY FILE FORMAT

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
id		Internal DaySim record ID
person_id		Internal DaySim record ID
household_day_id		Internal DaySim record ID
hhno	1 - 9999999	The household ID number. Values must be unique positive integers, and should be in ascending order. Must be present in the Household file.
pno	1 – 99	The person sequence number within the household. Values must be unique positive integers within a household, and match the hhno/pno combinations in the Person file
day	1 – 99	The survey day sequence, if using multi-day survey data, or if DaySim were programmed to simulate multiple days per household (which is not a current feature).
beghom	0 – 1	A flag if the survey diary day begins at home. (Not currently relevant for application mode, where all days are simulated to begin at home.)
endhom	0 – 1	A flag if the survey diary day ends at home. (Not currently relevant for application mode, where all days are simulated to end at home.)
hbtours	0 – 99	The total number of home-based tour records predicted for the person-day.
wbtours	0 – 99	The total number of work-based subtour records predicted for the person-day.
uwtours	0 – 99	The total number of home-based work tours predicted to go to the usual workplace in the person-day
wktours	0 – 99	The number of home-based work tours predicted in the person-day
sctours	0 – 99	The number of home-based school tours predicted in the person-day
estours	0 – 99	The number of home-based escort tours predicted in the person-day

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
pbtours	0 – 99	The number of home-based personal business tours predicted in the person-day (also includes medical tours in the Default models)
shtours	0 – 99	The number of home-based shopping tours predicted in the person-day
mltours	0 – 99	The number of home-based meal tours predicted in the person-day
sotours	0 – 99	The number of home-based social tours predicted in the person-day (also includes recreational tours in the Default models)
retours	0 – 99	The number of home-based recreation tours predicted in the person-day. (Is only predicted by the H version of the models.)
metours	0 – 99	The number of home-based medical tours predicted in the person-day. . (Is only predicted by the H version of the models.)
wkstops	0 – 99	The number of home-based work stops predicted in the person-day
scstops	0 – 99	The number of home-based school stops predicted in the person-day
esstops	0 – 99	The number of home-based escort stops predicted in the person-day
pbstops	0 – 99	The number of home-based personal business stops predicted in the person-day (also includes medical stops in the Default models)
shstops	0 – 99	The number of home-based shopping stops predicted in the person-day
mlstops	0 – 99	The number of home-based meal stops predicted in the person-day
sostops	0 – 99	The number of home-based social stops predicted in the person-day (also includes recreational stops in the Default models)
restops	0 – 99	The number of home-based recreation stops predicted in the person-day. (Is only predicted by the H version of the models.)
mestops	0 – 99	The number of home-based medical stops predicted in the person-day. (Is only predicted by the H version of the models.)
wkathome	0 – 1439	The number of minutes spent working at home during the day. (Is only predicted by the H version of the models.)

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
pdexpfac	Real >= 0	The expansion factor for the household-day – a non-negative real number. (Is set equal to hhexpfac in application mode)

Network Skims

The model produces three sets of skims: highway, transit, and non-motorized. The skims are under “Scenarios\FC23_BASE\01_Skims”.

Highway

The highway skims are for two time periods (PK: peak and OK: off-peak) and three modes (D1: drive alone, S2: shared-ride 2, and S3: shared-ride 3+). In all, six highway skims are output as {Scenario_Name}_SKM_{tod}_{mode}.mat, with each containing attributes as shown in Table 64.

TABLE 65: HIGHWAY SKIM ATTRIBUTES

SKIM INDEX	ATTRIBUTE	DESCRIPTION
1	GENTIME_0Veh	Generalized time for zone pair for low value-of-time group
2	TIME_0Veh	Congested travel time (mins) for zone pair for low value-of-time group
3	DIST_0Veh	Travel distance (miles) for zone pair for low value-of-time group
4	COST_0Veh	Travel cost for zone pair for low value-of-time group
5	GENTIME_1Veh	Generalized time for zone pair for medium value-of-time group
6	TIME_1Veh	Congested travel time (mins) for zone pair for medium value-of-time group
7	DIST_1Veh	Travel distance (miles) for zone pair for medium value-of-time group
8	COST_1Veh	Travel cost for zone pair for medium value-of-time group

SKIM INDEX	ATTRIBUTE	DESCRIPTION
9	GENTIME_2Veh	Generalized time for zone pair for high value-of-time group
10	TIME_2Veh	Congested travel time (mins) for zone pair for high value-of-time group
11	DIST_2Veh	Travel distance (miles) for zone pair for high value-of-time group
12	COST_2Veh	Travel cost for zone pair for high value-of-time group

Transit

The transit skims are for two time periods (PK: peak and OK: off-peak), two sub-modes (B: bus and R: rail), and two access modes (W: walk and D: drive). In all eight transit skims are output as { scenario_name }_SKM_{tod}_T{access_mode}{mode}.mat, with each containing attributes as shown in Table 65.

TABLE 66: TRANSIT SKIM ATTRIBUTES

SKIM INDEX	SKIM ATTRIBUTE	DESCRIPTION
1	IVTT	In-vehicle travel time (mins)
2	DRV_P	
3	DRVDIST_P	
4	WLK_P	Walk access time (mins)
5	WLK_A	Walk egress time (mins)
6	WLK_X	Walk transfer time (mins)
7	IWAIT	Initial wait time (mins)
8	XWAIT	Transfer wait time (mins)
9	FARE	Fare (dollars)
10	BRDS	Number of boardings

Non-motorized

The non-motorized (bike and walk) skims are generated at micro-zone (MAZ) level. Though, walk skims are also produced at zonal (TAZ) level. The bike skim is `{scenario_name}_MAZ_SKM_BIKE.mat` and contains attributes as shown in Table 66.

TABLE 67: BIKE SKIM (MAZ) ATTRIBUTES

SKIM INDEX	SKIM ATTRIBUTE	DESCRIPTION
1	DIST_BIKE	Bike distance (miles) for OD pair

The MAZ and TAZ walk skims are `WALK_SKIM_MAZ_MAZ_SORTED.TXT` and `{scenario_name}_TAZ_SKM_WALK.mat` respectively. Available attributes are presented in Table 67 and Table 68.

TABLE 68: WALK SKIM (MAZ) ATTRIBUTES

FIELD	DESCRIPTION
Record_id	Record number
From_node_id	Origin node id
To_node_id	Destination node id
Distance	Distance (miles)

Note: node ids are nearest nodes to micro-zones. The file “maz_node_2023.dat” provides nearest node to a micro-zone. The file is in the following format: id (mazid), node_id (nearest node id).

TABLE 69: WALK SKIM (TAZ) ATTRIBUTES

SKIM INDEX	SKIM ATTRIBUTE	DESCRIPTION
1	TIME_WALK	Walk travel time (mins) for OD pair
2	DIST_WALK	Walk distance (miles) for OD pair

Assignment Results

Assignment results are output in “Scenarios\FC23_BASE\09_Assignment”.

Highway

The highway assignment results are output in a CUBE network format (“FC23_BASE_LOADEDNETWORK_DETAIL.NET”), as well as in a database file format (“FC23_BASE_LOADEDNETWORK_DETAIL.DBF”). Both outputs contain attributes as shown in Table 69.

TABLE 70: ATTRIBUTES IN HIGHWAY ASSIGNMENT RESULT

FIELD	DESCRIPTION
A	A node
B	B node
SHAPE_LENGTH	Link length (feet)
DISTANCE	Distance (miles)
CAPCLASS	Capacity class
LANES	Number of lanes
NAME	Street name
ROUTE	Route
TERRAIN	Terrain type (F or R)
JURISDICTIO	Jurisdiction
SCREENLINE	Screen line id
SPEED	Speed (mph)
AREATYP	Area type (R-rural, U-urban, SU-suburban)
FACTYP	Facility type 0: local 1: Freeway 2: Highway

FIELD	DESCRIPTION
	3: Expressway
	4: Arterial
	5: Collector
	6: Local
	7: Ramp-Freeway-Freeway
	8: Ramp-Slip
	9: Ramp-Loop
	10: Connector1
	11: Connector2
AUX	Presence of auxiliary lane (1=yes; 0=no)
USE	Type of use
TOLL	Toll (dollars)
IMPROVED	Improvement id
A01_VOL	AB volume in AM peak hour
TOT_A01_VOL	Total (AB+BA) volume in AM peak hour
A03_VOL	AB volume in AM period
TOT_A03_VOL	Total (AB+BA) volume in AM period
M07_VOL	AB volume in MD period
TOT_M07_VOL	Total (AB+BA) volume in MD period
P01_VOL	AB volume in PM peak hour
TOT_P01_VOL	Total (AB+BA) volume in PM peak hour
P03_VOL	AB volume in PM period

FIELD	DESCRIPTION
TOT_P03_VOL	Total (AB+BA) volume in PM period
E11_VOL	AB volume in EV period
TOT_E11_VOL	Total (AB+BA) volume in EV period
D24_VOL	Daily AB volume
TOT_D24_VOL	Daily total (AB+BA) volume
A01_PAS_VOL	AB passenger car volume in AM peak hour
TOT_A01_PAS	Total (AB+BA) passenger car volume in AM peak hour
A03_PAS_VOL	AB passenger car volume in AM period
TOT_A03_PAS	Total (AB+BA) passenger car volume in AM period
M07_PAS_VOL	AB passenger car volume in MD period
TOT_M07_PAS	Total (AB+BA) passenger car volume in MD period
P01_PAS_VOL	AB passenger car volume in PM peak hour
TOT_P01_PAS	Total (AB+BA) passenger car volume in PM peak hour
P03_PAS_VOL	AB passenger car volume in PM period
TOT_P03_PAS	Total (AB+BA) passenger car volume in PM period
E11_PAS_VOL	AB passenger car volume in EV period
TOT_E11_PAS	Total (AB+BA) passenger car volume in EV period
D24_PAS_VOL	Daily AB passenger car volume
TOT_D24_PAS	Daily total (AB+BA) passenger car volume
A01_XX_VOL	AB external volume in AM peak hour

FIELD	DESCRIPTION
TOT_A01_XX_	Total (AB+BA) external volume in AM peak hour
A03_XX_VOL	AB external volume in AM period
TOT_A03_XX_	Total (AB+BA) external volume in AM period
M07_XX_VOL	AB external volume in MD period
TOT_M07_XX_	Total (AB+BA) external volume in MD period
P01_XX_VOL	AB external volume in PM peak hour
TOT_P01_XX_	Total (AB+BA) external volume in PM peak hour
P03_XX_VOL	AB external volume in PM period
TOT_P03_XX_	Total (AB+BA) external volume in PM period
E11_XX_VOL	AB external volume in EV period
TOT_E11_XX_	Total (AB+BA) external volume in EV period
D24_XX_VOL	Daily AB external volume
TOT_D24_XX_	Daily total (AB+BA) external volume
A01_TS_VOL	AB small truck volume in AM peak hour
TOT_A01_TS_	Total (AB+BA) small truck volume in AM peak hour
A03_TS_VOL	AB small truck volume in AM period
TOT_A03_TS_	Total (AB+BA) small truck volume in AM period
M07_TS_VOL	AB small truck volume in MD period
TOT_M07_TS_	Total (AB+BA) small truck volume in MD period
P01_TS_VOL	AB small truck volume in PM peak hour

FIELD	DESCRIPTION
TOT_P01_TS_	Total (AB+BA) small truck volume in PM peak hour
P03_TS_VOL	AB small truck volume in PM period
TOT_P03_TS_	Total (AB+BA) small truck volume in PM period
E11_TS_VOL	AB small truck volume in EV period
TOT_E11_TS_	Total (AB+BA) small truck volume in EV period
D24_TS_VOL	Daily AB small truck volume
TOT_D24_TS_	Daily total (AB+BA) small truck volume
A01_MED_VOL	AB medium truck volume in AM peak hour
TOT_A01_MED	Total (AB+BA) medium truck volume in AM peak hour
A03_MED_VOL	AB medium truck volume in AM period
TOT_A03_MED	Total (AB+BA) medium truck volume in AM period
M07_MED_VOL	AB medium truck volume in MD period
TOT_M07_MED	Total (AB+BA) medium truck volume in MD period
P01_MED_VOL	AB medium truck volume in PM peak hour
TOT_P01_MED	Total (AB+BA) medium truck volume in PM peak hour
P03_MED_VOL	AB medium truck volume in PM period
TOT_P03_MED	Total (AB+BA) medium truck volume in PM period
E11_MED_VOL	AB medium truck volume in EV period
TOT_E11_MED	Total (AB+BA) medium truck volume in EV period
D24_MED_VOL	Daily AB medium truck volume

FIELD	DESCRIPTION
TOT_D24_MED	Daily total (AB+BA) medium truck volume
A01_HVY_VOL	AB heavy truck volume in AM peak hour
TOT_A01_HVY	Total (AB+BA) heavy truck volume in AM peak hour
A03_HVY_VOL	AB heavy truck volume in AM period
TOT_A03_HVY	Total (AB+BA) heavy truck volume in AM period
M07_HVY_VOL	AB heavy truck volume in MD period
TOT_M07_HVY	Total (AB+BA) heavy truck volume in MD period
P01_HVY_VOL	AB heavy truck volume in PM peak hour
TOT_P01_HVY	Total (AB+BA) heavy truck volume in PM peak hour
P03_HVY_VOL	AB heavy truck volume in PM period
TOT_P03_HVY	Total (AB+BA) heavy truck volume in PM period
E11_HVY_VOL	AB heavy truck volume in EV period
TOT_E11_HVY	Total (AB+BA) heavy truck volume in EV period
D24_HVY_VOL	Daily AB heavy truck volume
TOT_D24_HVY	Daily total (AB+BA) heavy truck volume
A01_TRK_VOL	AB truck volume in AM peak hour
TOT_A01_TRK	Total (AB+BA) truck volume in AM peak hour
A03_TRK_VOL	AB truck volume in AM period
TOT_A03_TRK	Total (AB+BA) truck volume in AM period
M07_TRK_VOL	AB truck volume in MD period

FIELD	DESCRIPTION
TOT_M07_TRK	Total (AB+BA) truck volume in MD period
P01_TRK_VOL	AB truck volume in PM peak hour
TOT_P01_TRK	Total (AB+BA) truck volume in PM peak hour
P03_TRK_VOL	AB truck volume in PM period
TOT_P03_TRK	Total (AB+BA) truck volume in PM period
E11_TRK_VOL	AB truck volume in EV period
TOT_E11_TRK	Total (AB+BA) truck volume in EV period
D24_TRK_VOL	Daily AB truck volume
TOT_D24_TRK	Daily total (AB+BA) truck volume
A01_ASG_SP	AB speed in AM peak hour
A03_ASG_SP	AB speed in AM period
M07_ASG_SP	AB speed in AM period
P01_ASG_SP	AB speed in PM peak hour
P03_ASG_SP	AB speed in PM period
E11_ASG_SP	AB speed in EV period
D24_ASG_SP	Average daily AB speed
AIRBASIN	
LOS_AM	Level of service in AM period
LOS_MD	Level of service in MD period
LOS_PM	Level of service in PM period

FIELD	DESCRIPTION
LOS_EV	Level of service in EV period
LOS_AM1HR	Level of service in AM peak hour
LOS_PM1HR	Level of service in PM peak hour
TSM	
EJ	
A03_DA	AB drive alone volume in AM peak hour
TOT_A03_DA	Total (AB+BA) drive alone volume in AM peak hour
A03_DA	AB drive alone volume in AM period
TOT_A03_DA	Total (AB+BA) drive alone volume in AM period
M07_DA	AB drive alone volume in MD period
TOT_M07_DA	Total (AB+BA) drive alone volume in MD period
P01_DA	AB drive alone volume in PM peak hour
TOT_P01_DA	Total (AB+BA) drive alone volume in PM peak hour
P03_DA	AB drive alone volume in PM period
TOT_P03_DA	Total (AB+BA) drive alone volume in PM period
E11_DA	AB drive alone volume in EV period
TOT_E11_DA	Total (AB+BA) drive alone volume in EV period
D24_DA	Daily AB drive alone volume
TOT_D24_DA	Daily total (AB+BA) drive alone volume
A03_S2	AB shared-ride 2 volume in AM peak hour

FIELD	DESCRIPTION
TOT_A03_S2	Total (AB+BA) shared-ride 2 volume in AM peak hour
A03_S2	AB shared-ride 2 volume in AM period
TOT_A03_S2	Total (AB+BA) shared-ride 2 volume in AM period
M07_S2	AB shared-ride 2 volume in MD period
TOT_M07_S2	Total (AB+BA) shared-ride 2 volume in MD period
P01_S2	AB shared-ride 2 volume in PM peak hour
TOT_P01_S2	Total (AB+BA) shared-ride 2 volume in PM peak hour
P03_S2	AB shared-ride 2 volume in PM period
TOT_P03_S2	Total (AB+BA) shared-ride 2 volume in PM period
E11_S2	AB shared-ride 2 volume in EV period
TOT_E11_S2	Total (AB+BA) shared-ride 2 volume in EV period
D24_S2	Daily AB shared-ride 2 volume
TOT_D24_S2	Daily total (AB+BA) shared-ride 2 volume
A03_S3	AB shared-ride 3+ volume in AM peak hour
TOT_A03_S3	Total (AB+BA) shared-ride 3+ volume in AM peak hour
A03_S3	AB shared-ride 3+ volume in AM period
TOT_A03_S3	Total (AB+BA) shared-ride 3+ volume in AM period
M07_S3	AB shared-ride 3+ volume in MD period
TOT_M07_S3	Total (AB+BA) shared-ride 3+ volume in MD period
P01_S3	AB shared-ride 3+ volume in PM peak hour

FIELD	DESCRIPTION
TOT_P01_S3	Total (AB+BA) shared-ride 3+ volume in PM peak hour
P03_S3	AB shared-ride 3+ volume in PM period
TOT_P03_S3	Total (AB+BA) shared-ride 3+ volume in PM period
E11_S3	AB shared-ride 3+ volume in EV period
TOT_E11_S3	Total (AB+BA) shared-ride 3+ volume in EV period
D24_S3	Daily AB shared-ride 3+ volume
TOT_D24_S3	Daily total (AB+BA) shared-ride 3+ volume

Transit

The transit assignment results are available by two time periods (PK: peak and OK: off-peak), two sub-modes (B: bus and R: rail), and two access modes (W: walk and D: drive). The outputs are produced both in CUBE network format (`{scenario_name}_VOL_{tod}_T{access_mode}{submode}.NET`), as well as in database file format `{scenario_name}_VOL_{tod}_T{access_mode}{submode}.DBF`). The outputs contain attributes as shown in Table 70.

TABLE 71: ATTRIBUTES IN TRANSIT ASSIGNMENT RESULTS

FIELD	DESCRIPTION
A	Node A
B	Node B
MODE	Transit sub-mode id 1: local bus (FAX and Clovis) 2: local bus (FCRTA)
OPERATOR	Transit operator
NAME	Transit line name

FIELD	DESCRIPTION
LONGNAME	Transit line long name
DIST	Distance (miles)
TIME	Transit travel time
LINKSEQ	Link sequence
HEADWAY_2	Headway
STOPA	Is node A stop (1: yes, 0: no)
STOPB	Is node B stop (1: yes, 0: no)
VOL	Transit volume
ONA	On-boarding at node A
OFFA	Off-boarding at node A
ONB	On-boarding at node B
OFFB	Off-boarding at node B
REV_VOL	Revised transit volume
REV_ONA	Revised on-boarding at node A
REV_OFFA	Revised off-boarding at node A
REV_ONB	Revised on-boarding at node B
REV_OFFB	Revised off-boarding at node B

Non-motorized

The non-motorized assignment results are output in database file format: FC23_BASE_LOADEDNETWORK_BIKE.DBF and FC23_BASE_LOADEDNETWORK_WALK.DBF. Attributes of bike and walk assignment outputs are presented in Table 71 and Table 72.

TABLE 72: ATTRIBUTES IN BIKE ASSIGNMENT RESULTS

FIELD	DESCRIPTION
A	Node A
B	Node B
DISTANCE	Distance (miles)
CAPCLASS	Capacity class
LANES	Number of lanes
NAME	Street name
ROUTE	Route number
TERRAIN	Terrain
JURISDICTIO	Jurisdiction
SCREENLINE	Screen line id
SPEED	Posted speed (mph)
AREATYP	Area type
FACTYP	Facility type 0: local 1: Freeway 2: Highway 3: Expressway

4: Arterial
 5: Collector
 6: Local
 7: Ramp-Freeway-Freeway
 8: Ramp-Slip
 9: Ramp-Loop
 10: Connector1
 11: Connector2

AUX	Presence of auxiliary lane
USE	Use type
TOLL	Toll (dollars)
IMPROVED	Improvement id
BIKE_FACTY	<p>Bike facility type</p> <p>: Shared Roadway (No Bikeway Designation).</p> <p>1: Class I Bikeway (Bike Path). Provides a completely separated right of way for the exclusive use of bicycles and pedestrians with crossflow by motorists minimized.</p> <p>2: Class II Bikeway (Bike Lane). Provides a striped lane for one-way bike travel on a street or highway.</p> <p>3: Class III Bikeway (Bike Route). Provides for shared use with pedestrian or motor vehicle traffic.</p> <p>4: Class IV Separated Bikeway (cycle tracks). On-street bicycle facilities that include a vertical physical barrier between the bikeway and moving traffic.</p> <p>5: Separate highway overcrossings</p> <p>6: Unpaved Multipurpose Trails</p> <p>9: Freeways and Ramps (bicycling not permitted)</p>
BIKE_VOL	Bike volume

TABLE 73: ATTRIBUTES IN WALK ASSIGNMENT RESULTS

FIELD	DESCRIPTION
A	Node A
B	Node B
DISTANCE	Distance (miles)
CAPCLASS	Capacity class
LANES	Number of lanes
NAME	Street name
ROUTE	Route number
TERRAIN	Terrain
JURISDICTIO	Jurisdiction
SCREENLINE	Screen line id
SPEED	Posted speed (mph)
AREATYP	Area type
FACTYP	Facility type 0: local 1: Freeway 2: Highway 3: Expressway 4: Arterial 5: Collector 6: Local 7: Ramp-Freeway-Freeway 8: Ramp-Slip

FIELD	DESCRIPTION
	9: Ramp-Loop 10: Connector1 11: Connector2
AUX	Presence of auxiliary lane
USE	Use type
TOLL	Toll (dollars)
IMPROVED	Improvement id
BIKE_FACTY	<p>Bike facility type:</p> <p>Shared Roadway (No Bikeway Designation).</p> <p>1: Class I Bikeway (Bike Path). Provides a completely separated right of way for the exclusive use of bicycles and pedestrians with crossflow by motorists minimized.</p> <p>2: Class II Bikeway (Bike Lane). Provides a striped lane for one-way bike travel on a street or highway.</p> <p>3: Class III Bikeway (Bike Route). Provides for shared use with pedestrian or motor vehicle traffic.</p> <p>4: Class IV Separated Bikeway (cycle tracks). On-street bicycle facilities that include a vertical physical barrier between the bikeway and moving traffic.</p> <p>5: Separate highway overcrossings</p> <p>6: Unpaved Multipurpose Trails</p> <p>9: Freeways and Ramps (bicycling not permitted)</p>
WALK_VOL	Pedestrian volume

Reports and Summaries

Several summaries and reports are generated during a model run. DaySim summaries are generated in “11_DaySim\daysim_summaries” folder under the scenario folder, including the following outputs files in Table 73.

TABLE 74. DAYSIM SUMMARIES OUTPUTS

FILE	DESCRIPTION
VehAvailability.xlsm	Auto ownership summaries
WrkLocation.xlsm	Work location choice summaries
SchLocation.xlsm	School location choice summaries
DayPattern.xlsm	Person daily activity pattern summaries
TourDestination_[purpose].xlsm	Tour destination choice summaries by purpose (meal, shopping, personal business, social/recreation, escort, work-based)
TourDestination_maintenance.xlsm	Tour destination choice summaries for maintenance purpose – aggregation of shopping and personal business
TourDestination_discretionary.xlsm	Tour destination choice summaries for maintenance purpose – aggregation of meal and social/recreation
TripDestination.xlsm	Trip destination choice summaries
TourMode.xlsm	Tour mode choice summaries
TripMode.xlsm	Trip mode choice summaries
TourTOD.xlsm	Tour time of day summaries
TripTOD.xlsm	Trip time of day summaries

Highway and transit validation summaries are generated in “10_Reportng\validation\validation_summary_2023.xlsx”. The summaries include traffic count validation by facility type and volume group, traffic count validation along key highway corridors, vehicle trips and vehicle miles traveled by external market, transit boarding validation, bike and

walk validation, and vehicle miles traveled validation by facility type, time of day, and vehicle class.

APPENDIX A. DAYSIM CALIBRATION SUMMARIES

TABLE 75. SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ACS)

No. of Drivers	NUMBER OF VEHICLES					Total
	0	1	2	3	4+	
1	17.5%	63.3%	14.2%	3.7%	1.3%	100.0%
2	4.0%	22.1%	54.2%	16.3%	3.4%	100.0%
3	2.5%	14.1%	31.0%	38.9%	13.5%	100.0%
4+	1.3%	7.7%	21.6%	29.5%	40.1%	100.0%
Total	7.0%	30.0%	35.5%	18.2%	9.3%	100.0%

TABLE 76: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM)

No. of Drivers	NUMBER OF VEHICLES					Total
	0	1	2	3	4+	
1	22.0%	64.2%	11.3%	2.0%	0.5%	100.0%
2	3.6%	20.7%	60.1%	13.4%	2.2%	100.0%
3	2.6%	17.4%	35.7%	34.6%	9.8%	100.0%
4+	2.1%	11.0%	19.3%	28.7%	38.8%	100.0%
Total	8.2%	30.6%	37.8%	15.7%	7.7%	100.0%

TABLE 77: DIFFERENCE IN SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM - ACS)

No. of Drivers	NUMBER OF VEHICLES					Total
	0	1	2	3	4+	
1	4.5%	1.0%	-2.9%	-1.7%	-0.9%	0.0%
2	-0.4%	-1.4%	6.0%	-2.9%	-1.3%	0.0%

NUMBER OF VEHICLES						
3	0.0%	3.3%	4.7%	-4.3%	-3.7%	0.0%
4+	0.8%	3.4%	-2.2%	-0.8%	-1.2%	0.0%
Total	1.1%	0.6%	2.3%	-2.5%	-1.6%	0.0%

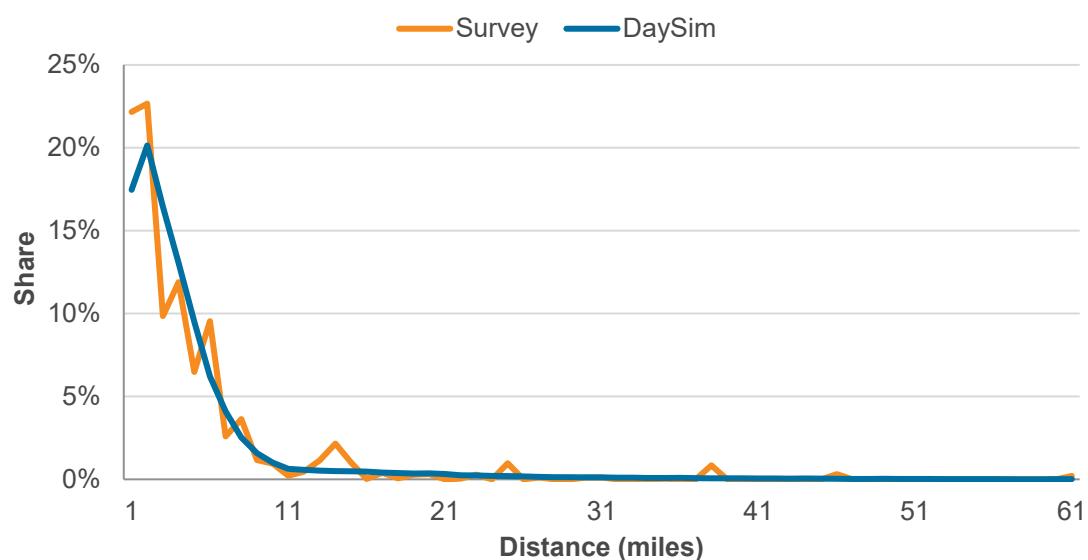


FIGURE 40: TOUR LENGTH DISTRIBUTION FOR DISCRETIONARY TRAVEL

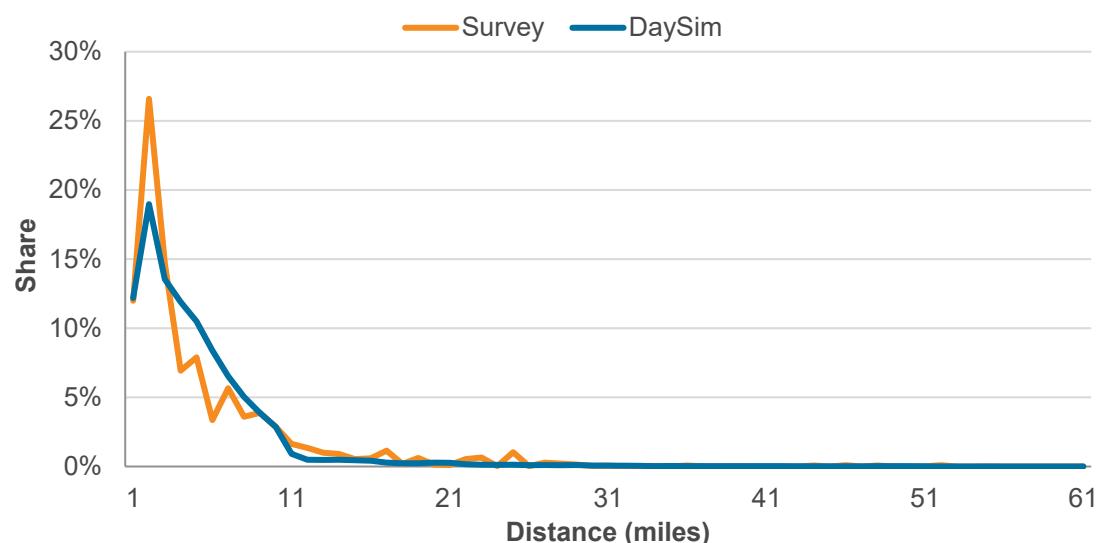


FIGURE 41: TOUR LENGTH DISTRIBUTION FOR MAINTENANCE TRAVEL

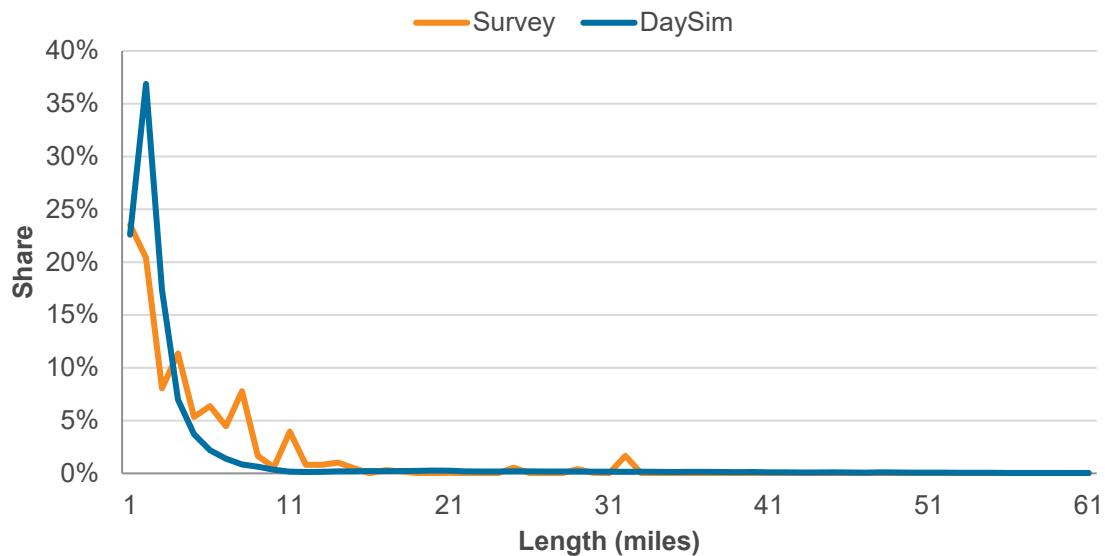


FIGURE 42: TOUR LENGTH FREQUENCY DISTRIBUTION FOR ESCORT TRAVEL

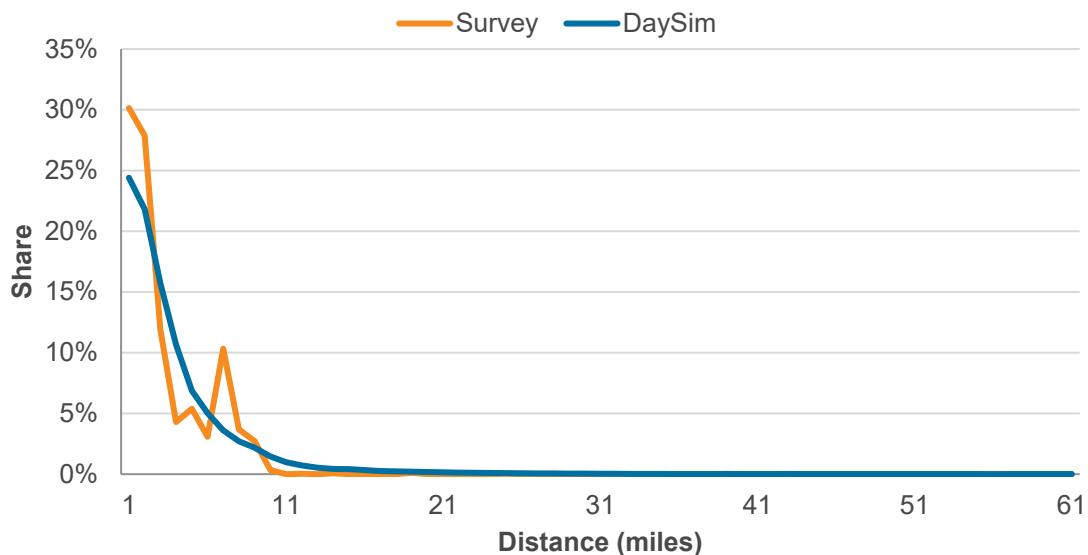


FIGURE 43: TOUR LENGTH FREQUENCY DISTRIBUTION FOR WORK-BASED TRAVEL

TABLE 78: TOUR MODE SHARES (CCTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	70%	21%	1%	31%	66%	35.6%
SR2	18%	17%	43%	29%	17%	25.7%
SR3+	7%	32%	48%	27%	9%	25.4%
Drive Transit	0.7%	0.0%	0.0%	0.0%	0.0%	0.2%
Walk Transit	1.4%	1.6%	0.0%	1.2%	0.1%	1.1%
Bike	1.0%	0.7%	0.0%	2.2%	0%	1.2%
Walk	2%	13%	8%	9%	9%	7.8%
School Bus	0%	14%	0%	1%	0%	2.9%
TNC	0%	0%	0%	0%	0%	0.1%
Total	100%	100%	100%	100%	100%	100%

TABLE 79: TOUR MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	72%	12%	1%	35%	67%	35.9%
SR2	16%	19%	41%	30%	14%	25.5%
SR3+	8%	43%	52%	25%	7%	27.0%
Drive Transit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk Transit	1.3%	1.3%	0.0%	1.2%	0.0%	1.0%
Bike	0.6%	0.5%	0.0%	2.3%	0%	1.1%
Walk	2%	12%	6%	8%	11%	7.2%
School Bus	0%	12%	0%	0%	0%	2.2%

TNC	0%	0%	0%	0%	0%	0.2%
Total	100%	100%	100%	100%	100%	100%

TABLE 80: DIFF IN TOUR MODE SHARES (ABM-CCTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	2.4%	-9.1%	0.2%	3.4%	1.4%	0.3%
SR2	-1.5%	1.9%	-1.8%	0.4%	-2.4%	-0.3%
SR3+	0.4%	10.1%	4.0%	-2.0%	-1.9%	1.6%
Drive Transit	-0.7%	0.0%	0.0%	0.0%	0.0%	-0.2%
Walk Transit	-0.2%	-0.3%	0.0%	0.0%	0.0%	-0.1%
Bike	-0.4%	-0.2%	0.0%	0.1%	0.2%	-0.1%
Walk	0.0%	-0.8%	-2.1%	-1.0%	2.8%	-0.6%
School Bus	0.0%	-2.1%	-0.2%	-0.7%	0.0%	-0.7%
TNC	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%
Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

TABLE 81. TRIP MODE SHARES (CCTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	75%	21%	26%	27%	67%	41.0%
SR2	16%	21%	35%	27%	17%	23.7%
SR3+	5%	25%	31%	25%	9%	19.6%
Transit	0.8%	1.3%	0.0%	1.1%	0.1%	0.8%
Bike	1%	1%	0%	1%	0%	0.8%
Walk	3%	19%	8%	14%	7%	10.5%
School Bus	0%	11%	0%	5%	0%	3.6%
TNC	0%	0%	0%	0%	0%	0.1%
Total	100%	100%	100%	100%	100%	100%

TABLE 82. TRIP MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	76%	13%	20%	37%	66%	42.7%
SR2	13%	20%	34%	30%	14%	23.5%
SR3+	6%	33%	36%	20%	6%	20.1%
Transit	0.9%	0.8%	0.0%	1.0%	0.0%	0.7%
Bike	1%	0%	0%	2%	0%	0.8%
Walk	4%	21%	10%	9%	14%	10.2%
School Bus	0%	11%	0%	0%	0%	1.9%
TNC	0%	0%	0%	0%	0%	0.1%
Total	100%	100%	100%	100%	100%	100%

TABLE 83. TRIP MODE SHARES (ABM-CCTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	0.6%	-8.3%	-5.5%	10.9%	-1.1%	1.7%
SR2	-2.4%	-1.1%	-1.3%	3.0%	-3.5%	-0.2%
SR3+	1.3%	8.6%	4.6%	-5.2%	-2.9%	0.5%
Transit	0.1%	-0.5%	0.0%	-0.1%	0.0%	-0.1%
Bike	-0.4%	-0.2%	0.1%	0.5%	0.2%	0.1%
Walk	0.9%	1.5%	2.4%	-4.4%	7.4%	-0.3%
School Bus	0.0%	-0.1%	-0.3%	-4.6%	0.0%	-1.7%
TNC	-0.1%	0.2%	0.0%	0.0%	0.0%	0.0%
Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

APPENDIX B. SYNTHETIC POPULATION

This appendix describes the setup and process to generate synthetic population for the Fresno Activity-Based Model (Fresno ABM). The synthetic population is generated using PopulationSim, an open platform for population synthesis, and is automated using several Python and R scripts and Windows Command Prompt batch files.

PopulationSim is a state-of-the-art standardized population synthesis program first developed for the Oregon Department of Transportation (ODOT) and its partner agencies. It is implemented in the Python-based ActivitySim modeling framework. Software development adheres to software engineering best practices. The system is under continuous integration (CI), which means the software and documentation are automatically built and tested against sample datasets to ensure that new features do not break the code base for any user. The PopulationSim source code and technical documentation are available online at the following public GitHub repository: <https://github.com/RSGInc/populationsim>.

PopulationSim is implemented for the Fresno modeling region to generate the synthetic population for base year 2023. The implementation is largely automated. All the data processing scripts are written in Python and R and automated using batch files including processes to build geographic crosswalks, download Census data across various geographies, build controls, process the Public Use Microdata Sample (PUMS), running the PopulationSim software and generating validation summaries and plots. The following sections describe setting up a PopulationSim run, details of Python and R scripts, batch files, and validation.

SOFTWARE REQUIREMENTS

The software below are for a machine with Windows operating systems (Windows 7). The following software are required to run the PopulationSim setup:

- R
- Anaconda 3

R software is included with the PopulationSim setup delivered to Fresno COG and Anaconda 3 setup is delivered in a zipped package “miniforge.zip”. The zipped conda package contains two environments – one to generate crosswalks and other to run PopulationSim. The user needs to unzip the package to a separate location as the path to this location will be used to run PopulationSim.

POPULATIONSIM DIRECTORY

Figure 44 presents the directory structure for the PopulationSim setup created for Fresno. The folders and files in the directory are explained as follows:

- The *Data* directory contains various geography shapefiles (BlockGroup, CensusTract, PUMS, TAZ, and MAZ), seed data (PUMS) and downloaded census data (Census)
- The *output* folder will have the final synthetic household and person file and summary attributes after a successful run. The household and group-quarter populations are stored separately under *HH* and *GQ* directories and a total combined synthetic population results are stored under *Combined* directory. It also contains a sub-folder *DaySimFormat* to contain formatted outputs to directly use in DaySim.
- The *logs* directory is where log files of each part of the run are stored.
- The *validation* directory houses the convergence and control plots generated by the validation step.

Name	Date modified	Type
Data	8/9/2024 6:08 PM	File folder
logs	8/9/2024 6:08 PM	File folder
Output	8/9/2024 6:08 PM	File folder
validation	8/9/2024 6:08 PM	File folder

FIGURE 44: POPULATIONSIM FOLDER STRUCTURE

Additional settings for PopulationSim are stored in the “App\Setup” folder of the model. These settings only need to be changed if reconfiguring PopulationSim to new controls.

- The **configs** folder contains the **settings.yaml** file and **controls.csv** file for both household (HH) and group-quarters (GQ) setups.
- PopulationSim is configured using the **settings.yaml** file. For this project, it is configured to run in base mode which means it is run from beginning to end and produces a new synthetic population
- **controls.csv** file specifies all the targets, geography, seed table, control field and their expression to the seed table required for the PopulationSim run.
- The *data* directory holds all intermediate files that are prepared for input to PopulationSim: seeds data, control data, and crosswalks.
- **run_populationsim.py** launches a PopulationSim run. The script is used in **RunPopulationSimHH.bat** file and **RunPopulationSimGQ.bat** file.
- **RunPopulationSimHH.bat (RunPopulationSimGQ.bat)** sets paths to Anaconda install and calls the *run_populationsim.py* to launch a PopulationSim run. This batch file

activates the PopulationSim environment and then calls the **run_populationsim.py** Python script to launch a PopulationSim run. This batch file is called by the main batch file **“RunAll.bat”**.

Run PopulationSim

The PopulationSim setup is now integrated in the Cube Catalog as a standalone feature. It must be run separately from the model run. Before starting, the user needs to configure two scenario keys – “Run_PopSim” set to 1, and “ANACONDA_DIRECTORY” set to the path of the unzipped *miniforge.zip* package. After updating these keys to appropriate values the user can then run PopulationSim by navigating to the PopulationSim module and selecting “Run” and checking “run current application only” as shown in Figure 45.

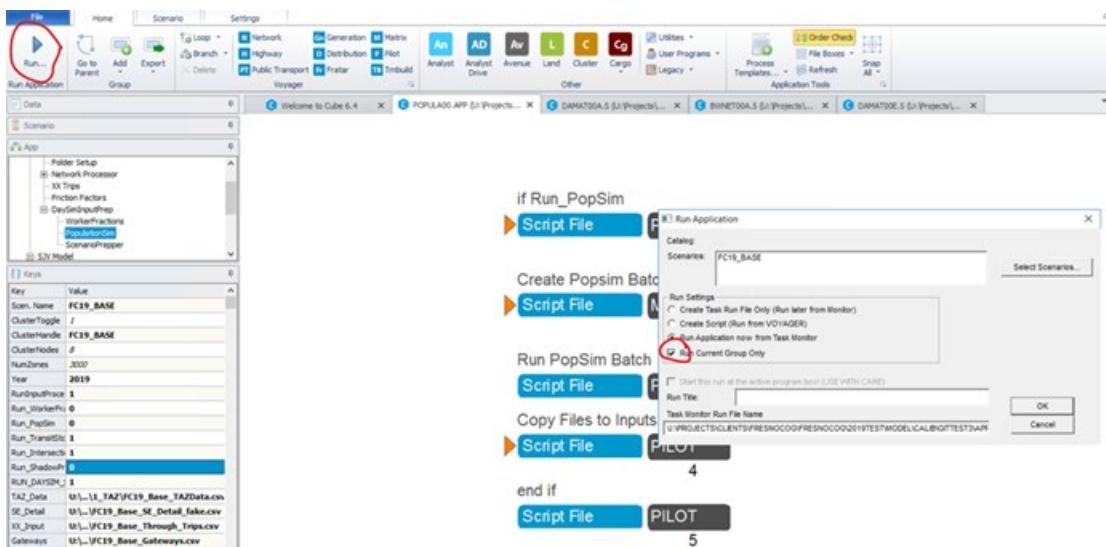


FIGURE 45: RUNNING POPULATIONSIM FROM THE CUBE CATALOG

A PopulationSim run generates outputs under “PopulationSim\output\HH(GQ)”: *synthetic_households.csv* and *synthetic_persons.csv*. These outputs are then automatically converted into DaySim format here: *PopulationSim\Setup\output\daysim_format*. When *RUN_POPSIM_GQ* is set to “YES”, the outputs of the HH Run and the GQ run will automatically be processed and combined. The output will be in “PopulationSim\Setup\output\Combined”. To update the population in the 2023 base year, the user should update the files described in Table 83.

TABLE 84: FILES FOR UPDATING POPULATION DATA

FILE NAME	FILE LOCATION	DATA
MazData.csv	PopulationSim\Data\Scenarios\base23	Number of Households in each MAZ
gq_maz.csv	PopulationSim\Data\Scenarios\base23	Number of University, Military, and other non-institutional group quarters in each MAZ
countyData.csv	PopulationSim\Data\Scenarios\base23	Total household population in the Fresno County

These files will determine the number of households and group quarters in each zone. The population will be generated based on the development of controls from census data.

The following section describes the processes that happen in a PopulationSim run.

Population Synthesis Procedure

PopulationSim is configured to run using a batch file and the order of execution of different steps are as follows: 1) creation of geographic crosswalk; 2) preparation of seed data and build controls; and 3) validation of outputs.

Geography Crosswalk

The main inputs to a PopulationSim are:

- Disaggregate population samples (Seed Sample)
- Marginal control distributions (Control variables)

PopulationSim can represent both household and person level controls at multiple geographic levels. Therefore, the user must define what geographic units to use for each control. The hierarchy of geographies is important when choosing controls. The Meta geography is the entire region. Currently, PopulationSim can handle only one Meta geography. The Seed geography is the geographic resolution of the seed data. There can be one or more Seed geographies. PopulationSim can handle any number of nested Sub-Seed geographies.

The geography level (hierarchy) selected for Fresno implementation to which the marginal distributions are specified are as follows:

- Seed Geography: PUMA

- Sub-seed Geography: TAZ and MAZ

Preparing Seed and Control Data

Preparing Seed Sample

One of the main requirements for the seed sample is that it should be representative of the modeling region. It must contain all the specified control variables, as well as any variables that are needed for the travel model but not specified as controls. The seed sample is obtained from 2012-2016 5-Year PUMS data. The PUMS data contain five years of household records. The PUMS data is downloaded from PUMS website and it is extracted both demographically and geographically for the Fresno region using PUMA codes conforming to the region. There are 7 PUMA regions in the Fresno county. The seed sample must include an initial weight field. In this project, the Seed sample contains a weight field, WGTP, which is used for control of total households.

Preparing Control Data

Controls or targets are the marginal distributions that form the constraints for the PopulationSim procedure. The objective of the PopulationSim procedure is to produce a synthetic population whose attributes match these marginal distributions. Controls can be specified for both household and person variables. The choice of control variables depends on the needs of the project. The mandatory requirement for a population synthesizer is to generate the right number of households in each travel model geography. Therefore, it is mandatory to specify a control on total number of households in each geographical unit at the lowest geographical level. If this control is matched perfectly, it ensures that all the upper geographies also have the correct number of households assigned to them. Once the raw data is obtained, it is aggregated or disaggregated to the desired geography to build these controls.

Level: Region

- Person by occupation at Census Tract Level

Level: TAZ

- Households by Household Size at Block Group Level
- Households by age of householder head at Block Group Level
- Households by number of workers at Census Tract Level
- HHs by income at Census Tract Level
- HHs by presence or absence of Kids at Tract Level
- Person by age at Census Tract Level

Level: MAZ

- Total households

The data obtained at this level is total number of households aggregated for each MAZ. Once the control files are prepared, the total number of households and persons are calculated across geographies to check for consistency.

Validation

One of the most critical steps in population synthesis is validating the final synthetic population. Validation can give us clues about inconsistencies among controls, data processing errors or misspecification of any settings. The validation procedure implemented for Fresno PopulationSim produces a validation summary, validation chart, frequency plots and expansion factor distribution. Each of these are described briefly below:

Validation summary statistics

At a regional level, for each control, the total number of records (household/person) desired by the control, the total number of records synthesized, the difference between the synthesized totals and the control totals and the percentage difference are reported.

Statistics that inform us of convergence at a more disaggregate level are also computed – please note that these statistics are being computed for the geography at which the controls are specified i.e. MAZ, TAZ or Meta as the case might be. The following three statistics are computed as a part of this exercise:

1. The average percentage difference between the control totals and the synthesized totals,
2. The standard deviation of the percentage difference – this measure informs us of how much dispersion from the average exists, and
3. The percentage root mean square error (RMSE) - an indicator of the proximity of synthesized and control totals.

The number of geographies for which the control is non-zero (N) are also reported.

Validation Chart

The validation chart is a visualization of the disaggregate summary statistics – mean percentage difference, STDEV and RMSE of percentage differences. A form of dot and whisker plot is generated for each control where the dots are the mean percentage differences and horizontal bars are twice the STDEV or RMSE centered around zero.

Frequency Distribution Plots

These are simply frequency distribution plots of differences between control and synthesized values across the geography at which the controls were specified.

Expansion factor Distribution

While a synthetic population may match the controls well, it is important to know how uniform the household weights are, and how different they are from the initial weights. The closer the final weights are to the initial PUMS weight, higher is the chance of matching the distribution of uncontrolled variables. An expansion factor is computed for each record in the PUMS data as total final weight/initial weight. A distribution plot of these expansion factors is created for each PUMA. A good synthetic population would have most of these expansion factors as close to one as possible.

Scripts

The PopulationSim works with Python and R databases. In the existing setup, the main batch file makes system calls to various Python and R scripts.

The data processing steps required to prepare inputs for PopulationSim in the right format are implemented via Python scripts. Separate R scripts handle data processing and creates validation summaries and plots. The **RunAll.bat** file makes system calls to run these scripts. A brief description of each script is as follows:

Note that the main batch file (RunAll.bat) creates various user inputs and parameters. The main batch file writes all the user settings to a CSV file and then calls the scripts. The scripts read the CSV parameters file and calls other scripts as required. The parameters file (parameters.csv) is read by other scripts as well to read in user parameters and settings.

downloadCensusData.py

This script downloads the census data required to build controls for the PopulationSim run. Census data is downloaded from the web which creates the appropriate URL to fetch data via the Census API. Census data which is not available for download via the Census API is downloaded once and is always read from the data directory.

buildControls.py

The objective of this script is to build MAZ and TAZ controls as well as process the seeds household and person data. The main inputs are block group or tract level Census data and the existing MAZ and TAZ level data which mainly contains the number of households for each geography.

Once the Census data has been downloaded at the block group and tract level, the next step is to allocate the control data and scale it to match the households at each of the relevant geographies. Block group level data is allocated to MAZs to create MAZ level controls and tract level data is allocated to TAZs to create TAZ level controls. MAZ level data can also aggregated

to TAZ geography to create TAZ level controls. The allocations are done proportional to the number of households in each lower geography. The allocation step requires two geographic crosswalks: MAZ-block group and TAZ-tract. The crosswalk creation is described in the next sub-section. The allocated data was scaled to match the total number of households for each geography as specified in the existing MAZ and TAZ level data. PopulationSim requires integer controls; therefore, the allocated data was rounded off to the nearest integer. To ensure that the resulting distribution of households sums to the total households, the difference between scaled households and target households was added to the majority category for each household variables. Similar checks were made for the population variables as well.

For person controls, first average persons in household with 4 or more persons are calculated in the PUMS data. The average persons are used to calculate total implied population in the household size category. Fresno COG provided an estimate of population in Fresno county. The estimate provided the required population in the households of 4 or more persons by taking the difference of the estimate with the implied population in households size 3 or less. Next, a factor on the average persons in household size 4 or more are calculated by taking the ratio of required population and the existing population in household size 4 or more. A new value of average persons in household size 4 or more is calculated by applying the factor to the average size from PUMS. The updated average persons are used in the calculating population at TAZ. Then the controls (age and gender) are scaled to match estimate of the Fresno population. Additionally, the census tract level population data by age includes both group quarter and household populations. The group quarter population is subtracted out from the total population in the age distribution categories using the same distribution factor of household to group quarter population from the PUMS data.

createGeogXWalks.py

This script creates the geographic crosswalk between MAZ, TAZ, PUMA, Block Group, Census Tract and Region boundaries to be used as input in the PopulationSim run. The script determines a geometrical hierarchy starting from the smallest geographical boundaries. MAZ's are described by a representative point. A representative point is similar to a polygon's centroid, but it is not allowed to be outside of the polygon. The representative point of each MAZ is mapped to a TAZ that the point is within. Next the TAZs are mapped with their representative points to the Block Group the point is within. This process is repeated with each geometry. Census shape files block groups and tracts were downloaded for Census 2010 boundaries¹.

For creating geographic crosswalks, it was assumed that each MAZ lies within a block group and correspondence can be established if the MAZ representative point lies within a block group polygon. Similar assumptions were made for TAZ centroids and Census Tracts. The crosswalk was produced with the geographies:

1. MAZ – TAZ - Block Group -Census Tract – PUMA – County

validatePopulationSim.R

The script generates standard deviation and PRMSE maps comparing generated synthetic population with controls data. The script reads “columnMapPopSim_Fresno.csv” as input from the “PopulationSim/Setup/Validation” directory. This specifies the controls which should be included in the validation process and their field names in summary views and controls tables.

popsimToDaysim(GQ).R

The script converts outputs of PopulationSim to formats required in DaySim. The script reads outputs from PopulationSim and raw PUMS data. It creates correspondence between ids in output synthetic population and PUMS data. Then it merges PUMS information to the synthetic population and calculated household and person variables as required in DaySim. The script outputs space delimited household and person files.

popsimToDaysimMerge.R

The script merges the household and group quarter daysim files into one total population and total households file. Each household and group quarter is given a unique ID and the group quarter records are appended to the household records.

mergeHHandGQ.py

The script combines the outputs from the HH PopulationSim run with the GQ PopulationSim run. It creates a unique ID for the group quarters and appends the resulting tables to the HH synthetic_households.csv and synthetic_persons.csv. This script is automatically run when RUN_POPSIM_HH or RUN_POPSIM_GQ is set to “YES” and the results are stored in “PopulationSim\setup\outputs\combined”.

Base Year (2023) Validation

This section first presents the performance of the existing PopulationSim setup and validation of the recommended controls for 2023. A base year (2023) PopulationSim run was completed with the initial setup, which included the following controls at various geographies:

1. MAZ
 - a. Total number of households
 - b. Total number of non-institutional group quarters
2. TAZ
 - a. Number of households by household size groups [1, 2, 3, 4+]
 - b. Number of households by number of workers [0, 1, 2, 3+]
 - c. Number of households by income groups [0-\$25K, \$25K-\$60K, \$60K-\$100K, \$100K+]

d. Number of persons by age groups [0-19, 20-34, 35-64,65+]

3. REGION

- a. Total population
- b. Persons with Management occupations
- c. Persons with Professional occupations
- d. Persons with Services occupations
- e. Persons with Retail occupations
- f. Persons with Manual occupations
- g. Persons with Military occupations

Table 84 describes the source of data for each control. Note that the data was scaled to 2023 1-year ACS as described in Section 2.9.

TABLE 85. CONTROL DATA SOURCE DESCRIPTION

Control Name	Control Geography	Data Source	Tables/Variables
Total households	MAZ	Fresno MAZ Data	
HH Size 1	TAZ	2015-19 ACS Block Group	["B11016_001E" to "B11016_016E"]
HH Size 2	TAZ	2015-19 ACS Block Group	["B11016_001E" to "B11016_016E"]
HH Size 3	TAZ	2015-19 ACS Block Group	["B11016_001E" to "B11016_016E"]
HH Size 4+	TAZ	2015-19 ACS Block Group	["B11016_001E" to "B11016_016E"]
HH Income (-Inf, \$25K)	TAZ	2015-19 ACS Tract	["B19001_001E" to "B19001_017E"]
HH Income [\$25K, \$60K)	TAZ	2015-19 ACS Tract	["B19001_001E" to "B19001_017E"]

HH Income [\$60K, \$100K)	TAZ	2015-19 ACS Tract	["B19001_001E" to "B19001_017E"]
HH Income [\$100K, +Inf)	TAZ	2015-19 ACS Tract	["B19001_001E" to "B19001_017E"]
HH Workers 0	TAZ	2015-19 ACS Tract	["B08202_001E" to "B08202_005E"]
HH Workers 1	TAZ	2015-19 ACS Tract	["B08202_001E" to "B08202_005E"]
HH Workers 2	TAZ	2015-19 ACS Tract	["B08202_001E" to "B08202_005E"]
HH Workers 3+	TAZ	2015-19 ACS Tract	["B08202_001E" to "B08202_005E"]
HH w/ children	TAZ	2015-19 ACS Tract	["B25012_001E" to "B25012_017E"]
HH w/o children	TAZ	2015-19 ACS Tract	["B25012_001E" to "B25012_017E"]
Population age 0 to 19 years	TAZ	2015-19 ACS Tract	["B01001_001E" to "B01001_049E"]
Population age 20 to 34 years	TAZ	2015-19 ACS Tract	["B01001_001E" to "B01001_049E"]
Population age 35 to 64 years	TAZ	2015-19 ACS Tract	["B01001_001E" to "B01001_049E"]
Population age 65plus years	TAZ	2015-19 ACS Tract	["B01001_001E" to "B01001_049E"]
Non-Institutional Group Quarters	MAZ	Fresno MAZ Data	
Occupation	MAZ	Fresno MAZ Data	

We address the inconsistencies among the controls by appropriately scaling the controls to match the total number of households to the MAZ level total number of households control for each geography. The validation results from the run for 2019 are presented in Figure 46.

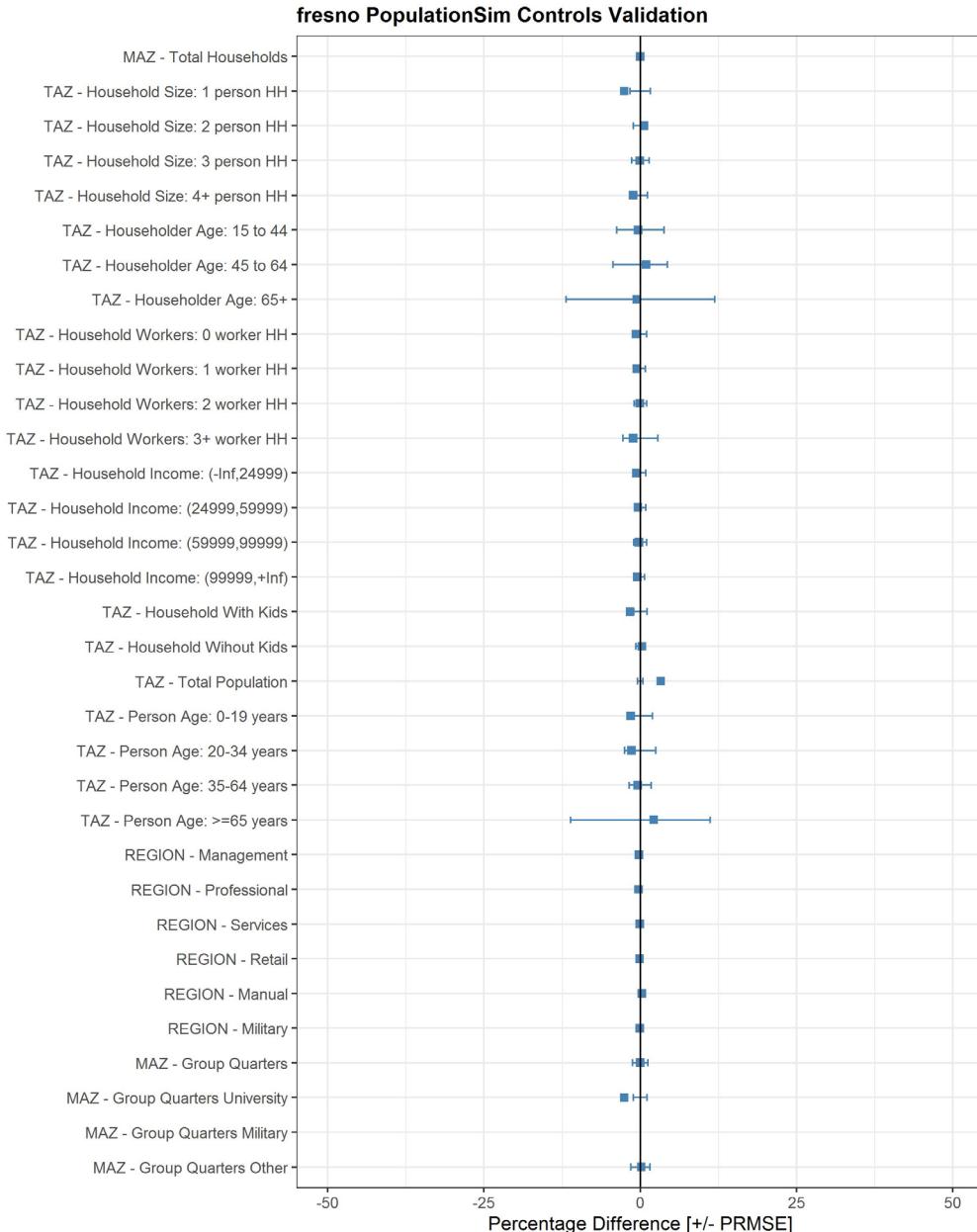


FIGURE 46. POPULATIONSIM VALIDATION – BASE YEAR (2023)

The validation results indicate that PopulationSim does reasonably well in matching the controls overall, as can be observed by the close to zero mean percentage differences across all controls. The standard deviation is also quite low for all the controls. However, some deviation can be observed for the person age group controls.

APPENDIX C. DAYSIM INPUT FILES

Input Micro-zone File

The input MAZ file, “1_Inputs\8_DaySim\02_Parcel\maz_2019_parks.csv”, provides landuse data input to DaySim. The input file is created from a shapefile provided by Fresno COG.

Table 85 presents a list of fields that are needed in the MAZ shapefile to be exported into the MAZ input file. It also describes the action required for a field, whether you need to add it as a new field or it already exists, and the field data type. If a new field is required, the corresponding field in the shapefile is provided.

TABLE 86. MAZ SHAPEFILE FIELDS

DAYSIM FIELD	DESCRIPTION
Parcelid	Unique parcel ID
xcoord_p	X coordinate of parcel centroid
ycoord_p	Y coordinate of parcel centroid
sqft_p	Square footage of parcel
taz_p	TAZ of parcel
hh_p	Total households in parcel
block_p	Census block of parcel
stugrd_p	Student gradeschool enrollment
stuhgh_p	Student high school enrollment
stuuni_p	Student university enrollment
empedu_p	NAICS 61
empfoo_p	NAICS 72
empgov_p	NAICS 92

DAYSIM FIELD	DESCRIPTION
empind_p	NAICS 22,31-33, 42, 48-49
empmed_p	NAICS 62
empofc_p	NAICS 51-56
empret_p	NAICS 44-45
empsvc_p	NAICS 71, 81
emпотh_p	NAICS 11, 21, 23
emptot_p	Total employment
parkdy_p	
parkhr_p	
Ppricdyp	
Pprichrp	

This formatted CSV file should be named “maz_2019_parks.csv” and be placed in the model directory under the folder “1_Inputs\8_DaySim\02_Parcel”.

Transit Stops File

The transit stops file is created using the input transit network and is automated in the input processing step of the model. The module “Scenario Prepper” inside the ‘DaySimInputPrep’ module (Figure 47) contains the process to generate this file. It must be run after the network processor. The network is exported to a shapefile as links and nodes. A python script reads the node shapefile and processes the transit line file to read all the stop nodes with their associated transit mode. This information is joined to the coordinate data of the nodes and exported in the format shown in Figure 48.

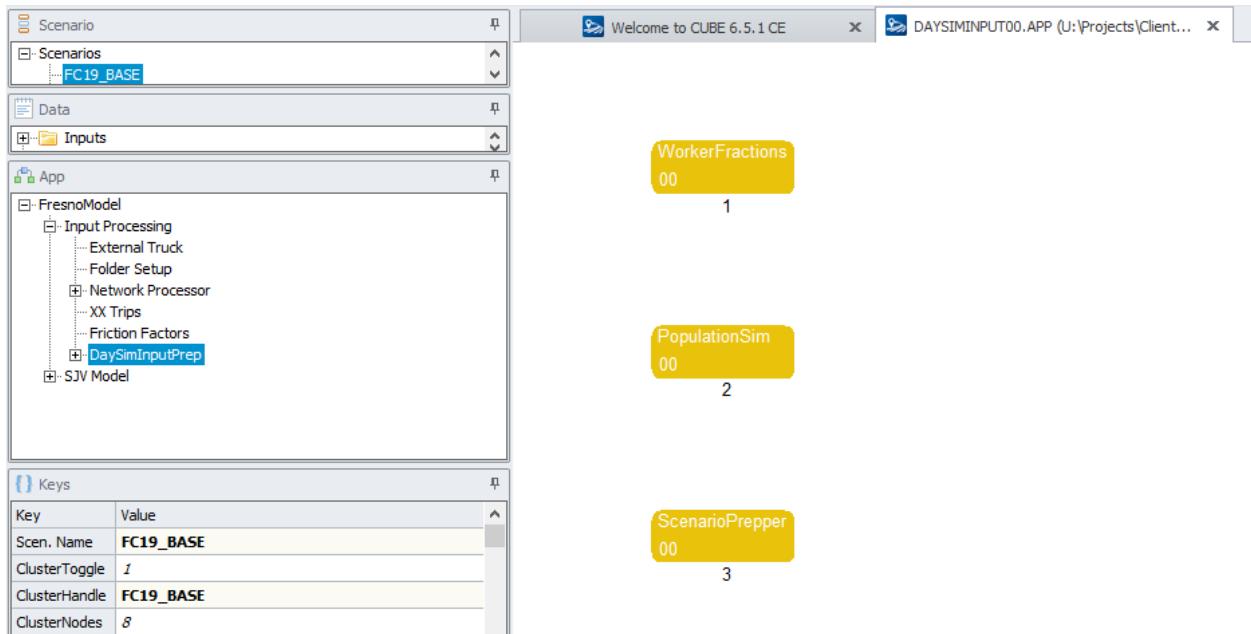


FIGURE 47. DAYSIM INPUT PREP MODULE

The stops file is in the following format:

id	mode	xcoord_p	ycoord_p
1	1	6309142	2167872
2	1	6309117	2166434
3	1	6309112	2165240
4	1	6307677	2165242
5	1	6306517	2165245
6	1	6306529	2166560
7	1	6306503	2167889
8	1	6309149	2169329
9	1	6309154	2170526
10	1	6309171	2171830
11	1	6307831	2173200
12	1	6306543	2173215
13	1	6305216	2173227
14	1	6303896	2173225
15	1	6303887	2174830

FIGURE 48. TRANSIT STOPS FILE FORMAT

Intersections File

The intersection file provides number of roads (links) at an intersection (node). The all-street network in the model is a dual road network where a two-way street is represented as one link for each direction. A two-way road is represented by two links representing to and from direction. Therefore, this network cannot simply be used to calculate number of links at an intersection. In the DaySim Input Prep Step in the cube catalog, the processed scenario network is exported as a shapefile and a python script is run to clean the network of two-way links, and determine the correct intersection density. The file is formatted and saved in the model inputs folder.

OpenSpace and Parks File

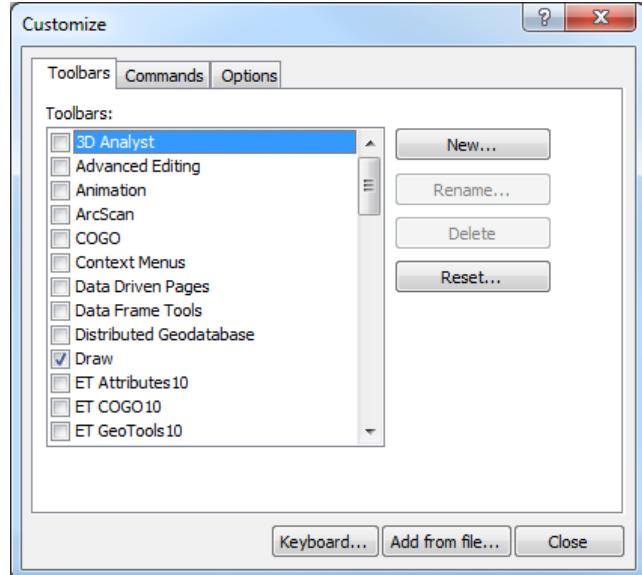
An ArcTool (ArcMap based) is created to process data in shapefile format and generate information in DaySim format. The tool is available on the Fresno ABM GitHub repository under tools.

Downloading and Installing ET Geowizards:

Continue to the next section if the current version of “ET Geowizards” is installed on the work computer.

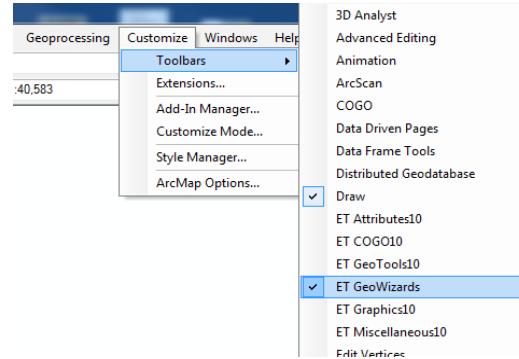
Following the steps below:

1. Locate the “ET Geowizards” installer (which can be found at the following Web address: <http://www.ian-ko.com/> . *Note: Makes sure that correct installer is downloaded for the specific computer and the specific version of ArcGIS being run on that computer.
2. Install the software by following the instructions that accompany the installer file.
3. Open a new project in ArcMap
4. Click the “Customize” dropdown menu at the top of the ArcMap window → hover over “Toolbars” →



Select “ET Geowizards” in the adjacent dropdown menu (see graphic to the right). Feel free to doc the “ET Geowizards toolbar”.

5. If “ET Geowizards” does not appear in the aforementioned dropdown menu, please recheck that the installer ran correctly. If it did install correctly, navigate to the bottom of the list of “Toolbars” and select “Customize” → a new window will appear which should look like the graphic to the right. Click on the “Add from file....” Button, and navigate to the *.dll file created by the Geowizards installer.



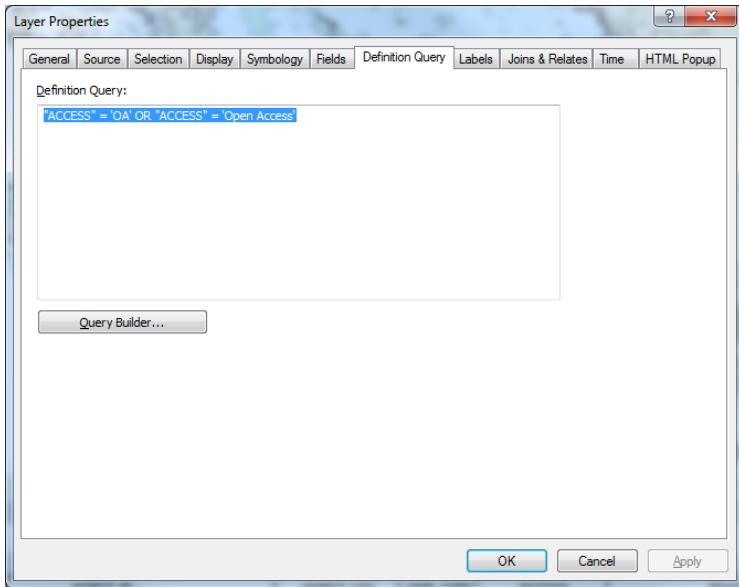
Finding Open source Representations of Protected Areas

Continue to the next section if adequate spatial representations (in polygon format) of the region’s open space areas have already been obtained.

Protected areas are locations which receive protection because of their recognized natural, ecological and/or cultural benefits. The USGS, as well as some state government agencies, actively monitor and inventory these areas. Spatial representations of California’s “Protected Areas” can be found here: <http://www.calands.org/>. For spatial representations of “Protected Areas” at a national level, follow this link: <http://gapanalysis.usgs.gov/data/padus-data/> *Note, the following steps use the California data, additional notes will supply directions for using the national data.

6. Navigate to the “CPAD: California Protected Areas Database” website using the link above. Download the most recently updated geospatial data. *Suggestion: download the data in *gdb format.
7. *Note: if using the national database, navigate to the second web address provided and download the equivalent data.
8. Once the data has completed downloading, open a new project in ArcMap and use the “Add Data” button  to add the shapefile (or feature class) named in the following convention “*_Holdings” (this data will be referred to as “_Holdings”).
9. Right click on the “_Holdings” file in the “Table of Contents” and select properties.
10. Navigate to the “Definition Query” tab.
11. In the box under “Definition Query:” write in the following expression:

"ACCESS" = 'OA' OR "ACCESS" = 'Open Access'



*Note: Users of the “national” database will have to determine their own qualifications for the equivalent of California’s “Open Access” space

12. Add the shapefile/feature class representing the region’s extent (forward referred to in the documentation as Extent”).

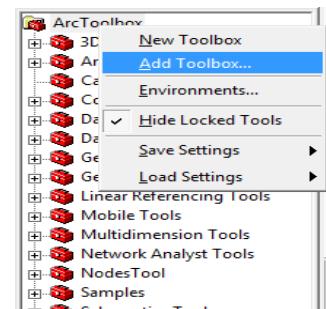
Adding the “OpenspaceTool” to ArcToolbox

An ArcTool was created to process the data created in the previous steps.

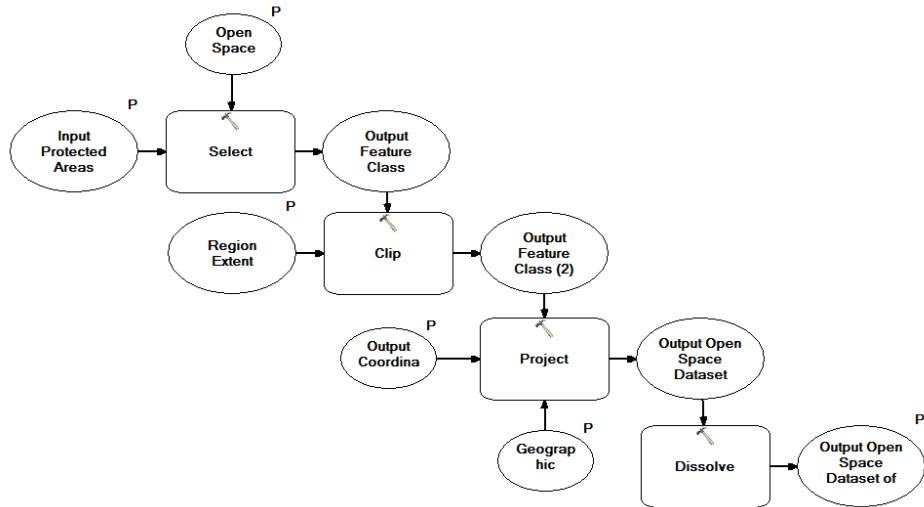
13. Open the ArcToolbox 

14. Right Click the “ArcToolbox” folder at the top of the directory and select “Add Toolbox”

15. Locate the “ParksTool” Toolbox on the computer and select “Ok”

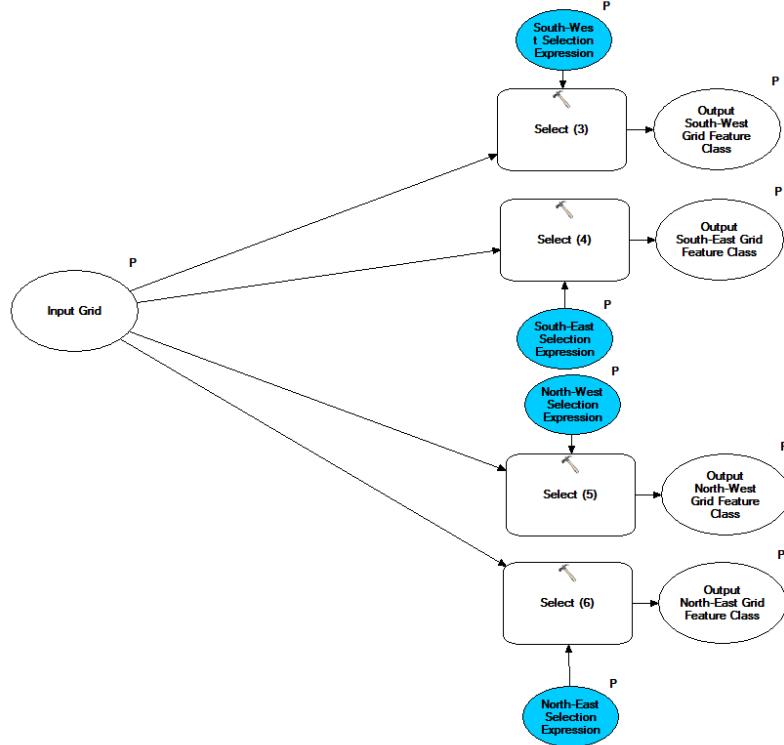


**Note: If problems arise with the “OpenspaceTool” Model consult the below image to understand the processes that make up the tool’s operation.*



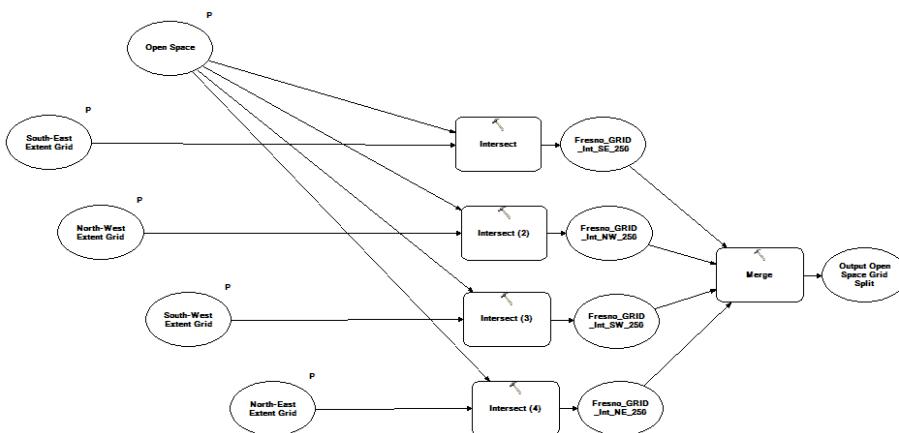
The tool first Selects the data by attribute to subset the “Open Space” data from the larger umbrella of “Protected Areas” (it is up to the user to decide what “attribute” in the database designates a feature as “Open Space”, for the California Data we suggest the “ACCESS” field where attributes are either 'OA' or 'Open Access'); The tool then clips the subset to the extent of the region in question; Then, the tool projects the data into the proper projection (reminder: all data should be prepared in a common projection); Last, the output is dissolved into one feature, this output constitutes all the “Open Space” in the region in question.

*Note: If problems arise with the “Grid1” Model consult the below image to understand the processes that make up the tool’s operation.



The tool merely selects data from the input grid and creates 4 new shapefiles/feature classes.

*Note: If problems arise with the “Grid2” Model consult the below image to understand the processes that make up the tool’s operation.



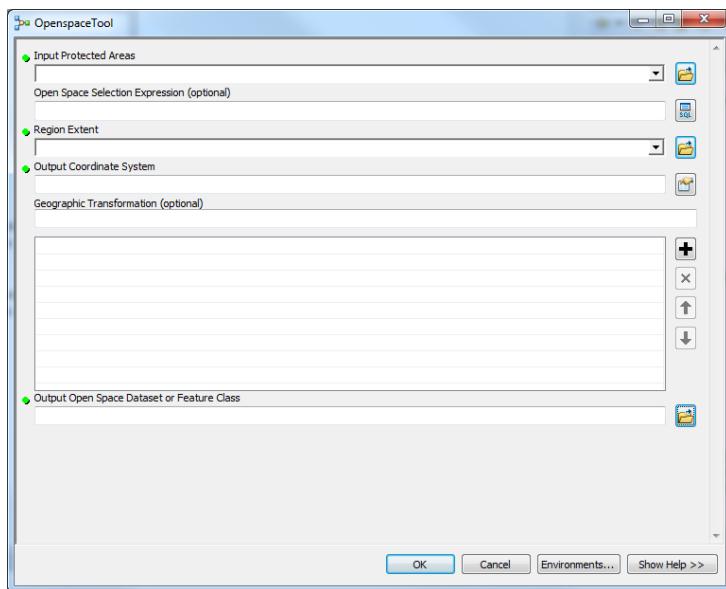
Based on user inputs the tool runs intersect the “Open Space” data with each of the 4 distinct sub-regions; once the data has been intersected, the 4 sub-regions are merged together.

Refining the “Protected Areas” data into “Open Space” Representations

NOTE: Steps 16-19 are not needed as Fresno COG provided open space that are only in Fresno County.

The following steps will use the protected areas data, “OpenspaceTool”, and Geowizards Toolbar to refine and separate the data into sections.

16. Open the “OpenspaceTool” Model in the “ParksTool”, a window like the one below should appear.



17. Submit the form with the following inputs:

- Input Protected Areas: -“_HOLDINGS” feature class
- Open Space Selection Expression (optional):-“ACCESS” = 'OA' OR “ACCESS” = 'Open Access'
- Region Extent -“Extent” feature class
- Output Coordinate System -Default Projection for Project
- Geographic Transformation -Leave blank unless asked to fill
- Output Open Space Dataset or Feature Class - Name/Location of Open space feature class (forward referred to in the documentation as “ Extent Open Space”)

18. Click “OK”.

**Note: if an error occurs run the “Select Tool” → “Clip Tool” → “Project Tool” and “Dissolve Tool” to get the same results*

19. Make sure the new feature class, “Extent OpenSpace”, is added to the ArcMap display. Remove all other data in the table of contents. This new feature class represents all the “Open Space” in the region in question.

Refining “Open Space” data to create a DAYSIM Input File

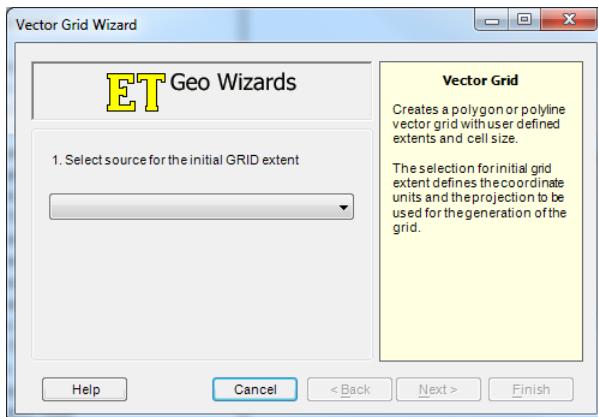
The following steps: 1.) Divide the region into a grid with 250' by 250' grid cells; 2.) Intersect the open space data, that has already been created, with the new grid; 3.) Converts the intersected “Open Space” data into centroid points that contain area data.

While ET Geowizards is a useful tool, there are many limitations to the tasks that the software can run. Many of the following steps concern getting around these limitations to create data that is as fine as possible. Feel free to attempt condensing the following steps into a single step (this may be possible for smaller, and/or less irregularly shaped, regions).

1. Open the “ParksExtent” excel workbook.

*Note: the excel document will be used to calculate some values to guide the production of the grid.

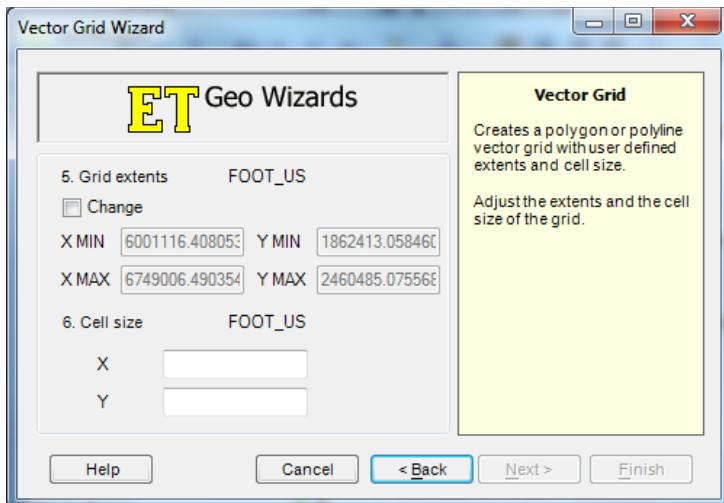
2. Return to ArcMap and Click the “ET Geowizards” Toolbar 
3. Navigate to the “Sampling” Tab → Double Click on the “Vector Grid” tool. A window similar to the one below will appear.



4. For object #1 “Select source for the initial GRID extent” use the “Extent OpenSpace” feature class.
5. For object #2 “Specify output feature class or shapefile” use a name and location of users choice (here forward referred to as “Extent_Grid”) → Click on the “Next>” button.
6. For #3 “Select output coordinate system”, click the “Select Output coordinate system” button and ensure that the coordinate system matches the default coordinate system for

the project. If it does not, change the projection to match the default projection for the project.

7. For object #4 “Select GRID type” select the option for “Polygon”. Click on the “Next>” button. The window should now look like this:



8. Object #5 “Grid extents” will need to be updated. The excel workbook generates the required values based on the region specific data. Copy the “X Min”, “X Max”, “Y Min”, and “Y Max” values into the appropriate cells in the excel workbook. The work book generates new “X Max” and “Y Max” values, copy and paste the new values into their appropriate places in Object #5.

The values can be copied by checking “Change”. This will turn boxes to edit box and you can copy value from each cell and paste into the excel workbook.

9. For Object #6 “Cell Size”, fill in the “X” and “Y” dimensions based on the values in the excel workbook. Click the “Finish” button.
10. Once the Geowizards processes have finished running, make sure that the new feature class, “Extent Grid,” is added to the display. The region should have been split into 4 different regions: two north and two south.

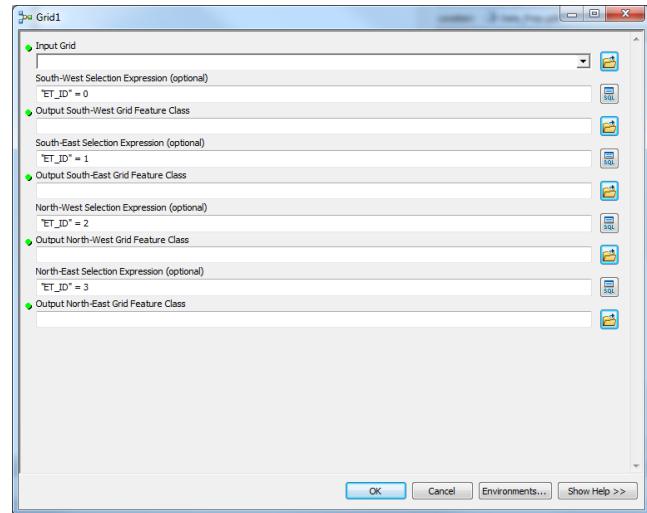
11. *Note: Given the limitation of the Geowizards software, the entire region can rarely ever be converted to a 250' by 250' Grid in one step. One can make an attempt at creating the 250' by 250' Grid in one step, but should not be surprised if/when the software fails.
12. Double click on the "Grid1" Model within the "ParksTool" Toolbox. A window similar to the one to the right will open.
13. *Note, the "Grid1" Tool separates the "Extent Grid" into 4 separate files. The defaults identify Geowizards conventions to separate the region into SE, SW, NE, and NW regions. If this tool fails to run, the step can be replicated by manually selecting each region, and exporting the selected data to shapefile.

Submit the form with the following inputs:

- Input Grid - "Extent_Grid" feature class
- South-West Selection Expression (optional) - "ET_ID" = 0
- Output South-West Grid Feature class - Name/Location of choosing (forward referred to as "Extent_Grid_SW")
- South-East Selection Expression (optional) - "ET_ID" = 1
- Output South-East Grid Feature class- Name/Location of choosing (forward referred to as "Extent_Grid_SE")
- North-West Selection Expression (optional) - "ET_ID" = 2
- Output North-West Grid Feature class - Name/Location of choosing (forward referred to as "Extent_Grid_NW")
- North-East Selection Expression (optional) - "ET_ID" = 3
- Output North-East Grid Feature class - Name/Location of choosing (forward referred to as "Extent_Grid_NE")

14. The following steps will subdivide each of the 4 regions created by step #19 into 250 foot grid cells. Re-open the "ET Geowizards" form and navigate to the "Vector Grid" tool. Submit the form once for each region using the following inputs (* represents each of the four subdivisions):

#1 "Select source for the initial GRID extent" - once each for all "Extent_Grid_*



#2 “Specify output feature class or shapefile” - Name/Location of users choosing
(forward referred to as “Extent_Grid_*_250”)

#3 “Select output coordinate system”- Check that it matches the default projection for
which all data is being prepared

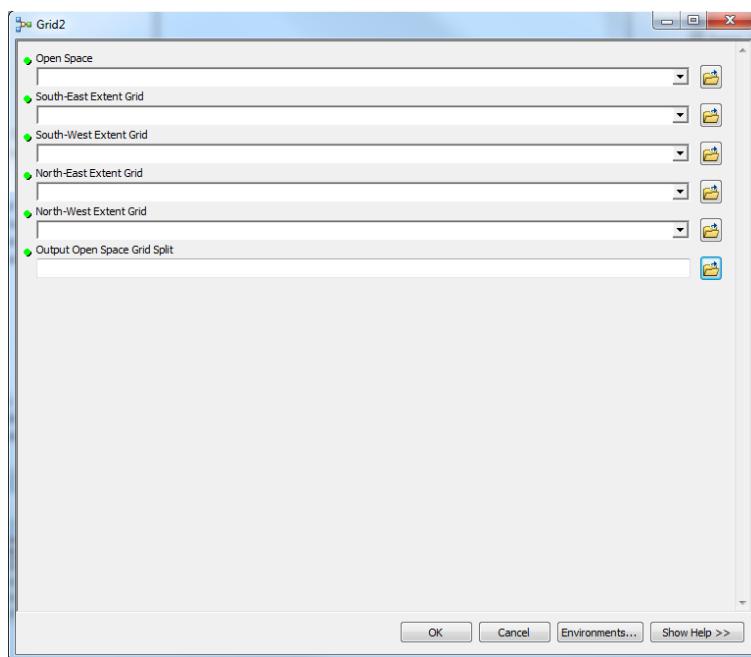
#4 “Select GRID type”- Polygon

#5 “Grid extents” - Use default

#6 “Cell Size” - both X and Y should = 250

Once generated, make sure all the “Extent_Grid_*_250” shapefiles are present in the ArcMAP display.

15. Double click the “Grid2” model within the “ParksTool” Toolbar. A window should appear matching the image below.



Fill in the appropriate fields with the following data:

“Open Space” - “Extent Open Space” feature class

“South-East Extent Grid” -“Extent_Grid_SE_250” feature class

“South-West Extent Grid” -“Extent_Grid_SW_250” feature class

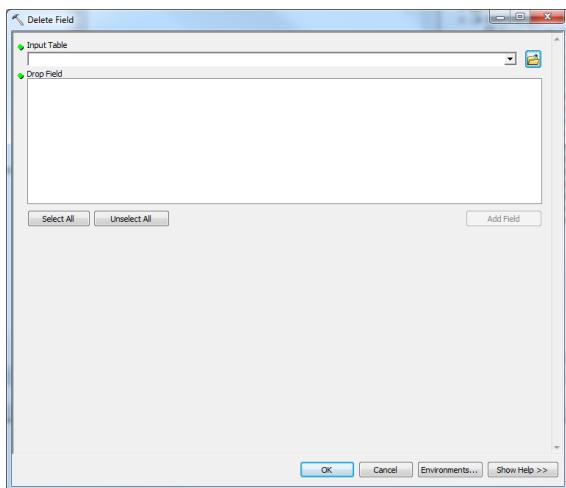
“North-East Extent Grid” -“Extent_Grid_NE_250” feature class

“North-West Extent Grid” -“Extent_Grid_NW_250” feature class

“Output Open Space Grid Split” - Name/Location of choosing
(forward referred to as “Extent Open Space 250”)

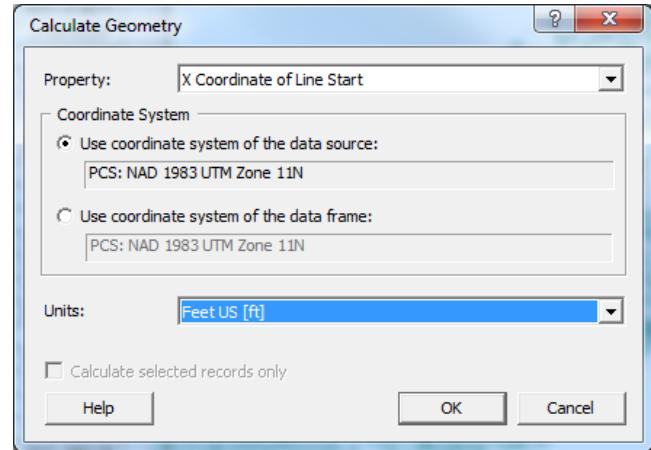
Click the “OK” button once all fields have been properly filled. Make sure the feature class generated through this tool, “Extent Open Space 250”, is added to the display.

16. Navigate to the “Delete Field” Tool in the ArcToolbox (“Data Management Tools” → “Fields” → “Delete Field”). A form like the image below should open.



17. The “Input Table” is the “Extent Open Space 250” feature class. Check the box next to all the fields present in the “Drop Field” box. Click Ok.
18. Open the “Extent Open Space 250” feature class ‘s attribute table to check that all fields (“ID”, “FID”, “Name”, etc.) have been removed. **Note: some fields are structurally mandatory and cannot be removed.*
19. In the Attribute Table menu select  and click on the option to “Add Field”. The “Name” will be “sqft” and the “Type” will be Long Integer.
20. Repeat the above step and add fields “xcoord_p” (Long) and “ycoord_p” (Long)

21. Right click on the “sqft” column heading and click the option to “Calculate Geometry...” The “property to be calculated” is “Area”; The Coordinate System choice is “Use coordinate system of the data source” and the Units should be “Square Feet US [sq ft]”. Click “OK”
22. Right click on the “xcoord_p” column heading and click the option to “Calculate Geometry...” The “property to be calculated” is “X Coordinate of Centroid”; The Coordinate System choice is “Use coordinate system of the data source” and the Units should be “Feet US [sq ft]”. Click “OK”
23. Right click on the “ycoord_p” column heading and click the option to “Calculate Geometry...” The “property to be calculated” is “Y Coordinate of Centroid”; The Coordinate System choice is “Use coordinate system of the data source” and the Units should be “Feet US [sq ft]”. Click “OK”.



This will give you the openspace and parks data in required DaySim format.

Future Year DaySim Inputs

Table 86 provides instructions on what DaySim inputs to update for a future scenario (DaySim inputs are here: 1_Inputs\8_DaySim):

TABLE 87. INSTRUCTIONS FOR FUTURE YEAR DAYSIM INPUTS

INPUT LOCATION	INSTRUCTION
01_TAZ_Index	Don't need to change unless your scenario has updated zone system.
02_Parcel	Need to update three input files. Open space and park file would not need to be changed, unless you know open space and park information for the future scenario which is unlikely. This appendix provides instructions to create these files: <ul style="list-style-type: none"> • maz_20XX_parks.csv • intersections_20XX_nohwys.csv

INPUT LOCATION	INSTRUCTION
	<ul style="list-style-type: none"> stops_transit_20XX.csv
03_Household	Need to update. Output of PopSim converted to DaySim format.
04_Person	Need to update. Output of PopSim converted to DaySim format.
05_ixxi	Update if you have share of XI and IX workers by zone (XI-outside workers working in Fresno; IX-resident workers going out for work). Otherwise, use the same as base year
06_Roster	Will automatically be updated in the input processing step.
07_Coefficients	Don't need to change.
10_ParkAndRide	Change only if you have updated park and ride locations in the region.

APPENDIX D. DAYSIM CONFIGURATION

This appendix describes the settings used in running DaySim. Note that a Cube script creates a configuration file before a DaySim run. So, any change to a setting, filename or file path needs to be done in two Cube scripts: DAMAT00F.S (Configuration_shadow_price.properties) and DAMAT00A.S (Configuration.properties). Both configuration files have the same settings, except that some models are turned off in shadow price runs. Table 87 presents the settings in the configuration files. The column “VALUE” contains the setting as in the Configuration.properties.

TABLE 88. DAYSIM CONFIGURATION FILE (CONFIGURATION.PROPERTIES)

SETTING	VALUE	DESCRIPTION
Sampling		
HouseholdSampling RateOneInX	1	The denominator of the fraction of households in the input sample to be simulated (e.g., 100 is for 1/100)
HouseholdSampling StartWithY	1	The household number to simulate first (e.g., 2, in combination with 100 above would simulate HH 2, 102, 202, etc.)
SamplingWeights SettingsType	SamplingWeights SettingsSimple	
General Path Settings		
BasePath	[CATALOG_DIR]\1 _Inputs\8_DaySim	Base directory; all DaySim inputs will be stored
OutputSubpath	[SCENARIO_DIR]\11_DaySim	Output folder path; DaySim outputs will be generated in this directory
WorkingDirectory	[SCENARIO_DIR]\11_DaySim \working	Directory for other DaySim outputs. DaySim generates other outputs in this directory.
WorkingSubpath	[SCENARIO_DIR]\11_DaySim\working	Directory path for other DaySim outputs
Threading Settings		
NProcessors	48	Number of processors (threads) to be used
NBatches	50	
Region Specific		

SETTING	VALUE	DESCRIPTION
ShouldRunInputTester	true	Flag to run DaySim input checks
CustomizationDll	Fresno.dll	Region-specific DLL
Parcel Buffered Data		
ImportParcels	true	Flag to import parcel file
RawParcelPath	[SCENARIO_DIR]\ Fresno_mzbuffer_a llstreets_2019.dat	Buffered parcel file name
RawParcelDelimiter	32	Buffered parcel file delimiter (9=TAB, 32=space, 44=comma)
UseParcelLandUseCodeAsSquareFeetOpenSpace	True	Switch for using open space square feet data from land-use type field ("ltype_p") in the parcel file
Roster Impedance		
UseMicrozoneSkimsForBikeMode	TRUE	Switch for using bike skims by microzones
RosterPath	.\06_Roster\roster_mz.csv	Name of roster CSV file, including full directory path
RosterCombinations Path	.\06_Roster\roster_combinations.csv	Name of valid roster combinations CSV file, including full directory path
UseShortDistance NodeToNode Measures	true	TRUE to use node-to-node distance in accessibility measures calculations
RawParcelNode Path	[SCENARIO_DIR]\ maz_node_2019.dat	File name providing the nearest node ID for a parcel
RawParcelNode Delimiter	32	Delimiter of the input parcel node file (9=TAB, 32=space, 44=comma)
NodeIndexPath	[SCENARIO_DIR]\ WALK_SKIM_MAZ _MAZ_SORTED_INDEX.TXT	File name for the file providing, for every node ID, starting and end record indices in node short-distance file (NodeDistancePath)
NodeIndexDelimiter	32	Delimiter of the node index file (9=TAB, 32=space, 44=comma)

SETTING	VALUE	DESCRIPTION
NodeDistances Path	[SCENARIO_DIR]\WALK_SKIM_MAZ_MAZ_SORTED.TXT.dat	File name for the file providing short distances for node pairs
MaximumBlending Distance	3	The maximum (network) Distance for which short-distance blending should be used, in miles. For short trips, DaySim uses a linear combination of parcel-to-parcel distances from an all streets network and zone-zone distances from the skim matrices. When the zone-zone skim distance exceeds this MaximumBlendingDistance, DaySim stop using the parcel-parcel distance and just use the zone-zone from the skims.
AllowNodeDistanceAsymmetry	True	
UseShortDistanceCircuitryMeasures	false	true to use circuity distance in accessibility measures calculations
Value of Time		
VotVeryLowLow	0	Boundary between VeryLow and Low VOT groups, in monetary units per hour
VotLowMedium	6	Boundary between Low and Medium VOT groups, in monetary units per hour
VotMediumHigh	12	Boundary between Medium and High VOT groups, in monetary units per hour
VotHighVeryHigh	5001	Boundary between High and VeryHigh VOT groups, in monetary units per hour
Global Settings		

SETTING	VALUE	DESCRIPTION
DataType	Default	Identifies the presence of client-specific household input data (currently only used for Actum)
ChoiceModelRunner	Default	Type of choice model runner
Settings	DefaultSettings	
Debug Settings		
TraceSimulatedChoice Outcomes	false	true to trace simulated choice outcomes
TraceModelError Validity	false	true to trace model result
InvalidAttempts BeforeTrace	100	
InvalidAttempts BeforeContinue	4	
ReportInvalidPerson Days	false	true to report invalid person days during a run
Shadow Price Settings for work and school locations		
ShouldUse ShadowPricing	true	true to apply shadow pricing for the Work Location and School Location models
UsualWorkParcel Threshold	5	Parcel-specific threshold used in the shadow price calculations of usual work location
UsualSchoolParcel Threshold	5	Parcel-specific threshold used in the shadow price calculations of usual school location
UsualUniversity ParcelThreshold	5	Parcel-specific threshold used in the shadow price calculations of usual university location
NumberOfParcels InReportDiffs	10	Control for printing out reporting on shadow price calculations
UsualWork PercentTolerance	0	Percentage tolerance to trigger work parcel shadow price adjustment
UsualWork AbsoluteTolerance	0	Absolute tolerance to trigger work parcel shadow price adjustment

SETTING	VALUE	DESCRIPTION
UsualSchool PercentTolerance	0	Percentage tolerance to trigger school parcel shadow price adjustment
UsualSchool AbsoluteTolerance	0	Absolute tolerance to trigger school parcel shadow price adjustment
UsualUniversity PercentTolerance	0	Percentage tolerance to trigger university parcel shadow price adjustment
UsualUniversity AbsoluteTolerance	0	Absolute tolerance to trigger university parcel shadow price adjustment
Shadow Price Settings		
ShadowPriceDelimiter	9	Delimiter of the shadow price files (9=TAB, 32=space, 44=comma)
ShouldUse ParkAndRide ShadowPricing	TRUE	true to use park-and-ride shadow pricing in the model
ParkAndRide ShadowPrice Delimiter	9	Delimiter of the park-and-ride shadow pricing file (9=TAB, 32=space, 44=comma)
ParkAndRide ShadowPrice MaximumPenalty	-3	
ParkAndRide ShadowPriceTime Spread	20	
ParkAndRide ShadowPriceStep Size	0.15	
Model Run Flags		
Should Run Choice Models	True	A toggle switch to run all choice models (true can be overridden by switches below and by individual model switches)
ShouldRunHouseholdModels	true	A toggle switch to run household-level models (used to perform partial runs, TRUE can be overridden by individual model switches)
ShouldRun PersonModels	True	A toggle switch to run person-level models (used to perform partial runs, true can be overridden by individual model switches)
ShouldRun PersonDayModels	true	A toggle switch to run person-day-level models (used to perform partial runs, TRUE can be overridden by individual model switches)
ShouldRunTour Models	True	A toggle switch to run tour-level models (used to perform partial runs, true can be overridden by individual model switches)

SETTING	VALUE	DESCRIPTION
ShouldRunTourTripModels	true	A toggle switch to run trip-level models (used to perform partial runs, true can be overridden by individual model switches)
ShouldRunSubtourModels	True	A toggle switch to run subtour level models (used to perform partial runs, true can be overridden by individual model switches)
ShouldRunSubtourTripModels	true	A toggle switch to run trip level models for subtours (used to perform partial runs, true can be overridden by individual model switches)
DestinationScale	1	For a model that uses parcels, this should be set at 0. If the model uses blocks (microzones) instead, then set this at 1, and it allows intra-microzone trips. But, with it set at 0, it does not allow intra-microzone trips.
ShowRunChoiceModelsStatus	True	true to show percentage of households simulated on the screen during simulation
ShouldRunRawConversion	True	If true, DaySim will convert and input all of the raw data files
Random Seed Settings		
RandomSeed	1234	Initial seed value for the random number generator
ShouldSynchronize RandomSeed	True	If true, DaySim will use a seed for each person/tour/trip/model combination that depends only on the initial seed
Internal-External Workers Settings		
IxxiPath	.\05_ixxi\Fresno_worker_ixxifractions.dat	Input worker IXXI fractions file name
IxxiDelimiter	32	Delimiter for the input file (9=TAB, 32=space, 44=comma)
IxxiFirstLinesHeader	False	If true, DaySim expects a header record for this file (all other raw data files have headers)
Park-and-Ride Nodes		
RawParkAndRide NodePath	.\10_ParkAndRide\p_r_Nodes_2019.dat	Input park-and-ride node file; if none given, the park-and-ride mode will not be available)

SETTING	VALUE	DESCRIPTION
RawParkAndRideNodeDelimiter	9	The delimiter for the input file (9=TAB, 32=space, 44=comma)
ImportParkAndRideNodes	true	If true, the raw file should be imported (always true if ShouldRunRawConversion=true)
ShouldReadParkAndRideNodeSkim	false	
Zones		
ImportZones	true	If true, the zone file should be imported (always true if ShouldRunRawConversion=true)
RawZonePath	.\01_TAZ_Index\Fresno_taz_indexes.dat	Input zone index file name
RawZoneDelimiter	9	The delimiter for the input zone index file (9=TAB, 32=space, 44=comma)
RawHouseholdPath	.\03_Household\Fresno_household_sampled.dat	Input household file
RawHouseholdDelimiter	32	The delimiter for the input household file (9=TAB, 32=space, 44=comma)
RawPersonPath	.\04_Person\Fresno_person_sampled.dat	Input person file
RawPersonDelimiter	32	The delimiter for the input household file (9=TAB, 32=space, 44=comma)
DaySim Output Files		
ImportHouseholds	True	
OutputHousehold Path	_household.tsv	The full path name for the household output file
OutputHousehold Delimiter	9	Delimiter for the household output file (9=TAB, 32=space, 44=comma)
ImportPersons	True	
OutputPersonPath	_person.tsv	Person output filename

SETTING	VALUE	DESCRIPTION
OutputPerson Delimiter	9	Delimiter for the person output file (9=TAB, 32=space, 44=comma)
OutputHousehold DayPath	_household_day.ts v	
OutputHousehold DayDelimiter	9	Household day output filename
OutputPersonDay Path	_person_day.tsv	Person day output filename
OutputPersonDay Delimiter	9	Delimiter for the person day output file (9=TAB, 32=space, 44=comma)
OutputTourPath	_tour.tsv	Tour output filename
OutputTourDelimiter	9	Delimiter for the tour output file (9=TAB, 32=space, 44=comma)
OutputTripPath	_trip.tsv	Trip output filename
OutputTripDelimiter	9	Delimiter for the trip output file (9=TAB, 32=space, 44=comma)
OutputJointTour Delimiter	9	Delimiter for the join tour output file (9=TAB, 32=space, 44=comma)
OutputJointTour Path	_joint_tour.tsv	Joint tour output filename
OutputFullHalfTour Path	_full_half_tour.tsv	Full half-tour output filename
OutputFullHalfTour Delimiter	9	Delimiter for the full half-tour output file (9=TAB, 32=space, 44=comma)
OutputPartialHalf TourPath	_partial_half_tour.ts v	Partial half-tour filename
OutputPartialHalf TourDelimiter	9	Delimiter for the partial half-tour output file (9=TAB, 32=space, 44=comma)
ShouldOutputTDM TripList	false	
Logsums		

SETTING	VALUE	DESCRIPTION
ShouldLoadAggregateLogsumsFromFile	False	true to read the aggregate logsums from a file generated by a previous run (otherwise recalculated)
ShouldOutputAggregateLogsums	True	true to write the aggregate logsums to a file for a subsequent run
OutputAggregateLogsumsPath	aggregate_logsums.dat	File name to write out aggregate logsums
ShouldLoadSamplingWeightsFromFile	False	true to read the precalculated sampling weights from a file generated by a previous run (otherwise recalculated)
ShouldOutputSamplingWeights	False	true to write the precalculated sampling weights to a file for a subsequent run
OutputSamplingWeightsPath	sampling_weights.dat	File name write out sampling weights at
Model Coefficients		
WorkLocationModelSampleSize	100	The maximum number of destinations to be sampled for this model
WorkLocationModelCoefficients	.\07_Coefficients\WorkLocationCoefficients.F12	Path of the coefficient file for the work location model
ShouldRunWorkLocationModel	True	A toggle switch to run the work location model; can be used for partial runs, TRUE can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
IncludeWorkLocationModel	True	false to always exclude this model from the set of models to be run. Set both - this and ShouldRunWorkLocatinModel - to the same (true or false).
SchoolLocationModelSampleSize	100	The maximum number of destinations to be sampled for this model
SchoolLocationModelCoefficients	.\\07_Coefficients\\SchoolLocationCoefficients.F12	Path of the coefficient file for the school location model
ShouldRunSchool LocationModel	True	A toggle switch to run the school location model; can be used for partial runs, TRUE can be overridden by more general switches above
IncludeSchool LocationModel	True	false to always exclude this model from the set of models to be run. Set both - this and ShouldRunSchoolLocationModel - to the same (true or false).
PayToParkAtWorkplace ModelCoefficients	.\\07_Coefficients\\PayToParkAtWorkplaceCoefficients.F12	Path of the coefficient file for the pay to park and workplace model
ShouldRunPayTo ParkAtWorkplace Model	True	A toggle switch to run the pay-to-park and workplace model; can be used for partial runs, true can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
IncludePayToParkAtWorkplaceModel	True	false to always exclude this model from the set of models to be run. Set both - this and ShouldRunPayToParkAtWorkplaceModel - to the same (true or false).
TransitPassOwnershipModelCoefficients	.\07_Coefficients\TransitPassOwnershipCoefficients.F12	Path of the coefficient file for the transit pass ownership model
ShouldRunTransitPassOwnershipModel	True	A toggle switch to run the transit pass ownership model; can be used for partial runs, true can be overridden by more general switches above
IncludeTransitPassOwnershipModel	True	false to always exclude this model from the set of models to be run. Set both - this and ShouldRunTransitPassOwnershipModel - to the same (true or false).
AutoOwnershipModelCoefficients	.\07_Coefficients\AutoOwnershipCoefficients.F12	Path of the coefficient file for the auto ownership model
ShouldRunAutoOwnershipModel	True	A toggle switch to run the auto ownership model; can be used for partial runs, true can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
IndividualPersonDayPatternModel Coefficients	.\\07_Coefficients\\IndividualPersonDayPatternCoefficients.F12	Path of the coefficient file for the individual person-day pattern model
ShouldRunIndividualPersonDayPattern Model	True	A toggle switch to run the individual person day pattern model; can be used for partial runs, true can be overridden by more general switches above
PersonExactNumberOfToursModel Coefficients	.\\07_Coefficients\\PersonExactNumberOfToursCoefficients.F12	Path of the coefficient file for the person exact number of tours model
ShouldRunPersonExactNumberOfTours Model	True	A toggle switch to run the person exact number of tours model; can be used for partial runs, true can be overridden by more general switches above
WorkTourDestinationModelSampleSize	100	Maximum number of destinations to be sampled for the work tour destination model
WorkTourDestinationModelCoefficients	.\\07_Coefficients\\WorkTourDestinationCoefficients.F12	Path of the coefficient file for the work tour destination model
ShouldRunWorkTourDestinationModel	True	
OtherTourDestinationModelSampleSize	100	Maximum number of destinations to be sampled for the other tour destination model
OtherTourDestinationModelCoefficients	.\\07_Coefficients\\OtherTourDestinationCoefficients.F12	Path of the coefficient file for the tour destination model

SETTING	VALUE	DESCRIPTION
ShouldRunOtherTourDestinationModel	True	A toggle switch to run the tour destination model; can be used for partial runs, true can be overridden by more general switches above
WorkBasedSubtourGenerationModelCoefficients	.\07_Coefficients\WorkbasedSubtourGenerationCoefficients.F12	Path of the coefficient file for the work-based subtour generation model
ShouldRunWorkBasedSubtourGenerationModel	True	A toggle switch to run the work-based subtour generation model; can be used for partial runs, true can be overridden by more general switches above
WorkTourMode ModelCoefficients	.\07_Coefficients\WorkTourModeCoefficients.F12	Path of the coefficient file for the work tour mode model
ShouldRunWorkTour ModeModel	True	A toggle switch to run the work tour mode model; can be used for partial runs, true can be overridden by more general switches above
SchoolTourMode ModelCoefficients	.\07_Coefficients\SchoolTourModeCoefficients.F12	Path of the coefficient file for the school tour mode model
ShouldRunSchool TourModeModel	True	A toggle switch to run the school tour mode model; can be used for partial runs, true can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
WorkBasedSubtourModeModelCoefficients	.\\07_Coefficients\\WorkBasedSubtourModeCoefficients.F12	Path of the coefficient file for the work-based subtour mode model
ShouldRunWorkBasedSubtourModeModel	True	A toggle switch to run the work-based subtour mode model; can be used for partial runs, true can be overridden by more general switches above
EscortTourModeModelCoefficients	.\\07_Coefficients\\EscortTourModeCoefficients.F12	Path of the coefficient file for the escort tour mode model
ShouldRunEscortTourModeModel	True	A toggle switch to run the escort tour mode model; can be used for partial runs, true can be overridden by more general switches above
OtherHomeBasedTourModeModel Coefficients	.\\07_Coefficients\\OtherHomeBasedTourModeCoefficients.F12	Path of the coefficient file for the other home-based tour mode model
ShouldRunOtherHomeBasedTourModeModel	True	A toggle switch to run the other home-based tour mode model; can be used for partial runs, true can be overridden by more general switches above
WorkTourTime ModelCoefficients	.\\07_Coefficients\\WorkTourTimeCoefficients.F12	Path of the coefficient file for the work tour time model

SETTING	VALUE	DESCRIPTION
ShouldRunWorkTourTimeModel	True	A toggle switch to run the work tour time model; can be used for partial runs, true can be overridden by more general switches above
SchoolTourTimeModelCoefficients	.\07_Coefficients\SchoolTourTimeCoefficients.F12	Path of the coefficient file for the school tour time model
ShouldRunSchoolTourTimeModel	True	A toggle switch to run the school tour time model; can be used for partial runs, true can be overridden by more general switches above
OtherHomeBasedTourTimeModelCoefficients	.\07_Coefficients\OtherHomeBasedTourTimeCoefficients.F12	Path of the coefficient file for the other home-based tour time model
ShouldRunOtherHomeBasedTourTimeModel	True	A toggle switch to run the home-based tour time model; can be used for partial runs, true can be overridden by more general switches above
WorkBasedSubtourTimeModelCoefficients	.\07_Coefficients\WorkbasedSubtourTimeCoefficients.F12	Path of the coefficient file for the work-based subtour time model
ShouldRunWorkBasedSubtourTimeModel	True	A toggle switch to run the work-based subtour time model; can be used for partial runs, true can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
IntermediateStopGenerationModeICoefficients	.\07_Coefficients\IntermediateStopGenerationCoefficients.F12	Path of the coefficient file for the intermediate stop generation model
ShouldRunIntermediateStopGenerationModel	True	A toggle switch to run the intermediate stop generation model; can be used for partial runs, true can be overridden by more general switches above
IntermediateStopLocationModelSampleSize	100	The maximum number of destinations to be sampled for the intermediate stop location model
IntermediateStopLocationModelCoefficients	.\07_Coefficients\IntermediateStopLocationCoefficients.F12	Path of the coefficient file for the intermediate stop location model
ShouldRunIntermediateStopLocationModel	True	A toggle switch to run the intermediate stop location model; can be used for partial runs, true can be overridden by more general switches above
TripModeModelCoefficients	.\07_Coefficients\TripModeCoefficients.F12	Path of the coefficient file for the trip mode model
ShouldRunTripModeModel	True	A toggle switch to run the trip mode model; can be used for partial runs, true can be overridden by more general switches above

SETTING	VALUE	DESCRIPTION
TripTimeModelCoefficients	.\\07_Coefficients\\TripTimeCoefficients.F12	Path of the coefficient file for the trip time model
ShouldRunTripTimeModel	True	A toggle switch to run the trip time model; can be used for partial runs, true can be overridden by more general switches above

Path Impedance Parameters

PathImpedance_PathChoiceScaleFactor	1.5	A scale factor for the coefficients of the path-type models; the inverse of a logsum coefficient in upper-level models. Not really used in BKRCast as BKRCast has only local bus under transit so don't have any path type competing under any modes.
PathImpedance_AutoOperatingCostPerMile	0.22	Auto operating cost, in monetary units per distance unit
PathImpedance_TransitInVehicleTimeWeight	1.0	Relative weight on transit in-vehicle time in the transit and park-and-ride path type models. These are all multiples of the auto in-vehicle time coefficient, which is set in the VOT parameters.
PathImpedance_TransitFirstWaitTimeWeight	2.0	Relative weight on transit first wait time in the transit and park-and-ride path-type models
PathImpedance_TransitTransferWaitTimeWeight	2.0	Relative weight on transit transfer wait time in the transit and park-and-ride path-type models

SETTING	VALUE	DESCRIPTION
PathImpedance_TransitNumberBoardingsWeight	8.0	Relative weight on transit number of boardings in the transit and park-and-ride path-type models
PathImpedance_TransitDriveAccessTimeWeight	2.0	Relative weight on transit drive access in-vehicle time in the park-and-ride path-type models
PathImpedance_TransitWalkAccessTimeWeight	2.0	Relative weight on transit walk access and egress times in the transit and park-and-ride path-type models
PathImpedance_WalkTimeWeight	2.5	Relative weight on walk mode time in the walk path-type model
PathImpedance_BikeTimeWeight	4.0	Relative weight on bike mode time in the bike path-type model
PathImpedance_WalkMinutesPerMile	20.0	Factor to convert parcel-based transit walk access/egress distance into time (in minutes per distance unit)
PathImpedance_TransitWalkAccessDistanceLimit	1.0	Maximum parcel-based transit walk access or egress distance allowed for available transit paths

SETTING	VALUE	DESCRIPTION
PathImpedance_TransitWalkAccessDirectLimit	1.0	Maximum parcel-based transit walk access or egress distance allowed for direct transit paths to be chosen over mixed paths
PathImpedance_TransitSingleBoarding Limit	1.1	Maximum number of boardings for a transit path to be considered a "direct path" (no transfers). When DaySim figures out the walk time from a parcel to the nearest transit stop for path types other than local bus, DaySim wants to figure out whether those paths could include local bus feeder or if they are a direct path with no transfers (the boardings skim value is \geq TransitSingleBoardingLimit). The fraction is because some transit skims are an average across multiple paths, some direct and some not.
PathImpedance_AutoTolledPath Constant	0.0	Path-type constant for an auto path that includes a nonzero toll cost (reflects extra resistance to paying tolls)
PathImpedance_AvailablePath UpperTimeLimit	200.0	Maximum total (unweighted) path travel time (in minutes) for a path to be considered an available option
PathImpedance_TransitLocalBus PathConstant	0.0	Path-type constant for transit local bus only paths

SETTING	VALUE	DESCRIPTION
PathImpedance_ TransitPremiumBus PathConstant	0.0	Path-type constant for transit premium bus (possibly plus feeder) paths
PathImpedance_ TransitLightRail PathConstant	0.0	Path-type constant for transit light rail (possibly plus feeder) paths
PathImpedance_ TransitCommuterRail PathConstant	0.0	Path-type constant for transit commuter rail (possibly plus feeder) paths
PathImpedance_ TransitFerry PathConstant	0.0	Path-type constant for transit passenger ferry (possibly plus feeder) paths
PathImpedance_ TransitUsePathType SpecificTime	True	A switch to use additional skims and weights to reflect transit submode-specific in-vehicle times (SACOG-specific)
PathImpedance_ TransitPremiumBus TimeAdditiveWeight	0.00	An additive weight on premium bus submode-specific in-vehicle time (adds to TransitInVehicleTimeWeight)
PathImpedance_ TransitLightRail TimeAdditiveWeight	-0.15	An additive weight on light-rail submode-specific in-vehicle time (adds to TransitInVehicleTimeWeight)

SETTING	VALUE	DESCRIPTION
PathImpedance_TransitCommuterRailTimeAdditiveWeight	-0.25	An additive weight on commuter rail submode-specific in-vehicle time (adds to TransitInVehicleTimeWeight)
PathImpedance_TransitFerryTime AdditiveWeight	-0.40	An additive weight on passenger ferry submode-specific in-vehicle time (adds to TransitInVehicleTimeWeight)
PathImpedance_BikeUseTypeSpecificDistanceFractions	False	A switch to use additional skims and weights to reflect bicycle distances on specific facility types (SACOG-specific)
PathImpedance_BikeType1Distance FractionAdditiveWeight	0.0	An additive weight on bike distance on Class 1 bike paths (adds to BikeTimeWeight, distance is converted to time)
PathImpedance_BikeType2Distance FractionAdditiveWeight	0.0	An additive weight on bike distance on Class 2 bike paths (adds to BikeTimeWeight, distance is converted to time)
PathImpedance_BikeType3Distance FractionAdditiveWeight	0.0	An additive weight on bike distance on Class 3 bike paths (adds to BikeTimeWeight, distance is converted to time)

SETTING	VALUE	DESCRIPTION
PathImpedance_BikeType4Distance FractionAdditiveWeight	0.0	An additive weight on bike distance on Class 4 bike paths (adds to BikeTimeWeight, distance is converted to time)
PathImpedance_TransitUseFareDiscount Fractions	True	A switch (true/false) to use transit fare discount fractions based on person type and age
PathImpedance_TransitFareDiscount FractionChildUnder5	0.8	Transit fare discount fraction for children under age 5
PathImpedance_TransitFareDiscount FractionChild5To15	0.5	Transit fare discount fraction for children ages 5 to 15
PathImpedance_TransitFareDiscount FractionHighSchool Student	0.5	Transit fare discount fraction for high school students (children age 16+)
PathImpedance_TransitFareDiscount FractionUniversity Student	0.5	Transit fare discount fraction for college students
PathImpedance_TransitFareDiscount FractionAge65Up	0.5	Transit fare discount fraction for adults age 65+
PathImpedance_TransitPassCost PercentChangeVersus Base	0	Policy input variable to change the cost of transit passes with respect to base year
<hr/>		
Path-type Impedance Coefficients		
Coefficients_BaseCostCoefficient PerDollar	-0.15	Base cost coefficient (per monetary unit), when income=BaseCostCoefficientIncomeLevel

SETTING	VALUE	DESCRIPTION
Coefficients_BaseCostCoefficient IncomeLevel	30000	Household income level (monetary units per year) where the cost coefficient is the BaseCostCoefficient
Coefficients_CostCoefficient IncomePower_Work	0.6	Power function exponent to use for adjusting the cost coefficient for income, for work tours
Coefficients_CostCoefficient IncomePower_Other	0.3	Power function exponent to use for adjusting the cost coefficient for income, for nonwork tours
Coefficients_MeanTimeCoefficient_Work	-0.03	Mean time coefficient (/minute) for work tours
Coefficients_MeanTimeCoefficient_Other	-0.015	Mean time coefficient (/minute) for nonwork tours
Coefficients_StdDeviationTime Coefficient_Work	0.8	Standard deviation of the time coefficient (/minute) for work tours, when using random VOT distribution
Coefficients_StdDeviationTime Coefficient_Other	1.0	Standard deviation of the time coefficient (/minute) for nonwork tours, when using random VOT distribution

SETTING	VALUE	DESCRIPTION
Coefficients_HOV2CostDivisor _Work	1.741	Divisor for the cost coefficient for the HOV2 mode for work tours (to reflect cost-sharing)
Coefficients_HOV2CostDivisor _Other	1.741	Divisor for the cost coefficient for the HOV2 mode for nonwork tours (to reflect cost-sharing)
Coefficients_HOV3CostDivisor _Work	2.408	Divisor for the cost coefficient for the HOV3+ mode for work tours (to reflect cost-sharing)
Coefficients_HOV3CostDivisor _Other	2.158	Divisor for the cost coefficient for the HOV3+ mode for nonwork tours (to reflect cost-sharing)
UseRandomVotDistribution	True	TRUE to randomly simulate a time coefficient for each tour, using a log-normal distribution
UrbanThreshold	500	
New Work-At-Home (Telecommute) Model settings		
UseDiaryVsSmartphoneBiasVariables	TRUE	
UseProxyBiasVariables	TRUE	
UseWorkAtHomeModelAndVariables	TRUE	Toggle Telecommute Model On/Off with True/False Value
WorkAtHome_DurationThreshold	2.5	Minimum hours that must be worked at home to be considered "telecommuting"
WorkAtHome_AlternativeSpecificConstant	-1.8067	Telecommute Alternative Specific Constant
WorkAtHome_PartTimeWorkerCoefficient	-0.264	Part Time Worker Telecommute Coefficient
WorkAtHome_Income0to50Coefficient	0.349	Income 0-50K telecommute coefficient

SETTING	VALUE	DESCRIPTION
WorkAtHome_IncomeOver150Coefficient	0.3	Income >150K telecommute coefficient
WorkAtHome_NonWorkerAndKidInHHCoefficient	0.399	Non-worker and kids in households telecommute coefficient
WorkAtHome_NoVehiclesInHHCoefficient	0.412	No Vehicles in households telecommute coefficient
WorkAtHome_FractionMedicalJobsCoefficient	-0.415	Medical Profession telecommute coefficient
WorkAtHome_FractionEducationJobsCoefficient	0	Education profession telecommute coefficient
WorkAtHome_FractionServiceJobsCoefficient	0	Service profession telecommute coefficient
WorkAtHome_FractionOtherJobsCoefficient	1.396	Other profession telecommute coefficient
WorkAtHome_FractionGovernmentJobsLowIncomeCoefficient	-0.65	Government Profession telecommute coefficient
WorkAtHome_FractionIndustrialJobsLowIncomeCoefficient	-0.402	Industrial jobs telecommute coefficient
WorkAtHome_FractionRetailFoodJobsLowIncomeCoefficient	-0.418	Retail and Food profession telecommute coefficients
WorkAtHome_FractionOfficeJobsLowIncomeCoefficient	-0.63	Low income and office worker telecommute coefficient
WorkAtHome_FractionGovernmentJobsHigherIncomeCoefficient	-0.311	High income and government profession telecommute coefficient
WorkAtHome_FractionIndustrialJobsHigherIncomeCoefficient	0.431	High income and industrial profession telecommute coefficient
WorkAtHome_FractionRetailFoodJobsHigherIncomeCoefficient	-0.385	High income and retail/food profession telecommute coefficient
WorkAtHome_FractionOfficeJobsHigherIncomeCoefficient	0.295	High income and office profession telecommute coefficient
Ride Share Settings		
PaidRideShareModelsAvailable	TRUE	Include Taxi/TNC ride share modes in Mode Choice models
PaidRideshare_UseEstimatedInsteadOfAssertedCoefficients	True	Use estimated coefficients for the Ride Share Model
PaidRideshare_OutputNumberOfPassengersOnTripRecord	True	Output Number of passengers to trip records
PaidRideshare_1PassengerShareForWorkTours	0.7	
PaidRideshare_2PassengerShareForWorkTours	0.2	
PaidRideshare_AverageNumberFor3plusPassengerWorkTours	4	
PaidRideshare_1PassengerShareForSchoolTours	0.5	
PaidRideshare_2PassengerShareForSchoolTours	0.3	

SETTING	VALUE	DESCRIPTION
PaidRideshare_AverageNumberFor3plusPassengerSchoolTours	4	
PaidRideshare_1PassengerShareForEscortTours	0.1	
PaidRideshare_2PassengerShareForEscortTours	0.4	
PaidRideshare_AverageNumberFor3plusPassengerEscortTours	3.3	
PaidRideshare_1PassengerShareForOtherTours	0.45	
PaidRideshare_2PassengerShareForOtherTours	0.35	
PaidRideshare_AverageNumberFor3plusPassengerOtherTours	4.25	
Other Settings		
RawPersonPath	.\\2016_prec_pp.csv	
DestinationScale	0	
HouseholdIncomeAdjustmentFactorTo2000Dollars	1	
UseWorkShadowPricingForWorkAtHomeAlternative	false	
CountAllIntermediateStopsOnPersonDayRecord	true	
PathImpedance_BikeUseTypeSpecificDistanceFractions	True	

APPENDIX E. TELECOMMUTE SHARES

Telecommute models can be turned on by adjusting the configurations in the DaySim module (Step 10 and 15). The “UseWorkAtHomeModelAndVariables” variable should be switched to True as shown in Figure 49.

```

371  '\n',
372  '\nPaidRideshare_1PassengerShareForEscortTours = 0.1',
373  '\nPaidRideshare_2PassengerShareForEscortTours = 0.4',
374  '\nPaidRideshare_AverageNumberFor3plusPassengerEscortTours = 3.3',
375  '\n',
376  '\nPaidRideshare_1PassengerShareForOtherTours = 0.45',
377  '\nPaidRideshare_2PassengerShareForOtherTours = 0.35',
378  '\nPaidRideshare_AverageNumberFor3plusPassengerOtherTours = 4.25',
379  '\n',
380  '\nUseDiaryVsSmartphoneBiasVariables = True',
381  '\nUseProxyBiasVariables = True',
382  '\nUseWorkAtHomeModelAndVariables = False',
383  '\nWorkAtHome_DurationThreshold = 2.5',
384  '\nWorkAtHome_AlternativeSpecificConstant = -1.8067',
385  '\nWorkAtHome_PartTimeWorkerCoefficient = -0.264',
386  '\nWorkAtHome_Income0to50Coefficient = 0.349',
387  '\nWorkAtHome_IncomeOver150Coefficient = 0.3',
388  '\nWorkAtHome_NonWorkerAndKidsInHHCoefficient = 0.399',
389  '\nWorkAtHome_NoVehiclesInHHCoefficient = 0.412',
390  '\nWorkAtHome_FractionMedicalJobsCoefficient = -0.415',
391  '\nWorkAtHome_FractionEducationJobsCoefficient = 0',
392  '\nWorkAtHome_FractionServiceJobsCoefficient = 0',
393  '\nWorkAtHome_FractionOtherJobsCoefficient = 1.396',
394  '\nWorkAtHome_FractionGovernmentJobsLowIncomeCoefficient = -0.65',
395  '\nWorkAtHome_FractionIndustrialJobsLowIncomeCoefficient = -0.402',
396  '\nWorkAtHome_FractionRetailFoodJobsLowIncomeCoefficient = -0.418',
397  '\nWorkAtHome_FractionOfficeJobsLowIncomeCoefficient = -0.63',
398  '\nWorkAtHome_FractionGovernmentJobsHigherIncomeCoefficient = -0.311',
399  '\nWorkAtHome_FractionIndustrialJobsHigherIncomeCoefficient = 0.431',
400  '\nWorkAtHome_FractionRetailFoodJobsHigherIncomeCoefficient = -0.385',
401  '\nWorkAtHome_FractionOfficeJobsHigherIncomeCoefficient = 0.295',
402  '\n'

```

FIGURE 49. DAYSIM CONFIGURATION TELECOMMUTE PARAMETER

After you run DaySim with this flag set to True, the *person day.tsv* file output from Daysim will have a field ‘wkathome’

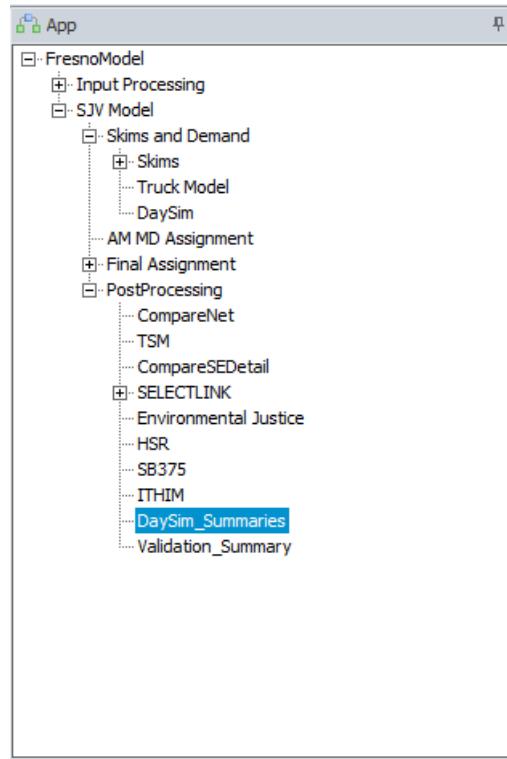
Fresno Council of Governments Activity-Based Model Update

which will have values of 0 or 4. 0 mean there were no hours worked at home, 4 means at least 3 hours of paid work were done at home that day.

The share of work from home will be the number of workers who worked at home divided by the total number of workers. In the WorkLocation.xlsx calibration spreadsheet (daysim_summaries), there is a tab for telecommute where this summary will be populated. The Calibration_Dist sheet (Figure 50) includes some helpful calculations. The user must:

1. Populate cell F26 to get the desired telecommute share in cell F31.
2. Populate cell N26 with the current Telecommute Alternative Specific Constant (ASC) (line 384 of the Daysim Configuration generation script in Figure 49)
3. Replace the ASC in the DaySim configuration file with the value in cell Q26.
4. Re-Run daysim with the same shadow pricing files (paste into “11_DaySim/working” folder)
5. Re-Run the DaySim summaries to see the new telecommute shares. (Note: this may be done from the Cube Catalog by navigating to the “DaySim Summaries” screen in the App window, and running the module being sure to select “Run Current Group Only”.

Fresno Council of Governments Activity-Based Model Update



i.

6. Repeat until the desired share is met.

Fresno Council of Governments Activity-Based Model Update

FIGURE 50. TELECOMMUTE ASC ADJUSTMENT

APPENDIX F. CATALOG KEYS

KEY	DESCRIPTION
ClusterHandle	Cluster handle name
ClusterNodes	Number of cluster nodes
NumZones	Number of zones
Year	Scenario year
RunInputProcessing	Boolean variable to enable or disable running Input Processing
Run_WorkerFrac	Boolean variable to enable or disable running Worker Frac
Run_PopSim	Boolean variable to enable or disable running PopulationSim
Run_TransitStops	Boolean variable to enable or disable running Transit Stops
Run_IntersectionDensity	Boolean variable to enable or disable running Intersection Density
Run_ShadowPrice	Boolean variable to enable or disable Shadow Price
RUN_DAYSIM_SUMMARIES	Boolean variable to enable or disable running DaySim summaries
Zonal data	Path to zonal data file
Socio-economic detail	Path to social economic detail file

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
MXD_Parameters	Path to MXD parameters file
Master highway network	Path to highway network file
Year of network scenario	Year of network scenario
Turn penalties	Path to turn penalties file
Truck_BaseMatrix	Path to Truck Base Matrix file
Truck_FutureMatrix	Path to Truck Future Matrix file
Use LOS capacity ranges rather than model VC	Check box to enable using LOS capacity ranges instead of model VC
Airbasins	
Define network to compare	Path to network file to compare to
Define SE Detail to compare	Path to SE detail file to compare to
Adjust trips to match value	Check box
Zones to adjust to match (ex. 101-105, 107)	
Trip targets by zone	Path to .DBF file with Zone,A1_IN, A1_OUT, P1_IN, P1_OUT, DAY_IN, DAY_OUT
Select Link/Zone Listing	Path to select/zone listing file
Rail Ridership	Rail .DBF file path

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
Collisions per VMT	Number of collisions per VMT
Total Collisions	Number of total collisions
Collision PDO	
Collision Injuries	Number of collision injuries
Collision Fatalities	Number of collision fatalities
Deaths	Number of deaths
Injuries	Number of injuries
Maximum travel time (minutes)	Maximum travel time in minutes
Time Interval for Summary (minutes)	
Range of Origin Zones for Summary	Origin zones to generate summaries for
Range of Destination Zones for Summary	Destination zones to generate summaries for
pt network available	Check to indicate public transit network is available
Non-highway transit links	Path to non-highway transit links file
XY coordinates for transit only nodes	Path to XY coordinates of transit nodes file
Peak transit lines file	Path to peak transit lines file

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
Peak drive access block file	Path to peak drive access block file
Peak walk access block file	Path to peak walk access block file
Off-peak transit drive access block	Path to off-peak transit drive access block
Off-peak transit walk access block	Path to off-peak transit walk access block
TransitFares	Path to transit fares file
TransitFactors	Path to transit factors file
TransitFactorsBus	Path to transit factors for bus
TransitSystem	Path to transit system points file path
TransitSystemBus	Path to bus system points file path
TripGenRates	Path to trip generation rates file
Truck Generation Rates	Path to truck generation rates file
SpdCapLookup	
AutoOpCosts	Path to auto operating costs file
MCPParameters	Path to mode choice parameters file
FricFacParam	Path to friction factors parameters file

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
DiurnalFactors	Path to diurnal factors file
TimeFacB_1	Transit speed time factor on facility class 1
TimeFacB_2	Transit speed time factor on facility class 2
TimeFacB_3	Transit speed time factor on facility class 3
TimeFacB_4	Transit speed time factor on facility class 4
TimeFacB_5	Transit speed time factor on facility class 5
TimeFacB_6	Transit speed time factor on facility class 6
TimeFacB_7	Transit speed time factor on facility class 7
TimeFacB_8	Transit speed time factor on facility class 8
TimeFacB_9	Transit speed time factor on facility class 9
VOT_0Veh	Low value of time
VOT_1Veh	Medium value of time
VOT_2Veh	High value of time
Speed_Bike	Bike speed (units)
Speed_Walk	Walk speed (units)

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
MaxBikeDist	Maximum bike distance (units)
MaxWalkDist	Maximum walk distance (units)
AOF_HW_SR3	
Dist_Iter_Truck	
Assign_Iter_Peak	
Assign_Iter_OffPeak	
AM Period Capacity Factor	AM period capacity factor
Mid-Day Period Capacity Factor	MD period capacity factor
PM Peak Period Capacity Factor	PM period capacity factor
Night-time Period Capacity Factor	EV period capacity factor
AM Peak Period Hours	AM peak period hours (24-hr format)
Mid-day Period Hours	MD period hours (24-hr format)
PM Peak Period Hours	PM peak period hours (24-hr format)
Night-time Period Hours	EV period hours (24-hr format)
AM Peak 1HR	AM peak hour (24-hr format)

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
PM Peak 1HR	PM peak hour (24-hr format)
TS_PCE	Small truck passenger car equivalent
TM_PCE	Medium truck passenger car equivalent
TH_PCE	Heavy truck passenger car equivalent
Truck Freeway Speed Factor	Truck freeway speed factor
Average rent for single-family development in first zone	Average rent for a single-family development in the first zone
Real estate attributes	Path to real estate attributes file
Initial zonal attributes for Cube Land	
DaySim Parcel File	Path to DaySim parcel file
DaySim Household File	Path to DaySim household file
DaySim Person File	Path to DaySim person file
Seed shadow price file	Path to seed shadow price file
AOF_SR3	
DaySimSeed	DaySim seed
NumMAZ	Number of MAZs

Fresno Council of Governments Activity-Based Model Update

KEY	DESCRIPTION
FareMatrix	Path to fare matrix file
Run_Validation	Boolean to enable or disable validation
HOV2_TOLL_FACTOR	HOV2 toll factor
HOV3_TOLL_FACTOR	HOV3 toll factor
ANACONDA_DIRECTORY	Anaconda installation directory
R_DIRECTORY	R installation directory