

2 Model Overview

2.1 Key Concepts and Parameters

SACSIM is a *typical weekday* model. It represents travel demands for a typical weekday, defined as a mid-week day (Tuesday, Wednesday or Thursday) during a Spring or early Fall month (March, April, May, September or October). Mid-week days are used because Mondays and Fridays are often affected by holiday or weekend activities or events. Spring or Fall months are used because those are months when schools are normally in session, weather does not often affect peoples' activities or travel, and a lower percentage of workers are on vacation. Activities and travel in late Fall and Winter months (November through February) are strongly affected by major holidays (Thanksgiving, Christmas, New Years Day, etc.) and inclement weather. Where required, typical weekday performance measures are annualized to represent travel through the course of the year, rather than only for a typical weekday. Figure 2-1 provides a high-level overview of the SACSIM model.

The term *simulation* is used in so many ways related to transportation modeling and analysis, that its use causes confusion, even to transportation professionals. The dictionary definition of *simulation* which is applicable to SACSIM is "...the imitative representation of the functioning of one system or process by means of the functioning of another <a computer ~ of an industrial process>; examination of a problem often not subject to direct experimentation by means of a simulating device..."¹ This general definition fits SACSIM, but also fits many other four-step travel demand models. Two characteristics of *transportation simulations* which apply to SACSIM, and distinguish SACSIM from four-step travel demand models are: 1) disaggregate application; and 2) explicit treatment of time.

In truth, only one key submodel which makes up SACSIM is truly a simulation, and that is DAYSIM. DAYSIM is disaggregate in its application—its units of analysis, or agents, are people. The units of analysis for conventional four-step models are TAZs. DAYSIM applies models estimated on a household travel survey of individual people to a representative population file with one record per person, and all person-level variables in the estimation accounted for explicitly in the model. Calibration aside, the model estimated is the model applied. For conventional four-step models, many of the key variables included in the estimated model are aggregated and simplified, with true distributions of behavior represented by the averages for groups of individuals.

DAYSIM also explicitly treats time. Durations of activities and travel times are constrained by the length of a day, and travel choices as modeled account for time explicitly in 30 minute blocks. Most conventional four-step models actually model a complete day's travel as a number of trips, with those trips blocked into times post-hoc, using fixed time factors or aggregate "choice" models.

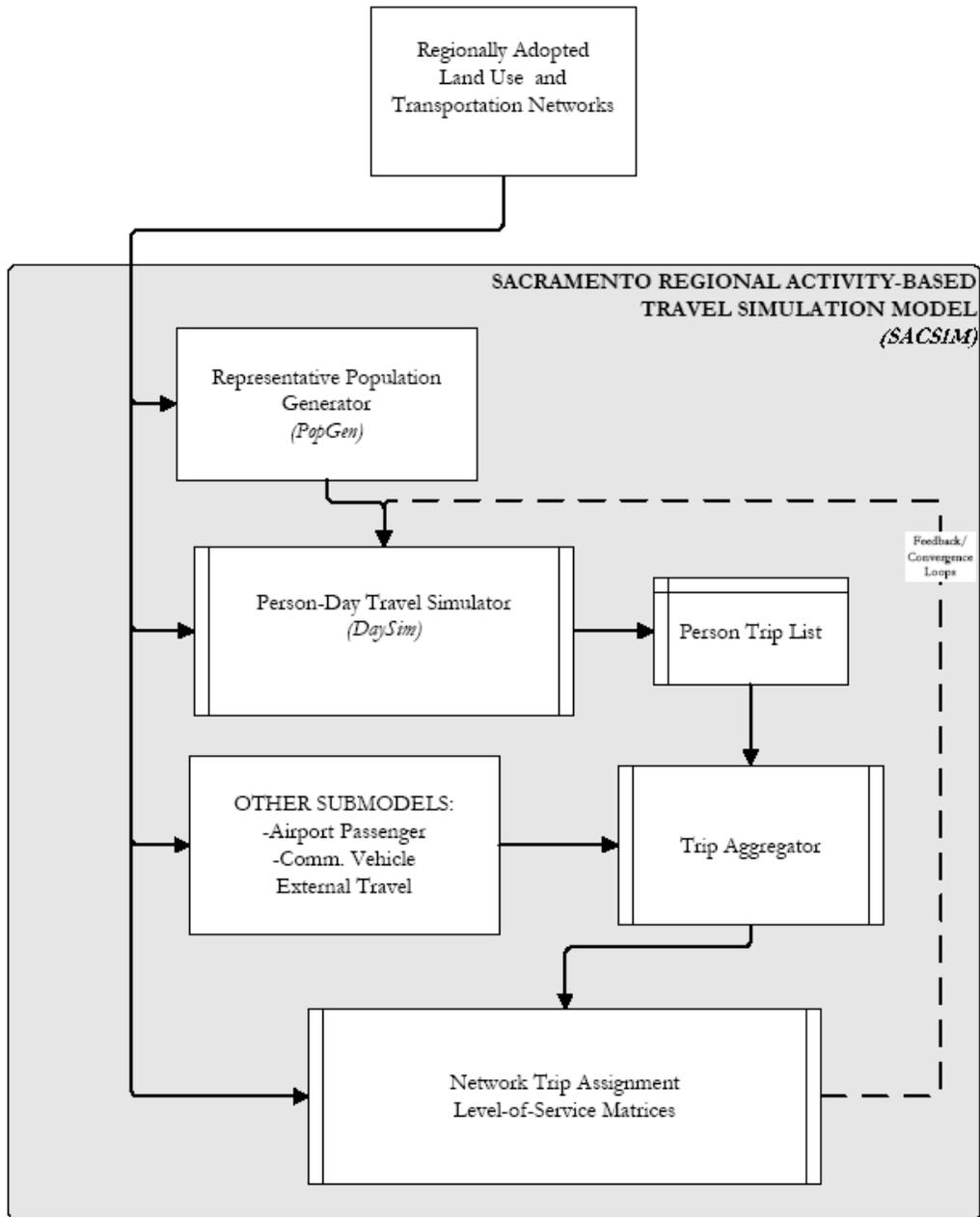
No other submodel within SACSIM is a true simulation. The airport passenger ground access model is a pseudo-simulation, with the model applied by enumerating the actual passenger survey

¹ Webster's Ninth New Collegiate Dictionary, Merriam-Webster, 1987.

database. The remaining submodels (commercial travel, external travel) are applied to TAZ's as the unit of analysis, and treat time post hoc through fixed factors.

When many transportation professionals hear *transportation simulation* what they think of is one of the increasingly prevalent *traffic operations simulations*, which show cars, or in some cases, cars, transit vehicle, and pedestrians, in animations. Some of the animations have vivid detail, e.g. three-dimensional vehicles and people, set in a world with buildings, streets, and even street fixtures and furniture shown in 3-D. SACSIM is NOT this sort of simulation. In fact, SACSIM skims and assigns trips in same old, TAZ-based, static way that is used by conventional four-step travel demand models. DAYSIM simulates the demand for travel, but the actual assignment of that demand to highway and transit networks is not simulated.

Figure 2-1 SACSIM Model System



2.2 Hardware and Software Requirements

As noted in the public access section above. SACSIM19 files and software are open to the public. However, the current version of the model does require specific hardware and software to run. Table 2-1 provides minimum recommended hardware specific to run SACSIM.

2.2.1 Hardware

Table 2-1 Minimum Hardware Recommendations

CPU Speed	Minimum: 1.5 GHz single core Recommended: 2.0 GHz dual-core or better With Cluster: 2.0 GHz quad-core or better
Processor	Minimum: Intel Pentium 4, AMD Athlon Recommended: Intel Core i5, i7, Xeon or better; AMD Phenom II, Athlon II, FX-Series, A-Series APU or better
Memory/RAM	1 GB minimum; 4 GB or higher recommended With Cluster: 2 GB per core recommended
Hard Disk	Minimum: ATAPI IDE; 5,400 rpm Recommended: SATA 3 Gb/s or 6 Gb/s; SAS; 7,200 RPM or better; SSD
Hard Disk Space	10 GB for the application and supporting applications and data (like GIS)100+ GB for output files
Screen Resolution	Minimum: 1024 x 768 at Normal size (96dpi); 16-bit color depth Recommended: 1440 x 900 or higher at Normal size (96dpi); 32-bit color dept
Video/Graphics Adapter	Minimum: 24-bit capable graphics adapter; 64 MB video memory Recommended: 32-bit capable graphics adapter; 512 MB or more video memory
Networking Hardwar	100BT or 1000BT TCP-IP compatible Ethernet or Wireless adapter
Peripherals	DVD-ROM drive(1) available USB port, parallel port, ExpressCard slot, or PCMCIA slot for hardware dongle
Operating System	Recommended: Windows 10
<i>Server Configuration</i>	
CPU Speed	2.0 GHz quad-core or higher; multiple CPUs are ideal

Processor	Recommended: Intel Xeon E3, E5, E7; AMD Opteron 42xx, 43xx, 62xx, 63xx, 83x
Memory/RAM	4 GB minimum; 16 GB or higher recommended, For Cluster, used in SACSIM19: 2 GB per core recommended
Hard Disk	Recommended: SATA 3 Gb/s or 6 Gb/s; SAS; 7,200 RPM or better; SSD
Hard Disk Space	10 GB for the application and supporting applications and data (like GIS)100+ GB for output files

Source: SACOG 2020. Hardware recommendations based primarily on Bentley (formerly Citilabs) Cube Base Reference Guide Recommended workstation and server configurations for Cube Base Version 6.4.4.

2.2.2 Software

SACOG staff uses a variety of software applications to develop, run, and analyze SACSIM19. The section is broken out into two primary categories. Required software is necessary to run SACSIM19. Nonrequired software is additional software that SACOG staff use to develop and maintain SACSIM19, however the model does not explicitly need any of these to be run.

2.2.2.1 Required Software

2.2.2.1.1 Operating system

Microsoft Windows (64-bit version), such as Windows 10.

2.2.2.1.2 Cube Voyager 6.4.4 Software

Cube is a proprietary software package, which is produced, licensed, and marketed by Bentley Systems, Inc. Thus, to run the regional travel model, you will need to purchase the Cube software from Citilabs (www.citilabs.com). Cube software license is required to run SACSIM19.

Cube Voyager: Cube Voyager is the numerical engine that powers the Cube suite of software and includes its own proprietary scripting language. SACSIM19 was developed and applied by using Cube versions 6.4.4.

Cube Cluster

Cube Cluster is also part of the Cube software package used for distributed processing, by running processes across multiple cores. Cube cluster significantly reduces model run times. If not available, Cube clustering can be turned off in SACSIM19 script, but model run time will significantly increase and this is not recommended.

2.2.2.1.3 DAYSIM

DAYSIM a travel demand microsimulation software package that works in conjunction with network modeling software packages to forecast a population’s response to changes in transport infrastructure and policy. DAYSIM uses an integrated system of discrete choice models to simulate long term choices for each household, and the activity and travel choices for a 24-hour period for each household member. It uses 48 half-hour time periods across the day as the basic units of

temporal resolution, and uses either individual parcels of land or block-sized microzones as the basic units of spatial resolution. DAYSIM is licensed under an [open source](#) license.

2.2.2.2 Nonrequired

2.2.2.2.1 Cube Base

Cube Base is the network Graphic User Interface (GUI) part of the Cube software package. While this is not technically needed to run SACSIM19, it is strongly recommended. Cube Base is needed to make any edits to the network variables and visualize any SACSIM19 model run results.

2.2.2.2.2 ArcGIS

ArcGIS is an ESRI platform for organizations to create, manage, share, and analyze spatial data. It consists of server components, mobile and desktop applications, and developer tools. SACOG staff uses various desktop and developer tools to develop and display SACSIM data. None ESRI GIS platforms may also be used to display the modeling spatial datasets. During release of this document SACOG staff developed data using Arc Desktop 10.7.0 and Arc Pro 2.5.2

2.2.2.2.3 PopGen version 1.1

PopGen, software developed by the Mobility Analytics Research Group alongside multiple universities and Metropolitan Planning Organizations (MPO), was used to generate a representative synthetic population with person and household-level attributes. More information and PopGen software can be downloaded from the Mobility Analytics webpage <https://www.mobilityanalytics.org/popgen.html>. Distributed as free software.

2.2.2.2.4 SQL Server

Microsoft SQL Server is a relational database management system developed by Microsoft. SACOG staff use to preform general data processing and analysis tasks. Version used as of release: SQL Server 2019. SQL Server Management Studio v18.3. SQL Server Software is proprietary software, license required.

2.2.2.2.5 Python

Python is an interpreted, high-level, general-purpose programming language. SACOG staff use to preform general data processing and analysis tasks. Version used as of release: Python 3.6.8 (Anaconda, Inc). Python 2.7.9 used for PopGEN version 1.1. Distributed as free software.

2.2.2.2.6 Notepad++

Notepad++ is a text and source code editor for use with Microsoft Windows, distributed as free software. Used to view and edit large text files. Version v7.8.5 used as of release.

2.3 Model Inputs

2.3.1 Scenario

Table 2-2 lists the files required for each model scenario folder.

Table 2-2 SACSIM19 Input File Descriptions for Scenario Folder

Folder	File Name	Type	Description
scenario_folder (can be any name)	SACSIM_Run.s (Can be any name)	Cube Voyager Script	SACSIM Cube Voyager primary script for model.
scenario_folder (can be any name)	config.sacsim.trips.xml	Trip Configuration File	User input control file for DAYSIM configurations.
scenario_folder	config.sacsim.wksclloc.xml	Work Location Configuration File	User input control file for DAYSIM configurations.
scenario_folder	tolls.csv	Toll Facility Cost Input File	User input controls for dynamic tolling during assignment.
scenario_folder	RAD_UserFee.csv	Milaged Based Fee Input File	User input for spatial adjustments for mileage based user fie.
scenario_folder	2016_thru.dbf	Landuse/transportation	Through Trips
scenario_folder	2016_taz.dbf	Landuse/transportation	Transportation Analysis Zones
scenario_folder	2016_ixxi.dbf	Landuse/transportation	Internal (i) External (e) Production and Attractions
scenario_folder	2016_base.net	Landuse/transportation	Roadway Network
scenario_folder	2016_tranline.txt	Landuse/transportation	Transit Line
scenario_folder	2016_transit_links.csv	Landuse/transportation	Transit Network
scenario_folder	2016_station_links.csv	Landuse/transportation	Transit Station Nodes
scenario_folder	2016_pnr.dbf	Landuse/transportation	
scenario_folder	2016_raw_person.txt	Landuse/transportation	Person Inputs
scenario_folder	2016_raw_household.txt	Landuse/transportation	Household Inputs
scenario_folder	2016_raw_parcel.txt	Landuse/transportation	Parcel Inputs

Source: SACOG 2020.

2.3.2 Input

Table 2-3 lists the files in the “input” folder. The “input” folder sits in the parent directory of each model run scenario folder and contains higher-level inputs.

Table 2-3 SACSIM19 Input File Descriptions for Input Folder

Folder	File Name	Type	Description
input	airportsurvey.dbf	Airport module input	Airport survey input for SACSIM airport module
input	Ptfactor.mustcom.txt	Transit input	Sub transit mode control file: commuter buses
input	Ptfactor.mustlrt.txt	Transit input	Sub transit mode control file: light rail
input	Ptfactor.onlyloc.txt	Transit input	Sub transit mode control file: local bus
input	Ptfactor.txt	Transit input	Transit all mode control file
input	Ptfare.txt	Transit input	Transit fares for all modes
input	Ptssystem.txt	Transit input	Transit wait curves by sum mode and operator
input	sacfftpp.txt	IXXI input	Friction Factors input by trip type
input	todfactors.txt	IXXI input	Time of day factors by trip type

Source: SACOG 2020

2.3.3 daysim

Table 2-4 lists the files needed in the daysim folder. The daysim folder sits in the parent directory of the scenario folder and contains parameter and coefficient files related to the daysim submodel.

Table 2-4 SACSIM19 Input File Descriptions for DAYSIM Folder

Folder	File Name	Type	Description
daysim	sacog_roster.combinations.csv	Roster	DAYSIM Mode Roster
daysim	sacsim_roster_mat.csv	Roster	DAYSIM Input Roster
daysim	sacog_taz_indexes.dat	TAZ	
daysim	WorkLocationCoefficients_SACOG-v1.5.f12	Coefficients Files	
daysim	SchoolLocationCoefficients_SACOG-v1.8.f12	Coefficients Files	
daysim	PayToParkAtWorkplaceCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	TransitPassOwnershipCoefficients_SACOG-v1.5.f12	Coefficients Files	
daysim	AutoOwnershipCoefficients_SACOG-v1.5.f12	Coefficients Files	
daysim	IndividualPersonDayPatternCoefficients_SACOG-v1.8.f12	Coefficients Files	
daysim	PersonExactNumberOfToursCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	WorkTourDestinationCoefficients_SACOG-v1.8.F12	Coefficients Files	
daysim	OtherTourDestinationCoefficients_SACOG-v1.8.F12	Coefficients Files	
daysim	WorkbasedSubtourGenerationCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	WorkTourModeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	SchoolTourModeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	WorkBasedSubtourModeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	EscortTourModeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	OtherHomeBasedTourModeCoefficients_SACOG-v1.5.F12	Coefficients Files	

daysim	WorkTourTimeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	SchoolTourTimeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	OtherHomeBasedTourTimeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	WorkbasedSubtourTimeCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	IntermediateStopGenerationCoefficients_SACOG-v1.5.F12	Coefficients Files	
daysim	IntermediateStopLocationCoefficients_SACOG-v1.8.F12	Coefficients Files	
daysim	TripModeCoefficients_SACOG-v1.5.f12	Coefficients Files	
daysim	TripTimeCoefficients_SACOG-v1.5.f12	Coefficients Files	

Source: SACOG 2020.

2.4 Model Outputs

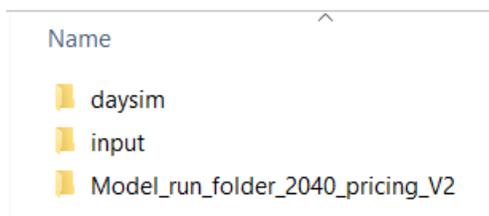
Refer to Appendix A DAYSIM Reference Guide.xlsx. Appendix A contains DAYSIM data tables describing required inputs, intermediate files and outputs such as output person, households, tours and trip tables.

Other SACSIM19 output files include loaded Cube trip skim matrixes, loaded assignment Cube network files by time period, roadway pricing costs, and Transit boarding's /alighting's files. Further information on these outputs can be found in Chapter 6 Highway Networks, Chapter 7 Transit Networks, and Chapter 9 Auto Operating Costs, Pricing, and Transit Fares.

2.5 Preparing a model run

This section is to provide practitioners of SACSIM how to set up the SACSIM19 input structure to create a scenario to run. The scenario requires three subfolder directories as shown in Figure 2-2. The [model inputs section](#) above provides files names and descriptions of the required files. If multiple scenario have the same input daysim and input folder inputs, which is common for multiple scenarios using the same scenario forecast year, you can create multiple “Scenario” in the same directory to call the daysim and input files. Each scenario will require its own SACSIM19 run script (.s file) and associated inputs

Figure 2-2 SACSIM Run Folders



2.5.1 Model run scenario structure

The following figures represent examples of a model files and folder structure ready to be ran. For more information on files review [model inputs section](#) above and Appendix A DAYSIM Reference Guide.xlsx for descriptions, requirements and file type information.

Figure 2-3 Example Scenario Input Folder Setup

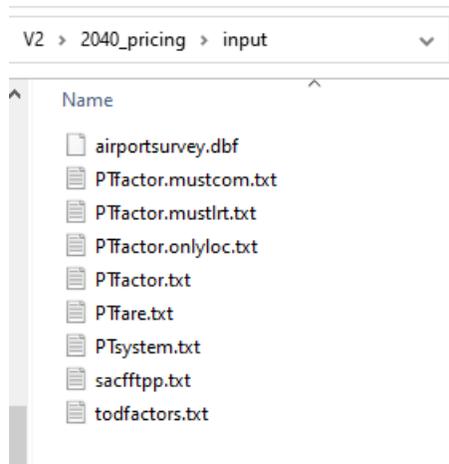


Figure 2-4 Example Scenario daysim Folder Setup

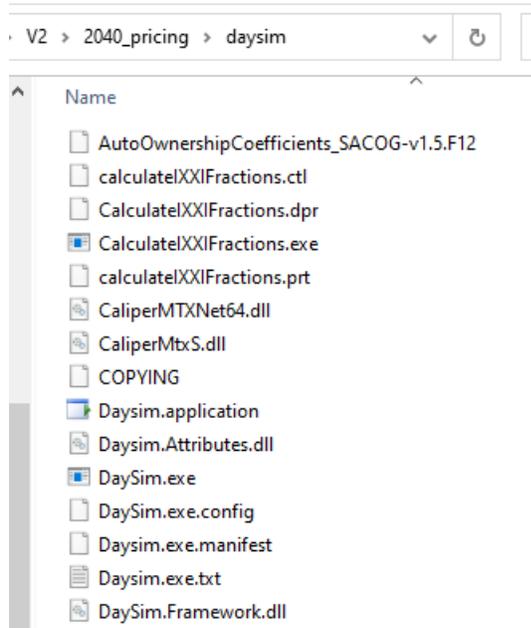
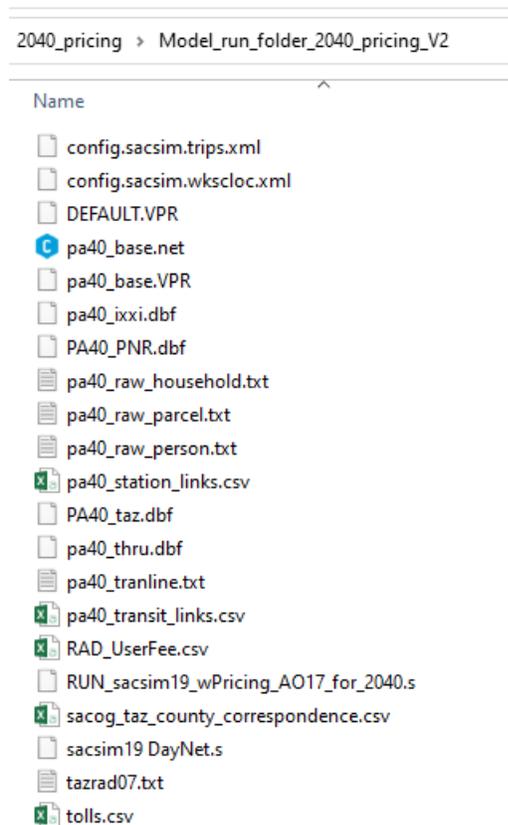


Figure 2-5 Example Scenario Run Folder Setup



2.5.2 Setup for Model Run Pricing Parameters

As part of the 2020 MTP/SCS, SACSIM19 was updated to run a variety of policy-based scenarios. These scenarios vary SACSIM19 base assumptions and require slightly different setups. It's important to understand and check the following scenario files to determine if a baseline, mileage-based user fee, and/or managed or toll lane pricing scenario is setup in the input structure. Further details on costs, fees and pricing can be found in Chapter 9.

2.5.2.1 Setup Mileage Based User Fee

2.5.2.1.1 SACSIM19 run script

To incorporate pricing alternatives into SACSIM's utility cost of travel function, SACSIM19 breaks out auto cost, typically referred to as the "Cost of Driving" and a separate mileage-based user fee. This is a model feature that can be turned on or off by the user based on a few input parameters. Figure 2-6 illustrates variable in SACSIM19 model run script to update mileage-based user fee and auto operating cost. For example, if a model run is testing a mileage-based user fee compared to today's California gas tax, the user would need to factor in the reduction by subtracting a portion of the auto cost per mile input. Therefore, if Mileage Based User fee is tuned off, variable "userfee_per_mile" is equal to 0.00. If Mileage based user fee variable turned on, "userfee_per_mile" is equal to a value greater than zero. Important Note: all auto operating costs need to be converted to 2000 dollars for model input. Further description on SACSIM19 pricing implementation is in Chapter 9.

Figure 2-6 SACSIM19 Auto Cost and User Fee Inputs

```

9 ;-----
10
11 ;Set per-mile auto operating cost here
12 auto_cost_per_mile = 0.162
13 userfee_per_mile = 0.014

```

Spatial and Time Period Fee Adjustments

In addition to a mileage-based user fee, spatial and temporal components can be set using the RAD_Userfee.csv input file in the Scenario run folder. Table 2-5 describes the four inputs in the RAD_Userfee.csv required and an example with and without the mileage-based fee adjustments. Source: SACOG 2020.

Figure 2-7 shows an example of the RAD_Userfee.csv.

Table 2-5 Spatial and Temporal Mileage-Based Fee Adjustment

Header (Not in actual file)	RAD	Multiplicative Factor	Peak Adjustment	Off Peak Adjustment
Required input description	Regional Analysis Distract Spatial Geography where factor will apply to roadways. Default is all RAD Zones within region.	Factor used to multiple userfee_per_mile input. Default is 1.	Peak congestion rate adjustment factor applied to AM (7am-10am) and (4PM – 6PM) peak hours. Default is 0.	Off Peak period discount rate during non-congested times applied to Evenings (7-9), Nighttime (10-5am) and Middyay. Default is 0
Example Spatial Adjustment Turned On	1	2	0.007	-0.007
Example Spatial Adjustment Turned Off	1	1	0	0

Source: SACOG 2020.

Figure 2-7 RAD_Userfee.csv Example

26	26	1	0.007	-0.007
27	27	2	0.007	-0.007
28	28	1	0.007	-0.007

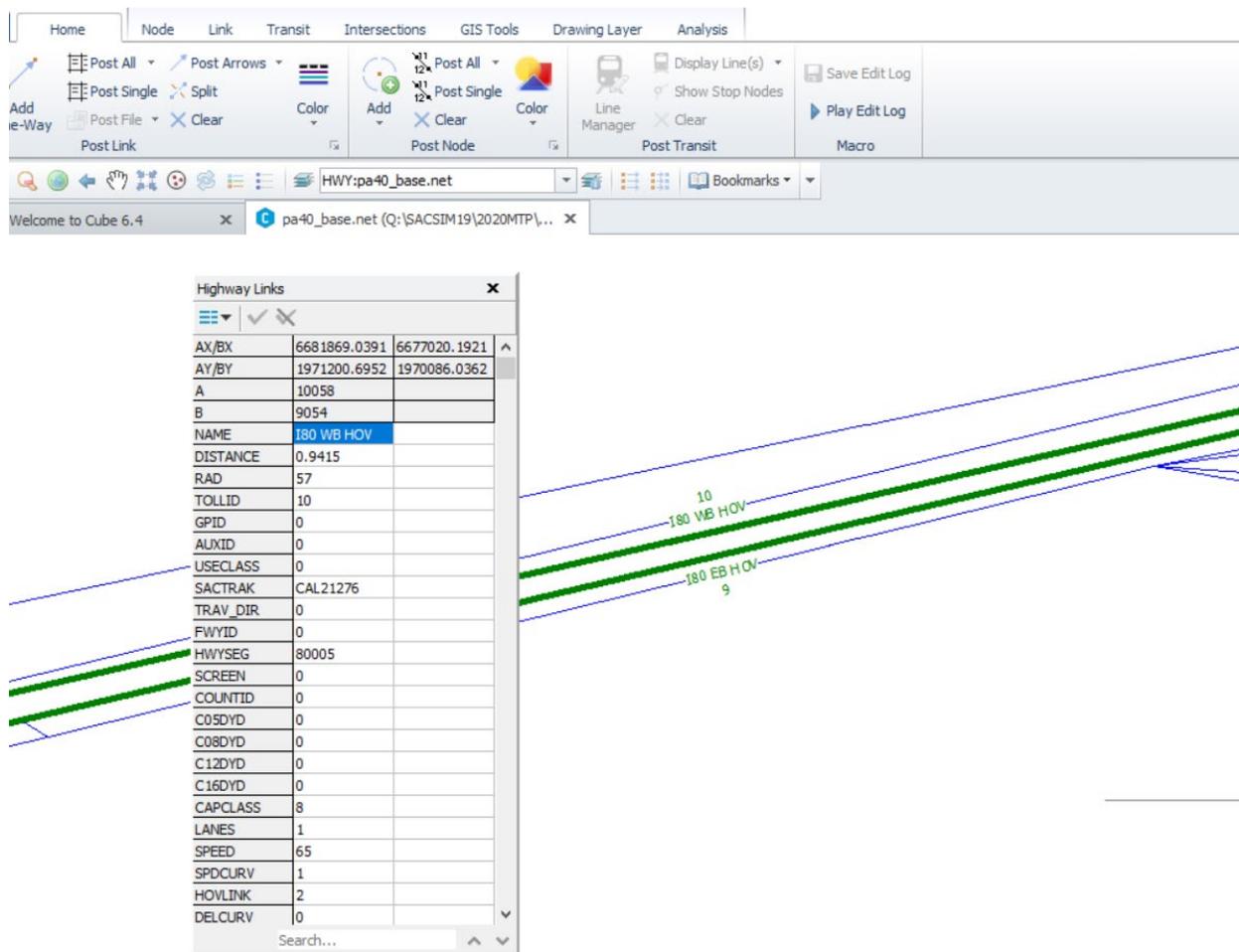


2.5.2.2 Setup Managed Lanes Tolling

2.5.2.2.1 Base Scenario Model Network

A scenario’s model highway network is typically named **<scenario year>_base.net**. Every priced facility must have a TOLLID number associated. For parallel general purpose and auxiliary lanes, the same ID number must be assigned to GPID (general purpose lanes) and AUXID (auxiliary lanes). This is used to determine the cost of the managed facility relative to the congestion on the parallel “free” facilities. Depending on the type of managed lane, USECLASS must also be set with a value of 0, 2, or 3 to determine the allowed vehicle type on the managed facility. Zero allows all users to drive on the facility being priced, 2 allows only vehicles with 2 or more passengers, while 3 allows only vehicles 3+ passengers. Note, USECLASS does not determine which vehicles are *priced*; it just determines which vehicles are allowed to use the facility. Prices are set in the Toll Input File described below. Figure 2-8 shows an example of a managed lane facility coding on the base network. In this example all vehicle types are allowed on the managed lane facility.

Figure 2-8 Base Network Toll ID Coding



2.5.2.2.2 Toll Input Cost File

The TOLLID coded on the network identifies the toll segments. The costs by vehicle type then need to be associated and defined to the network toll segments. This is done in the Toll Input Cost File **tolls.csv**. Each row represents a unique TOLLID segment by time period. For every tolled segment there will be nine additional rows added to the input file (1 TOLLID X 9 SACSIM time periods). The user must specify initial, minimum, and maximum values for each row for each of the four modes:

- drive alone,
- SOV2,
- SOV3+,
- commercial vehicle.

Table 2-6 shows an example of how the Toll Input Cost File may look. If a scenario requires no toll pricing, Inputs columns 4-22 should all be set to zero. For more information, review Chapter 9 on Roadway and Mileage Based Pricing.

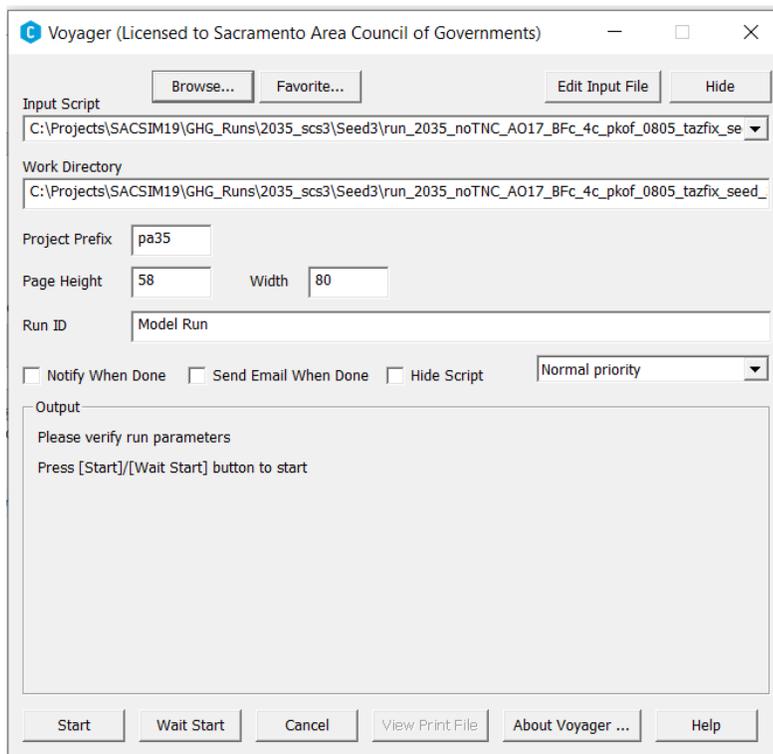
Table 2-6 Toll Cost Input Example

Fac. Index	Seg.	Per.	Fac. Type	Adjust	Toll DA	Toll S2	Toll S3	Toll CV	Min DA	Min S2	Min S3	Min CV	Max DA	Max S2	Max S3	Max CV	Reversible Lane AM	Reversible Lane PM	Shoulder Lane AM	Shoulder Lane PM	Take a Lane AM	Take a Lane PM
101	1	1	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
102	1	2	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
103	1	3	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
104	1	4	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
105	1	5	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
106	1	6	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
107	1	7	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
108	1	8	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0
109	1	9	2	1	1	0	0	2	0.1	0	0	0.2	30	0	0	30	0	0	0	0	0	0

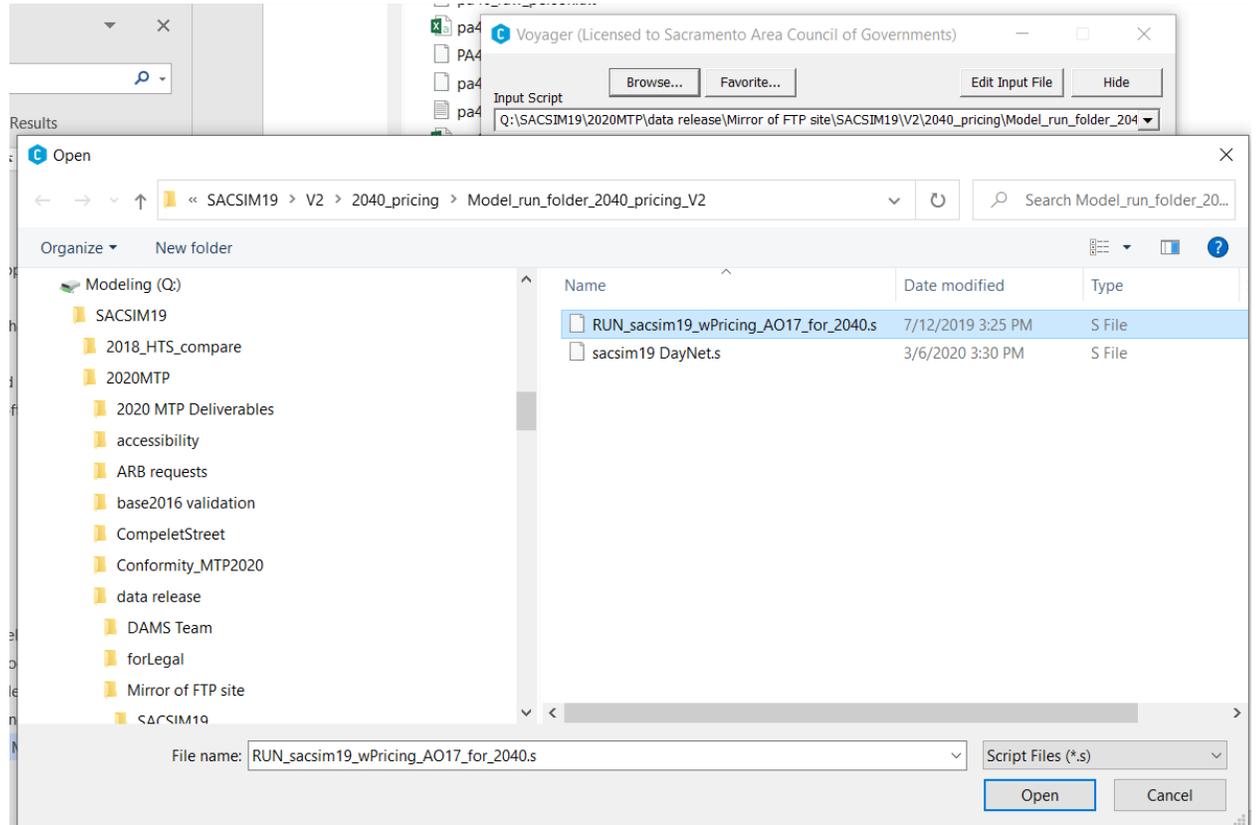
Source: SACOG 2020.

2.5.3 Start Scenario Model Run with Cube Voyager

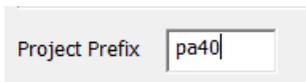
1. Open Cube Voyager Application



2. Select Browse and navigate the SACSIM model run script in Scenario folder created.



3. Check Prefix matches with files structure. For example, for SACOG SACSIM19 2040 modeling scenarios, prefix pa40 is used for all input files using Cube special "Token" inputs in naming.



4. Select "Start" to begin model run.

