FRESNO COG ACTIVITY BASED MODEL UPDATE

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Fresno Council of Governments

FRESNO COUNCIL OF GOVERNMENTS

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Fresno ABM Model Update Report:

Fresno COG Activity Based Model Update

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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, truck restrictions in addition to compact and mixed-use development, active transportation, and transit.

The report describes the updated ABM system in detail and is also aimed to serve as a user's guide for the model system. The ABM is integrated with Cube software, which is primarily used for network models (skimming and assignment) and auxiliary demand models (external trips and truck model). The ABM is calibrated to a new base-year (2019) using the 2017 National Household Travel Survey. The model system is also validated against 2019 observed data for traffic counts, and transit ridership.

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

- Implemented latest version of DaySim (ABM)
- Included Taxi/TNC modes in DaySim
- Included a telecommuting model in DaySim
- Generated input external auto and truck trip tables using Replica Data
- Implemented HOT Lanes and HOV Tolls
- Implemented truck restrictions
- Updated output reporting procedures to generate new summaries
- Developed inputs for a new base year (2019)
- Calibrated and validated the base year model
- Updated the model GitHub repository with the latest model setup[1]

The rest of this report refers to the ABM system as "Fresno ABM" and is organized as follows. The next chapter, Chapter 2, describes features of the new ABM system. Then 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 instructions to run the model system. At the end of the report, several appendices (Appendix A-E) provide supplemental information about various tasks performed during this project.

[1] Fresno ABM GitHub repository: https://github.com/RSGInc/FresnoABM

2.0 MODEL DESIGN

This model update includes updating the model base year from 2014 to 2019 and adding model usability and feature enhancements. The Fresno ABM is versioned on a GitHub repository[2]: https://github.com/RSGInc/FresnoABM.

2.1 OVERVIEW

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

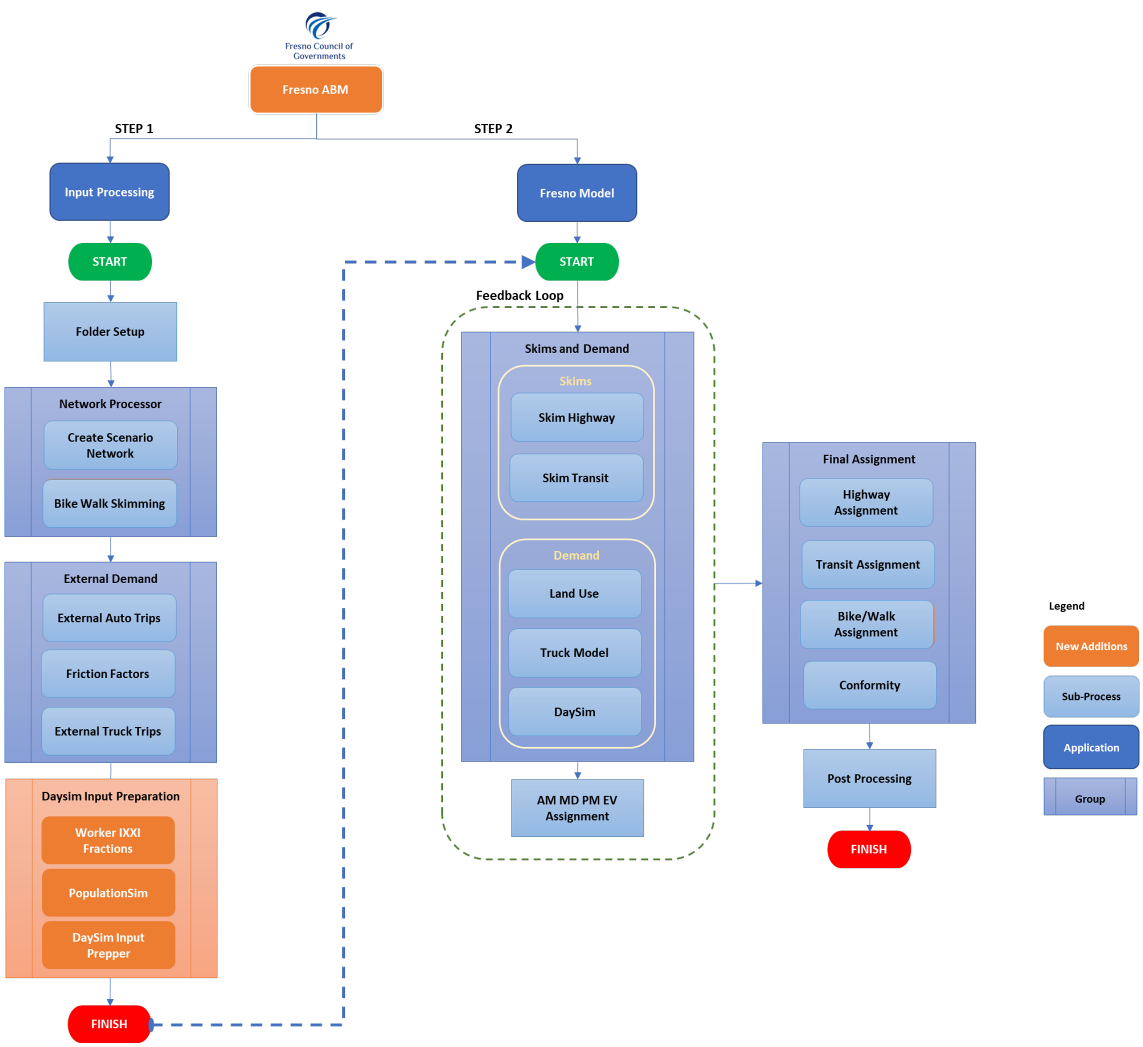


FIGURE 1: MODEL PROCESS FLOW

[2] The repository is private and requires permissions to access. Presently, RSG maintains the repository.

The ABM is run in two sequential steps: Input Processing and Fresno Model. These steps can be run in one step from the Cube catalog. The first step, Input Processing, processes the model network and creates inputs required in the second step, Fresno 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, Fresno 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 produce 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 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 (also skimming) 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, 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 four primary tasks that are completed sequentially:

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

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 skimmed 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 pairs[3]. 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 weights[4] 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

[3] 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.
[4] 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 to 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. In this implementation, bike distance is calculated on a shortest path based on generalized cost (BIKE_MINMILE) and the walk distance is determined on distance-based shortest path.

Generate External Demand

The ABM system contains two sets of external demand: auto demand and truck demand. These external trip tables were developed using data from the Replica platform[5]. FresnoCOG with Replica's help developed these trip tables..

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,

[5] https://www.replicahq.com/

since the model external stations are not a comprehensive list of roadways that enter or exit Fresno County, there were a number of ‘one-legged’ external-external 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 FresnoABM vehicle assignment happens in different vehicle occupancy classes. This is important for testing managed lane and pricing scenarios based on vehicle occupancy. The Replica trips are assumed to be vehicle trips, so an occupancy rate is needed to convert them into different occupancy classes. Vehicle occupancy rates were calculated from the NHTS survey. The IXXI sample was selected by whether the trip origin or destination was within Fresno County. The XX sample was selected if a straight line between the origin and destination intersected Fresno County. These records were then used to determine a vehicle occupancy share for IXXI and XX trips which was applied to the total Replica trips.

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 (Figure 2) contains the process to generate this file. It is run after the network processor. First, the highway network is exported to a shapefile 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 3.

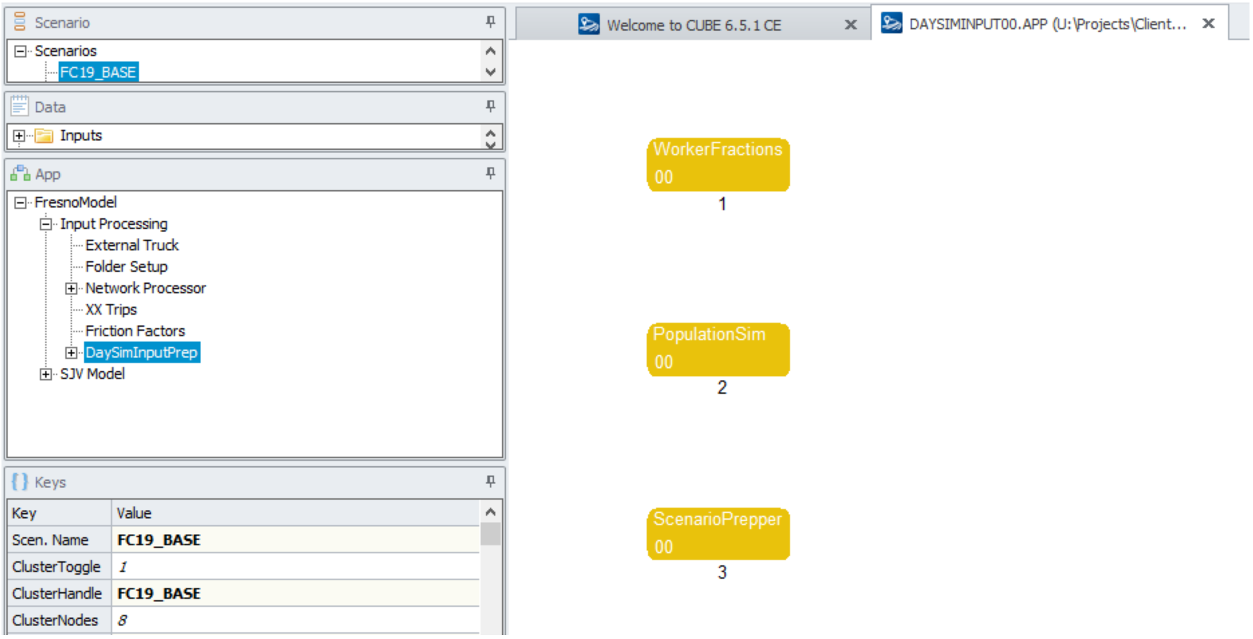


FIGURE 2: DAYSIM INPUT PREP MODULE

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 3: TRANSIT STOPS FILE FORMAT

Generate Intersection Density

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 SE 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',
'empoth_p'	'EMPAGR',
'emptot_p'	'TOTEMP'

Generate Internal-External (IXXI) Worker Fractions

The IXXI 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. 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".

Generate Synthetic Population

The PopulationSim setup is also integrated into the workflow of the CUBE catalog. It may also be toggled on and off using the CUBE catalog key "Run_PopSim". This step does not need to be run unless the underlying population assumptions are being changed. The steps for updating the synthetic population controls and targets are outlined in Appendix A.

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. These costs were all updated to reflect a value in the base year dollar (2019). 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 two important enhancements to the skimming procedure: toll capability and truck restrictions. The following changes were made to implement the toll and truck restrictions:

- Network Attributes:
    - Additional network attributes were added to facilitate tolls and restrictions

NETWORK ATTRIBUTE	VALUE	DESCRIPTION
USE (BASE_USE, IMP1_USE, IMP2_USE)	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[6]
TRK_USE	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)

- Network Processor:
  - Network processing was updated to accommodate the new link attributes
- Skimming:
  - Skimming within the feedback loop was updated to include all four time periods
  - Skimmed costs were updated to use respective TOD toll attribute
  - Each skimming class was updated to accommodate the new restrictions for HOV and Truck restricted facilities
- Assignment:

[6] 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.

- Assignment within the feedback loop was updated to include assignment for all 4 time periods
- Assignment class definition was updated to accommodate the new restrictions for HOV and Truck restricted facilities
- For tolling, each assignment reads in the respective time period toll as the toll cost (AM sees TOLL_AM, MD sees TOLL_MD, etc.)
- Final assignment step was updated with the same improvements as the assignment in the feedback loop

Transit

The transit skimming process generates 8 skim matrices for two time periods (peak and off-peak), two transit sub-modes (bus and rail), and two access modes (walk and drive). Each transit skim matrix contains the following impedances:

- Transit in-vehicle time (mins)
- 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 ($1.25) is applied to FAX and CLOVIS operated bus routes, whereas the zone-based fare ($0.75 - $6.75) is applied to the Fresno County inter-city buses operated by FCRTA.

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 tool[7].

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

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, 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 is illustrated in Figure 4.

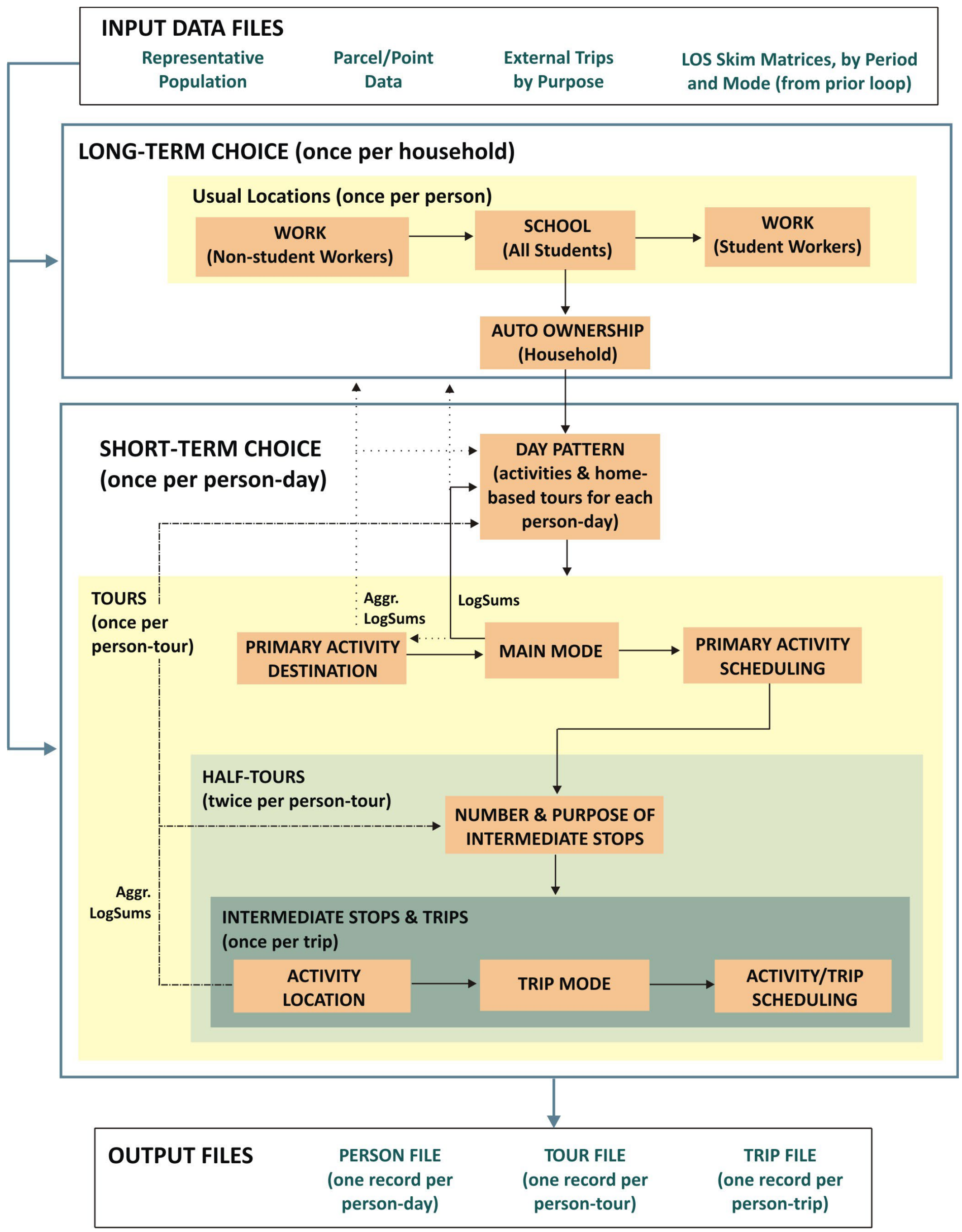


FIGURE 4: DAYSIM SUB-MODELS

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. ¼ 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 and equation for the logistic curves used for DaySim model estimation and calibration are listed below. It is necessary that these same parameters be used for model application.

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(1, (1 + Exp(DECAY – 0.5 + BOFFS/5280))

/ (1 + Exp(DECAY * (Distance/BDIST – 0.5 – BOFFS/5280))))

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

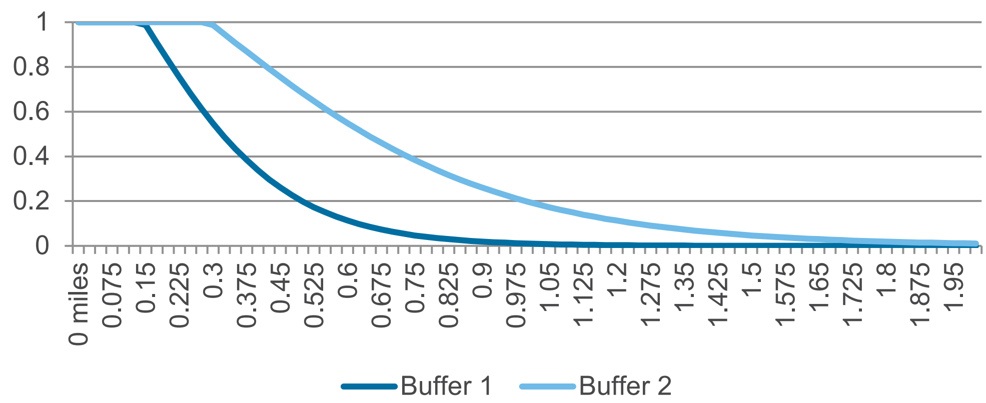


FIGURE 5: BUFFER1 AND BUFFER2 DISTANCE DECAY WEIGHTS

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 "circuity 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 model[8].

[8] 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.

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.

FresnoCOG 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 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 (2019) 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 with 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 model, the model coefficients are consistent with the 2014 FresnoABM base year and calibrated to match 2019 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, SOV, HOV2, HOV3, transit, park-and-ride, school-bus, other) and 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 pathbuilding 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 enables, 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 seed 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 2019 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 4) 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 4: HIGHWAY ASSIGNMENT TIME PERIODS IN THE FRESNO ABM

TIME PERIOD	DURATION
AM	6 am – 9 am
MD	9 am – 4 pm
PM	4 pm – 7 pm
EV	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 5 presents the occupancy factors used to convert DaySim person trips to vehicle trips.

TABLE 5: 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 4) 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. As 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 on 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 setup 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 the next iteration new (congested) travel times calculated based on the previous iteration results.

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 table[9] 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

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

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

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_reporting\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
- Transit Revenue Miles
- Transit Revenue Hours

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_reporting\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.

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 for ex. trip mode, time of day etc. The demand is then loaded on to network (assignment) to determine frequency 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, 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. 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.

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 6 presents a list of datasets utilized to calibrate the Fresno ABM.

TABLE 6:MODEL CALIBRATION DATASETS

DATASET	YEAR	PURPOSE
National Household Travel Survey (NHTS)	2017	Fresno - Tour Destination, SJV – Other Sub-models
California Household Travel Survey (CHTS)	2012	Work Location Choice, Tour Destination, TOD Distributions
ACS 5-Year Public Use Microdata Sample (PUMS)	2015-2019	Auto Ownership
1-Year American Community Survey (ACS)	2019	Auto Ownership
Longitudinal Employer Household Dynamics (LEHD)	2019	Workers Flow
Transit On-Board Survey	2014	Transit Tours/Trips

The present effort used multiple datasets to calibrate the Fresno ABM. The 2017 National Household Travel Survey (NHTS) is the primary dataset used during the calibration. Due to limited sample records within the Fresno region, when possible, the calibration utilized NHTS records of the entire San Joaquin Valley (SJV). As tour destinations require geocoding of destination locations to Fresno TAZ/MAZ, the calibration of tour destination choice models used survey records that are for the Fresno residents only. We also took advantage of the 2012 CHTS to assess reasonableness of travel behavior observed in the NHTS data.

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. Since the transit on-board survey year was older, the targets were adjusted based on the observed 2019 total boardings as reported by each transit operator. Also, the 2019 LODES data provides flow of workers and used to validate estimated work location choice of Fresno residents. Census (PUMS and 1-year ACS) informed targets for adjusting the auto ownership model in DaySim.

National Household Travel Survey (NHTS)

The 2017 National Household Travel Survey collected travel behavior of sampled households in the nation. The NHTS dataset was filtered to keep travel records only for the residents of the San Joaquin Valley (SJV) and then processed to prepare in formats similar to DaySim outputs. The survey weights were scaled based on the person-type distributions in the FresnoCOG synthetic population.

The NHTS data in DaySim format are further processed to retain records only for the residents of Fresno County. The travel origin and destination locations within the model region are then geocoded to assign corresponding MAZ and TAZ. Two sets of weights were prepared adjusting the sample to the synthetic population person type distributions. One set of weights is for only residents of Fresno County and are used for calibrating distance-based sub models (home to work distance, home to school distance, tour/trip destination). The second set of weights is for the entire SJV and are used for non-distance-based travel patterns (travel rates and mode choice).

The limitations of using the NHTS as the primary source of calibration is the low sample size in the modeling region. After filtering records to remove travel on weekends and travel that did not start and end at home, 25% of the population reported no trips in the person-day. It is noted that this is typical for NHTS and is exaggerated by the exclusion trip records for children ages 0-4. The trip rates reported from NHTS may be much lower than reality.

California Household Travel Survey (CHTS)

The 2010-2012 California Household Travel Survey (CHTS) was a collaborative effort lead by Caltrans to gather travel information needed for regional and statewide travel and environmental models using the same instrument and methods across the state. The study was jointly sponsored and funded by Caltrans, the California Strategic Growth Council, the California Energy Commission, and 8 local transportation agencies, including Fresno Council of Governments (Fresno COG).

The CHTS was designed to collect travel information from households in all of California's 58 counties for the year 2012. NuStat's obtained detailed travel behavior information from over 42,500 households, using multiple data collection methods, including computer assisted telephone interviewing (CATI), online, mail surveys, wearable and in-vehicle GPS as well as using on-board diagnostic (OBD) sensors. Out of the completed households, 36,714 were non-GPS households and 5,717 were GPS households.

The collected sampled data was weighted and expanded by first, calculating weights at household and person levels. Then travel of GPS households are used to apply trip correction factors to non-GPS households. The final weights were developed at the county level, but demographic controls were balanced at the statewide level only. Also trip correction factors developed at the statewide level only. During a separate work, Fehr and Peers re-weighted the CHTS data for the Fresno region[10]. While this data is very old, it still served a purpose for filling in gaps where the NHTS data is lacking. It represents a better sample size of residents in Fresno and the SJV in general. This survey is not used directly in calibration but serves as a comparison for some behaviors and relationships where the NHTS is lacking.

[10] See Technical Memorandum: Cleaning and Weighting of California Household Travel Survey Data, From Jennifer Ziebarth, Fehr & Peers, To Users of CHTS data, June 23, 2015, and Weighting Report for Fresno County, Jennifer Ziebarth, Fehr and Peers, June 19, 2015

Worker Flows

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. This project utilized multiple observed datasets, and validated workers flow 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.

Initially, workers flow from the LEHD LODES were used to validate estimated flow of workers by destination district. However, the team found that the LEHD LODES covers only about 95% of all jobs[11] and results in a total job count of 380,997 in Fresno County. FresnoCOG developed the employment data for the ABM using 2019 Quarterly Census of Employment and Wages (QCEW) and California Employment Development Department (EDD) provides. The total employment input to the model is 400,028. The LEHD data does not cover employment in a couple DaySim categories (industrial and other) that well, therefore, causing the difference in total employment. Also, it was found that the LEHD assigned 6,000 government jobs to one USPS office at 1606 E Griffith Way, Fresno, CA 93704. This was corrected in the input land use file informing employment data to the model. The team decided to use employment data to validate workers flow generated by the model.

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 below.

Note that the tour/trip destination summaries are compared with the NHTS (or CHTS) data for the Fresno region only. The other summaries are compared with the NHTS data for the entire San Joaquin Valley (SJV).

Synthetic Population

Table 7 and Table 8 compare synthetic population in the ABM with observed data (the NHTS for the SJV). The population includes both households and Group Quarters. The survey weights were scaled to match the person-type distribution in the synthetic population so these distributions match well. The population weights shown in the table below are those developed with records from the entire San Joaquin Valley. Note that the totals do not match exactly because of the small sample size in the NHTS and the fact that some initial weights were far from the targets. For example, university students were highly underrepresented in NHTS so had to be weighted significantly up. This led to some high variation in the weights to keep the weighted totals within range of the targets.

[11] https://www.census.gov/programs-surveys/ces/data/restricted-use-data/lehd-data.html

TABLE 7: POPULATION BY PERSON TYPE

PERSON TYPE	NHTS (SJV)	ABM
Full Time Worker	297,409	302,649
Part Time Worker	48,991	48,572
Retired	97,773	98,169
Non-Worker	194,336	192,062
University Student	80,095	83,663
Student Age 16+	57,476	56,350
Student Age 5-15	124,794	120,223
Total	**900,874**	**901,688**

TABLE 8: POPULATION BY PERSON TYPE (%)

PERSON TYPE	NHTS (SJV)	ABM
Full Time Worker	33%	34%
Part Time Worker	5%	5%
Retired	11%	11%
Non-Worker	22%	21%
University Student	9%	9%
Student Age 16+	6%	6%
Student Age 5-15	14%	13%
Total	**100%**	**100%**

Home to Work Distance

As presented in Table 9, the NHTS data indicate an average home to work distance of 7.9 miles regionwide. This is low compared to other datasets – 9.1 miles in CHTS and 9.06 miles in the LEHD LODES. The calibration adjusted distance coefficients in the work location choice model to match distances in the CHTS data. 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 9: AVERAGE HOME TO WORK DISTANCE

WORKER TYPE	CHTS (FRESNO)	NHTS (FRESNO)	ABM
Full Time	9.4	8.2	9.5
Part Time	7.8	5.0	7.4
Other	8.2	9.2	6.9
All Workers	**9.1**	**7.9**	**9.0**

Figure 6 compares distributions of home to work distances of workers in the CHTS 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 CHTS.

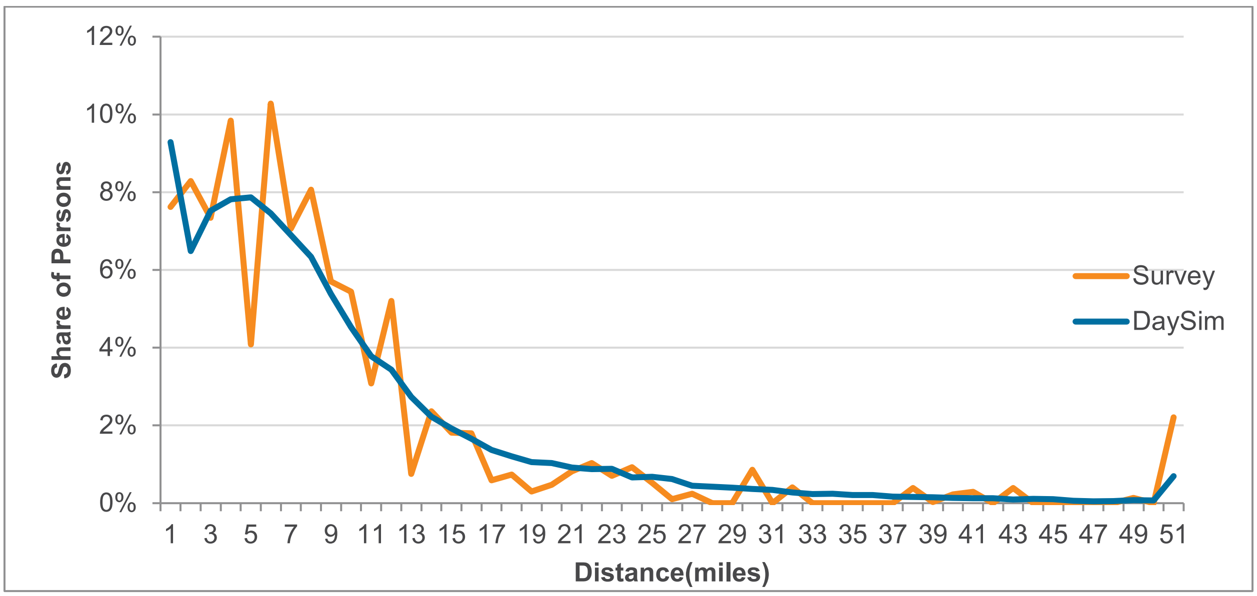


FIGURE 6: DISTRIBUTION OF HOME TO WORK DISTANCES

A comparison of estimated work locations (workers working at a location) and corresponding employment by TAZ, Figure 7, 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.

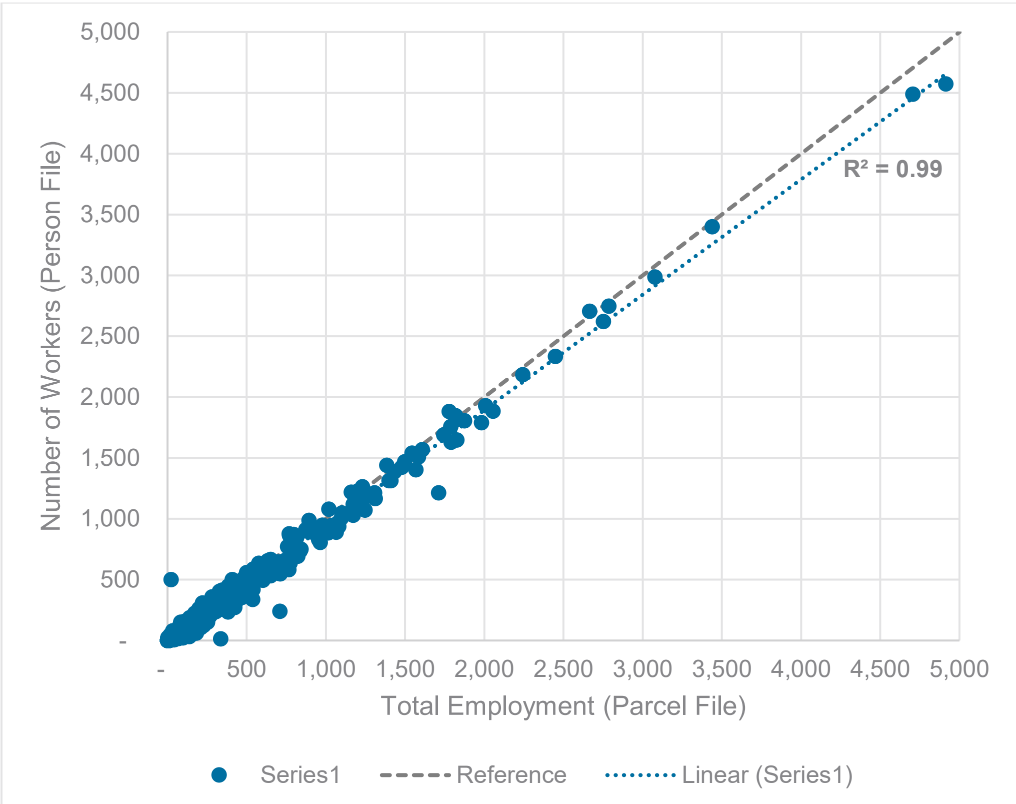


FIGURE 7: EMPLOYMENT VS WORKERS BY TAZ

Table 10 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 8. The comparison once again confirmed DaySim's ability to balance workers with the available employment. The comparison is extended to compare estimated workers with observed workers from LEHD LODES. Note that for comparison observed datasets are scaled to match estimated workers by home district. As mentioned in *Worker Flows*, the observed worker flows in the LEHD LODES were missing employment in some categories, therefore, the data were not used in the adjustments of district flows. Instead, the ABM was adjusted based on comparison with employment by district. The calibration used district level coefficients in the work location choice model to match estimated workers with employment by district. The district-level adjustments improved model validation results to some extent.

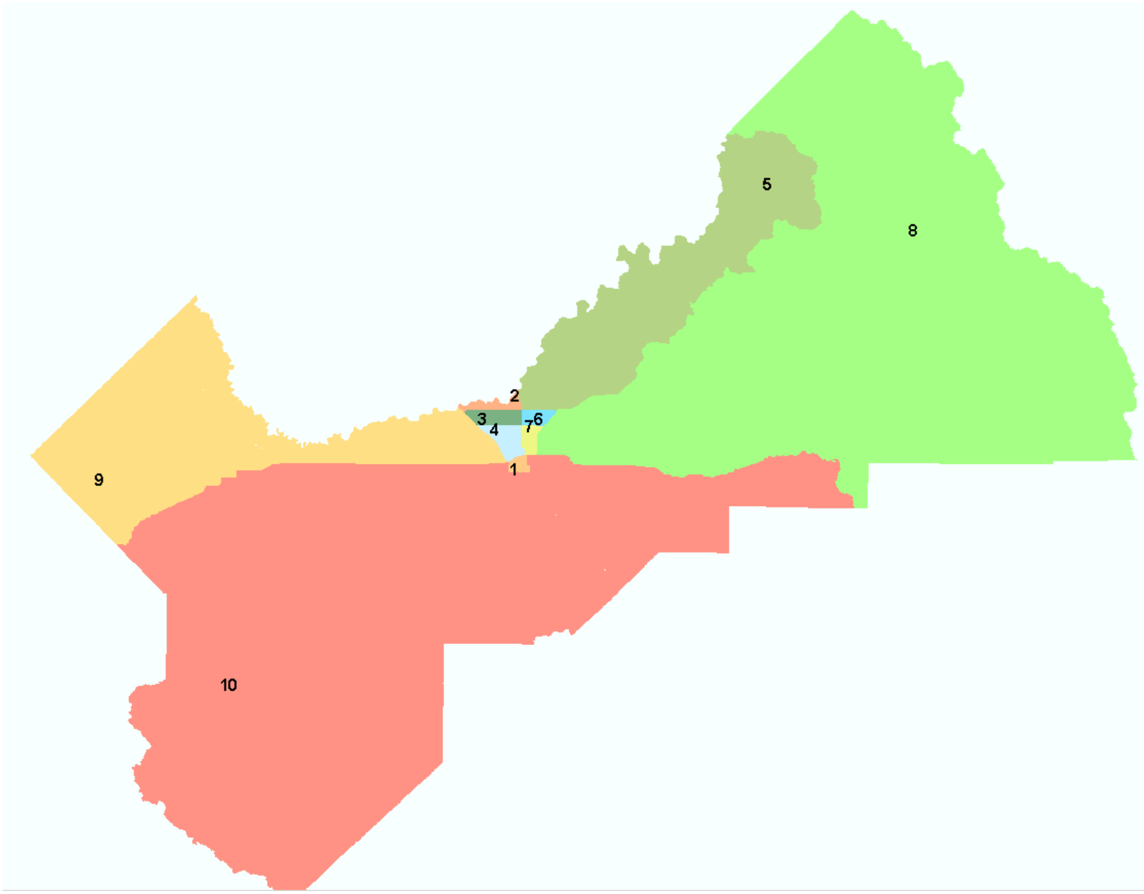


FIGURE 8: MAP OF DISTRICTS

TABLE 10: WORKERS BY DISTRICT

WORK DISTRICT	LEHD	EMPLOYMENT	ABM	%DIFF (ABM-EMP/EMP)
1	32,755	33,853	34,414	2%
2	12,286	13,469	13,483	0%
3	18,707	17,528	18,680	7%
4	29,521	22,907	24,196	6%
5	22,926	23,945	23,809	-1%
6	15,559	15,236	15,578	2%
7	13,170	12,860	13,730	7%

WORK DISTRICT	LEHD	EMPLOYMENT	ABM	%DIFF (ABM-EMP/EMP)
8	41,594	39,947	40,965	3%
9	11,644	12,906	12,469	-3%
10	79,583	85,093	80,420	-5%
TOTAL	**277,744**	**277,744**	**277,744**	

NOTES:

LEHD data include workers travelling from out of Fresno

NHTS data is only for Fresno workers.

ABM is estimated workers working within the Fresno region only

The work location model also includes a choice for workers who work from home (do not have an out of home work location). This parameter was also calibrated to the ACS-2019 5 Year estimates for share working from home as shown in Table 11. Note that due to lack of calibration data, the telecommute model is not used in the base year calibration.

TABLE 11: WORK FROM HOME SHARE

SOURCE	WORK FROM HOME SHARE
ACS 2019 5-Year Estimates	4.50%
ABM	4.68%

Home to School Distance

As per the NHTS data, Table 12, the average distance travelled by students to go from home to school is 3.15 miles. The CHTS data suggest a slightly higher distance (3.49 miles). The ABM is adjusted to a value (4.85 miles) higher than the two observed values.

TABLE 12: AVERAGE HOME TO SCHOOL DISTANCE (MILE)

STUDENT TYPE	CHTS (FRESNO)	NHTS (FRESNO)	ABM
Kids 5 to 15	2.58	2.84	2.75
Student 16+	3.55	5.02	4.80
University Student	7.98	0.00	7.86
Total	**3.49**	**3.15**	**4.85**

Figure 9 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.

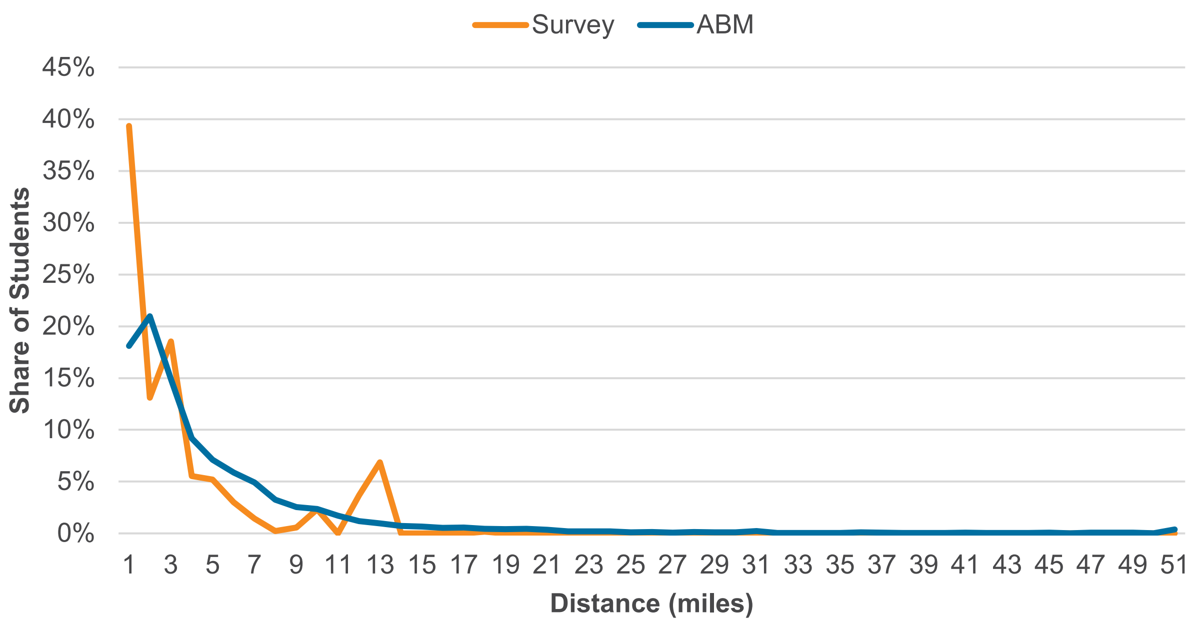


FIGURE 9: DISTRIBUTION OF HOME TO SCHOOL DISTANCE

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

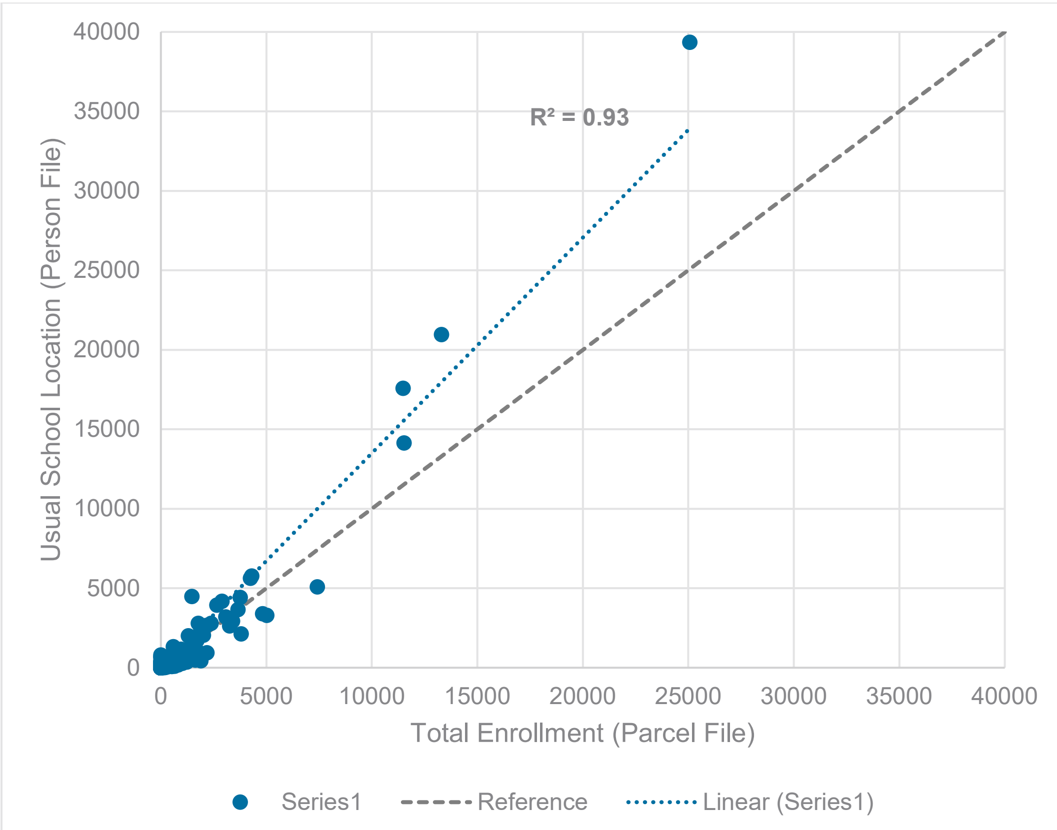


FIGURE 10: ENROLLMENT VS STUDENTS BY TAZ

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 2019 ACS data. The calibration adjusted regional constants by autos owned and number of drivers to match estimated auto ownership with the observed, see Figure 11.

Additionally, the calibration added new auto-ownership constants for households in districts 5, 6, and 8 to resolve transit boarding overestimation on routes serving the City of Clovis. These districts cover the Clovis area and showed too many zero-auto households compared to Census data. Adjustments of the new district level constants improved the auto-ownership distributions in this region, however, it disturbed the regional auto-ownership distribution a little. The calibration found a balance between the two that resulted in reasonable calibration of both regional, and Clovis auto-ownership distributions.

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

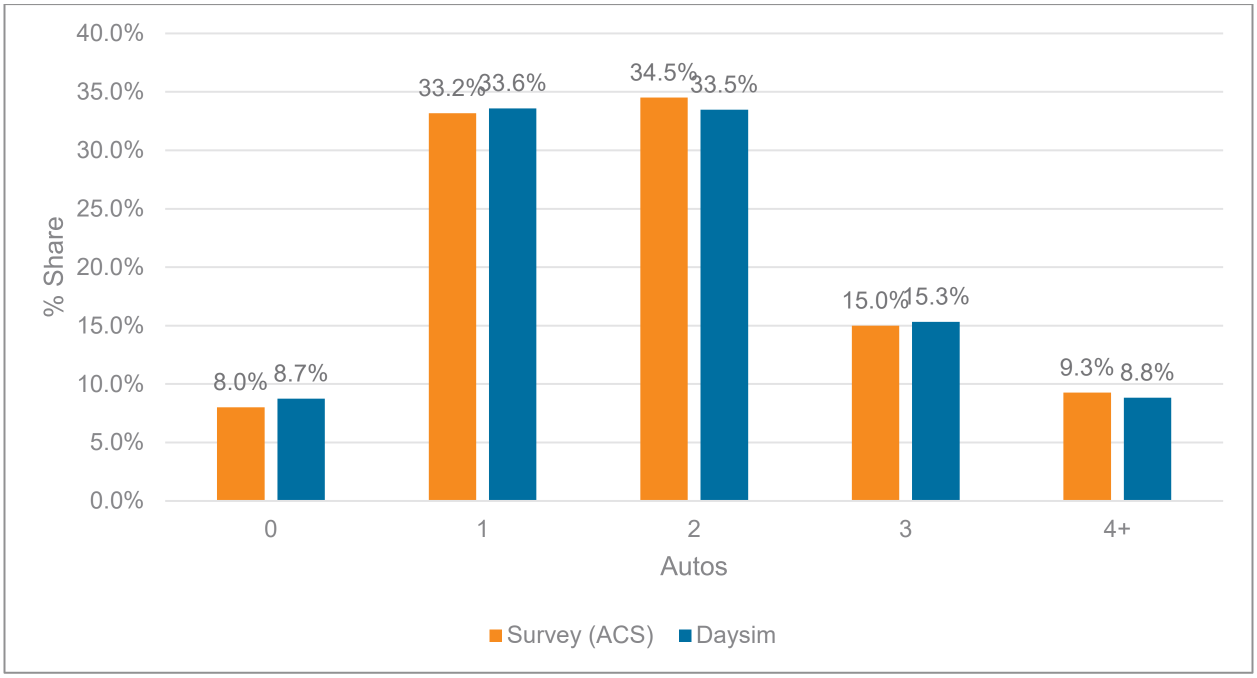


FIGURE 11: AUTO OWNERSHIP DISTRIBUTION - REGIONAL

Day Pattern

Day pattern summaries compare observed and estimated resident travel (tours and trips) by purpose and person type. As the observed data (NHTS) is for the entire SJV region but the ABM outputs are for the Fresno County only, the comparisons use share of travel instead of actual numbers.

Table 13 compares distribution of tours by tour purpose in the NHTS (SJV) and the model. The calibration adjusted tour level constants by purpose and person type to match observed distribution. The calibrated tours by purpose generally follow the observed distribution. Work and escort tours in the NHTS data were found too high and low respectively when compared with the CHTS data. Therefore, the calibration did not try to match their shares and kept similar to the shares produced by the previous model (2014 base year).

TABLE 13: TOURS BY PURPOSE

TOUR PURPOSE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Work	31%	23%	-7.3%
School	16%	16%	0.3%
Escort	15%	18%	2.6%
Personal Business	9%	11%	1.7%
Shop	10%	10%	0.6%
Meal	4%	4%	0.0%
Social/Recreation	11%	12%	0.6%
Work-based	5%	7%	1.5%
Total	**100%**	**100%**	**0.0%**

A tour rate is calculated as number of tours divided by number of persons. Table 14 compares tour rates by tour purpose. The NHTS indicates on average 1.25 tours per person in the SJV region. The ABM was calibrated to produce a slightly higher tour rate (1.36) to resolve underestimation seen in the count validation summaries.

TABLE 14: TOUR RATE BY PURPOSE

TOUR PURPOSE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Work	0.38	0.32	-0.06
School	0.19	0.22	0.02
Escort	0.19	0.24	0.05
Personal Business	0.11	0.14	0.03
Shop	0.12	0.14	0.02
Meal	0.05	0.05	0.00
Social/Recreation	0.14	0.16	0.02
Work-based	0.07	0.09	0.03
Total	**1.25**	**1.36**	**0.12**

Table 15 compares observed and estimated tours by person type. Generally, the tours in the ABM match with the NHTS distribution by person type. Some differences are due to the differences observed by tour purpose.

TABLE 15: TOURS BY PERSON TYPE

PERSON TYPE	NHTS (SJV)	ABM	DIFF
Full-Time Worker	39%	34%	-5.8%
Part-Time Worker	5%	6%	0.3%
Retired	7%	9%	1.6%
Non-Worker	20%	22%	2.4%
University Student	11%	11%	0.5%
Student 16+	5%	6%	0.3%
Student 5-15	12%	13%	0.8%
Total	**100%**	**100%**	**0%**

Table 16 presents a comparison of tour rate by person type.

TABLE 16: TOUR RATE BY PERSON TYPE

PERSON TYPE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Full-Time Worker	1.49	1.37	-0.12
Part-Time Worker	1.25	1.44	0.19
Retired	0.84	1.13	0.29
Non-Worker	1.13	1.41	0.28
University Student	1.51	1.66	0.15
Student 16+	1.04	1.22	0.19
Student 5-15	1.09	1.33	0.24
Total	**1.25**	**1.37**	**0.12**

The distribution of ABM trips by trip purpose matches well with the NHTS data of the SJV region, see Table 17.

TABLE 17: TRIPS BY PURPOSE

TRIP PURPOSE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Work	15%	12%	-3.1%
School	6%	6%	-0.1%
Escort	9%	10%	0.2%
Personal Business	9%	10%	1.6%
Shop	12%	14%	1.7%
Meal	7%	8%	1.6%
Social/Recreation	7%	7%	0.1%
Home	35%	33%	-2.0%
Total	**100%**	**100%**	**0.0%**

As shown in Table 18, according to the NHTS data, a resident of the SJV region makes 3.29 trips in a day on average. The ABM is calibrated to produce a slightly higher trip rate of 3.88 trips per person in the Fresno region. The model is calibrated to a higher rate to resolve underestimation observed in highway validation summaries.

TABLE 18: TRIP RATE BY PURPOSE

TRIP PURPOSE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Work	0.50	0.47	-0.03
School	0.20	0.24	0.03
Escort	0.31	0.38	0.06
Personal Business	0.29	0.40	0.11
Shop	0.40	0.54	0.14
Meal	0.23	0.33	0.10
Social/Recreation	0.22	0.27	0.05
Home	1.14	1.27	0.13
Total	**3.29**	**3.88**	**0.59**

As indicated in Table 19, The NHTS data suggests, on average, residents of the SJV region make 2.64 trips on a tour. The ABM produces a similar estimate of 2.85 trips per tour for the residents of the Fresno region. The estimated trips per tour by destination purpose, except shop and meal, show similar trips per tour as the NHTS data.

TABLE 19: TRIPS PER TOUR BY PURPOSE

DESTINATION PURPOSE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Work	1.31	1.48	0.16
School	1.04	1.08	0.04
Escort	1.65	1.56	-0.09
Personal Business	2.61	2.80	0.19
Shop	3.32	3.84	0.52
Meal	4.80	6.39	1.59
Social/Recreation	1.61	1.68	0.07
Total	**2.64**	**2.85**	**0.21**

The distribution of model trips by person type categories is similar to the NHTS data for the SJV region, see Table 20.

TABLE 20: TRIPS BY PERSON TYPE

PERSON TYPE	NHTS (SJV)	ABM	DIFF
Full-Time Worker	37%	37%	-0.8%
Part-Time Worker	5%	6%	0.1%
Retired	9%	9%	0.0%
Non-Worker	20%	21%	0.4%
University Student	12%	12%	0.2%
Student 16+	5%	5%	0.1%
Student 5-15	11%	11%	0.0%
Total	**100%**	**100%**	**0.0%**

As presented in Table 21, similar to the tour rate by person type (see Table 16), the regional trip rate in the ABM is slightly higher (3.88 trips/person) than the NHTS trip rate (3.29 trips/person) for the SJV region. Person type categories too show higher trip rates in the ABM.

TABLE 21: TRIP RATE BY PERSON TYPE

PERSON TYPE	NHTS (SJV)	ABM	DIFF (ABM-NHTS)
Full-Time Worker	3.74	4.25	0.51
Part-Time Worker	3.28	3.99	0.71
Retired	2.68	3.14	0.46
Non-Worker	3.09	3.76	0.67
University Student	4.48	5.18	0.70
Student 16+	2.39	2.92	0.53
Student 5-15	2.67	3.27	0.60
Total	**3.29**	**3.88**	**0.59**

Other Tour Destination

A comparison of average tour lengths by purpose between the observed (NHTS) and the model data is presented in Table 22. A tour length is calculated as distance between tour origin and primary destination. The comparison includes only non-mandatory tour purposes - mandatory tour purposes (work and school) have already been discussed before (see Table 9 and Table 12). 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.

For each purpose, the average model tour length is adjusted to a range of the NHTS and CHTS values (Table 22). Due to the small sample size in the observed datasets, the tour length frequency distributions are very lumpy (NHTS distributions by purpose can be found in Appendix A) which makes it difficult to know the real travel behavior for these tours.

TABLE 22: AVERAGE TOUR LENGTHS FOR OTHER TOUR PURPOSE

TOUR PURPOSE	CHTS (FRESNO)	NHTS (FRESNO)	ABM
Maintenance	2.88	4.65	4.68
Discretionary	4.91	4.70	4.58
Escort	2.88	2.91	4.07
Work-based	3.26	5.35	3.59

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 NHTS targets (SJV) to accommodate transit targets from the 2014 scaled transit on-board survey, the NHTS 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 NHTS 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 NHTS shares reasonably well (Figure 12). The comparison within the tour purpose categories are available in Appendix A. The NHTS observes an overall tour mode share of 35.3% by drive-alone (SOV) and 26.2% and 25.7% by shared-ride 2 and shared-ride 3, respectively compared to the ABM shares of 36.5%, 25.6% and 25.6%. The non-motorized tour modes (walk and bike) make up for 8.9% of the tours in the region according to the NHTS, compare to 8.8% in the ABM. The newly implemented TNC mode is a very small percent of total mode share. 1.2% of the tours in NHTS use some form of transit mode, where most of those transit trips use walk to transit (1.0%) compared to the model share of 0.9% which are almost exclusively walk to transit. With inputs from FresnoCOG staff, the model is calibrated to almost no drive-to-transit tours. It was discovered in the transit validation that the drive to transit trips were causing large over-estimations in the Clovis Transit services because of the park and ride lots servicing Clovis Transit. In reality, these lots are not getting used, so the drive to transit tour mode was calibrated to reflect extremely low utilization.

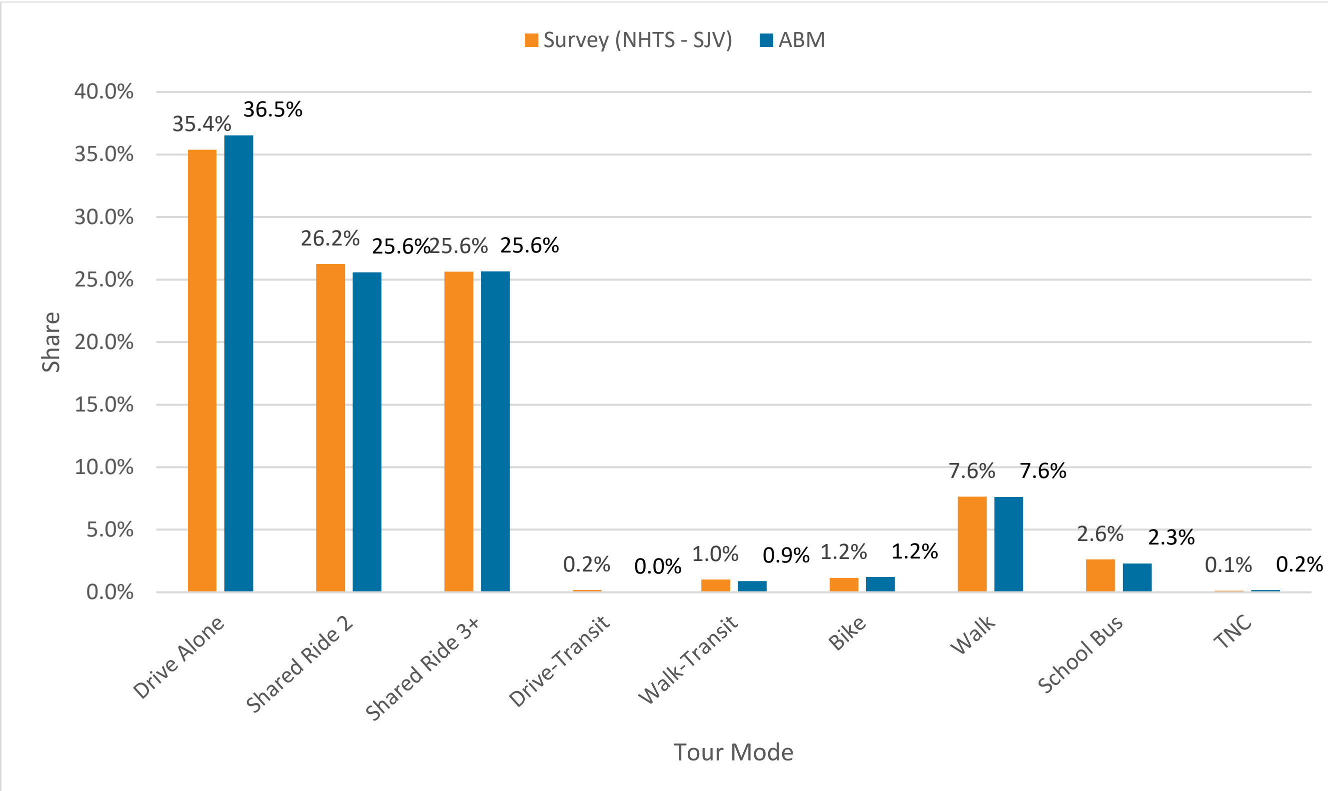


FIGURE 12: TOUR MODE SHARES (TOTAL)

Trip Destination

As presented in Table 23, the NHTS data suggest an average trip length of 4.97 miles regionwide (Fresno). The ABM is calibrated to produce a slightly higher trip length of 5.53 miles. The model is calibrated to longer trip lengths to resolve underestimation observed in highway validation summaries.

TABLE 23: TRIP LENGTHS (MILES) BY DESTINATION PURPOSE

TRIP PURPOSE	NHTS (FRESNO)	ABM
Home	5.31	5.73
Work	7.74	7.19
School	4.76	4.18
Escort	3.14	4.93
Personal Business	4.82	5.80
Shop	2.93	5.20

TRIP PURPOSE	NHTS (FRESNO)	ABM
Meal	3.91	4.94
Social/Recreational	3.35	4.76
Total	**4.97**	**5.53**

Tour Time-of-Day

Plots of tour arrival and departure times at primary destination are presented in Figure 13 through

Figure 20. Because of the suspicious diurnal distributions in the NHTS, the time-of-day distributions are compared and adjusted to the 2012 CHTS distributions. The ABM distributions generally match well with the CHTS distribution by purpose.

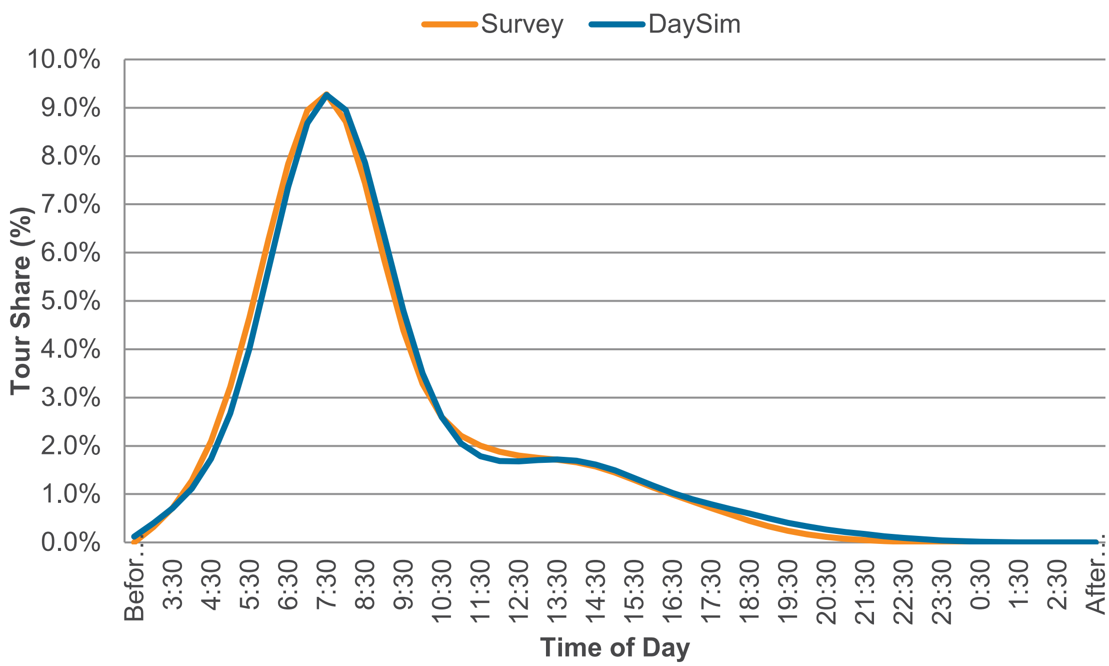


FIGURE 13: TIME OF DAY DISTRIBUTION OF WORK ARRIVAL TIMES

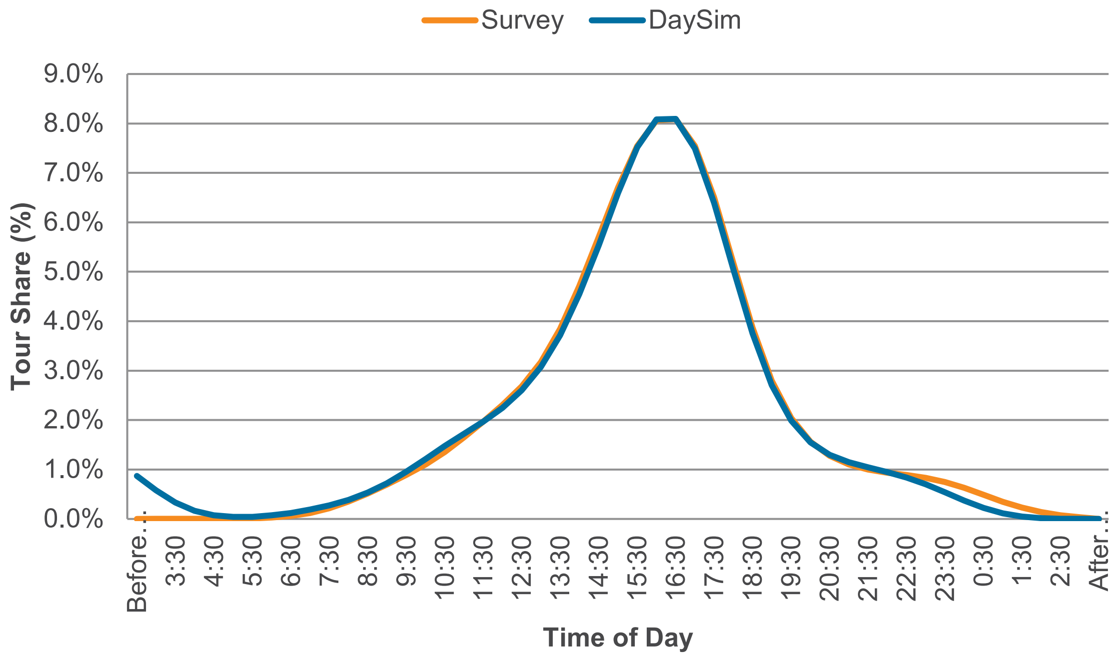


FIGURE 14: TIME OF DAY DISTRIBUTION OF WORK DEPARTURE TIMES

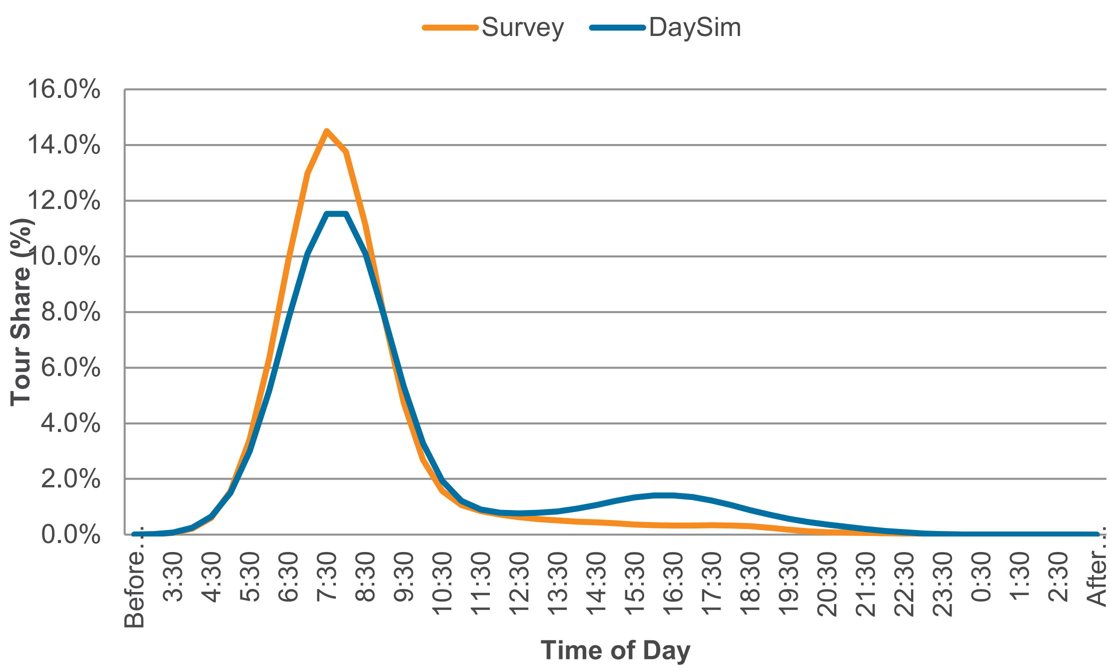


FIGURE 15: TIME OF DAY DISTRIBUTION OF SCHOOL ARRIVAL TIMES

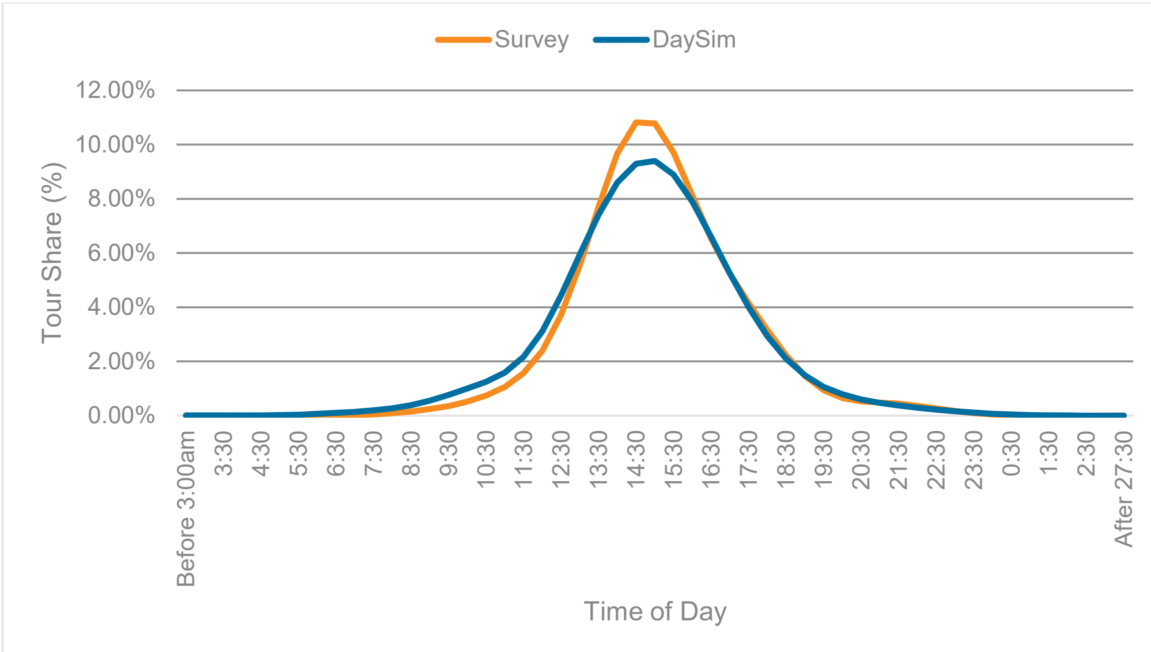


FIGURE 16: TIME OF DAY DISTRIBUTION OF SCHOOL DEPARTURE TIMES

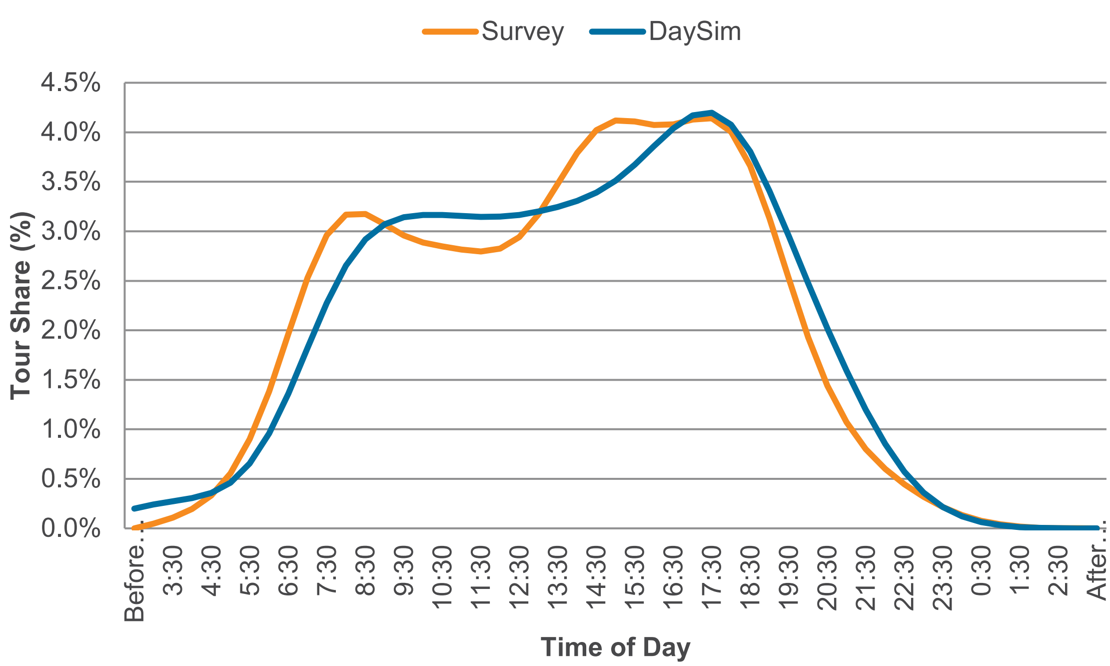


FIGURE 17: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE ARRIVAL TIMES

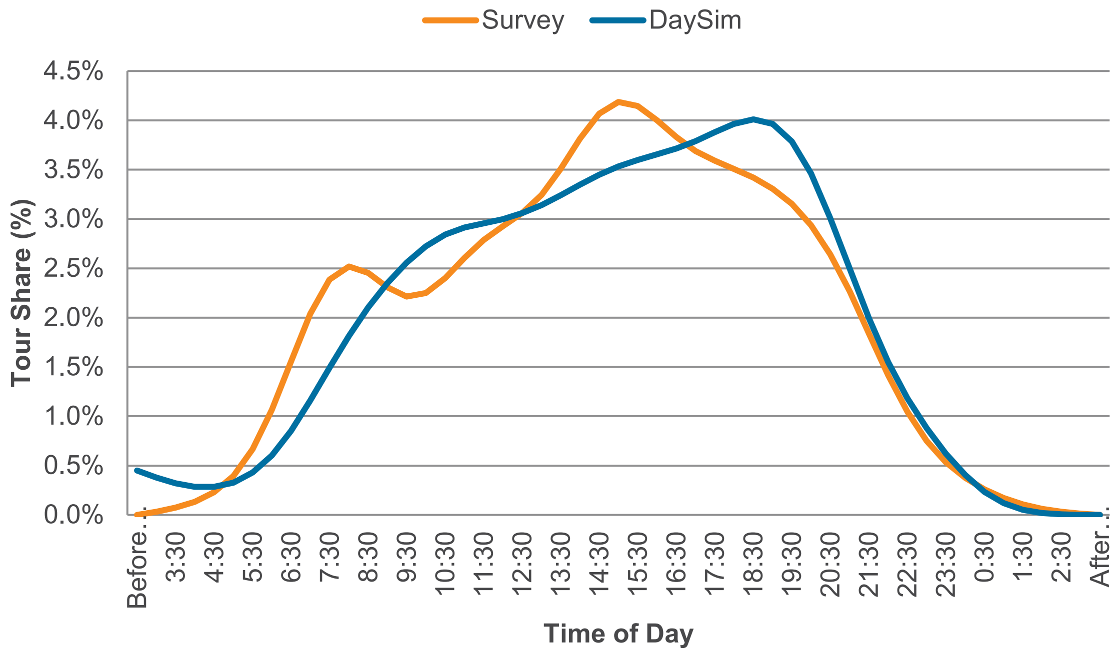


FIGURE 18: TIME OF DAY DISTRIBUTION OF OTHER PURPOSE DEPARTURE TIMES

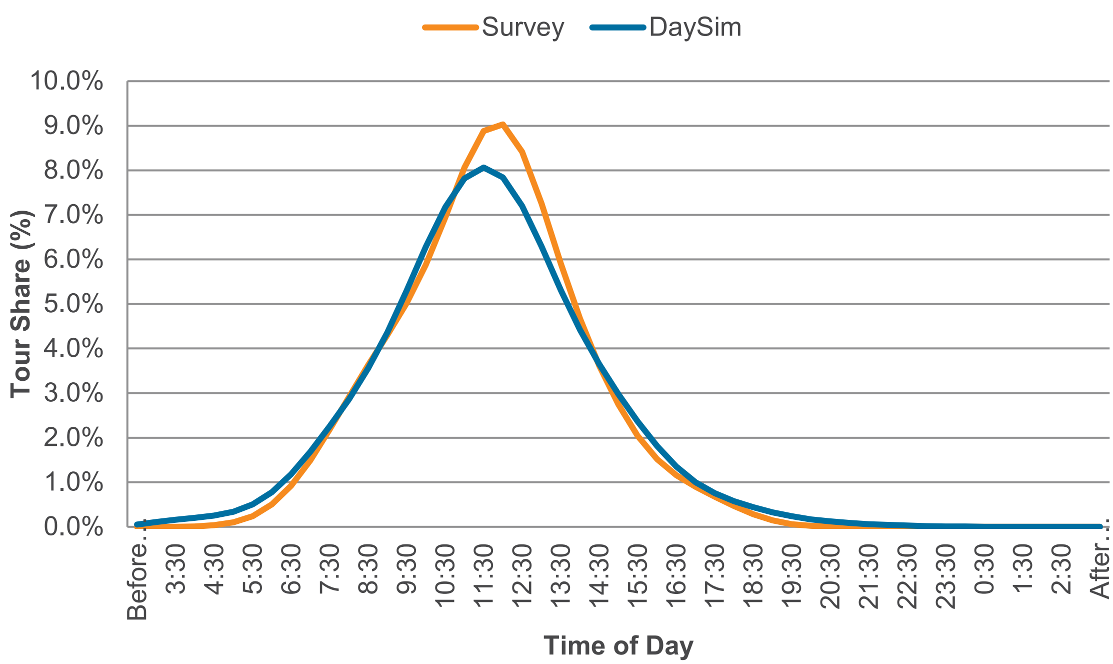


FIGURE 19: TIME OF DAY DISTRIBUTION OF WORK-BASED ARRIVAL TIMES

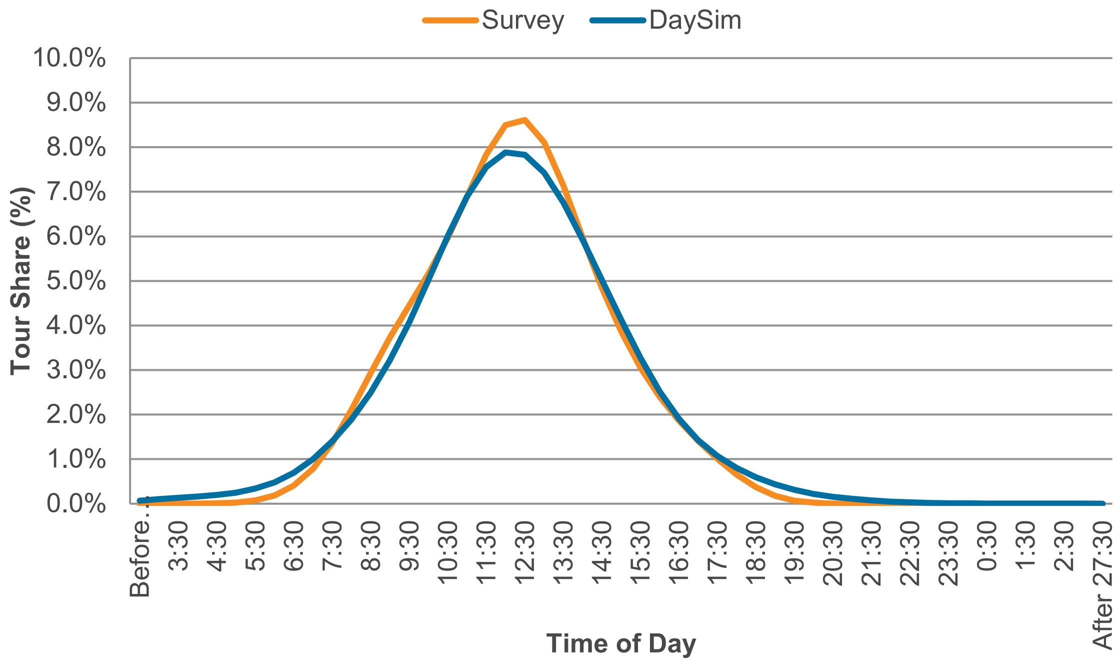


FIGURE 20: TIME OF DAY DISTRIBUTION OF WORK-BASED DEPARTURE TIMES

Trip Mode Choice

Trip mode targets are prepared from the NHTS data for the SJV region and updated with transit trip targets from the scaled 2014 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 onboard survey is matched in calibration.

The calibration process involves adjustment of alternative-specific constants to match observed trips by trip mode and tour mode within each tour purpose. 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.

Overall, the ABM generates a trip mode distribution which is very similar to observed (

Figure 21). The trip mode share by purpose distributions can be found in Appendix A. The NHTS data indicate that on an average weekday, 41.8% trips in the SJV region are drive alone and 43.2% are shared-ride (SR2 and SR3), approximately 0.8% of Fresno County resident trips are made by transit, and 10.8% are made by a non-motorized mode (walk or bike).

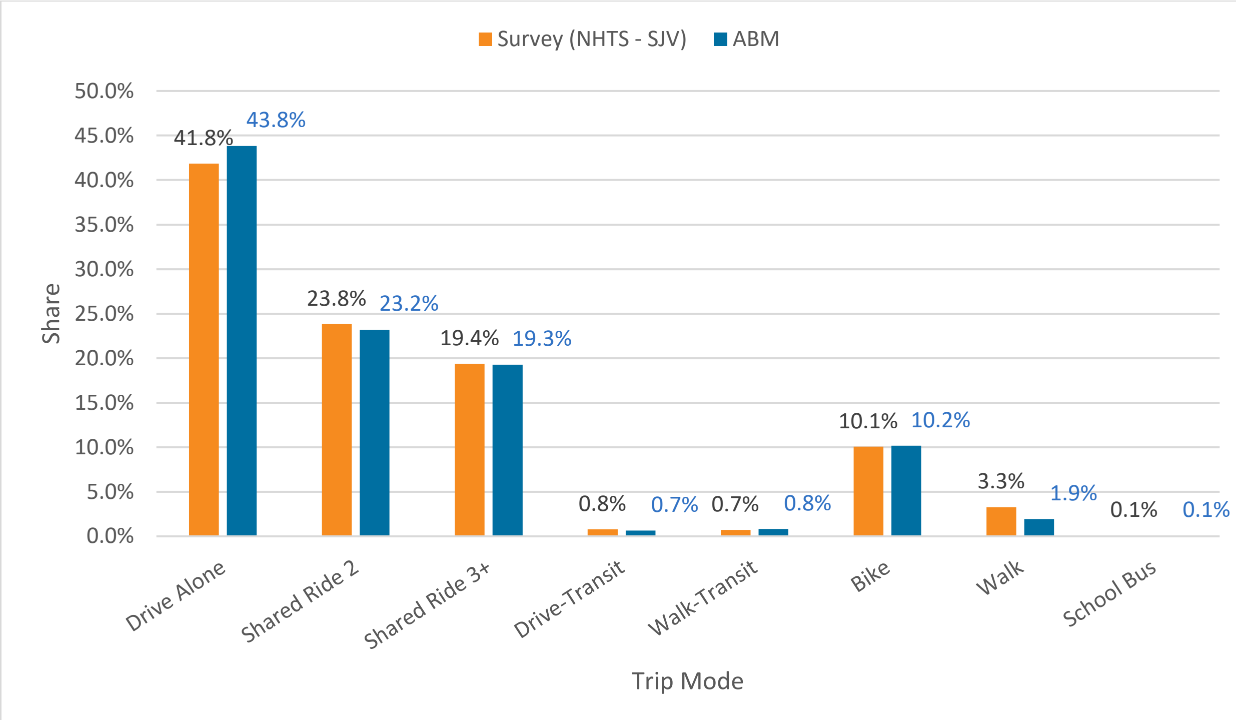


FIGURE 21: TRIP MODE SHARES (TOTAL)

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; static validation, which compares model outputs against independent data that was not used to build the travel model, and dynamic validation, in which model inputs are systematically varied to assess the reasonableness of model responses. The static validation process compares outputs from model assignment with observed data. Model parameters are adjusted until the model outputs fall within an acceptable range of error.

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

TABLE 24: MODEL VALIDATION DATASETS

DATASET	YEAR	SOURCE	PURPOSE
Traffic Counts	2019	CalTrans and FresnoCOG	Highway Validation
Vehicle Miles Travelled (VMT)	2019	Highway Performance Management System (HPMS)	Highway Validation
Transit Ridership	2019	FAX, Clovis, and FCRTA	Transit Validation
Transit Revenue Miles/Hours	2019	FAX, Clovis, 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 two sources: CalTrans and FresnoCOG. The Caltrans traffic census program[12] provides traffic counts on highways (interstates and state routes) in the State of California. These Caltrans traffic counts in year 2019 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 joins that appeared incorrect. Also, an appropriate count value (Before AADT or After AADT) is assigned to the joined link in the model network.

FresnoCOG provided traffic counts for the facility types (arterial, collector, local etc.) other than highway. 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

[12] http://www.dot.ca.gov/trafficops/census/

discovered therefore some traffic counts were manually reviewed for their correctness of the network link id.

VMT

The 2019 observed VMT is obtained from Caltrans[13]. Caltrans provide daily vehicle miles of travel for COFCG (Council of Fresno County Governments).

Transit

Transit ridership (boardings) by route compare the estimated boardings in the model by transit line.

Transit Boardings

The transit boardings are assembled from three sources: FAX, CLOVIS and FCRTA. The three transit agencies provided monthly ridership for 2019 for their transit routes. The monthly ridership for October was factored by using number of days and weekend versus weekday ridership shares to estimate average weekday ridership.

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 1,222 links on the highway network. The total traffic across these links amounts to 14.8 million vehicles. On the same links, the ABM produces a comparable estimate of traffic volume (14.9 million vehicles) and is only 0.9% higher than the total observed vehicle count. According to the HPMS[14], on an average weekday in year 2019, the roadway travel in the Fresno region resulted in 25.54 million vehicle miles of travel (VMT). The estimated traffic flows from the ABM produce a daily regionwide VMT value of 24.83 million, within 3% of the observed estimate from the HPMS.

Table 25: Highway Validation – Region

[13] http://www.dot.ca.gov/hq/tsip/hpms/datalibrary.php
[14] Highway Performance Monitoring System

MEASURE	OBSERVED	ABM	DIFF	% DIFF
Traffic Volume	14,803,579	14,935,250	131,672	0.9%
VMT*	25,541,760	24,827,361	(714,399)	-2.8%

Note: Observed VMT is from the HPMS estimate of the total VMT in the Fresno region for year 2019

Regionally, the estimated traffic flows are compared with the observed traffic counts by creating a scatter plot, Figure 22. 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.

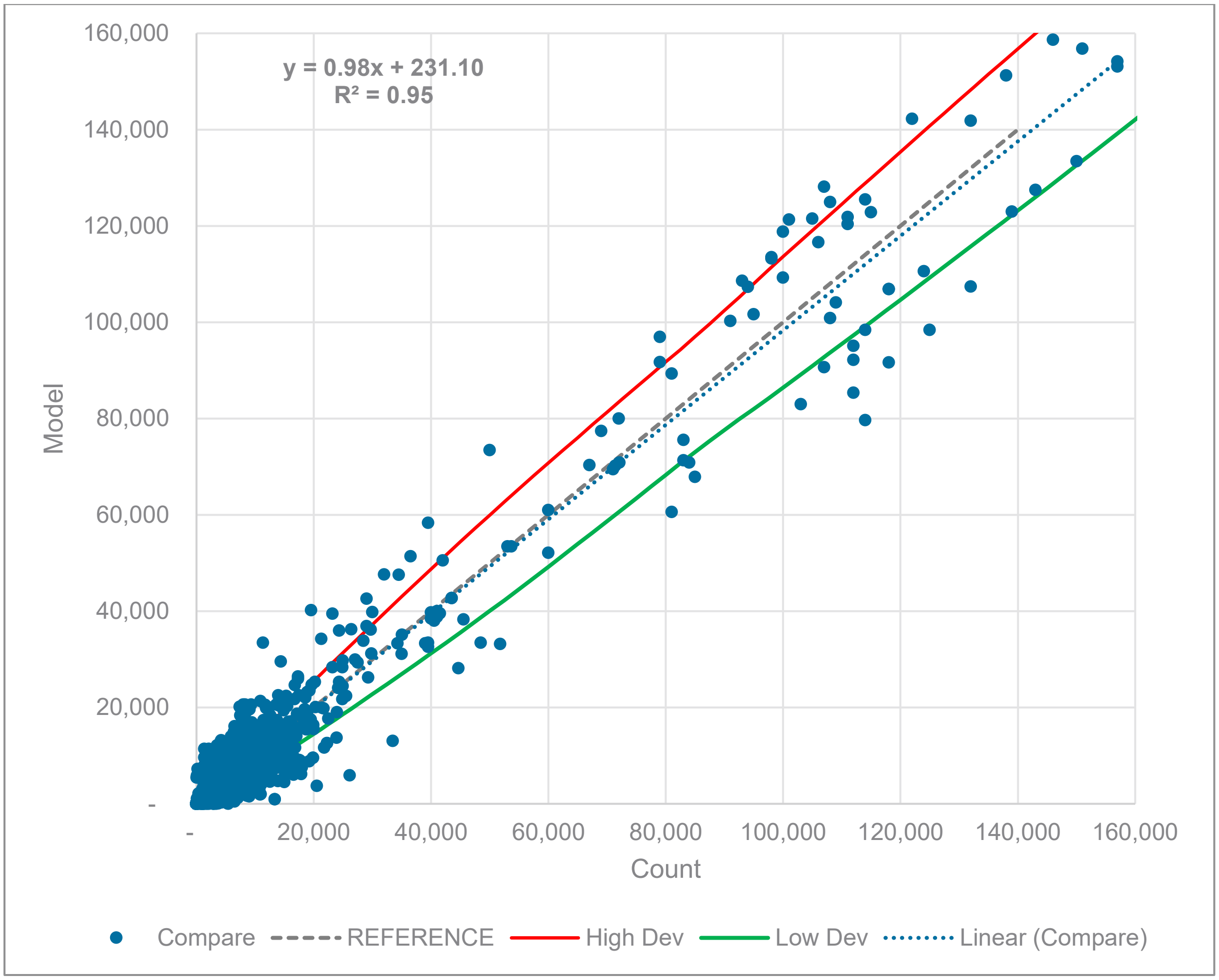


FIGURE 22: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS

As displayed in the scatter plot, the linear regressed line has a slope of 0.98 and R-squared value of 0.95. The r-squared value close to 1.0 indicates that fitted regression line represents the data well.

Facility Type

Table 26 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 (1%) 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 regionally as well as by facility type.

TABLE 26: HIGHWAY VALIDATION – BY FACILITY TYPE

FACILITY TYPE	COUNT	ABM	DIFF	DIFF (%)	*CALTRANS DIFF
Freeway	6,667,000	6,655,729	(11,271)	-0.2%	7%
Highway, Expressway, Arterial	4,891,229	5,319,463	428,234	8.8%	15%
Other (Collector, local, ramp, connector)	3,245,350	2,960,059	(285,291)	-8.8%	25%
Total	**14,803,579**	**14,935,250**	**131,672**	**0.9%**	**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 27, 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 in conjunction with model inputs, however, could not find any obvious issues. The other possibility is potential issues with demand generation in the model. However, the team could not verify or make any reasonable adjustment due to absence of reasonable quality observed data. The DaySim model calibration used 2017 NHTS that collected very few samples in Fresno County and underrepresented travel in the region. As discussed in DaySim Calibration Summaries, the survey data showed suspicious travel patterns. The team also looked at the 2012 CHTS data, but the respective travel patterns were outdated (7 years older) making the model calibration a challenging task. Replica data was also available, however, review of the data indicated quality issues, so the team decided to not use it in model development. Recently, a household travel survey was conducted in the valley. Unfortunately, the data was not available for this work. We hope the next model update will use the new survey and improve the shortcomings identified in the current work.

TABLE 27: HIGHWAY VALIDATION – BY VOLUME GROUP

VOLUME GROUP		COUNT	ABM	DIFF	DIFF (%)	RMSE	*CALTRANS RMSE
>=0	<1000	49,518	96,590	47,072	95%	310%	60%
>=1000	<2500	327,622	445,916	118,294	36%	145%	47%
>=2500	<5000	930,694	1,052,154	121,460	13%	74%	36%
>=5000	<10000	2,739,345	2,819,355	80,010	3%	55%	29%
>=10000	<25000	3,231,319	3,034,097	(197,222)	-6%	40%	25%
>=25000	<60000	1,537,597	1,550,008	12,411	1%	27%	22%
>=60000		5,987,484	5,937,130	(50,354)	-1%	14%	21%
ALL		**14,803,579**	**14,935,250**	**131,672**	**1%**	**43.44%**	**40%**

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

Key Highway Corridors

Figure 23 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, therefore assigning them the traffic volume more than actual. Incorrect locations of the centroid connectors would load un-reasonable 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.

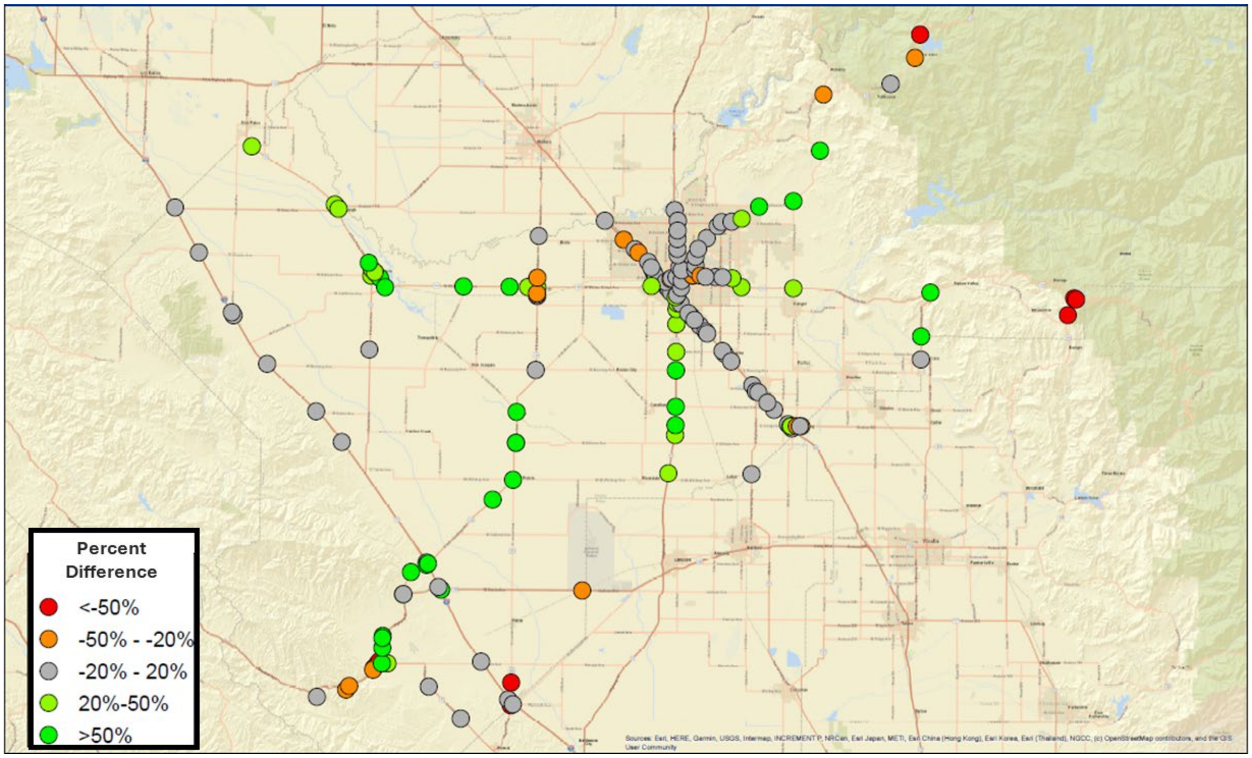


FIGURE 23: HIGHWAY VALIDATION – SPATIAL PERFORMANCE OF THE FRESNO HIGHWAY

Table 28 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, AR180) are doing well with respective percentage difference within 12% of the observed traffic count. Only one highway corridor, SR33, exhibits under performance with overestimation of 66%. Note that SR33 is also a low volume corridor which makes it relatively difficult to get right.

TABLE 28: HIGHWAY VALIDATION – KEY CORRIDORS

ROUTE	CALTRANS_AADT	ABM_VOL	DIFF	DIFF (%)
5	564,798	531,454	(33,344)	-6%
33	101,434	168,341	66,908	66%
41	1,663,103	1,854,890	191,787	12%
99	3,081,484	3,165,862	84,378	3%
168	677,350	641,878	(35,472)	-5%
180	1,287,850	1,242,761	(45,089)	-4%

ROUTE	CALTRANS_AADT	ABM_VOL	DIFF	DIFF (%)
Total	**7,376,019**	**7,605,187**	**229,168**	**3%**

To examine the model's performance along corridors, separate validation plots are prepared for these key highway corridors (see Figure 24 - Figure 29). 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.

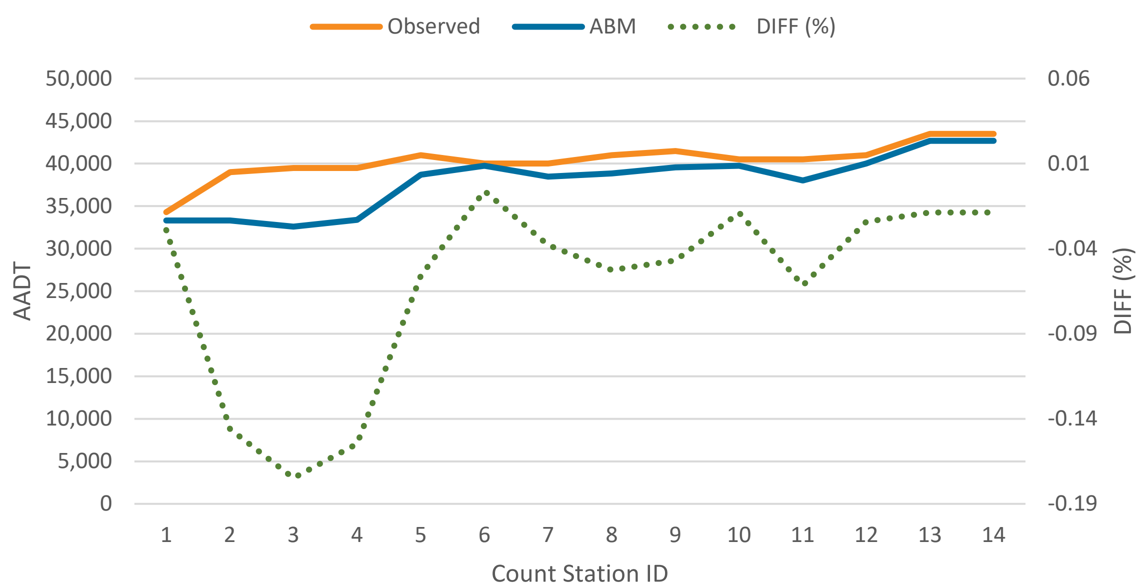


FIGURE 24: HIGHWAY VALIDATION – I5 (SOUTH TO NORTH)

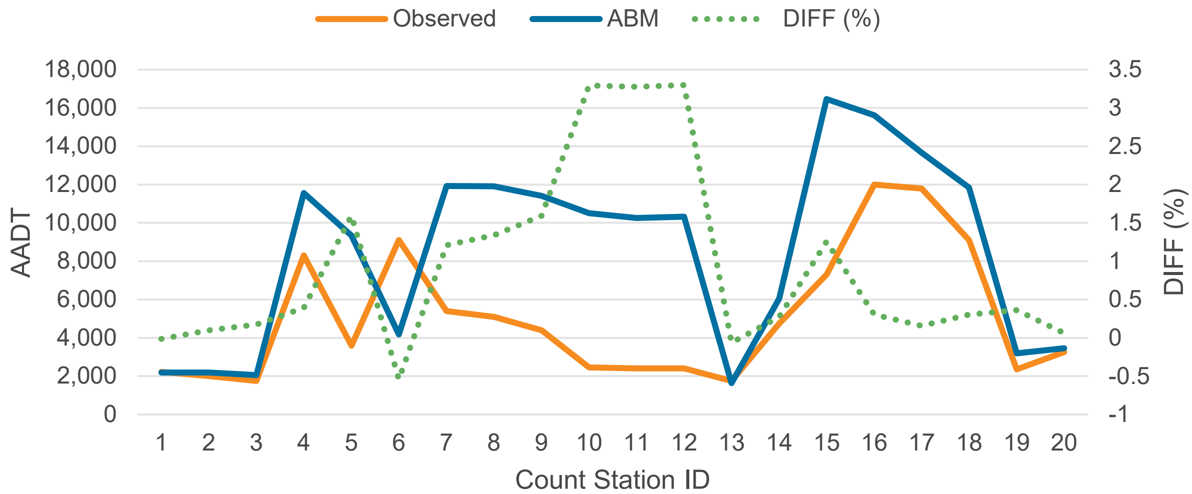


FIGURE 25: HIGHWAY VALIDATION – SR33 (SOUTH TO NORTH)

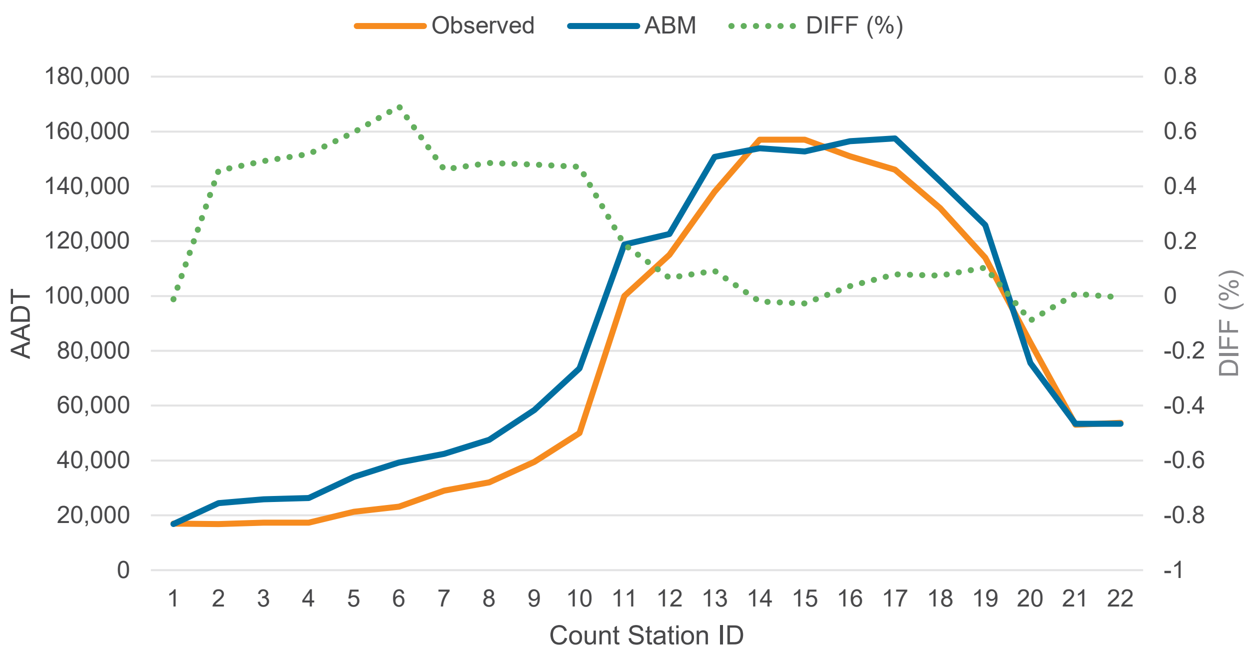


FIGURE 26: HIGHWAY VALIDATION – SR41 (SOUTH TO NORTH)

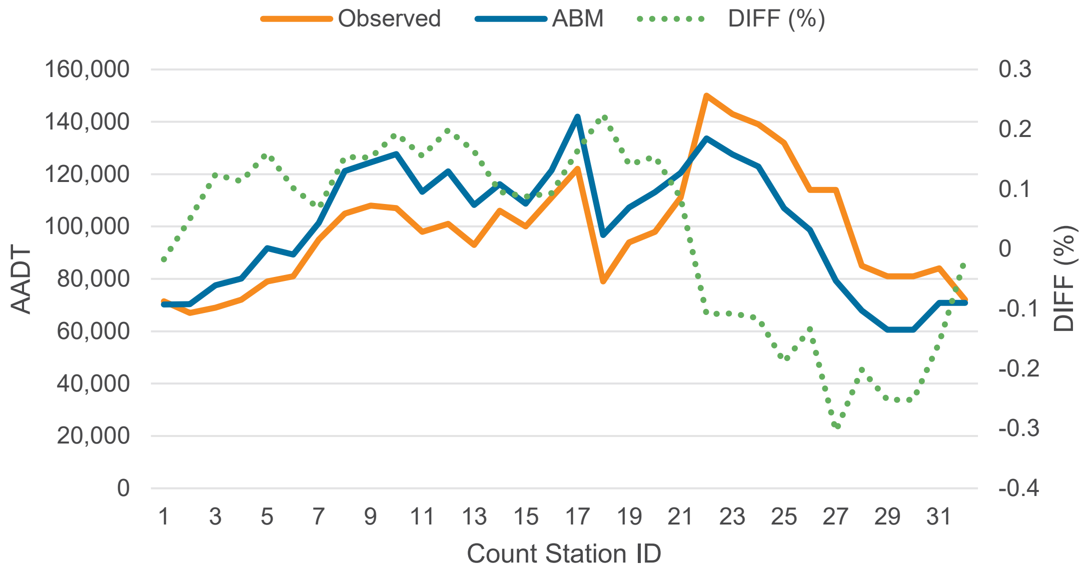


FIGURE 27: HIGHWAY VALIDATION – SR99 (SOUTH TO NORTH)

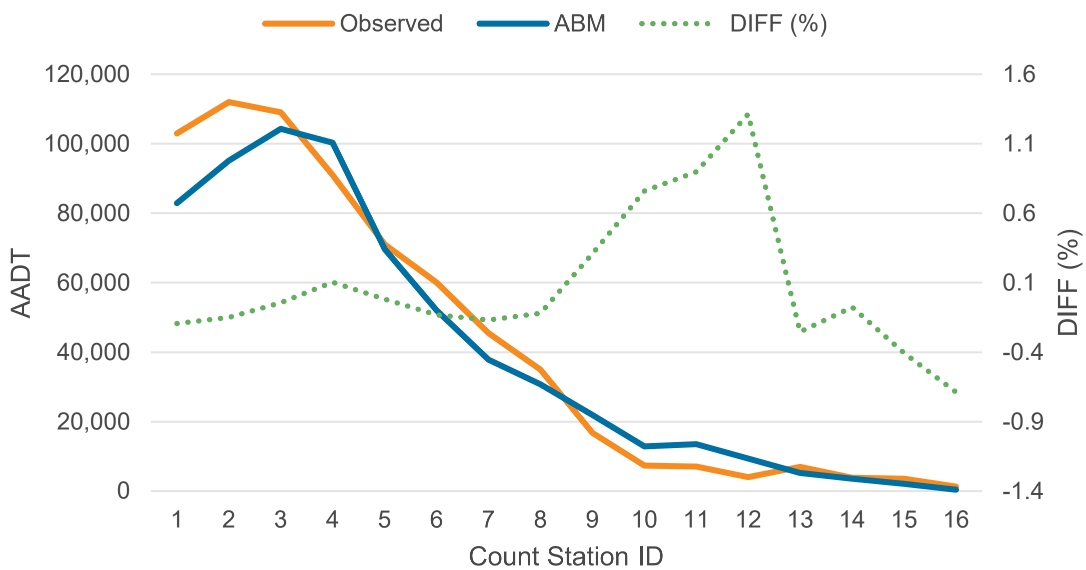


FIGURE 28: HIGHWAY VALIDATION – SR168 (WEST TO EAST)

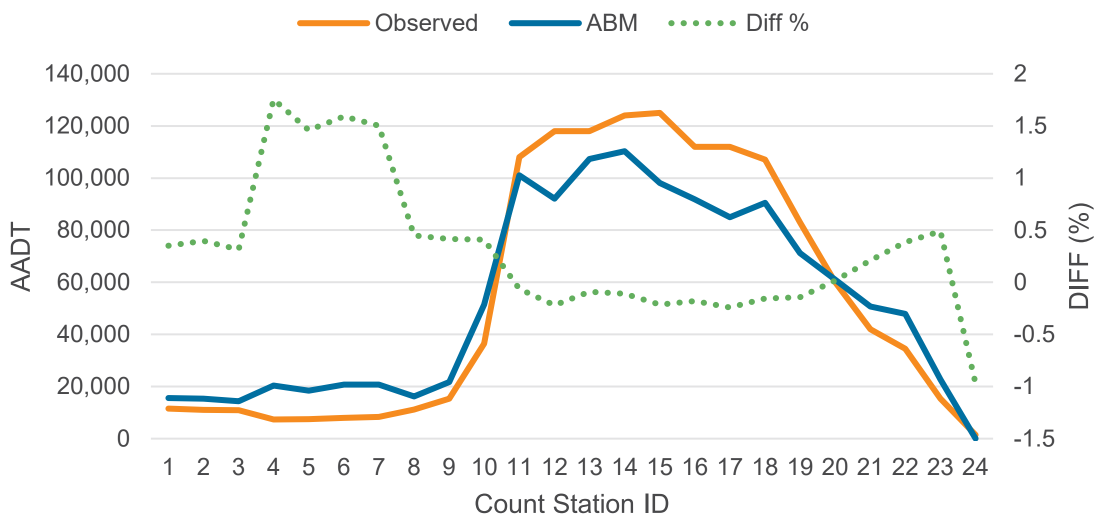


FIGURE 29: HIGHWAY VALIDATION – SR180 (WEST TO EAST)

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 29.

TABLE 29: 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 30, the ABM generates transit boardings within 3% of the observed ridership. The model indicates a boarding rate (boardings/trips) of 1.63.

TABLE 30: TRANSIT SUMMARIES - REGIONAL

MEASURE	OBSERVED	ABM	DIFF	% DIFF
Boardings	38,324	38,047	-277	-1%
Trips	-	23,471	-	-
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 31 shows the relationship between the transit boardings from the ABM and the observed boarding by transit line. The X-axis in the plot represent 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 0.94 indicating that it is a reasonable fit. This suggests that the model is predicting the transit behavior reasonably well.

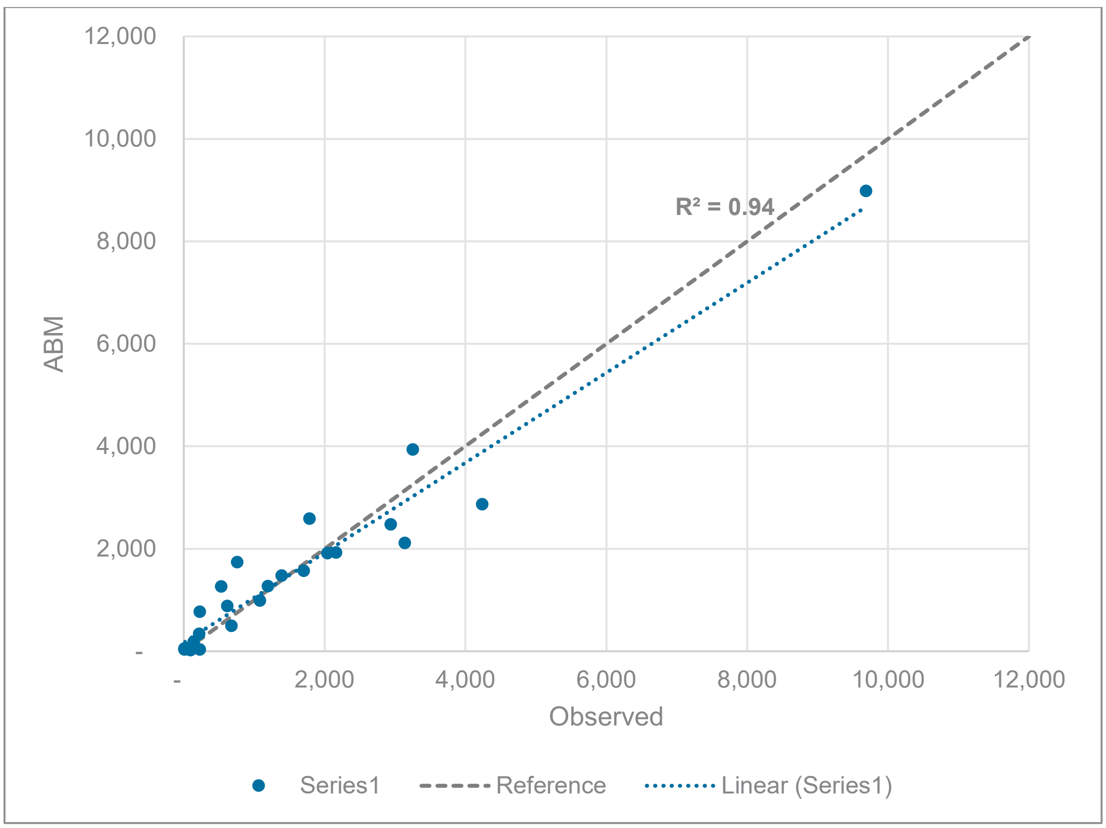


FIGURE 30: OBSERVED AND ESTIMATED TRANSIT BOARDINGS

A comparison of number of boardings by individual transit line is presented in Figure 31. 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. There are three noticeable differences: FAX 45, FAX 26, Clovis 10, and Clovis 50. A significant effort was made to improve transit validations. Problematic lines were reviewed to ensure their service in the model represented observed service frequencies. Though the auto-ownership calibration matched observed data very well in the region as a whole, 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. These tactics helped improve some of the individual route validations, but a more comprehensive review of the transit validation should be done once a new transit on-board survey is available.

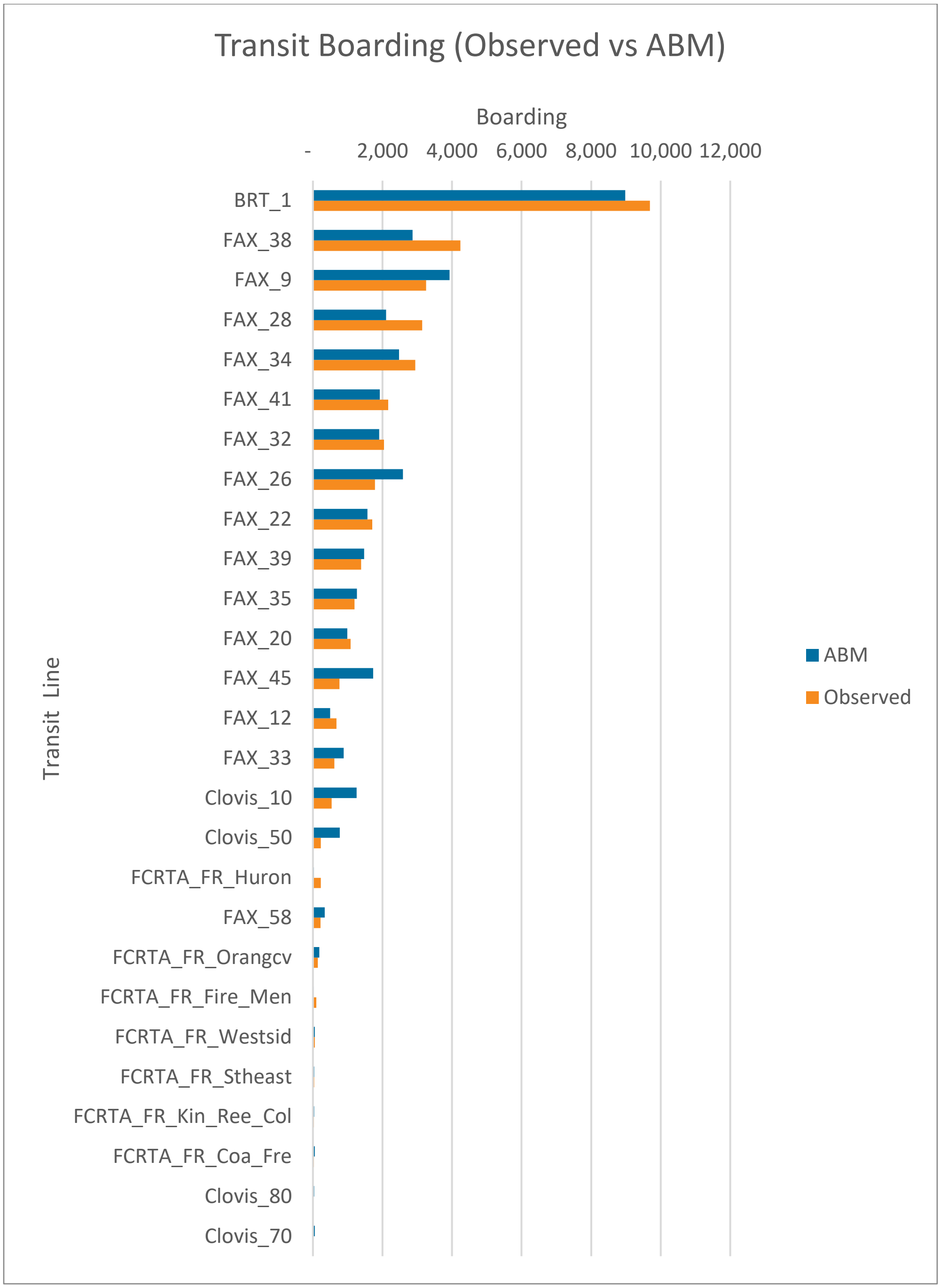


FIGURE 31: ESTIMATED AND OBSERVED BOARDINGS BY TRANSIT LINE

Revenue Miles and Hours

In addition to transit ridership, coding of the transit systems is reviewed by comparing the revenue miles and hours. Revenue miles are defined as miles traveled by transit services while in operation, while revenue hours are similarly, hours in operation. The observed numbers were shared by transit agencies, and where only fiscal year estimates were available, a factor of 312 is used to convert into a daily value based on the fact that weekend services tend to be half as frequent as weekday service. The model summary is generated from the transit assignment which reports the time and distance along the network for operating services. These times and distances are summed and multiplied by the service frequency in operating hours. Table 31 shows the results of this validation. The overall revenue miles and hours across the four transit providers is matching well – within 3%.

TABLE 31: TRANSIT REVENUE MILES/HOURS VALIDATION

	2019 FY MILES	MODEL MILES	DIFF	2019 FY HOURS	MODEL HOURS	DIFF
FAX	14,949	15,340	3%	1,291	1,481	15%
FCRTA	2,742	1,706	-38%	216	59	-72%
Clovis	962	1,129	17%	82	88	8%
Total	**18,652**	**18,175**	**-3%**	**1,589**	**1,629**	**2%**

3.3 SUMMARY

The Fresno ABM is reasonably calibrated to match observed travel behavior reported in the 2017 National Household Trael Survey (NHTS). The team used judgment and some other data sources (e.g., CHTS and LODES), when the survey exhibited unexpected behavior or biases.

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 present work 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. A better-quality data for external travel would certainly improve model validation.
- DaySim is calibrated to represent the observed travel behavior primarily in the 2017 NHTS. However, the survey is older than the base year (2019) and has a limited sample size for Fresno County and San Joaquin Valley. Therefore, it possibly represents outdated or non-normative travel patterns. Even though the ABM reasonably predicts travel patterns shown in the calibration datasets, highway validation shows an underestimation of traffic flows north of Fresno downtown and over estimation on routes through more rural parts of the county. Further, the calibration datasets were collected

for the entire nation (NHTS), so only a small number of Fresno residents were included in the surveys. The issue of small sample records was more evident during calibration by different market segments (e.g. purpose, mode). To overcome this issue, the current model calibration effort utilized survey records from the Fresno region for tour/trip destination and the entire San Joaquin Valley for the other model components. The recently collected valley-wide household travel survey includes sufficient number of respondents in the Fresno region and therefore, would contribute greatly in better representing resident travel in the ABM.

- Transit calibration and validation also showed a need for a recent transit on-board survey covering all transit services in the Fresno model region.

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, twelve sets of tests are designed to examine the Fresno ABM's sensitivity and include:

1. Auto operating Cost
2. Transit Fare
3. New Transit Service
4. Transit Frequency
5. Road Diet
6. New Bike Lanes
7. HOV Lanes
8. Managed Lane/Toll Pricing
9. Truck Restrictions
10. Capacity Increasing project
11. New Employment
12. Change in Speeds

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. The base setup for the sensitivity tests differs slightly from the final calibration and validation reports due to some additional calibration of time-of-day distributions. However, these differences are minimal, and there is no expected impact on the sensitivity tests since all tests use the same model setup.

4.1 CHANGE IN AUTO OPERATING COST (AOC)

Two model runs, Table 32, examine model's response to change in auto operating cost (AOC): double AOC and half AOC.

TABLE 32: 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 discuss 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 file[15] that contains auto operating cost (cents per mile) by year.

The AOC values for the 2019 base year is 22.45 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 44.9 cents per mile and for the half AOC test, the AOC value is decreased to 11.23 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 33, increase in auto-operating cost by 100% results in shorter tour lengths. That means residents of Fresno County are now finding activity locations nearby due to higher cost of travelling by car. Work tour lengths decrease the most (-12%) with school and discretionary tour length following (-9%).

Decreasing the auto-operating cost increased tour lengths. The relative response by tour purpose is similar to the results of the double AOC test; mandatory (work, work-based, and school) purpose see the most increase (9%, 7% and 6% respectively) and escort (3%) and maintenance (2%) purpose see the least increase.

TABLE 33: AOC SENSITIVITY - TOUR LENGTHS (MILES) BY PURPOSE

TOUR PURPOSE	DOUBLE AOC	HALF AOC
Work	-12%	9%
School	-9%	6%
Maintenance	-4%	2%

[15] The input CSV file is here: 1_Inputs\6_Static\AutoOperatingCost.csv

Discretionary	-9%	5%
Escort	-5%	3%
Work-based	-8%	7%

Mode Share

As presented in Table 34, the drive alone tour mode sees the most decrease (-6.8%) 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 2.1% of the original SR2 tours. The shared-ride 3+ mode even received more tours (0.2%). 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 8.1%. 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.

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 (4.9%) 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.

TABLE 34: AOC SENSITIVITY - TOUR MODE SHARE

TOUR MODE	DOUBLE AOC	HALF AOC
Drive Alone	-6.8%	4.9%
Shared Ride 2	-2.1%	1.4%
Shared Ride 3+	0.2%	-0.3%
Drive-Transit	12.7%	-8.1%
Walk-Transit	5.8%	-3.9%
Bike	12.0%	-4.9%
Walk	3.9%	-2.2%

School Bus	0.4%	-0.5%
TNC	8.1%	-4.4%
Total	-2%	1.8%

The change in trip mode shares, Table 35, also exhibit the same behavior as the tour mode shares.

TABLE 35: AOC SENSITIVITY - TRIP MODE SHARE

TRIP MODE	DOUBLE AOC	HALF AOC
Drive Alone	-7.3%	4.6%
Shared Ride 2	-0.6%	0.4%
Shared Ride 3+	1.8%	-1.1%
Transit	10.6%	-5.3%
Bike	11.7%	-4.4%
Walk	8.0%	-4.4%
School Bus	0.0%	-0.6%
TNC	11.5%	-5.4%
Total	-2.0%	1.4%

Regional VMT

The regionwide total vehicle miles travelled (VMT), Table 36, responds expectedly to the change in auto operating cost. Doubling the auto operating cost reduce the VMT by 8.0%, whereas halving the cost increase the VMT by 6.5%.

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 -0.12 and -0.09 for double AOC and half AOC.

TABLE 36: AOC SENSITIVITY – REGIONAL VMT

MEASURE	DOUBLE AOC	HALF AOC
VMT	-8.0%	6.5%
Elasticity	-0.12	-0.09

4.2 CHANGE IN TRANSIT FARE

Two model runs, Table 37, examine model's response to change in transit fare: double transit fare and half transit fare.

TABLE 37: 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 2019 base year ABM apply two sets of fare for the transit services in the Fresno County. The first set[16] is a flat fare of $1.25 for the local buses operated by FAX and Clovis. The other set[17] 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 change in: tour/trip mode shares, transit trips by income groups and regional transit ridership (boardings).

Mode Shares

As presented in Table 38, 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 (-11.4%) are affected less than the transit tours walking to transit (-14.5%). 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

[16] This is provided in "1_inputs\4_Transit\FC_BASE_TRAN_FAR.FAR"
[17] This is provided in 1_Inputs\4_Transit\fareMatrix.txt

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 (0.9%) – see 3.1 Calibration.

With half fare, the transit tours increase 8.6% and 2.4% for walk and drive to transit modes while drive alone mode decreased -0.1%.

TABLE 38: TRANSIT SENSITIVITY - TOUR MODE SHARE

TOUR MODE	DOUBLE FARE	HALF FARE
Drive Alone	0.1%	-0.1%
Shared Ride 2	0.1%	0.0%
Shared Ride 3+	0.1%	-0.1%
Drive-Transit	-11.4%	2.4%
Walk-Transit	-14.5%	8.6%
Bike	1.0%	-0.3%
Walk	0.2%	-0.1%
School Bus	0.1%	-0.1%
TNC	0.2%	-0.2%
Total	0.1%	-0.1%

The change in trip mode shares, Table 39, also exhibit the same behavior as the tour mode shares.

TABLE 39: TRANSIT FARE SENSITIVITY - TRIP MODE SHARE

TRIP MODE	DOUBLE FARE	HALF FARE
Drive Alone	0.1%	-0.1%
Shared Ride 2	0.1%	0.0%
Shared Ride 3+	0.1%	-0.1%
Transit	-17.1%	9.8%
Bike	1.1%	-0.3%
Walk	0.1%	-0.03%
School Bus	0.2%	-0.1%
TNC	-0.2%	-0.6%
Total	0.0%	0.0%

Transit Trips by Household Income

Table 40 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 less 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 less choices for travel mode.

TABLE 40: TRANSIT FARE SENSITIVITY – CHANGE IN TRANSIT TRIPS BY HOUSEHOLD INCOME

HOSEHOLD INCOME	HALF FARE	DOUBLE FARE
$0-$15,000	11%	-13%
$15,000-$35,000	13%	-16%
$35,000-$50,000	12%	-16%
$50,000-$75,000	13%	-18%
$75,000-$100,000	16%	-19%

$100,000+	16%	-18%

Transit Boardings

The regionwide transit ridership, Table 41, responds appropriately to the change in transit fare; doubling the transit fare reduce the ridership by 16.8% and halving the transit fare increase the ridership by 9.9%.

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 -0.28 and -0.14 for double transit fare and half transit fare.

TABLE 41: TRANSIT FARE SENSITIVITY – TRANSIT BOARDINGS

MEASURE	DOUBLE FARE	HALF FARE
Change in Boardings	-16.7%	9.5%
Elasticity	-0.27	-0.14

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 32 shows the route of the new line (dotted).

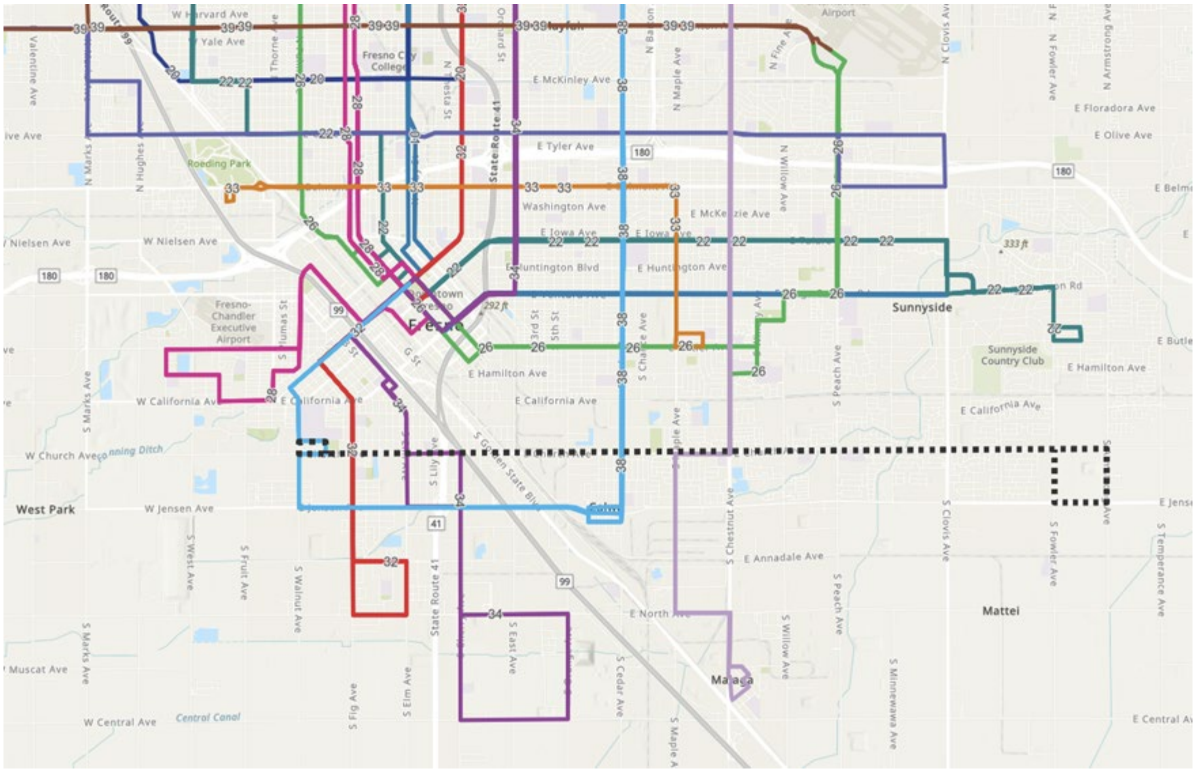


FIGURE 32: SENSITIVITY TEST - NEW TRANSIT SERVICE

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 0.25mi along the route. The BRT line is coded with 10 minute peak and 15 minute off-peak headways and a dwell time of 0.5minutes. The BRT is coded with stops every 0.5mi 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 2019 base year transit system results in a small increase in overall transit boardings (1.79% and 2.37% for the local bus and BRT coding). The line as a local bus attracts 431 daily riders, while the line as a BRT nearly doubles the ridership (805 daily boardings), Table 42. In both cases, the total boardings increase by more than the ridership on the test line. This indicates that the new line is facilitating trips which transfer to other services as well.

TABLE 42: SENSITIVITY TEST – NEW BRT SERVICE BOARDINGS

LINE CODING	NEW LINE BOARDINGS	TOTAL TRANSIT BOARDINGS	CHANGE IN TOTAL BOARDINGS	TOTAL BOARDINGS PERCENT DIFFERENCE
Local Bus	431	40,776	716	1.79%
BRT	805	41,009	948	2.37%

4.4 TRANSIT FREQUENCY

To evaluate the model's response to a transit frequency, the frequency of an existing route is adjusted. Figure 33 shows the highlighted route tested, Route 41.

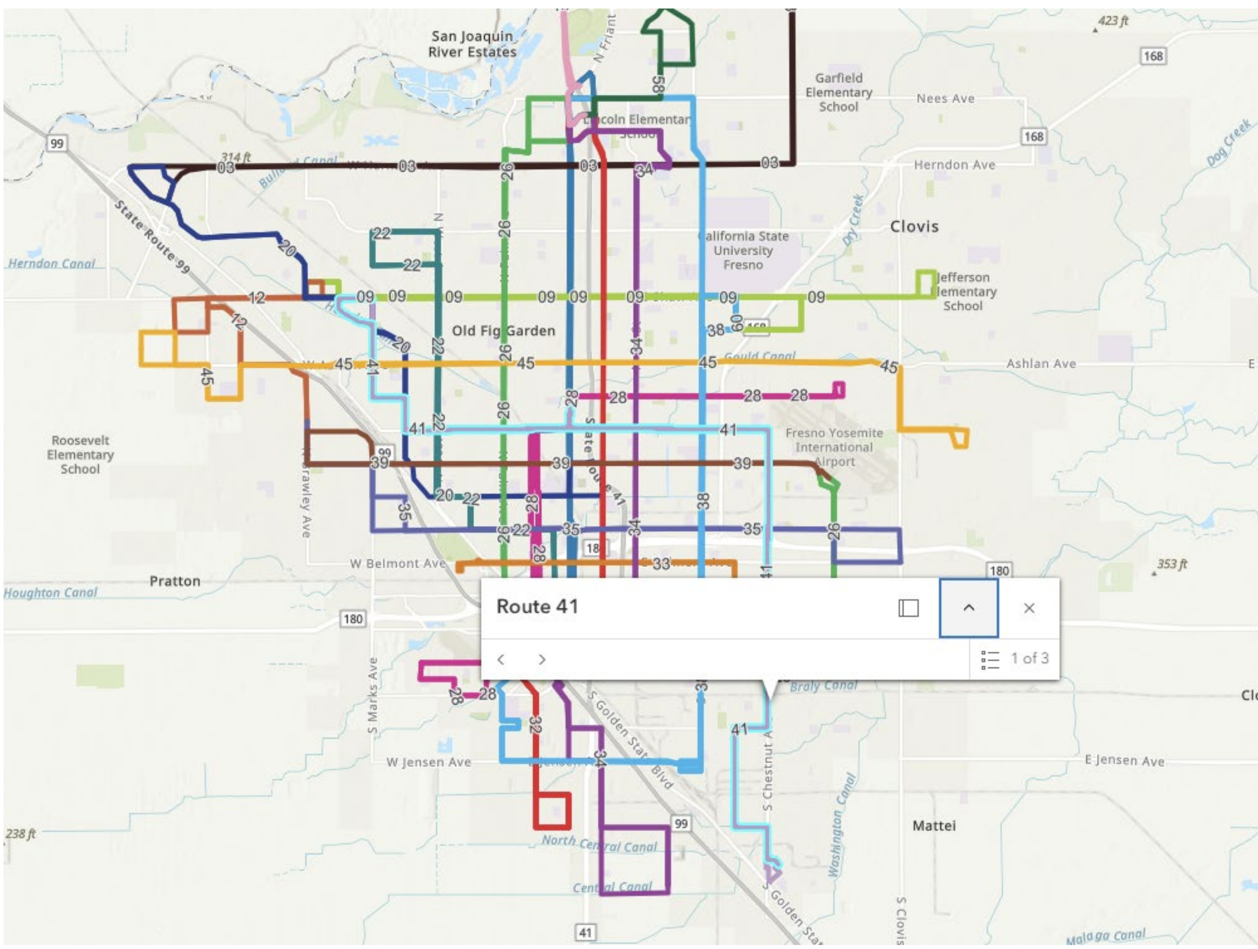


FIGURE 33: SENSITIVITY TEST – TRANSIT FREQUENCY LINE

Model setup

The headway of the existing route 41 is 30mins. To test the sensitivity to frequency, the route is adjusted to 15 minute and 60 minute headways. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

Increasing the frequency of the route to 15 minutes increased the ridership on route 41 by 732 boardings while system-wide ridership increased 741 boardings. Doubling the headway to 60 minutes decreased the ridership by 355 boardings, and decreased system wide boardings by 261 (Table 43). Decreasing the service frequency impacts the individual line more than the system indicating that while some boardings have been lost due to the cut in service, most have switched from route 41 to other services. The opposite is shown when the frequency is increased; riders may be making more transfers to utilize the more frequent route resulting in more systemwide boardings than new boarding on route 41.

TABLE 43: SENSITIVITY TEST – TRANSIT FREQUENCY TEST

ROUTE 41 HEADWAY (MIN)	CHANGE IN ROUTE 41 BOARDINGS	TOTAL TRANSIT BOARDINGS	CHANGE IN TOTAL BOARDINGS
15	732	40,801	741
60	-355	39,799	-261

4.5 ROAD DIET

A road diet is a strategy to create a more pedestrian friendly environment by reducing the number of lanes and increasing available space for bike lanes or pedestrian walkways. This test reduced the number of traffic lanes from 3 to 2 on a 5-mile stretch of Shaw Avenue as shown in Figure 34.

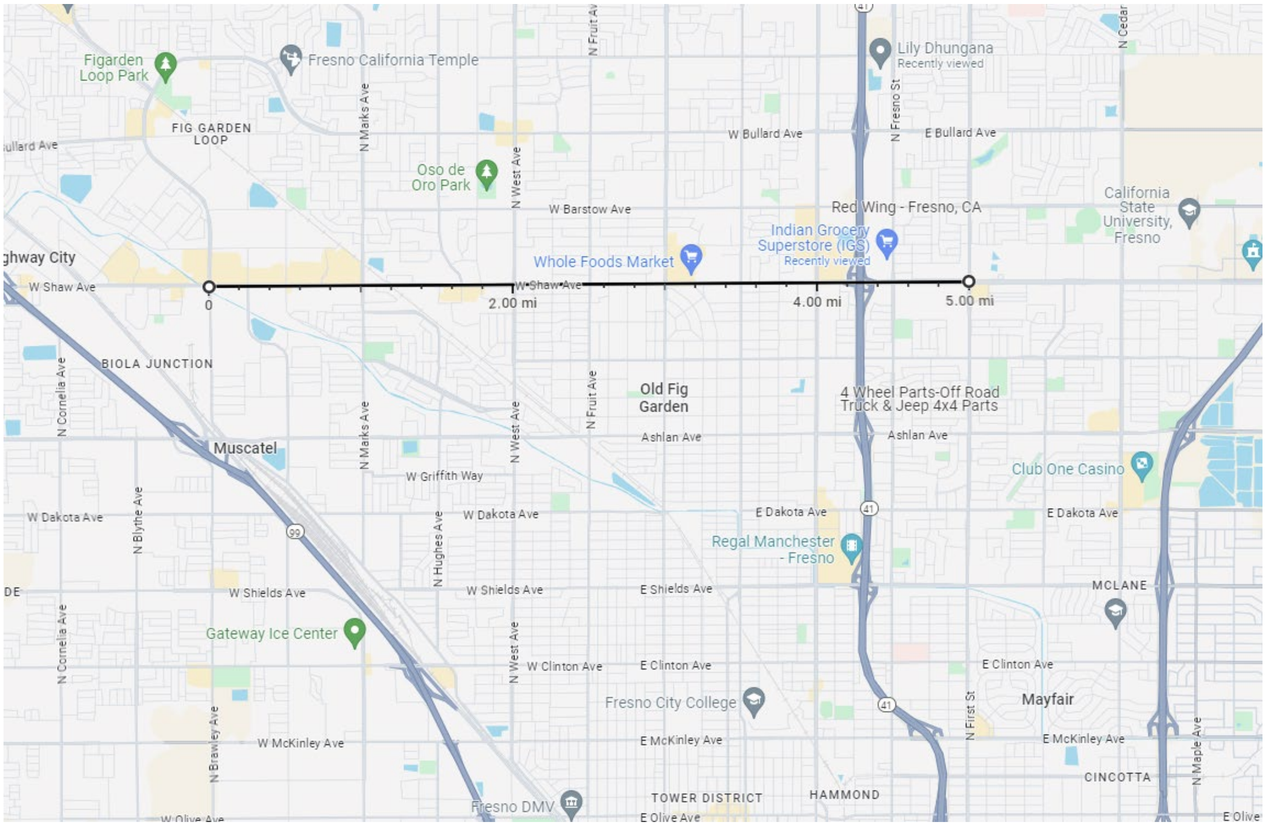


FIGURE 34: ROAD DIET ON SHAW AVE

Model setup

The model setup for this test is to reduce the lanes and capacity of the project link. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

Regional VMT shows a very minor increase regionwide (119) in this scenario as shown in Table 44. As the number of lanes reduces some vehicles may be re-routing and actually taking longer paths to avoid the congested road. In 2 and 5 mile buffers around the project, the VMT decreases .34% and .01%. By reducing the number of lanes on this segment of road, the network capacity has decreased, and it follows that demand would decrease. While mode share is not impacted, drive alone trips reduce by 177 and walk and transit trips increase 69 and 6 trips (Table 45).

TABLE 44: ROAD DIET VMT AND TRANSIT BOARDINGS

ANALYSIS ZONE	MEASURE	BASE	ROAD DIET
Regionwide	VMT	24,878,881	24,879,000
	VMT Diff.	-	119
	VMT Diff.%	-	**0.00%**
2 mi Buffer	VMT	3,391,986	3,380,584
	VMT Diff.	-	(11,402)
	VMT Diff.%		**-0.34%**
5 mi Buffer	VMT	16,205,895	16,204,671
	VMT Diff.	-	(1,223)
	VMT Diff.%		**-0.01%**
Regionwide	Transit Boardings	40,060	40,448
	Boardings %change	-	1.0%

TABLE 45: ROAD DIET TRIP MODE

TRIP MODE	BASE	ROAD DIET	DIFF.
Drive Alone	1,540,611	1,540,434	(177)
Shared Ride2	847,264	847,352	88
Shared Ride3+	684,162	684,072	(90)
Transit	24,131	24,137	6
Bike	27,490	27,489	(1)
Walk	355,285	355,354	69
School Bus	66,680	66,680	-
TNC	2,600	2,590	(11)

4.6 NEW BIKE LANES

As described in Input Preparation, the FresnoABM includes a bike network for better representing bike skims throughout the county. Bike facilities which separate cyclists from motorists by either painted bicycle lanes or physical vertical barriers give more attractive paths for bicycle trips. This test adds 5 miles of bike lanes on Clinton Ave between Marks Ave and Cedar Ave as shown in Figure 35.

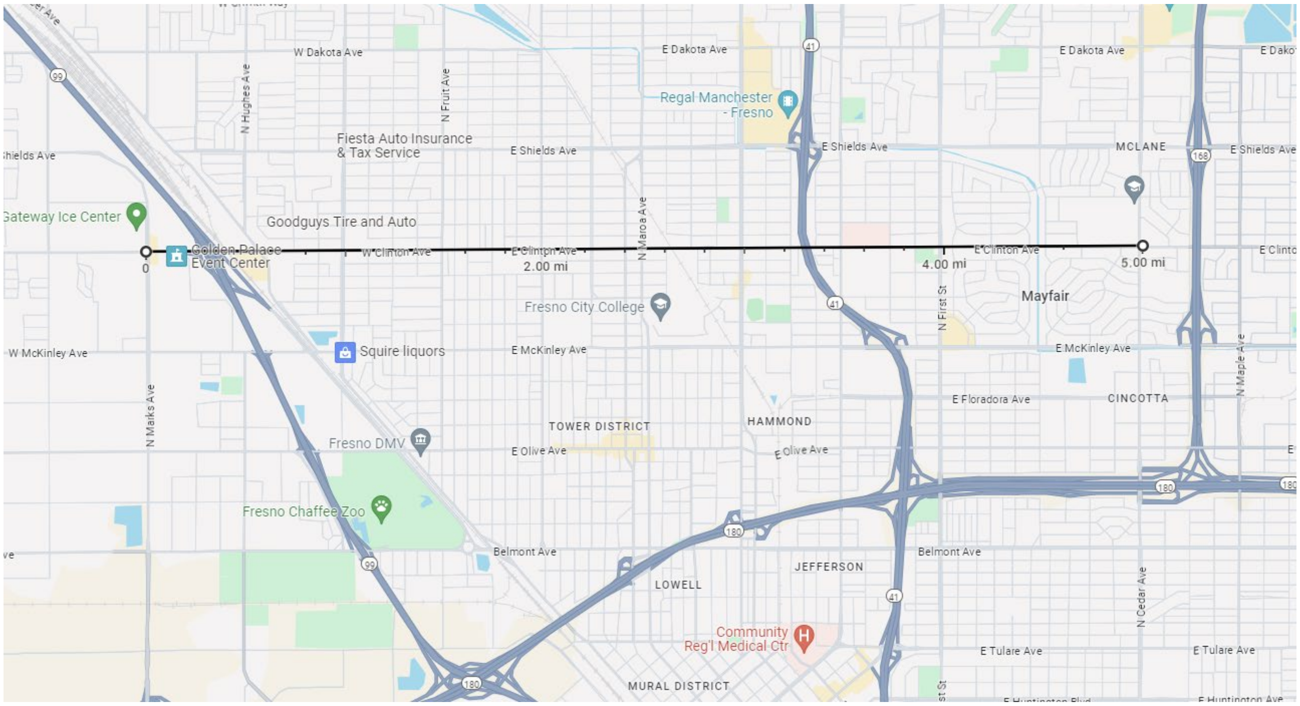


FIGURE 35: NEW BIKE LANES ON CLINTON AVE

Model setup

The new bike lane is coded on the existing roadway as a Class II facility type. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

Additional bike lanes provide a more attractive route for cyclists along the project corridor. As a result, the bicycle trips increase by 217 as shown in Table 46. The increase in active modes also leads to a decrease in regional VMT of 963 (Table 47).

TABLE 46: CHANGE IN TRIP MODE SHARE WITH BIKE LANES

TRIP MODE	BASE	NEW BIKE LANE	DIFF.
Drive Alone	1,540,611	1,540,618	7
Shared Ride2	847,264	847,254	(10)
Shared Ride3+	684,162	684,030	(132)
Transit	24,131	24,102	(29)
Bike	27,490	27,707	217
Walk	355,285	355,180	(105)
School Bus	66,680	66,683	3
TNC	2,600	2,592	(8)
Total	3,548,223	3,548,166	(56)

TABLE 47: CHANGE IN VMT WITH BIKE LANES

MEASURE	BASE	NEW BIKE LANE
VMT	24,878,881	24,877,918
VMT Diff.	-	(963)
VMT Diff.%	-	-0.004%

4.7 HOV LANES

As described in Network Skimming, this model update included enhancements to implement HOV only lanes with optional coding to implement HOV2+, HOV3+, or HOV2+ only in the peak periods. This model run tests the third option: HOV2+ lane restrictions in the peak period on a stretch of highway SR-41 north of Fresno downtown as shown in Figure 36.

Model setup

For coding this test, an additional set of links is needed alongside the original SR-41 highway links with connectors before and after each ramp. The original links lanes and capacity are reduced to only 2 lanes, and the new links are coded with 1 lane. This represents keeping the highway lane structure, but converting one lane into the HOV2+ lanes. However, the base highway network is slightly different in this test compared to other sensitivity tests because of the segregated one lane HOV link. In the peak periods, the new lane will be restricted, in the off-peak periods, all vehicles will be allowed to use these lanes. Shadow pricing is turned off and stable shadow prices from the base run are used.

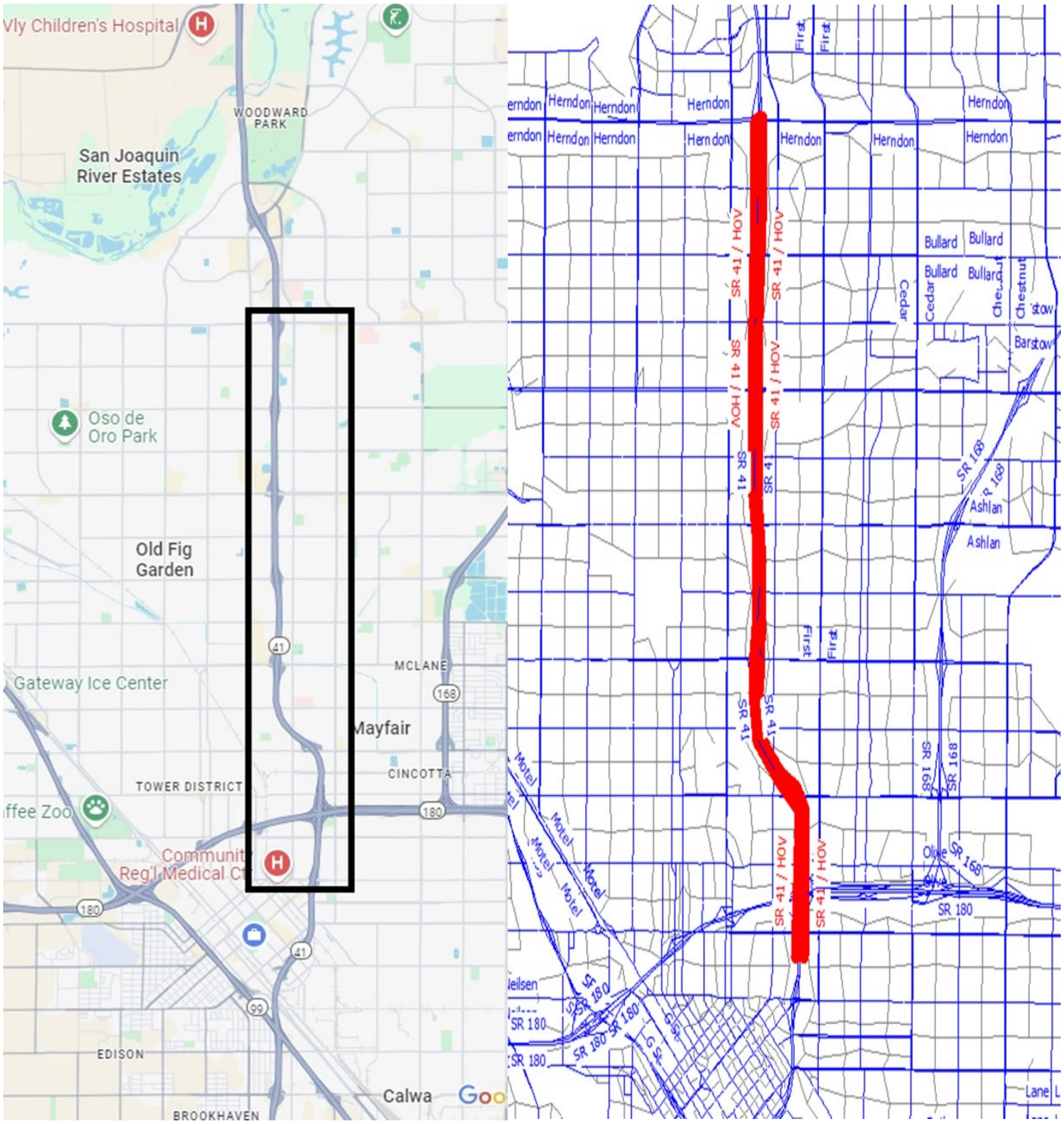


FIGURE 36: SR-41 HOV LANES

Results

The base VMT in this scenario goes up slightly because of the longer link lengths as people need to travel on the connectors to switch between normal and HOV assigned lanes. This VMT increase is happening only in the modeling test and won't happen in the reality as the managed lanes are on the side of general purpose lanes, just like another lane. The new configuration and managed lane policy reduces VMT by -0.08% as shown in Table 48.

TABLE 48: HOV TEST VMT

MEASURE	BASE	HOV TEST
VMT	24,899,351	24,879,970
VMT Diff.	-	(19,381)
VMT Diff.%	-	-0.08%

The HOV lanes do not cause any significant shift in tour and trip mode choice (Table 49 and Table 50). The HOV restriction applies only to the peak period. This is similar to reducing the supply of the network for SOV trips since they see a reduction in lanes along the project.

TABLE 49: HOV TEST TOUR MODE

TOUR MODE	BASE	HOV TEST	DIFF
Drive Alone	444,919	444,925	7
Shared Ride2	326,092	326,156	64
Shared Ride3+	317,750	317,706	-44
Drive Transit	40	41	1
Walk Transit	11,520	11,485	-35
Bike	14,210	14,214	4
Walk	91,213	91,159	-54
School Bus	27,267	27,251	-16
TNC	1,905	1,904	-1
Total	1,234,916	1,234,842	-74

TABLE 50: HOV TEST TRIP MODE

TRIP MODE	BASE	HOV TEST	DIFF
Drive Alone	1,540,486	1,540,636	149
Shared Ride2	847,288	847,233	-55
Shared Ride3+	684,306	684,222	-83
Transit	24,265	24,145	-120
Bike	27,492	27,486	-6
Walk	355,472	355,330	-142
School Bus	66,701	66,647	-53
TNC	2,596	2,592	-4
Total	3,548,606	3,548,292	-314

4.8 MANAGED LANE/ TOLL PRICING

The managed lane and toll pricing test is similar to the HOV lanes tests. Along a stretch of SR168, SR180 and SR41 (black solid line shown in Figure 37), the existing highway lane structure is changed to include a toll of 1$ per mile.

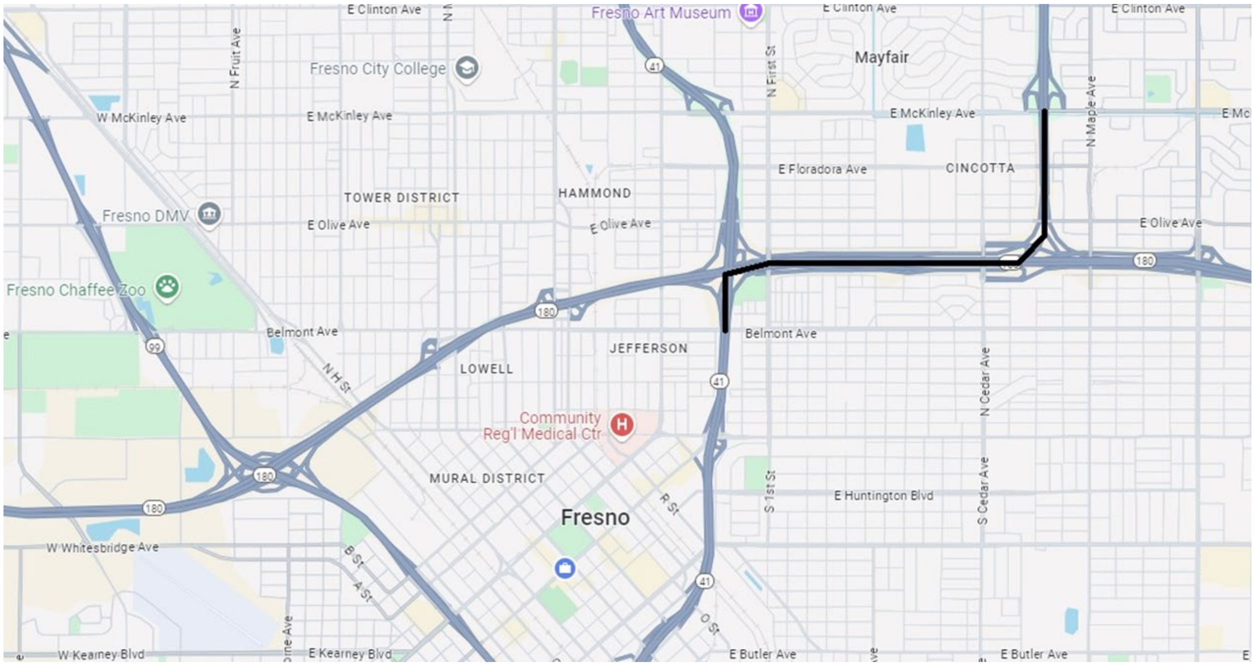


FIGURE 37: MANAGED LANE TOLL PROJECT

Model setup

The project is coded by adding an equivalent 1$ per mile toll on the links in the project. HOV2 and HOV3+ vehicles are exempt from the toll. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

The new toll reduces total VMT by -0.12% and increases transit boardings by 0.1% as shown in Table 51. The trip mode shifts slightly from drive alone to shared ride as shown in Table 52.

TABLE 51: TOLL PRICING VMT AND TRANSIT BOARDINGS

MEASURE	BASE	TOLL
VMT	24,878,881	24,849,018
VMT Diff.	-	(29,863)
VMT Diff.%	-	-0.12%
Transit Boardings	40,060	40,103
Boardings %change	-	0.1%

TABLE 52: TOLL PRICING TRIP MODE

TRIP MODE	BASE	TOLL	DIFF.
Drive Alone	1,540,611	1,538,947	(1,663)
Shared Ride2	847,264	848,573	1,309
Shared Ride3+	684,162	684,754	592
Transit	24,131	24,150	19
Bike	27,490	27,468	(22)
Walk	355,285	355,330	45
School Bus	66,680	66,733	53
TNC	2,600	2,598	(2)
Total	**3,548,223**	**3,548,554**	**331**

4.9 TRUCK RESTRICTIONS

The truck restrictions are now available to implement in the model network. The restriction excludes a link from being used by light, medium, and heavy truck class assignments. This test adds truck restrictions on a stretch of South Maple Ave as shown in Figure 38.

Model setup

The truck restriction is added to the project links. Shadow pricing is turned off and stable shadow prices from the base run are used.

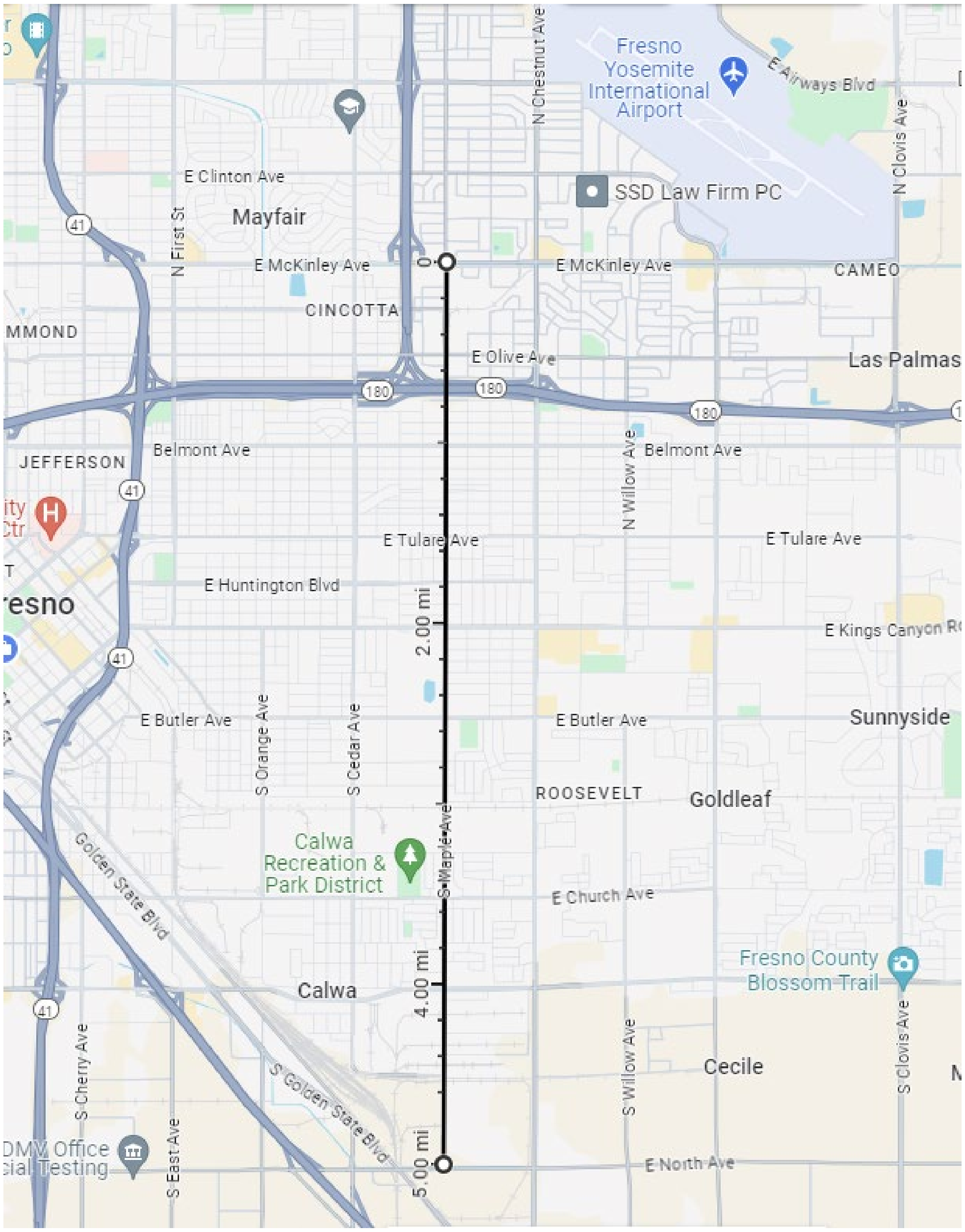


FIGURE 38: TRUCK RESTRICTION TEST

Results

The addition of the truck restrictions reduced the truck VMT overall by 1,961 as shown in Table 53. This is a small share of total truck VMT (-0.04%) which makes sense for a small change in the truck network. Supply is also essentially reduced as trucks are no longer allowed to use this stretch of road, so it follows that demand would also reduce. The VMT on arterials increases, which may suggest that trucks must take longer diverting routes to avoid the restricted segment.

TABLE 53: TRUCK VMT

FACILITY TYPE	TRUCK SMALL	TRUCK MED	TRUCK HEAVY	TOTAL
Freeway & Highway	(1,111)	(1,261)	(60)	(1,111)
Arterial	6,311	1,700	134	6,311
Other (Collector, local & ramp)	(5,929)	(1,606)	(139)	(5,929)
TOTAL	**(729)**	**(1,167)**	**(65)**	**(729)**

4.10 CAPACITY INCREASE

Sensitivity to change in network capacity is tested by increasing the number of lanes on a stretch of Bullard Ave as shown in Figure 39.

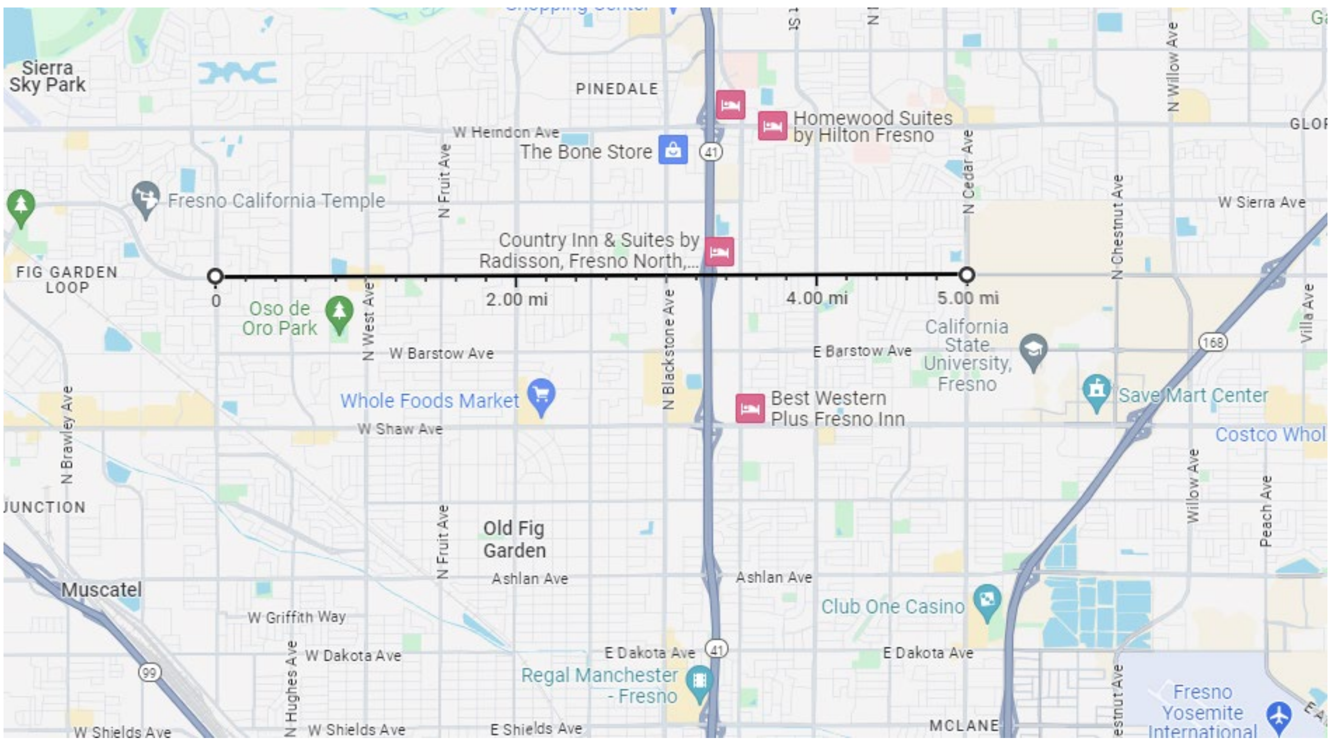


FIGURE 39: CAPACITY INCREASE ON BULLARD AVE

Model setup

The number of lanes on Bullard Ave between Marks Ave and Cedar Ave is updated from 2 to 3 in each direction with the associated capacity increase. Shadow pricing is turned off and stable shadow prices from the base run are used.

Results

For a small network change, the VMT is reviewed in different buffer areas around the project of 2mi and 5mi as shown in Table 54. In the 2 and 5-mile buffers, the VMT increases as the increased capacity routes more vehicles along the project road. Regionwide, the increase is very small.

TABLE 54: CAPACITY INCREASE VMT

	REGIONWIDE		2 MILES BUFFER		5 MILES BUFFER	
Measure	**Base**	**Cap Inc Projects**	**Base**	**Cap Inc Projects**	**Base**	**Cap Inc Projects**
VMT	24,878,881	24,879,188	3,266,341	3,273,747	10,807,614	10,810,077
VMT Diff.	-	307	-	7,406	-	2,463
VMT Diff.%	-	0.00%	-	0.23%	-	0.02%

4.11 NEW EMPLOYMENT

This test updates the land use in 3 zones to include a new employment center with 3850 employees. Three tests are done including 100%, 50%, and 150% of the employment proposed by the employment center.

Model setup

Employment in 3 zones is adjusted to reflect inclusion of the new center at 100%, 50%, and 150% of the proposed employment. The test zones are shown in Figure 40. Table 55 shows the employment used in each scenario. Shadow pricing is turned on.

TABLE 55: EMPLOYMENT TEST INPUTS

MAZ_ID	EMPLOYMENT CENTER EMPLOYEES	BASE EMPLOYMENT	100%	50%	150%
18739	1200	0	1200	600	1800
19008	717	83	800	400	1200
19010	1635	215	1850	925	2775
Total	**3552**	**298**	**3850**	**1925**	**5775**

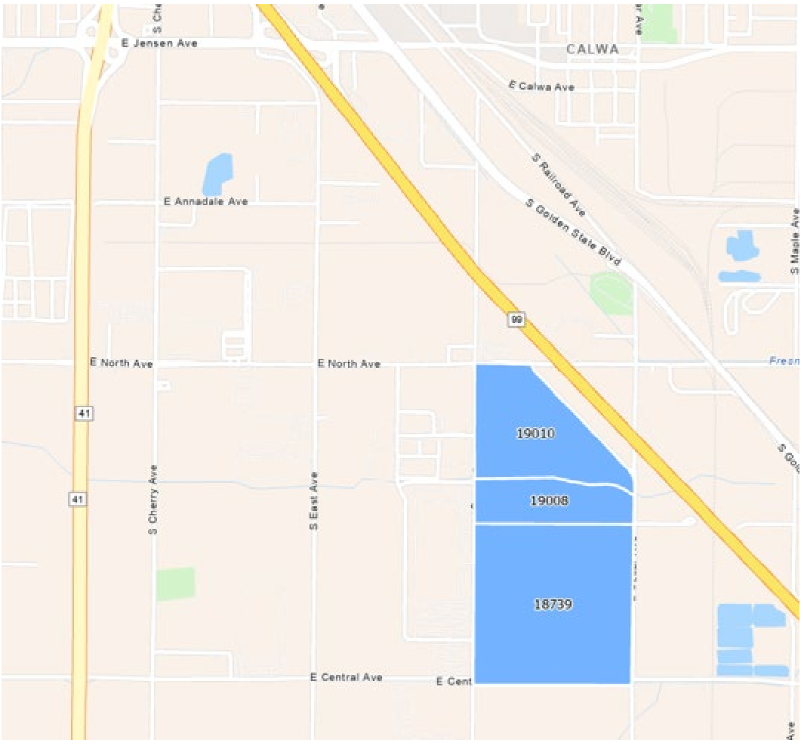


FIGURE 40: EMPLOYMENT TEST ZONES

Results

Table 56 shows the VMT and transit results of this sensitivity test. Adding the employment center increases regional VMT by 0.40% while adding 50% of the proposed employment only increases regional VMT by 0.20%. The test with 150% of the proposed employment shows a slight increase in VMT over the 100% employment with the same total increase percentage of 0.40%.

TABLE 56: EMPLOYMENT TEST RESULTS

MEASURE	BASE	100% EMPLOYMENT	50% EMPLOYMENT	150% EMPLOYMENT
VMT	24,878,881	24,974,690	24,940,556	24,976,301
VMT Diff.	-	95,809	61,675	97,420
VMT Diff.%	-	0.40%	0.20%	0.40%
Transit Boardings	40,060	39,506	39,752	39,265

4.12 CHANGE OF SPEEDS

This sensitivity test updates the speeds on freeway facilities by either +5mph or -5mph.

Model setup

In the model network, links of facility type 1 (freeway) have their speeds adjusted either up by 5mph or down by 5mph. Shadow pricing is turned on.

Results

Table 57 shows the regional VMT and transit results of this sensitivity test. Decreasing the freeway speeds by 5mph decreases regional VMT by 0.7% while increasing the freeway speeds by 5mph increases the regional VMT by 0.6%. The change is small, but when freeway speeds are decreased, the transit boardings increase, and when freeway speeds are increased, transit boardings decrease. This is the expected result as driving will become more attractive when freeways are faster and less attractive when they are slower.

TABLE 57: FREEWAY SPEED TEST VMT AND TRANSIT RESULTS

MEASURE	BASE	-5 MPH	+ 5MPH
VMT	24,878,881	24,713,677	25,029,359
VMT Diff.	-	-165,204	150,478
VMT Diff.%	-	-0.70%	0.60%
Transit Boardings	40,060	40,166	39,985

4.13 SUMMARY

Twelve 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 various tests.

5.0 FRESNO ABM USER'S GUIDE

This chapter describes model setup and steps to run the Fresno ABM for base year 2019. 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

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 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

5.2 SETUP ABM

System Setup

Once all the required software is installed (5.1Software 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\CubeVoyager). 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 41) 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.

```
* RSC file for User Program PYTHON
*
#PYTHON

&ProgPath=C:\Program Files\Anaconda2\python.exe
&ProgDesc=Python Software for Python Programming Language Programs Inclusion
&ProgType=1
&ProgUI=0
&UsePath=0


 &FILES
1100
 0,"Script File   ","*  ",1,PYT,"      ",1
 1,"Data File 1   ","*  ",1,PYT,"      ",1
 2,"Data File 2   ","*  ",1,PYT,"      ",1
 3,"Data File 3   ","*  ",1,PYT,"      ",1
 4,"Data File 4   ","*  ",1,PYT,"      ",1
 5,"Data File 5   ","*  ",1,PYT,"      ",1
 6,"Data File 6   ","*  ",1,PYT,"      ",1
 7,"Data File 7   ","*  ",1,PYT,"      ",1
 8,"Data File 8   ","*  ",1,PYT,"      ",1
 9,"Data File 9   ","*  ",1,PYT,"      ",1
10,"Data File 10  ","*  ",1,PYT,"      ",1

 &PARAM
 &PARHLP
 &PAREG

 &OPTION

 &OPTHLP

 &COMLIN
Inputs
Outputs

&END
```

FIGURE 41: 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 42): Scenario, Data, App, and Keys.

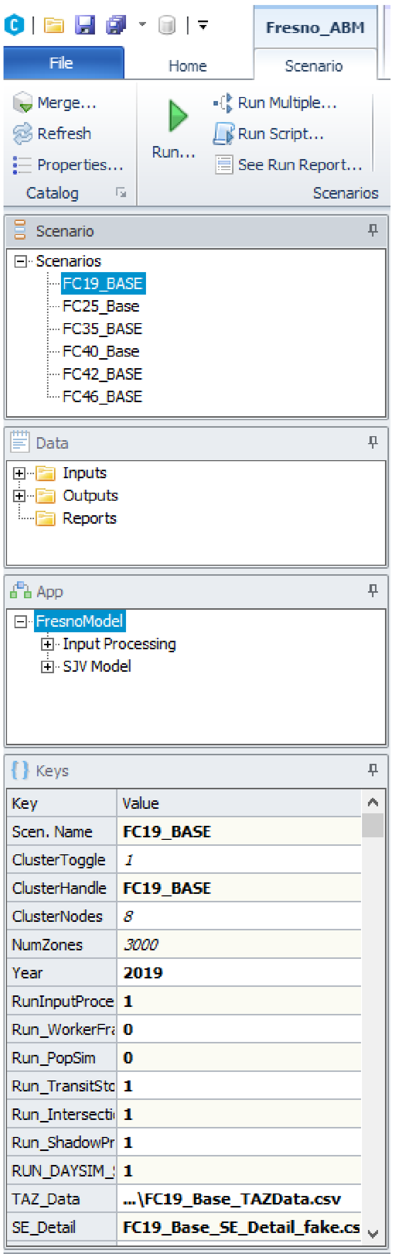


FIGURE 42: MAIN CUBE CATALOG FILE

The *Scenario* frame contains a list of scenarios to pick for the current run. User needs to pick a scenario under this frame. For 2019, user would select FC19_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 43. Table 58 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.

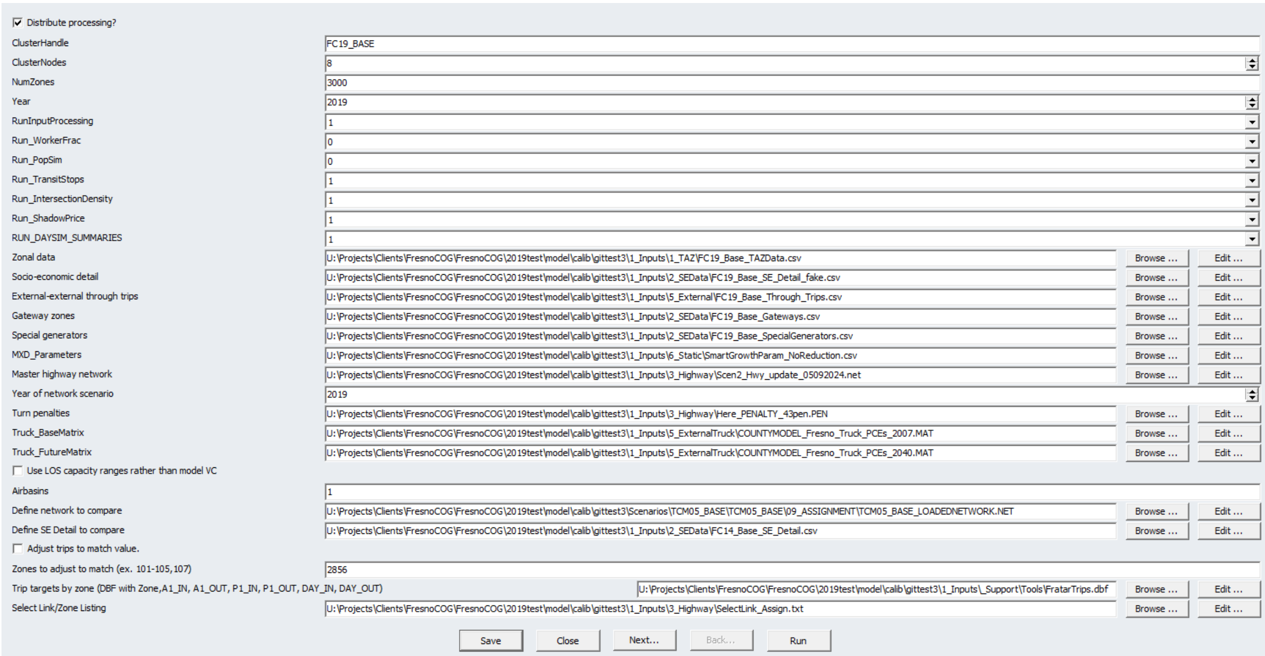


FIGURE 43: SCENARIO KEYS SCREEN

TABLE 58: 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.
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.

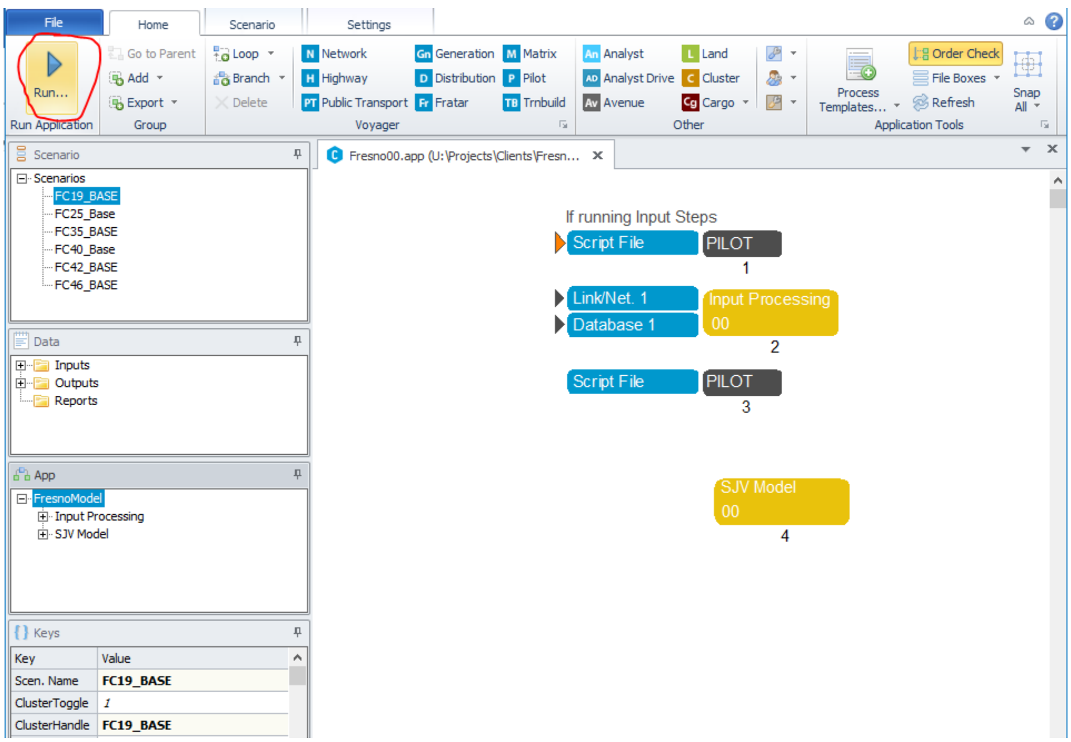
The Fresno AB model is run in one step with the option to skip input processing if needed. The two main modules are:

- 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

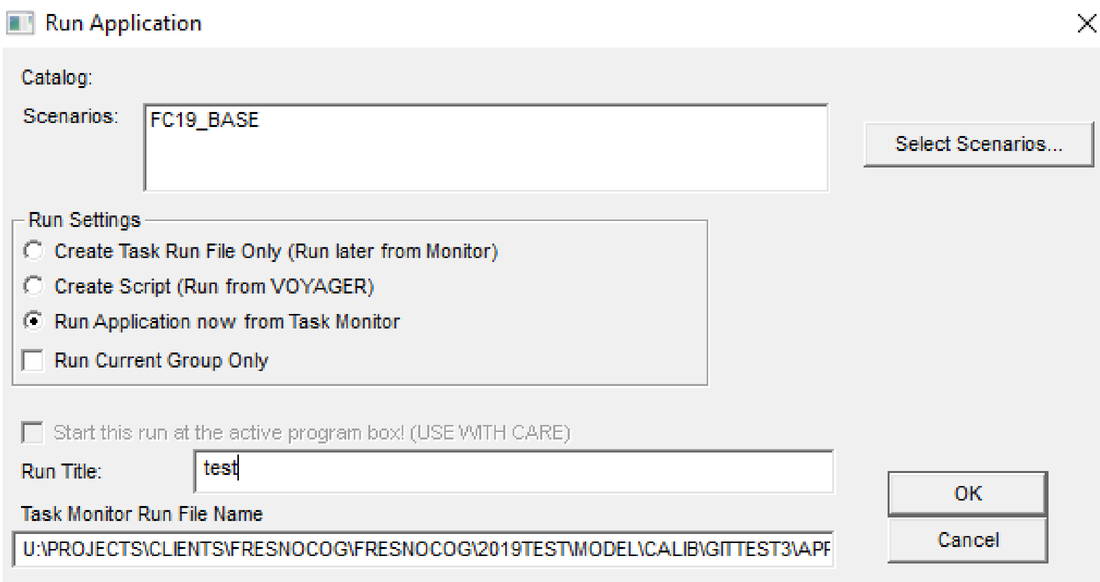
runs DaySim. This produces demand matrices by mode and time period. The demand matrices are then assigned on highway and transit networks for AM and MD periods. After three feedback loops, a final assignment of all four periods is performed. Assignment also include bike and walk assignments.

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.



5. This will bring up a Run Application window. Enter "Run Title" of your choice and click OK. This will start Cube processing.



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 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 *GIS* 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. FC19_BASE for year 2019). The scenario specific folders contain outputs organized by model components. In addition, a temp folder contains intermediate files produced during a scenario run.

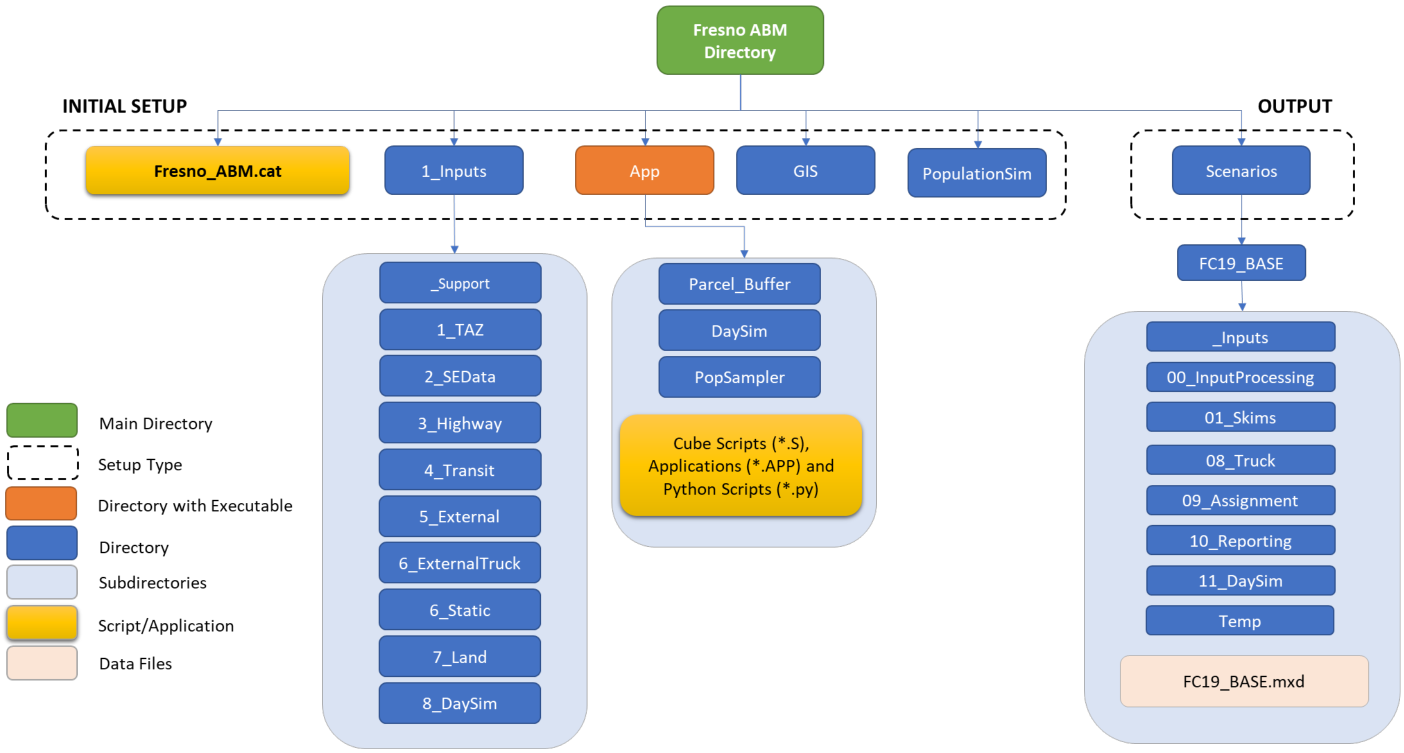


FIGURE 41: FRESNO ABM DIRECTORY STRUCTURE

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_2019_parks.csv". This file is created in-house by Fresno COG. Table 59 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 59: 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

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
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
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 60 provides a list of fields available in the household file. Of the variables listed below, only five (hhno, hhsize, 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 60: 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.
hhsize	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.)
hhwkrs	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.)

hhownrent	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 61 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 61: 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.
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 "hhsize" 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

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
		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.
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

HEADER LABEL	VALID VALUES	DESCRIPTION, COMMENTS
		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.)
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 62 presents format of the file.

TABLE 62: 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
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 63 presents format of the file.

TABLE 63: 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_IXFrac	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_XIFrac	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_2019.dat". Table 64 presents format of the file.

TABLE 64: 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 65. 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 65: 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_2019_nohwys.csv". Table 66 presents contents of the file.

TABLE 66: 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_2019.csv". Table 67 summarizes the contents of this file.

TABLE 67: 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 68.

TABLE 68: 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 44 provides an example of a coefficient file.

FIGURE 44: COEFFICIENT FILE EXAMPLE

```
Auto availability auto27.ALO
Created by ALOGIT version 4                            22:08:29 on 30 Dec 20
END
 1 Beta000001 F -3.75488401423
 2 Beta000002 F -1.43947756024
 3 Beta000003 F -3.25364812373
 4 Beta000004 F -4.30330562145
 5 Beta000005 F -4.05176795548
 6 Beta000006 F -1.41819142329
 7 Beta000007 F -1.47531914845
 8 Beta000008 F -3.13089802675
 9 Beta000009 F -3.33391748513
 10 Beta000010 F -0.59233491336
 11 Beta000011 F -0.30703688340
 12 Beta000012 F -0.96373295824
 13 Beta000013 F -2.56166024388
 14 Beta000014 F -0.55021635237
 15 Beta000015 F -0.20725368004
 16 Beta000016 F -0.23469785064
  18 Beta000018 F   0.29809501011
  19 Beta000019 F   0.97804158764
  20 Beta000020 F   0.34302331597
  22 Beta000022 F   -0.56184165791
  24 Beta000024 F   -0.07875177966
  25 Beta000025 F   0.27622060968
  26 Beta000026 F   0.07021559821
  28 Beta000028 F   0.00229947670
  29 Beta000029 F   -0.78751694870
  31 Beta000031 F   2.66149521117
```

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-tolled 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 vaild 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 69. 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 <u>require</u> separate “no-tolls” matrices for the auto modes, or separate “ferry” matrices for transit – but it would <u>allow</u> 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.

TABLE 69: 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
commuter-rail	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE
ferry	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	FALSE	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.

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 F 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\FC19_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 $1/8^{th}$ 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 70 presents a list of fields available in the buffered micro-zone file.

TABLE 70: 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
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

FIELD	DESCRIPTION
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
ppricdy1	average offstreet daily parking price within buffer 1
pprichr1	average offstreet hourly parking price within buffer 1
nodes1_1	number of single link street nodes (dead ends) within buffer 1
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

FIELD	DESCRIPTION
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
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

FIELD	DESCRIPTION
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\FC19_BASE\11_DaySim_tour.tsv”

TABLE 71: 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.
tmodetp	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\FC19_BASE\11_DaySim_trip.tsv"

TABLE 72: 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 60. The household file is here: "Scenarios\FC19_BASE\11_DaySim_household.tsv"

The household day output file is here: "Scenarios\FC19_BASE\11_DaySim_household_day.tsv". Table 73 presents the format of the file.

TABLE 73: 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 61. The person file is here: "Scenarios\FC19_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\FC19_BASE\11_DaySim_person_day.tsv". The format of the file is shown in Table 74.

TABLE 74: 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
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.)
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\FC19_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 75.

TABLE 75: 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
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 76.

TABLE 76: 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 77.

TABLE 77: 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 78 and Table 79.

TABLE 78: 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_2019.dat" provides nearest node to a micro-zone. The file is in the following format: id (mazid), node_id (nearest node id).

TABLE 79: 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\FC19_BASE\09_Assignment".

Highway

The highway assignment results are output in a CUBE network format "FC19_BASE_LOADEDNETWORK_DETAIL.NET"), as well as in a database file format ("FC19_BASE_LOADEDNETWORK_DETAIL.DBF"). Both outputs contain attributes as shown in Table 80.

TABLE 80: ATTRIBUTES IN HIGHWAY ASSIGNMENT RESULT

FIELD	DESCRIPTION
A	A node
B	B node
SHAPE_LENGT	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 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 (cents)

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
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
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
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
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
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

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
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
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 81.

TABLE 81: 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
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: FC19_BASE_LOADEDNETWORK_BIKE.DBF and FC19_BASE_LOADEDNETWORK_WALK.DBF. Attributes of bike and walk assignment outputs are presented in Table 82 and Table 83.

TABLE 82: 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 (cents)
IMPROVED	Improvement id
BIKE_FACTY	Bike facility type : 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 9: Freeways and Ramps (bicycling not permitted)
BIKE_VOL	Bike volume

TABLE 83: 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 9: Ramp-Loop 10: Connector1 11: Connector2
AUX	Presence of auxiliary lane
USE	Use type
TOLL	Toll (cents)
IMPROVED	Improvement id
BIKE_FACTY	Bike facility type : 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 9: Freeways and Ramps (bicycling not permitted)
WALK_VOL	Pedestrian volume

Reports and Summaries

Several summaries and reports are generated during a model run. DaySim summaries are generated under the scenario folder. The summaries produce the following outputs under the "11_DaySim\daysim_summaries" folder:

TABLE 84. 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

APPENDIX A. DAYSIM CALIBRATION SUMMARIES

TABLE 1: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (NHTS-SJV)

	NUMBER OF VEHICLES					
No. of Drivers	0	1	2	3	4+	Total
1	19.1%	65.9%	12.1%	2.2%	0.7%	26.8%
2	5.2%	27.1%	54.3%	11.2%	2.1%	36.5%
3	3.7%	19.9%	35.8%	30.9%	9.7%	15.3%
4+	2.1%	12.1%	27.7%	26.1%	32.0%	21.4%
Total	**8.0%**	**33.2%**	**34.5%**	**15.0%**	**9.3%**	**100.0%**

TABLE 2: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM)

	NUMBER OF VEHICLES					
No. of Drivers	0	1	2	3	4+	Total
1	19.2%	66.3%	12.1%	1.9%	0.5%	26.8%
2	5.9%	25.4%	56.2%	10.9%	1.6%	36.5%
3	4.8%	21.6%	35.0%	30.8%	7.7%	15.4%
4+	3.3%	15.2%	20.3%	28.7%	32.5%	21.3%
Total	**8.7%**	**33.6%**	**33.5%**	**15.3%**	**8.8%**	**100.0%**

TABLE 3: DIFFERENCE IN SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM-NHTS)

	NUMBER OF VEHICLES					
No. of Drivers	0	1	2	3	4+	Total
1	0.1%	0.4%	0.0%	-0.3%	-0.2%	0.0%

2	0.8%	-1.7%	1.8%	-0.3%	-0.5%	0.0%
3	1.1%	1.7%	-0.8%	-0.1%	-2.0%	0.0%
4+	1.2%	3.1%	-7.4%	2.6%	0.5%	0.0%
Total	**0.7%**	**0.4%**	**-1.0%**	**0.3%**	**-0.4%**	**0.0%**

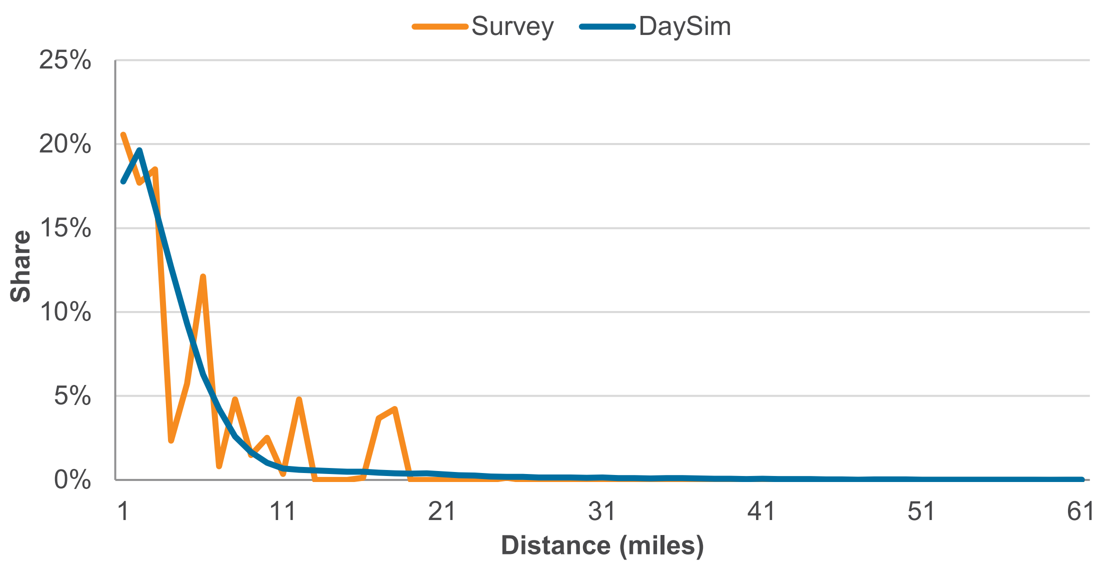


FIGURE 1: TOUR LENGTH DISTRIBUTION FOR DISCRETIONARY TRAVEL

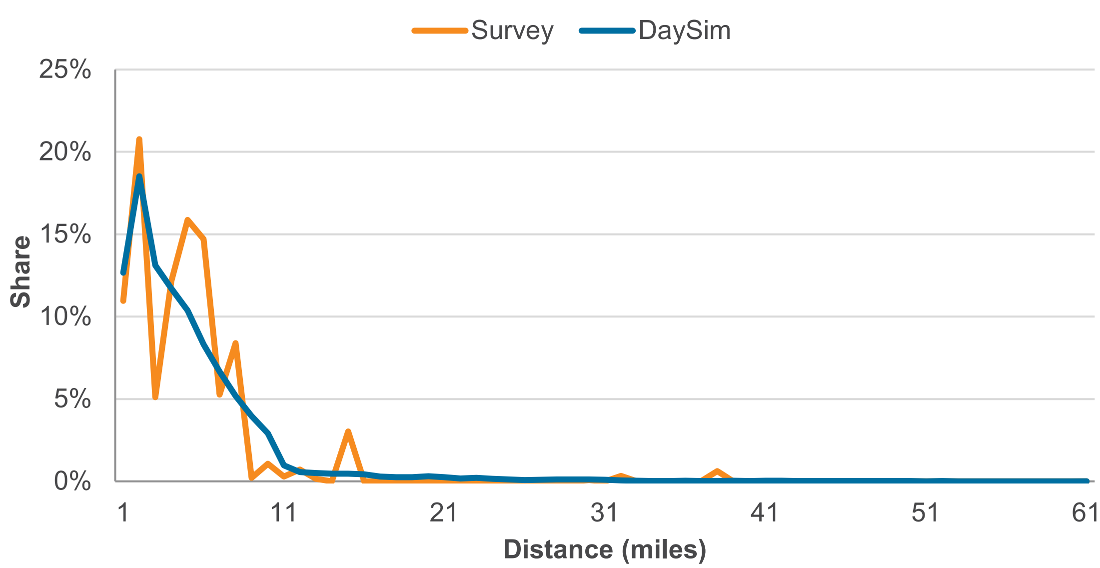


FIGURE 2: TOUR LENGTH DISTRIBUTION FOR MAINTENANCE TRAVEL

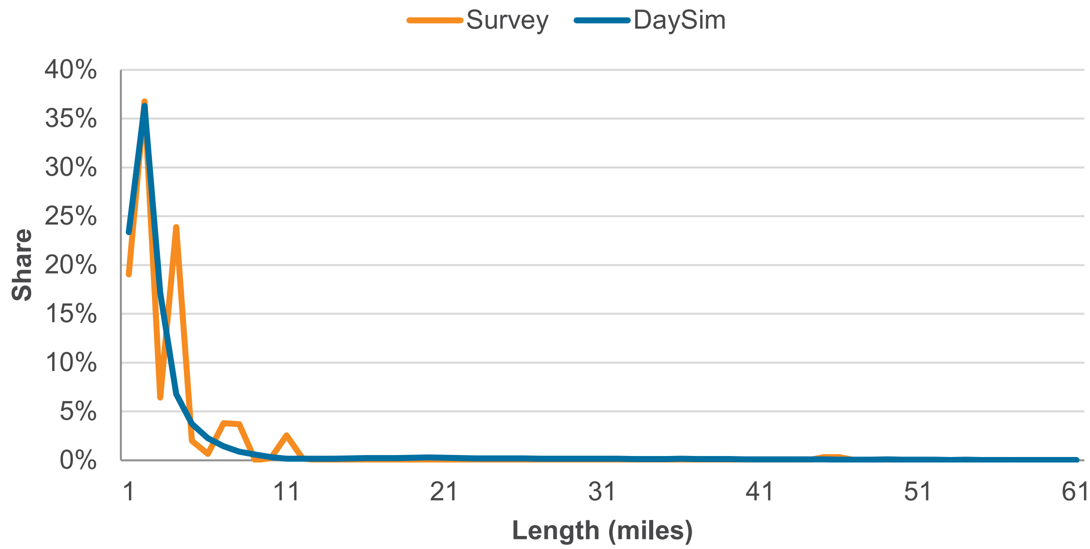


FIGURE 3: TOUR LENGTH FREQUENCY DISTRIBUTION FOR ESCORT TRAVEL

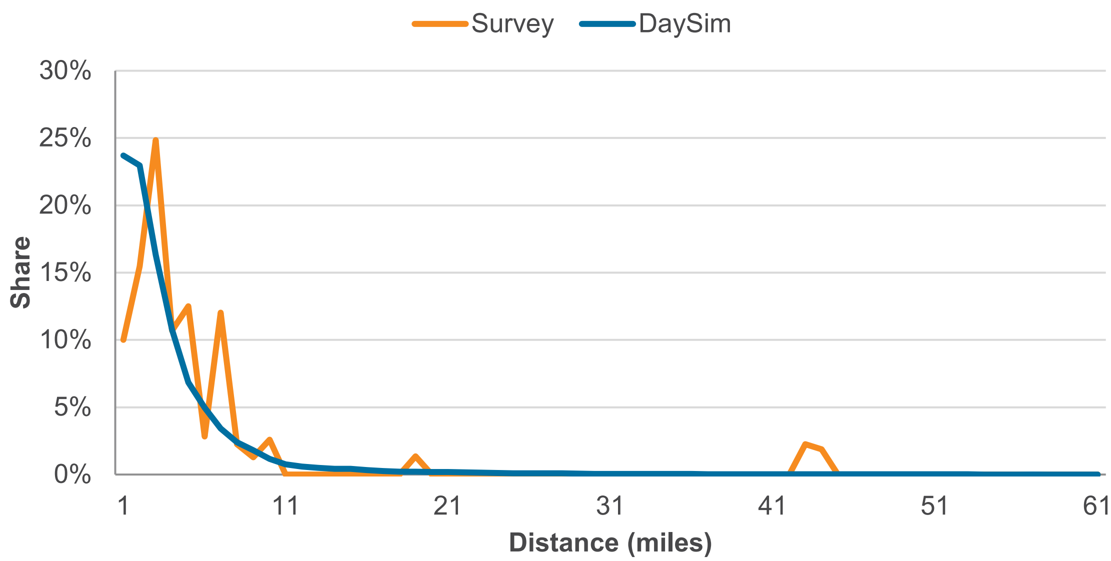


FIGURE 4: TOUR LENGTH FREQUENCY DISTRIBUTION FOR WORK-BASED TRAVEL

TABLE 4: TOUR MODE SHARES (NHTS-SJV)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	70%	21%	1%	31%	66%	35.3%
SR2	18%	17%	43%	29%	17%	26.2%

SR3+	7%	32%	48%	27%	9%	25.7%
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%	1.0%
Bike	1.0%	0.7%	0.0%	2.2%	0%	1.2%
Walk	2%	13%	8%	9%	9%	7.7%
School Bus	0%	14%	0%	1%	0%	2.6%
TNC	0%	0%	0%	0%	0%	0.1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 5: TOUR MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	73%	20%	1%	32%	71%	36.5%
SR2	16%	18%	43%	29%	13%	25.6%
SR3+	7%	33%	48%	27%	6%	25.6%
Drive Transit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Walk Transit	1.4%	1.2%	0.0%	1.0%	0.0%	0.9%
Bike	1.1%	0.6%	0.0%	2.3%	0%	1.2%
Walk	2%	12%	8%	8%	10%	7.6%
School Bus	0%	14%	0%	0%	0%	2.3%
TNC	0%	0%	0%	0%	0%	0.2%

Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 6: DIFF IN TOUR MODE SHARES (ABM-NHTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	3.0%	-0.4%	0.0%	0.4%	5.6%	1.2%
SR2	-1.9%	0.2%	-0.1%	0.1%	-3.8%	-0.7%
SR3+	-0.6%	0.5%	0.3%	0.6%	-3.2%	0.0%
Drive Transit	-0.7%	0.0%	0.0%	0.0%	0.0%	-0.2%
Walk Transit	0.0%	-0.4%	0.0%	-0.2%	0.0%	-0.1%
Bike	0.1%	-0.1%	0.0%	0.1%	0.2%	0.1%
Walk	0.1%	0.0%	0.0%	-0.3%	1.3%	0.0%
School Bus	0.0%	-0.1%	-0.2%	-0.7%	0.0%	-0.3%
TNC	0.0%	0.3%	0.0%	0.0%	0.0%	0.1%
Total	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

TABLE 7: TRIP MODE SHARES (NHTS-SJV)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	75%	21%	26%	27%	67%	41.8%
SR2	16%	21%	35%	27%	17%	23.8%
SR3+	5%	25%	31%	25%	9%	19.4%
Transit	0.8%	1.3%	0.0%	1.1%	0.1%	0.8%
Bike	1%	1%	0%	1%	0%	0.7%
Walk	3%	19%	8%	14%	7%	10.1%

School Bus	0%	11%	0%	5%	0%	3.3%
TNC	0%	0%	0%	0%	0%	0.1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 8: TRIP MODE SHARES (ABM)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	76%	21%	20%	34%	70%	43.8%
SR2	13%	18%	34%	30%	13%	23.2%
SR3+	5%	26%	34%	23%	5%	19.3%
Transit	1.0%	0.8%	0.0%	0.8%	0.0%	0.7%
Bike	1%	0%	0%	2%	0%	0.8%
Walk	4%	20%	12%	10%	13%	10.2%
School Bus	0%	13%	0%	0%	0%	1.9%
TNC	0%	0%	0%	0%	0%	0.1%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 9: TRIP MODE SHARES (ABM-NHTS)

MODE	WORK	SCHOOL	ESCORT	OTHER	WORK-BASED	TOTAL
Drive Alone	1.3%	-0.2%	-5.6%	7.7%	2.7%	2.0%
SR2	-2.8%	-2.9%	-0.8%	3.2%	-4.9%	-0.6%
SR3+	0.6%	1.5%	2.7%	-2.4%	-4.0%	-0.1%
Transit	0.2%	-0.6%	0.0%	-0.3%	0.0%	-0.1%
Bike	-0.3%	-0.2%	0.1%	0.5%	0.2%	0.1%
Walk	0.9%	0.7%	3.9%	-4.1%	6.1%	0.1%
School Bus	0.0%	1.4%	-0.3%	-4.6%	0.0%	-1.3%
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 2019. 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
- Anaconda2

Both software are included with the PopulationSim setup delivered to FresnoCOG, therefore, no separate installations are required.

POPULATIONSIM DIRECTORY

Name	Date modified	Type	Size
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 1. PopulationSim Folder Structure

Figure 1 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.

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. It can be run as part of a model run if the "Run_PopSim" key is set to 1. It can also be run on its own by navigating to the PopulationSim module and selecting “Run” and checking “run current application only” as shown in Figure 2.

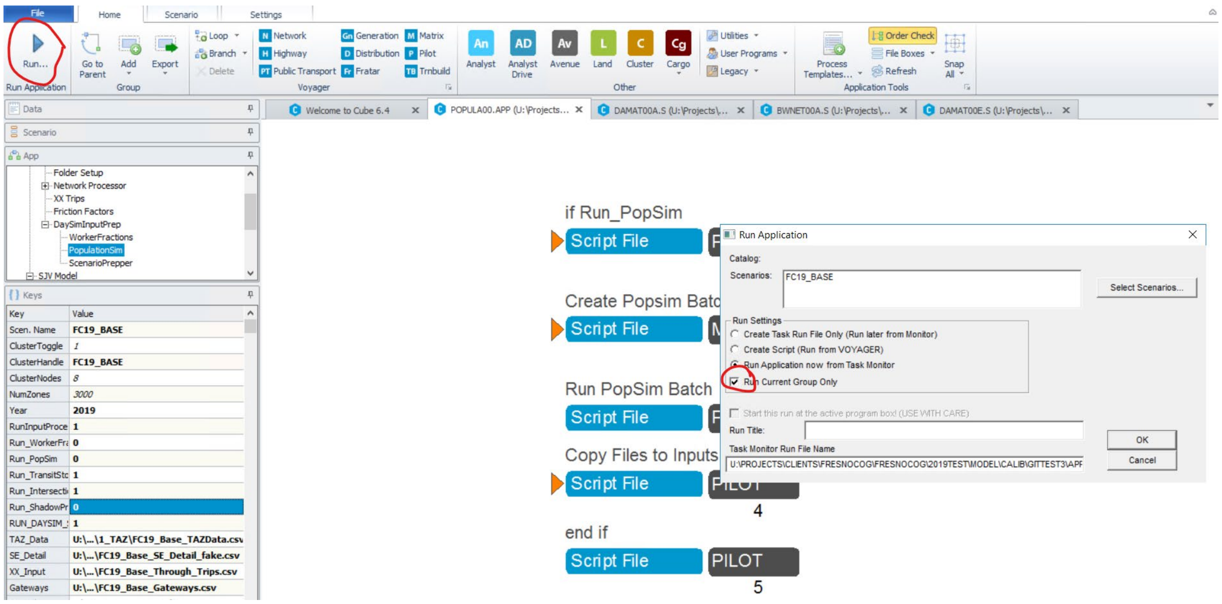


FIGURE 2:RUNNING POPULATIONSIM FROM THE CUBE CATALOG

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, the user should update the files described in the following table:

FILE NAME	FILE LOCATION	DATA
MazData_2019.csv	PopulationSim\Data\MAZ	Number of Households in each MAZ
Gq_maz_2019.csv	PopulationSim\Data\MAZ	Number of University, Military, and other non-institutional group quarters in each MAZ

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 ouputs.

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 2015-2019 5-Year PUMS data. The PUMS data contains 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 create 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 be 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. FresnoCOG 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 update 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 where the point is within. This process is repeated with each geometry. Census shape files block groups and tracts were downloaded for Census 2010 boundaries[1].

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 (2019) Validation

This section first presents the performance of the existing PopulationSim setup and validation of the recommended controls for 2019. A base year (2019) 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 households by presence of children
   e. 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 1 describes the source of data for each control.

Table 1: Control Data Source Description - 2019

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 2.

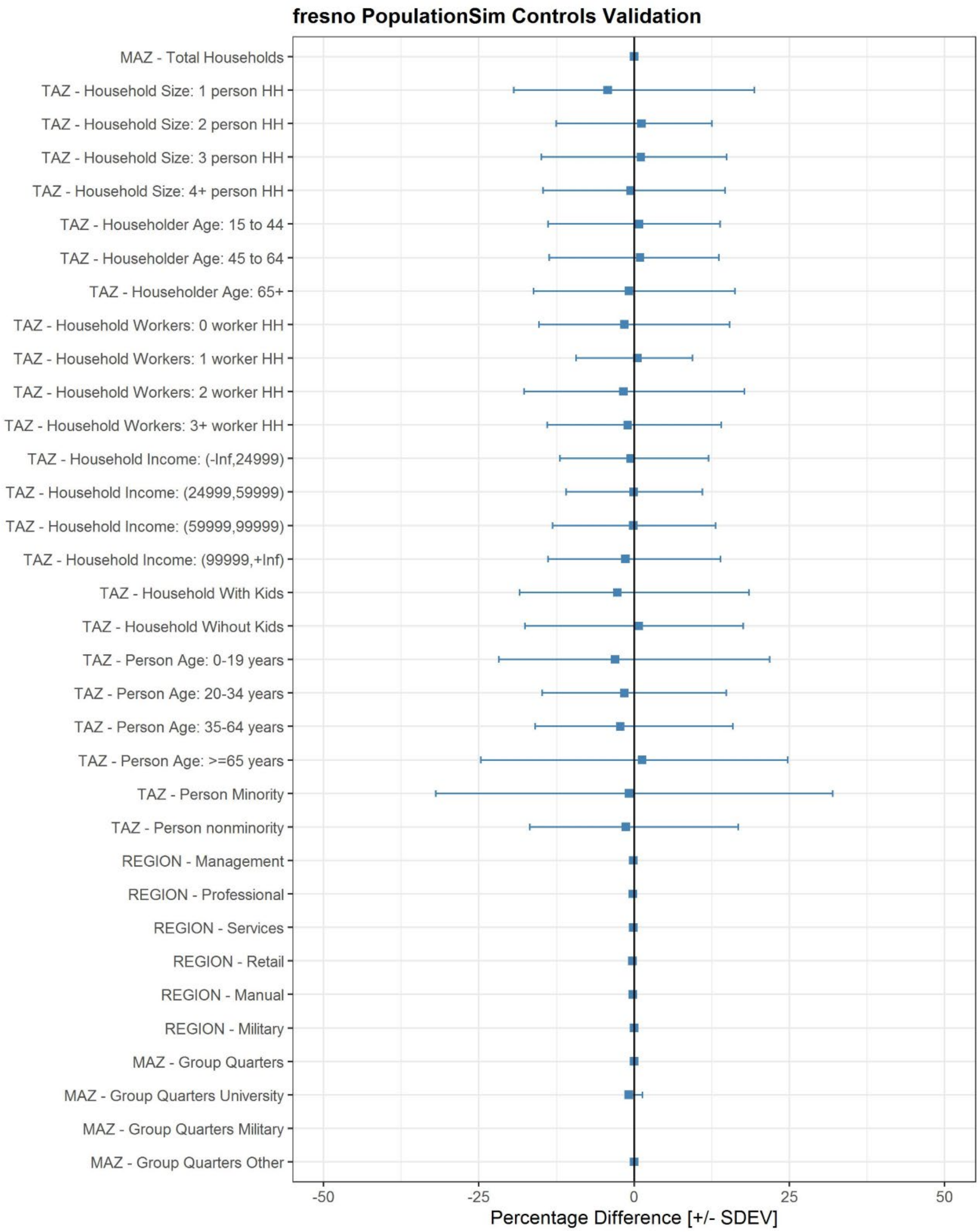


Figure 2: PopulationSim Validation – Base year (2019)

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 FresnoCOG.

Table 1presents 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 1. 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 grade school enrollment
stuhgh_p	Student high school enrollment
stuuni_p	Student university enrollment
empedu_p	NAICS 61
empfoo_p	NAICS 72
empgov_p	NAICS 92
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
empoth_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 1) 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 2.

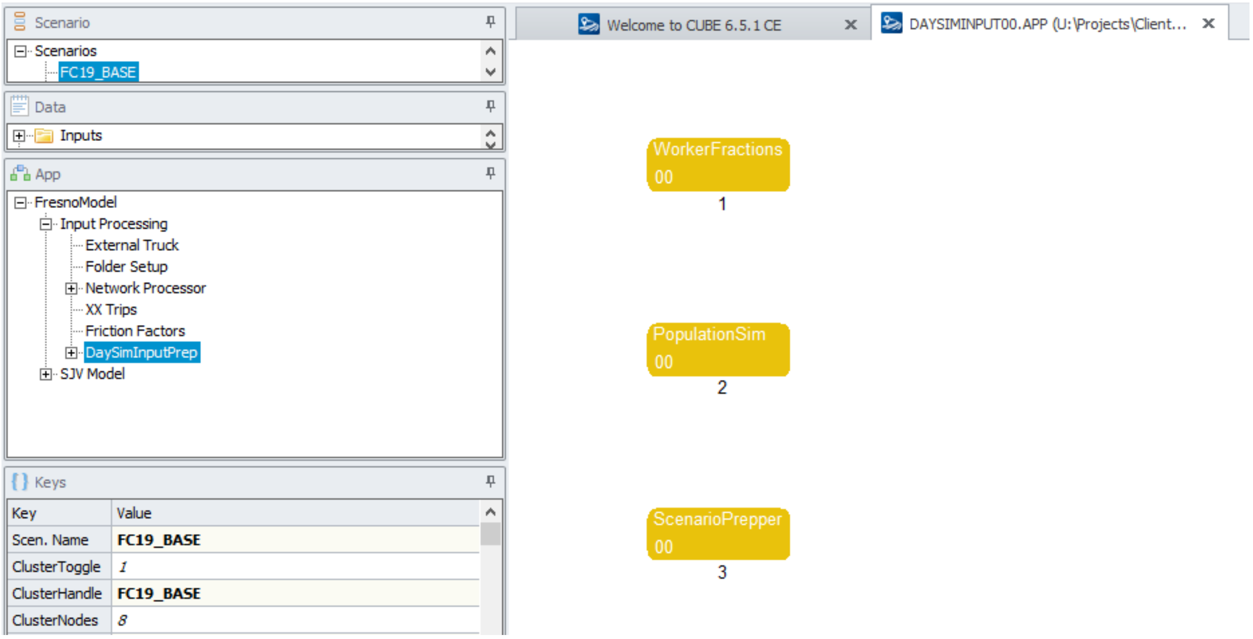


FIGURE 1: DAYSIM INPUT PREP MODULE

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 2: 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.

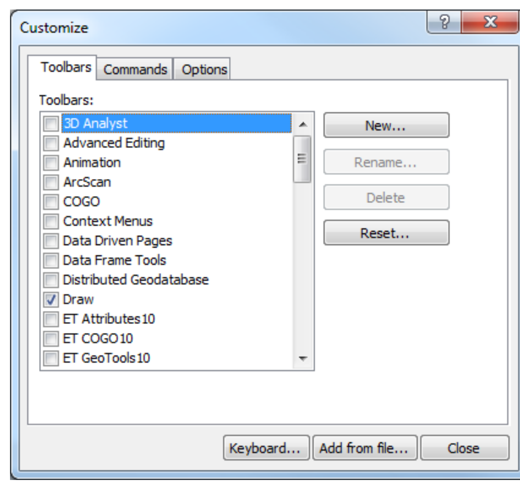
OpenSpace and Parks File

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:

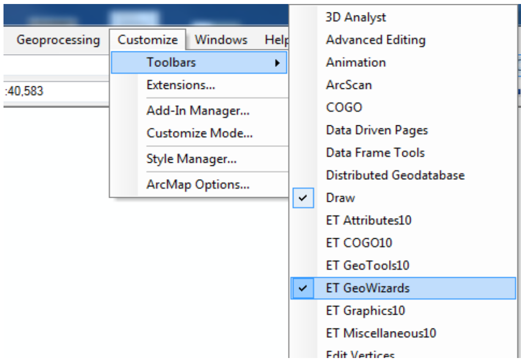
Continue to the next section if the current version of "ET Geowizards" is installed on the work computer.

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.



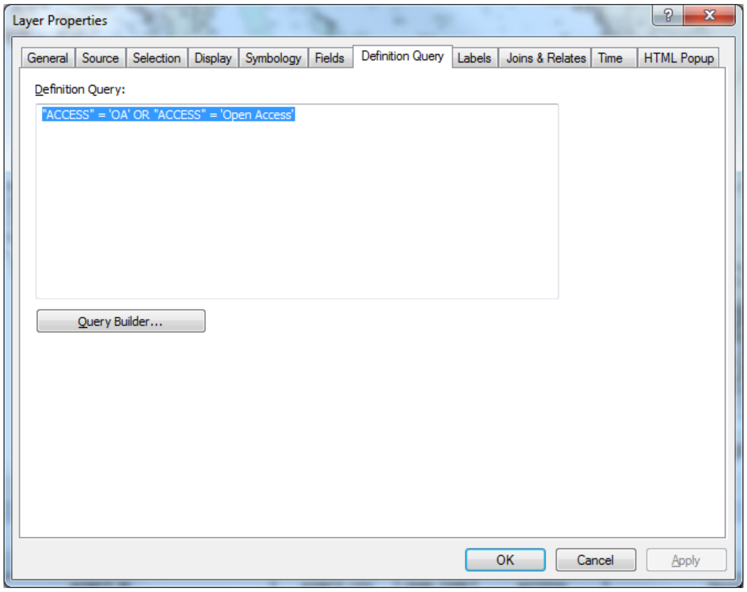
Finding Open source Representations of Protected Areas

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'



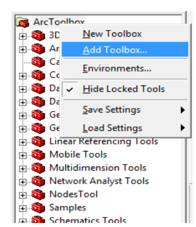
*Note: Users of the "national" database will have to determine their own qualifications for the equivalent of California's "Open Access" space

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

Adding the "OpenspaceTool" to ArcToolbox

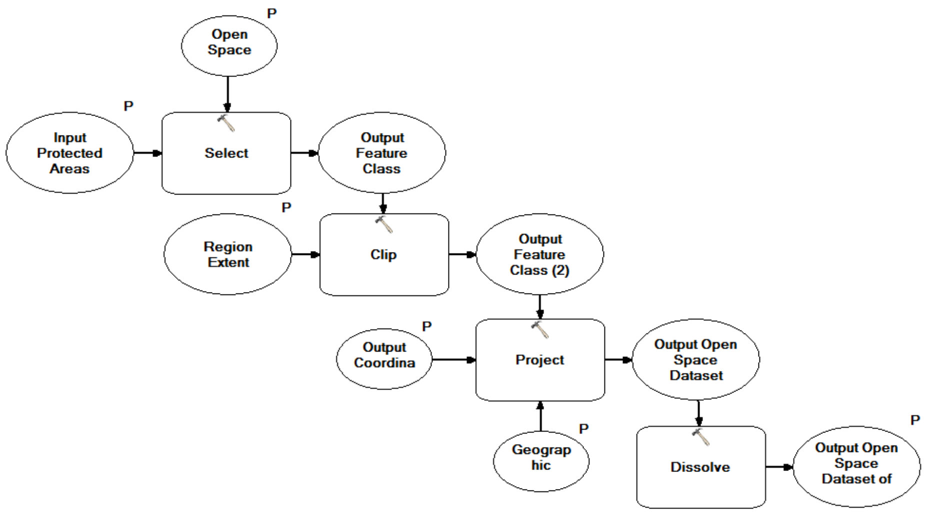
An ArcTool was created to process the data created in the previous steps.

13. Open the ArcToolbox 



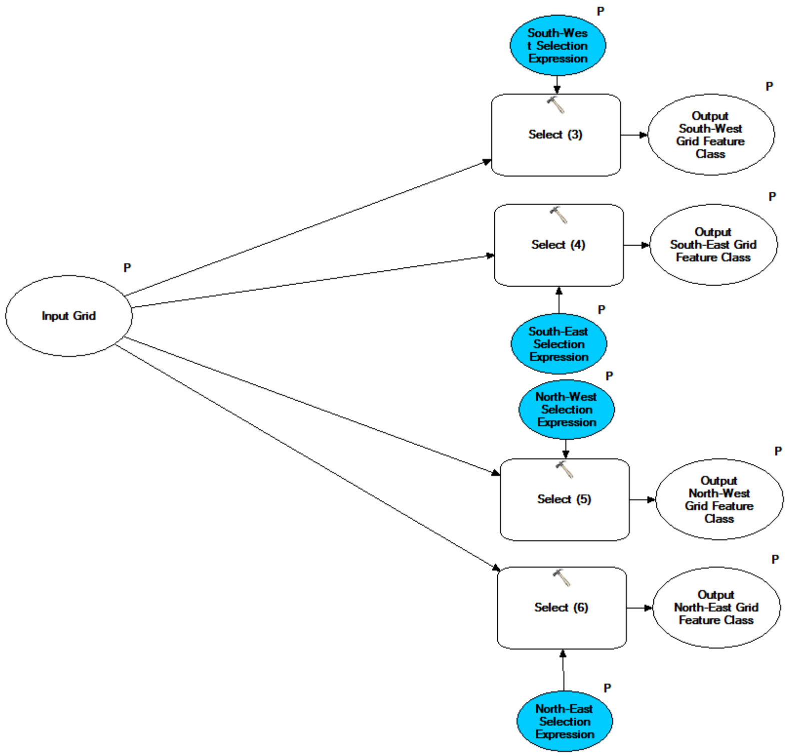
14. Right Click the "ArcToolbox" folder at the top of the directory and select "Add Toolbox"
15. Locate the "ParksTool" Toolbox on the computer and select "Ok"

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



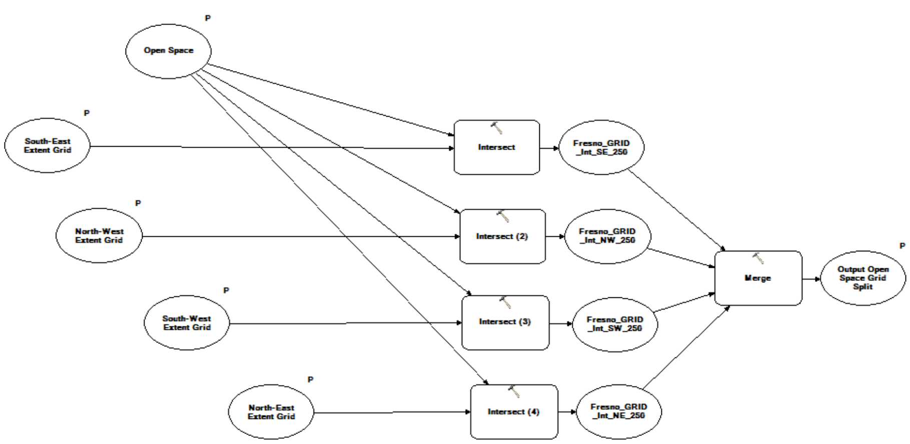
The tool first Selects the data by attribute to subset the “Open Space” data from the larger umbrella of “Protected Areas” (it is up to the user to decide what “attribute” in the database designates a feature as “Open Space”, for the California Data we suggest the "ACCESS" field where attributes are 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.



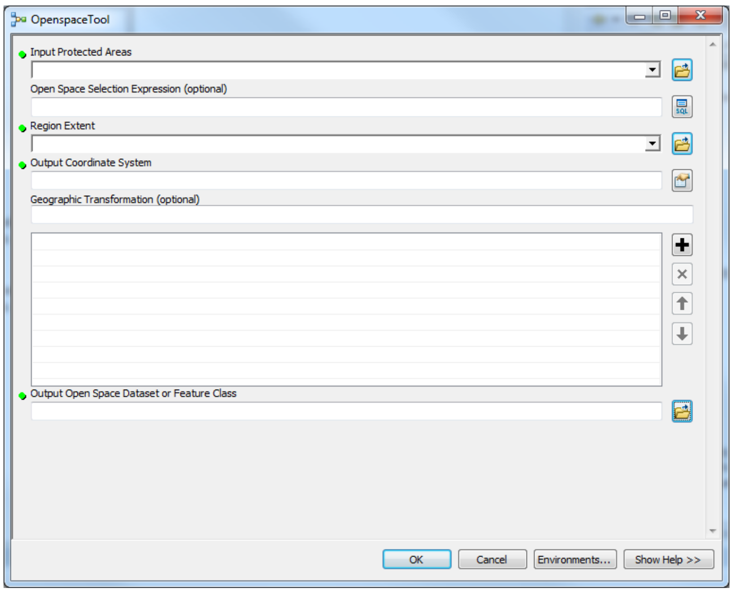
Based on user inputs the tool runs intersect the “Open Space” data with each of the 4 distinct sub-regions; once the data has been intersected, the 4 sub-regions are merged together.

Refining the "Protected Areas" data into "Open Space" Representations

NOTE: Steps 16-19 are not needed as FresnoCOG 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 ETGW

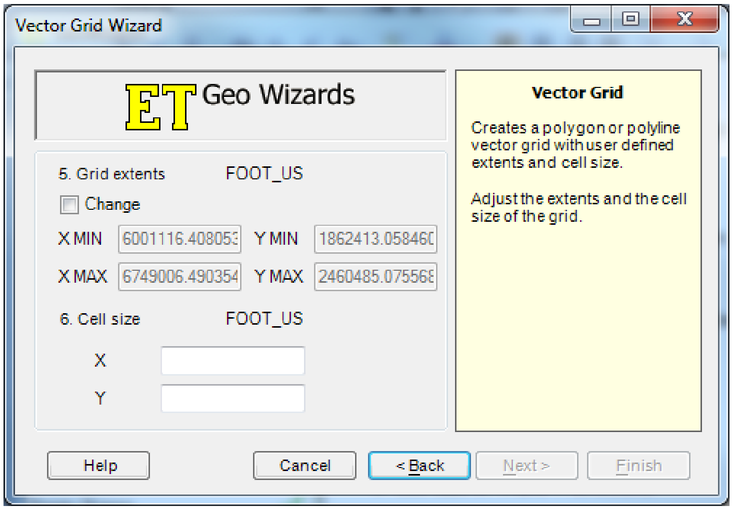
3. Navigate to the “Sampling” Tab → Double Click on the “Vector Grid” tool. A window similar to the one below will appear.

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:

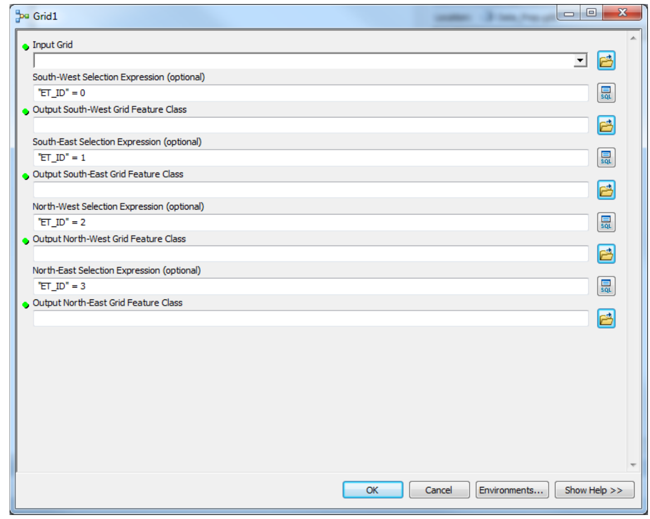


8. Object #5 “Grid extents” will need to be updated. The excel workbook generates the required values based on the region specific data. Copy the “X Min”, “X Max”, “Y Min”, and “Y Max” values into the appropriate cells in the excel workbook. The work book generates new “X Max” and “Y Max” values, copy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

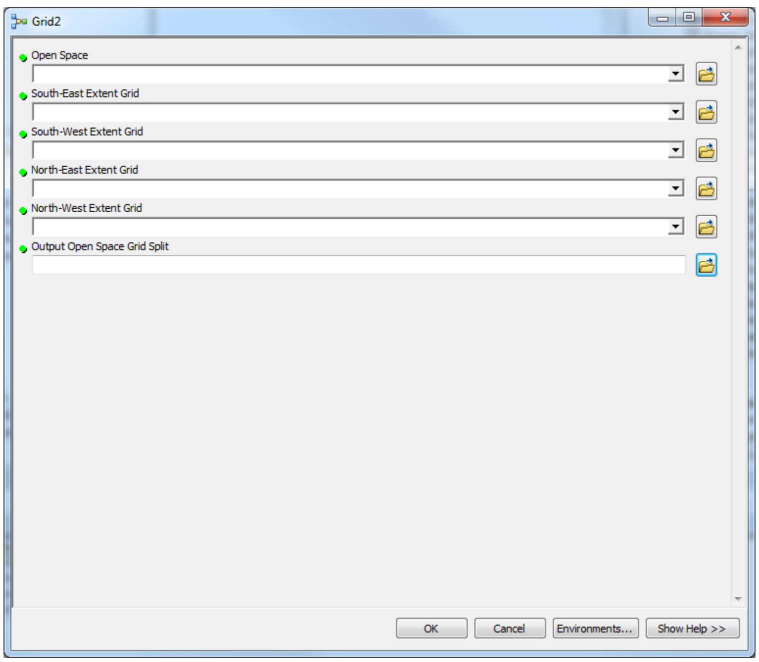
#4 "Select GRID type"- Polygon

#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

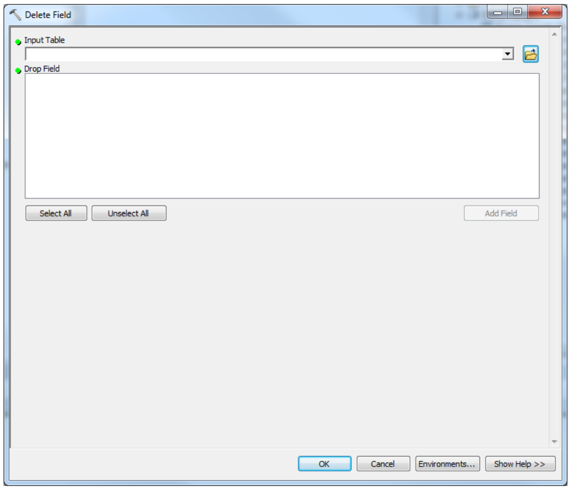
"North-West Extent Grid" -"Extent_Grid_NW_250" feature class

"Output Open Space Grid Split" - Name/Location of choosing

(forward referred to as “Extent Open Space 250”)

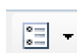
Click the “OK” button once all fields have been properly filled. Make sure the feature class generated through this tool, “Extent Open Space 250”, is added to the display.

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.

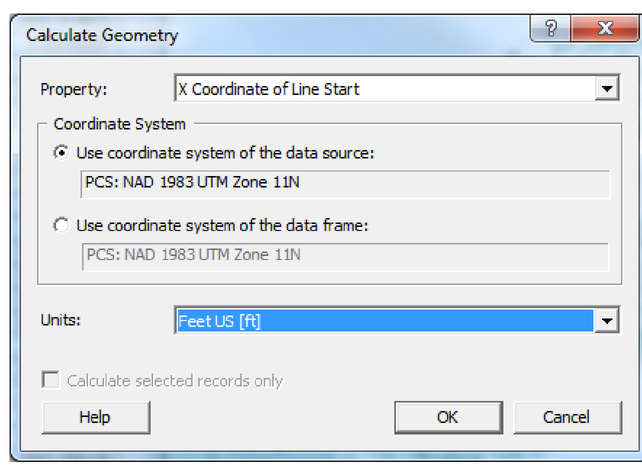
18. Open the “Extent Open Space 250” feature class ‘s attribute table to check that all fields (“ID”, “FID”, “Name”, etc.) have been removed. **Note: some fields are structurally mandatory and cannot be removed.*

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

TABLE 1: 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: • maz_20XX_parks.csv • intersections_20XX_nohwys.csv • 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.

INPUT LOCATION	INSTRUCTION
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 1 presents the settings in the configuration files. The column "VALUE" contains the setting as in the Configuration.properties.

TABLE 1: 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		

SETTING	VALUE	DESCRIPTION
NProcessors	48	Number of processors (threads) to be used
NBatches	50	
Region Specific		
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_allstreets_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 ("lutype_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

SETTING	VALUE	DESCRIPTION
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)
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 exceeeds this MaximumBlendingDistance, DaySim stop using the parcel-parcel distance and just use the zone-zone from the skims.
AllowNodeDistanceAsymmetry	True	
UseShortDistance CircuityMeasures	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

SETTING	VALUE	DESCRIPTION
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		
DataType	Default	Identifies the presence of client-specific household input data (currently only used for Actum)
ChoiceModelRunner	Default	Type of choice model runner
Settings	DefaultSetti ngs	
Debug Settings		
TraceSimulatedChoice Outcomes	false	true to trace simulated choice outcomes
TraceModelResult 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		

SETTING	VALUE	DESCRIPTION
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
UsualSchool PercentTolerance	0	Percentage tolerance to trigger school parcel shadow price adjustment
UsualSchool AbsoluteTolerance	0	Absolute tolerance to trigger school parcel shadow price adjustment

SETTING	VALUE	DESCRIPTION
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		
ShouldRunChoiceModels	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)

SETTING	VALUE	DESCRIPTION
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)
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)

SETTING	VALUE	DESCRIPTION
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
Inernal-External Workers Settings		

SETTING	VALUE	DESCRIPTION
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)
IxxiFirstLineIsHeader	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)
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)

SETTING	VALUE	DESCRIPTION
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
OutputPerson Delimiter	9	Delimiter for the person output file (9=TAB, 32=space, 44=comma)
OutputHousehold DayPath	_household_day.tsv	
OutputHousehold DayDelimiter	9	Household day output filename
OutputPersonDay Path	_person_day.tsv	Person day output filename

SETTING	VALUE	DESCRIPTION
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.tsv	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		
ShouldLoadAggregate LogsumsFromFile	False	true to read the aggregate logsums from a file generated by a previous run (otherwise recalculated)

SETTING	VALUE	DESCRIPTION
ShouldOutput AggregateLogsums	True	true to write the aggregate logsums to a file for a subsequent run
OutputAggregate LogsumsPath	aggregate_logsums.dat	File name to write out aggregate logsums
ShouldLoadSampling WeightsFromFile	False	true to read the precalculated sampling weights from a file generated by a previous run (otherwise recalculated)
ShouldOutputSampling Weights	False	true to write the precalculated sampling weights to a file for a subsequent run
OutputSampling WeightsPath	sampling_weights.dat	File name write out sampling weights
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
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).

SETTING	VALUE	DESCRIPTION
SchoolLocationModelSample Size	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
IncludePayTo ParkAtWorkplace Model	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).

SETTING	VALUE	DESCRIPTION
TransitPassOwnership ModelCoefficients	.\07_Coefficients\TransitPassOwnershipCoefficients.F12	Path of the coefficient file for the transit pass ownership model
ShouldRunTransit PassOwnershipModel	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
IncludeTransit PassOwnershipModel	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).
AutoOwnership ModelCoefficients	.\07_Coefficients\AutoOwnershipCoefficients.F12	Path of the coefficient file for the auto ownership model
ShouldRun AutoOwnershipModel	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
IndividualPerson DayPatternModel Coefficients	.\07_Coefficients\IndividualPersonDayPatternCoefficients.F12	Path of the coefficient file for the individual person-day pattern model
ShouldRunIndividual PersonDayPattern 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

SETTING	VALUE	DESCRIPTION
PersonExactNumberOf ToursModel Coefficients	.\07_Coefficients\PersonExactNumberOfToursCoefficients.F12	Path of the coefficient file for the person exact number of tours model
ShouldRunPerson ExactNumberOf Tours 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
WorkTourDestination ModelSampleSize	100	Maximum number of destinations to be sampled for the work tour destination model
WorkTourDestination ModelCoefficients	.\07_Coefficients\WorkTourDestinationCoefficients.F12	Path of the coefficient file for the work tour destination model
ShouldRunWorkTour DestinationModel	True	
OtherTourDestination ModelSampleSize	100	Maximum number of destinations to be sampled for the other tour destination model
OtherTourDestination ModelCoefficients	.\07_Coefficients\OtherTourDestinationCoefficients.F12	Path of the coefficient file for the tour destination model
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

SETTING	VALUE	DESCRIPTION
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
WorkBasedSubtour ModeModelCoefficients	.\07_Coefficients\WorkBasedSubtourModeCoefficients.F12	Path of the coefficient file for the work-based subtour mode model
ShouldRunWorkBased SubtourModeModel	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
EscortTourMode ModelCoefficients	.\07_Coefficients\EscortTourModeCo	Path of the coefficient file for the escort tour model model

SETTING	VALUE	DESCRIPTION
	efficients.F12	
ShouldRunEscort TourModeModel	True	A toggle switch to run the escort tour model model; can be used for partial runs, true can be overridden by more general switches above
OtherHomeBased TourModeModel Coefficients	.\07_Coefficients\OtherHomeBasedTourModeCoefficients.F12	Path of the coefficient file for the other home-based tour mode model
ShouldRunOther HomeBasedTour ModeModel	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
ShouldRunWorkTour TimeModel	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
SchoolTourTime ModelCoefficients	.\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

SETTING	VALUE	DESCRIPTION
OtherHomeBasedTour TimeModelCoefficients	.\07_Coefficients\OtherHomeBasedTourTimeCoefficients.F12	Path of the coefficient file for the other home-based tour time model
ShouldRunOtherHomeBased Tour TimeModel	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
IntermediateStopGeneration ModelCoefficients	.\07_Coefficients\IntermediateStopGenerationCoefficients.F12	Path of the coefficient file for the intermediate stop generation model
ShouldRunIntermediate StopGenerationModel	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
IntermediateStopLocation ModelSampleSize	100	The maximum number of destinations to be sampled for the intermediate stop location model

SETTING	VALUE	DESCRIPTION
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
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.

SETTING	VALUE	DESCRIPTION
PathImpedance_ AutoOperating CostPerMile	0.22	Auto operating cost, in monetary units per distance unit
PathImpedance_ TransitInVehicle TimeWeight	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 coeffcient, which is set in the VOT parameters.
PathImpedance_ TransitFirst WaitTimeWeight	2.0	Relative weight on transit first wait time in the transit and park-and-ride path-type models
PathImpedance_ TransitTransfer WaitTimeWeight	2.0	Relative weight on transit transfer wait time in the transit and park-and-ride path-type models
PathImpedance_ TransitNumber BoardingsWeight	8.0	Relative weight on transit number of boardings in the transit and park-and-ride path-type models
PathImpedance_ TransitDriveAccess TimeWeight	2.0	Relative weight on transit drive access in-vehicle time in the park-and-ride path-type models
PathImpedance_ TransitWalkAccess TimeWeight	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

SETTING	VALUE	DESCRIPTION
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_ TransitWalkAccess DistanceLimit	1.0	Maximum parcel-based transit walk access or egress distance allowed for available transit paths
PathImpedance_TransitWalk AccessDirectLimit	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 >=TransitSingleBoardingLimit). The fraction is because some transit skims are an average across multiple paths, some direct and some not.

SETTING	VALUE	DESCRIPTION
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
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)

SETTING	VALUE	DESCRIPTION
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)
PathImpedance_ TransitCommuterRail TimeAdditiveWeight	-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_ BikeUseTypeSpecific DistanceFractions	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)

SETTING	VALUE	DESCRIPTION
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)
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 FractionUniverity Student	0.5	Transit fare discount fraction for college students
PathImpedance_ TransitFareDiscount FractionAge65Up	0.5	Transit fare discount fraction for adults age 65+

SETTING	VALUE	DESCRIPTION
PathImpedance_ TransitPassCost PercentChangeVersus Base	0	Policy input variable to change the cost of transit passes with respect to base year
Path-type Impedance Coefficients		
Coefficients_ BaseCostCoefficient PerDollar	-0.15	Base cost coefficient (per monetary unit), when income=BaseCostCoefficientIncomeLevel
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

SETTING	VALUE	DESCRIPTION
Coefficients_ StdDeviationTime Coefficient_Other	1.0	Standard deviation of the time coefficient (/minute) for nonwork tours, when using random VOT distribution
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		
UseDiaryVsSmartphoneBias Variables	TRUE	
UseProxyBiasVariables	TRUE	
UseWorkAtHomeModelAndV ariables	TRUE	Toggle Telecommute Model On/Off with True/False Value
WorkAtHome_DurationThres hold	2.5	Minimum hours that must be worked at home to be considered “telecommuting”

SETTING	VALUE	DESCRIPTION
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
WorkAtHome_IncomeOver150Coefficient	0.3	Income >150K telecommute coefficient
WorkAtHome_NonWorkerAndKidsInHHCoefficient	0.399	Non-worker with Kids 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

SETTING	VALUE	DESCRIPTION
PaidRideshare_1PassengerShareForWorkTours	0.7	
PaidRideshare_2PassengerShareForWorkTours	0.2	
PaidRideshare_AverageNumberFor3plusPassengerWorkTours	4	
PaidRideshare_1PassengerShareForSchoolTours	0.5	
PaidRideshare_2PassengerShareForSchoolTours	0.3	
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

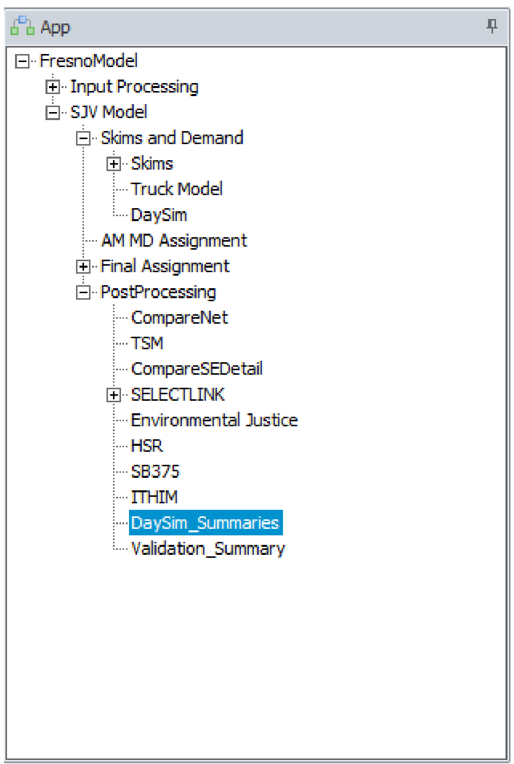
Telecommute models can be turned on by adjusting the configurations in the DaySim module (Step 10 and 15). The “UseWorkAtHomeModelAndVariables” variable should be switched to True as shown in Figure 1.

```
'\n',
'\nPaidRideshare_1PassengerShareForEscortTours = 0.1',
'\nPaidRideshare_2PassengerShareForEscortTours = 0.4',
'\nPaidRideshare_AverageNumberFor3plusPassengerEscortTours = 3.3',
'\n',
'\nPaidRideshare_1PassengerShareForOtherTours  = 0.45',
'\nPaidRideshare_2PassengerShareForOtherTours = 0.35',
'\nPaidRideshare_AverageNumberFor3plusPassengerOtherTours = 4.25',
'\n',
'\nUseDiaryVsSmartphoneBiasVariables = True',
'\nUseProxyBiasVariables = True',
'\nUseWorkAtHomeModelAndVariables = False',
'\nWorkAtHome_DurationThreshold = 2.5',
'\nWorkAtHome_AlternativeSpecificConstant = -1.8067',
'\nWorkAtHome_PartTimeWorkerCoefficient = -0.264',
'\nWorkAtHome_Income0to50Coefficient = 0.349',
'\nWorkAtHome_IncomeOver150Coefficient = 0.3',
'\nWorkAtHome_NonWorkerAndKidsInHHCoefficient = 0.399',
'\nWorkAtHome_NoVehiclesInHHCoefficient = 0.412',
'\nWorkAtHome_FractionMedicalJobsCoefficient = -0.415',
'\nWorkAtHome_FractionEducationJobsCoefficient = 0',
'\nWorkAtHome_FractionServiceJobsCoefficient = 0',
'\nWorkAtHome_FractionOtherJobsCoefficient = 1.396',
'\nWorkAtHome_FractionGovernmentJobsLowIncomeCoefficient = -0.65',
'\nWorkAtHome_FractionIndustrialJobsLowIncomeCoefficient = -0.402',
'\nWorkAtHome_FractionRetailFoodJobsLowIncomeCoefficient = -0.418',
'\nWorkAtHome_FractionOfficeJobsLowIncomeCoefficient = -0.63',
'\nWorkAtHome_FractionGovernmentJobsHigherIncomeCoefficient = -0.311',
'\nWorkAtHome_FractionIndustrialJobsHigherIncomeCoefficient = 0.431',
'\nWorkAtHome_FractionRetailFoodJobsHigherIncomeCoefficient = -0.385',
'\nWorkAtHome_FractionOfficeJobsHigherIncomeCoefficient = 0.295',
'\n'
```

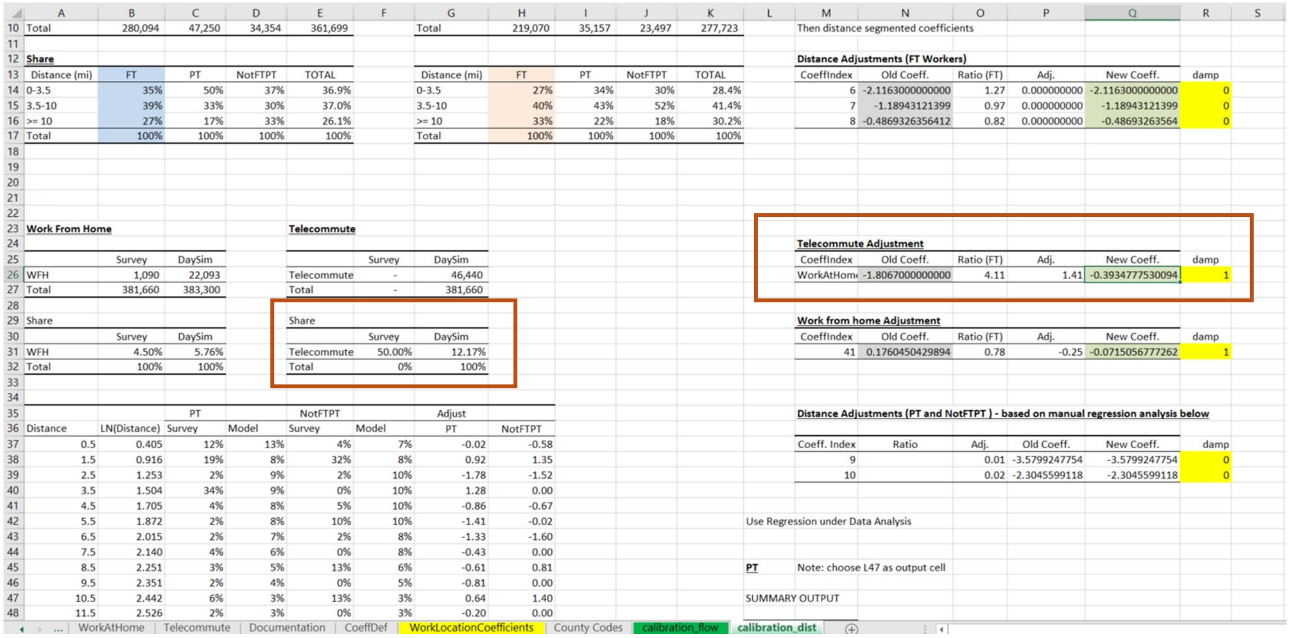
FIGURE 1: DAYSIM CONFIGURATION TELECOMMUTE PARAMETER

After you run DaySim with this flag set to True, the *person* day.tsv file output from Daysim will have a field ‘wkathome’ 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) includes some helpful calculations. The user must:

1. Populate cell F31 with the desired telecommute share.
2. Populate cell N26 with the current Telecommute Alternative Specific Constant (ASC) (line 384 of the Daysim Configuration generation script Figure 1.)
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 from "1_Inputs\8_daySim\09_SeedShadow" 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".
   i. 

6. Repeat until the desired share is met.



	FT	PT	NotFTPT	TOTAL
Total	280,094	47,250	34,354	361,699

Share

Distance (mi)	FT	PT	NotFTPT	TOTAL
0-3.5	35%	50%	37%	36.9%
3.5-10	39%	33%	30%	37.0%
>= 10	27%	17%	33%	26.1%
Total	100%	100%	100%	100%

	FT	PT	NotFTPT	TOTAL
Total	219,070	35,157	23,497	277,723

Distance (mi)	FT	PT	NotFTPT	TOTAL
0-3.5	27%	34%	30%	28.4%
3.5-10	40%	43%	52%	41.4%
>= 10	33%	22%	18%	30.2%
Total	100%	100%	100%	100%

Then distance segmented coefficients

Distance Adjustments (FT Workers)

CoeffIndex	Old Coeff.	Ratio (FT)	Adj.	New Coeff.	damp
6	-2.1163000000000	1.27	0.000000000	-2.1163000000000	0
7	-1.18943121399	0.97	0.000000000	-1.18943121399	0
8	-0.4869326356412	0.82	0.000000000	-0.48693263564	0

Work From Home

	Survey	DaySim
WFH	1,090	22,093
Total	381,660	383,300

Share

	Survey	DaySim
WFH	4.50%	5.76%
Total	100%	100%

Telecommute

	Survey	DaySim
Telecommute	-	46,440
Total	-	381,660

Share

	Survey	DaySim
Telecommute	50.00%	12.17%
Total	0%	100%

Telecommute Adjustment

CoeffIndex	Old Coeff.	Ratio (FT)	Adj.	New Coeff.	damp
WorkAtHom	-1.8067000000000	4.11	1.41	-0.3934777530094	1

Work from home Adjustment

CoeffIndex	Old Coeff.	Ratio (FT)	Adj.	New Coeff.	damp
41	0.1760450429894	0.78	-0.25	-0.0715056777262	1

		PT		NotFTPT		Adjust	
Distance	LN(Distance)	Survey	Model	Survey	Model	PT	NotFTPT
0.5	0.405	12%	13%	4%	7%	-0.02	-0.58
1.5	0.916	19%	8%	32%	8%	0.92	1.35
2.5	1.253	2%	9%	2%	10%	-1.78	-1.52
3.5	1.504	34%	9%	0%	10%	1.28	0.00
4.5	1.705	4%	8%	5%	10%	-0.86	-0.67
5.5	1.872	2%	8%	10%	10%	-1.41	-0.02
6.5	2.015	2%	7%	2%	8%	-1.33	-1.60
7.5	2.140	4%	6%	0%	8%	-0.43	0.00
8.5	2.251	3%	5%	13%	6%	-0.61	0.81
9.5	2.351	2%	4%	0%	5%	-0.81	0.00
10.5	2.442	6%	3%	13%	3%	0.64	1.40
11.5	2.526	2%	3%	0%	3%	-0.20	0.00

Distance Adjustments (PT and NotFTPT) - based on manual regression analysis below

Coeff. Index	Ratio	Adj.	Old Coeff.	New Coeff.	damp
9		0.01	-3.5799247754	-3.5799247754	0
10		0.02	-2.3045599118	-2.3045599118	0

Use Regression under Data Analysis

PT Note: choose L47 as output cell

SUMMARY OUTPUT

FIGURE 2: TELECOMMUTE ASC ADJUSTMENT

TELECOMMUTE SENSITIVITY TEST TELEWORKING

The new version of DaySim includes a telecommuting model which predict if workers with a usual out of home work location will work at least 2-4 hours from home on the given model day. This model includes an alternative specific constant which must be calibrated to the desired share of telecommuters. This sensitivity test is meant to show the regional effects when the teleworking share changes.

Model setup

Two scenarios are tested: telecommute target share is 25% (High Tech 1) and telecommute share is 50% (High Tech 2). The alternative specific constant is calibrated so the telecommute frequency matches the targets. Shadow pricing is kept on.

Results

The actual shares of telecommuting for each run is 25% and 50.9%. Table 85 shows that VMT decreased 0.72% in the High Tech 1 test, and decreased 0.82% in the High Tech 2 test. This is not unexpected as teleworking tends to increase trips with purposes other than work. Table 86 shows the tours by purpose in each scenario. The total number of tours in both telecommute scenarios is lower than the base number of tours with the most reduction happening in work purposes (work and work-based). The number of tours is higher in scenario High Tech 2 compared to High Tech 1, however, the number of trips is lower (Table 87). This suggests that higher telecommuting patterns may not increase overall travel, but changes the relationship of that travel to have more single purpose tours. For example, instead of making a shopping or escort trip as part of a work tour, an escort or shopping tour is generated.

TABLE 85: TELECOMMUTE TEST VMT

MEASURE	BASE	HIGH TECH 1	HIGH TECH 2
VMT	24,878,881	24,699,025	24,673,974
VMT Diff.	-	(179,856)	(204,907)
VMT Diff.%	-	-0.72%	-0.82%
Telecommute%	0%	25.0%	50.9%

TABLE 86: TELECOMMUTE TEST TOURS BY PURPOSE

PURPOSE	BASE	HIGH TECH 1	HIGH TECH 2
work	284,947	282,196	278,790
school	198,938	200,572	202,706
escort	218,809	215,690	217,427
pers.bus	129,172	128,048	129,232
shop	126,205	125,324	127,667
meal	46,745	46,114	47,562
soc/rec	148,877	146,236	148,893
work based	82,738	80,829	78,223
Total	1,236,430	1,225,009	1,230,500

TABLE 87: TELECOMMUTE TEST TRIPS BY PURPOSE

DEST PURPOSE	BASE	HIGH TECH 1	HIGH TECH 2
work	424,418	418,239	411,309
school	215,527	216,768	218,465
escort	341,055	337,719	336,248
pers.bus	371,750	365,227	362,101
shop	490,246	486,919	485,913
meal	302,583	299,184	298,389
soc/rec	251,700	248,064	248,543
home	1,150,937	1,142,181	1,150,259
Total	3,548,216	3,514,301	3,511,226

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 summaires
Zonal data	Path to zonal data file
Socio-economic detail	Path to social economic detail 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
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)	
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 cooridnates of transit notes file
Peak transit lines file	Path to peak transit lines file
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
FricFacParam	Path to friction factors parameters file
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)
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)
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	
Seed shadow price file	Path to seed shadow price file
AOF_SR3	
DaySimSeed	DaySim seed
NumMAZ	Number of MAZs
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