# CSTDM09 – California Statewide Travel Demand Model

## Model Development

## Long Distance Personal Travel Model

### Final System Documentation: Technical Note

ULTRANS
Institute of Transportation Studies,
UC Davis
Davis, California

HBA Specto Incorporated
Calgary, Alberta

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# 1. Introduction and Overview

This technical note describes the Long Distance Personal Travel Model (LDPTM) component of the California Statewide Travel Demand Model (CSTDM).

The CSTDM has defined two distinct models to be applied to forecast personal travel by California residents on a typical weekday in the fall. The Short Distance Personal Travel Model will apply for all trips made up to 100 miles from home. The LDPTM will apply to all trips made greater than 100 miles.

The California statewide travel model developed for The California High Speed Rail Authority (the HSR model), documented in the August 2006 “Interregional Model System Development” Report, explicitly predicted inter-regional trips for two distance categories:

- Short Distance Inter-regional trips < 100 miles
- Long Distance Inter-regional trips > 100 miles.

The CSTDM framework proposes that the LDPTM model of the CSTDM use the Long Distance model component of the HSR model, integrated into the overall CSTDM modeling framework. This Technical Note summarizes the form and implementation of the LDPTM .

The LDPTM is applied at a traffic zone (TAZ) level. It predicts trips by each person in the TAZ population, with the following major model components:

1. **Trip Frequency** models for 4 purposes (business; commute; recreation; & other), which predict how many long distance trips for that purpose will be made by each person from & to home;
2. **Party Size** models for 2 purpose groups (business & commute; recreation & other) which predict whether the person is travelling alone or in a group;

3. **Destination** Choice models for 2 purpose groups (business & commute; recreation & other) which predict to or from which TAZ (<100 miles from home TAZ) the long distance trip is made;
4. **Main Mode** models for 2 purpose groups (business & commute; recreation & other) which predict which of 4 potential modes of travel will be chosen for the long distance trip between the home TAZ & the destination zone (Car; Air; Conventional Rail; High Speed Rail);
5. **Access Mode** models for 2 purpose groups (business & commute; recreation & other) which predict which of 6 potential modes of travel will be chosen for the long distance trip to access the main mode (drive & park; rental car; drop off; taxi; local transit; walk);
6. **Egress Mode** models for 2 purpose groups (business & commute; recreation & other) which predict which of 6 potential modes of travel will be chosen for the long distance trip to egress from the main mode (unpark & drive; rental car; pick up; taxi; local transit; walk);
7. **Car Occupancy / Time of Day / Direction** factors convert car person trips to car vehicle trips, and split the predicted daily trips by 4 time periods (AM peak, Midday, PM peak and Off-peak) and by direction (from home or to home).

Three sources from the original HSR model work were used in the description of the LDPTM:

1. the August 2006 HSR Model Development Report,
2. the HSR model computer program coded in “Pascal”.
3. the “Updated values of Final Coefficients and Constants in the HSR Ridership & Revenue Model“ contained in the January 29, 2010 Memorandum from Cambridge Systematics, the HSR Model developer.

The LDPTM model implemented in the CSTDM framework has some differences compared to the HSR model:

- In the LDPTM, long-distance trips are defined to include all trips greater than 100 miles straight-line distance between zone pairs. This includes both inter-regional

and intra-regional trips. The HSR model excluded any intra-regional trips > 100 miles (using the HSR region definitions for this criteria); and defined the 100 mile distance using CUBE road network distances. In practice most regions are <100 miles in size, and so the difference in trip definition affects only a small number of trips.

- In the LDPTM, intraregional accessibility is defined to consider all zones within 100 miles straight-line distance of the origin zone. The HSR model used accessibility for inter-regional zoneswithin100 miles network distance.
- In the LDPTM, four time periods are explicitly used. Peak travel skims are explicitly calculated using the AM peak networks; and off-peak skims are calculated using the Midday networks. Trips are allocated to the AM, Midday, PM and offpeak time periods. The HSR model also had AM and PM peak periods, but one offpeak period representing all other times of day.
- .The access/egress mode choice models in the LDPTM do not use the “Car Used for Access to Transit” and “Rail Used in Transit” variables used in the HSR model, because of the simplified representation of local transit in the CSTDM.
- The CSTDM09 framework, operates with a micro-simulation approach, with individual persons making whole numbers of trips. only on whole numbers of trips. The HSR model is a fully aggregate model: it divides the total trips generated in each zone by destination, mode, and access/egress mode exactly in proportion to the calculated probabilities associated with those options. Since there are many more origin-destination pairs (over 25 million) than trips (about 500 thousand), most options have a small fraction of a trip assigned to them. It was necessary to replace the HSR model’s method of trip distribution and mode split with a disaggregate process, to integrate the LDPTM into the micro-simulation “whole number of trips” framework.

The LDPTM calculates the probabilities for all its sub-models (trip frequency, party size, destination choice, main mode choice, access/egress mode choice, and occupancy/time of day/direction) in the same way as the HSR model. Once

the probabilities are calculated, the model switches to simulating individual trips. Each household segment in each zone generates a number of trips given by the trip frequency models, rounded to the nearest integer. Since many segments generate less than half a trip, and these segments would be rounded down to zero, resulting in too few trips overall, Poisson sampling is used if the nominal trip generation rate is less than 4.7. Once the trips are generated, each trip is assigned probabilistically to a party size, a destination zone, a main mode, an access/egress mode (if applicable), an occupancy (if applicable), a time of day, and a direction, based on the probabilities given by the relevant sub-model.

- Model parameters were adjusted so that the LDPTM output for the year 2000 matches the calibration targets for that year.

The LDPTM is therefore similar in design to the original HSR model, but is not identical. The original HSR model explicitly includes the capability to predict trips made by the High Speed Rail mode, with separate explanatory variables and model parameters estimated for that mode share, based on revealed and stated preference surveys about potential use of alternative modes for long distance personal travel. The LDPTM has been designed to have the same capability to predict HSR usage, but whilst other model parameters have been changed to calibrate to observed flows, no change has been made to the HSR model parameter values for the HSR mode (because that mode does not exist as an option in the year 2000). Any HSR mode usage forecasts produced by the LDPTM have therefore to be treated with some caution.

Sections 2 to 7 of this Technical Note describe each of the LDPTM sub-models. Section 8 describes the calibration of the model to Year 2000 “observed” travel patterns. Section 9 summarizes how they are implemented in the CSTDM model.

## 2. Trip Frequency Models

The trip frequency models are applied using logit models to predict the probability that a person will make 0, 1, or 2 long distance trips on the model day. 4 separate models, one for each trip purpose, are applied. By definition, the utility for the 0-trip choice is set at 0 for all models. Table 1 summarizes the utility equations for making 1 or 2 trips in a day – (the only difference between the utility of making 1 trip & the utility of making 2 trips is in the choice constant).

**Table 1: Trip Frequency Model Utilities – One or Two Trips / Day**

| Parameter | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| ***Level of Service*** | | | | |
| Intra-Region Accessibility | -0.2170 | -0.2170 | -0.2170 | -0.2170 |
| Logsum Destination Choice | 0.1232 | 0.1232 | 0.1232 | 0.1232 |
| ***Household Type*** | | | | |
| 1-Person HH | | | | -0.4236 |
| 3+Person HH | | | -0.483 | -0.3785 |
| Ratio Workers / Size | 0.5371 | 1.2741 | | |
| No Workers in HH | -2.0984 | -2.6676 | | 0.3718 |
| Medium Inc ($35-$75K) | 0.5266 | 0.1881 | | |
| High Income (>$75K) | 1.1387 | 0.2910 | -0.2464 | 0.3931 |
| Cars < Workers | -0.4121 | -0.4574 | -0.9218 | -0.9152 |
| ***Origin Area*** | | | | |
| SACOG Resident | 0.2342 | 0.0107 | 1.8073 | 4.0798 |
| SANDAG Resident | -0.1735 | -0.3420 | 1.2857 | 3.6853 |
| MTC Resident | -0.6830 | -1.4211 | 3.0022 | 4.6764 |
| SCAG Resident | -0.2735 | -0.9481 | 1.5707 | 3.8985 |
| ***Choice Constant*** | | | | |
| 1 Trip | -4.6107 | -2.6735 | -4.5175 | -8.5096 |
| 2 Trip | -5.2468 | -4.1097 | -6.0809 | -9.8395 |

For the **business & commute** purposes intra-region accessibility are defined using peak period car times, for each zone I, in a region with j zones, as:

$$\text{Accessibility}_I = \ln(1+\Sigma(\text{Total Employment}_j * \exp(-2*\text{Peak Cartime}(I,j)/105.0))$$

Where 105.0 = the mean peak car time (minutes)

For the **recreation & other** purposes intra-region accessibility are defined using off-peak period car times, for each zone I, in a region with j zones, as:

$$\text{Accessibility}_I = \ln(1+\Sigma((\text{Retail Employment}_j + \text{Service Employment}_j + \text{Households}_j) * \exp(-2*\text{Off-Peak Cartime}(I,j)/86.0))$$

Where 86.0 = the mean off-peak car time (minutes)

The destination choice logsums are calculated using the destination choice models described below, weighted by party size.

These trip frequency models are applied for ALL trips > 100 miles, including those made within a HSR region.

The accessibility measures in the models use the AM peak period & midday time periods, for all zones within 100 miles of the home zone. Straight line distances are used to define long-distance trips, to be consistent with the other components of the CSTDM, in particular to avoid overlap with the short-distance personal model,

## 3. Party Size Models

The party size models are applied using logit models to predict the probability that a person will make a trip travelling alone, or in a group. 2 separate models, one for business / commute trips, and one for recreation / other trips, are applied. By definition, the utility for travelling alone choice is set at 0 for both models. Table 2 summarizes the utility equations for travelling in a group.

**Table 2: Party Size Model Utilities – Travel in a Group**

| Parameter | Business / Commute | Recreation / Other |
|---|---|---|
| ***Household Type*** | | |
| 1-Person HH | -1.2219 | -1.5459 |
| HH Size (1 to 4+) | | 0.1402 |
| High Income (>$75K) | -0.7337 | |
| No cars in HH | -1.0970 | |
| ***Purpose*** | | |
| Commute | -0.6765 | |
| Recreation | | 0.3016 |
| ***Choice Constant*** | -0.3217 | 0.6804 |

The Party Size model is used to develop party-size weighted logsums from the destination choice model, for use in the trip frequency model.

1) The shares for travelling alone (***alfrac***) & travelling in a group (***grfrac***) are calculated using the above models, for a particular purpose segment;
2) Weighted logsum destination choice accessibilities for the business & commute purposes are calculated as:

   Wlogsum = alfrac * logsum (business) + grfrac * logsum (commute)

   Note: The party size, destination choice, main mode & access / egress models are all specified for a combined business / commute purpose.

However the use of “Travel Alone” & “Travel in a Group” 0-1 parameters in the Main Mode Choice & Access / Egress which are explicitly defined to have different values for the Business & Commute purposes means that the logsums feeding up through destination choice will be different.

3) Weighted logsum destination choice accessibilities for the recreation & commute purposes are calculated as:

Wlogsum = alfrac * logsum (recreation) + grfrac * logsum (other)

## 4. Destination Choice Models

The destination choice models are applied using logit models to predict the probability that a person will select a particular destination zone outside the home region. 2 separate models, one for business / commute trips, and one for recreation / other trips, are applied. By definition, the utility for travelling to SACOG as a destination district is set at 0 for both models. Table 3 summarizes the utility equations for destination choice.

**Table 3: Destination Choice Models Utilities**

| Parameter | Business / Commute | Recreation / Other |
|---|---|---|
| ***Accessibility*** | | |
| Mode Choice Logsum | 0.0534 | 0.0534 |
| Distance (Miles) | -0.0239 | -0.0306 |
| Distance Squared / 100 | 0.00698 | 0.00865 |
| Distance Cubed / 10,000 | -0.0005227 | -0.0007016 |
| ***Area Types*** | | |
| Urban Destination (0/1) | 0.7240 | 0.8097 |
| Rural Destination (0/1) | 0.2220 | 0.6071 |
| Urban to Urban (0/1) | -0.0098 | -0.0964 |
| Suburban to Suburban (0/1) | -0.1854 | -0.0292 |
| Rural to Rural (0/1) | -0.1115 | -0.0358 |
| ***Destination District*** | | |
| AMBAG | -0.2418 | 0.1833 |
| Central Coast | -0.2546 | 1.3342 |
| Far North | -1.7279 | -0.8390 |
| Fresno | -0.6854 | -0.1504 |
| Kern and Madera | 0.4764 | 0.5223 |
| Merced | -0.8552 | -0.0942 |
| S. San Joaquin | -0.1435 | 0.5465 |
| SACOG | 0.0000 | 0.0000 |
| SANDAG | -5.0724 | -4.3954 |
| San Joaquin | -0.1083 | -0.3754 |
| Stanislaus | -1.0433 | -1.4260 |
| W. Sierra Nevada | -0.1343 | 0.4070 |
| Alameda | -0.6781 | 5.0000 |
| Contra Costa | 0.2262 | 5.0000 |
| Marin / Sonoma / Napa | 0.1486 | 5.0000 |
| San Francisco | -0.8474 | 5.0000 |
| San Mateo | -0.6874 | 5.0000 |
| Santa Clara | -0.7104 | 5.0000 |
| Solano | 0.8002 | 5.0000 |
| Los Angeles | -1.8101 | 5.0000 |

| | | |
|---|---|---|
| Orange | -2.9451 | 5.0000 |
| Riverside | 0.0963 | 5.0000 |
| San Bernardino | -4.4162 | 5.0000 |
| Ventura | -3.8305 | 5.0000 |
| Imperial | -3.0011 | 5.0000 |
| ***Regional Interactions*** | | |
| MTC to SCAG | -1.1226 | -6.4000 |
| SCAG to MTC | -1.1226 | -6.4000 |
| MTC to SANDAG | 1.1415 | 3.6322 |
| SANDAG to MTC | 1.1415 | 3.6322 |
| MTC to SACOG | 0.7700 | 0.5322 |
| SACOG to MTC | 0.7700 | 0.5322 |
| SCAG to SANDAG | 5.4033 | 8.0982 |
| SANDAG to SCAG | 5.4033 | 8.0982 |
| SCAG to SACOG | -1.7357 | -1.2741 |
| SACOG to SCAG | -1.7357 | -1.2741 |
| SANDAG to SACOG | 0.3684 | 8.0000 |
| SACOG to SANDAG | 0.3684 | 8.0000 |
| ***Size Variables*** | | |
| Size Multiplier | 1.000 | 1.0000 |
| Other Employment | 1.000 | |
| Households | | 1.000 |
| Retail Emp – Low Income | 1.0607 | -0.0410 |
| Retail Emp – Medium Income | 2.2319 | -0.1627 |
| Retail Emp – High Income | 1.9930 | 0.3256 |
| Service Emp – Low Income | 0.5468 | -1.2501 |
| Service Emp – Medium Income | 0.8293 | -0.9850 |
| Service Emp – High Income | 0.9261 | -0.9331 |

Note: The cubic distance function parameters produce an additional utility that represents the disutility of choosing a destination that is further away than an alternative, everything else being equal. (The mode choice logsum also represents of travel disutilty for a particular zone-pair, so it is the combined impact of the logsum and the distance parameter that determines the relative travel disutility for each destination choice).

The value of this distance disutility is capped at the utility occurring at 230 miles for Business / Commute trips; and 357 miles for Recreation / Other trips, to ensure that it does not produce values that make more distant destinations relatively more attractive. This is illustrated in Figure 1. This “capping” feature was introduced as part of the model validation process.

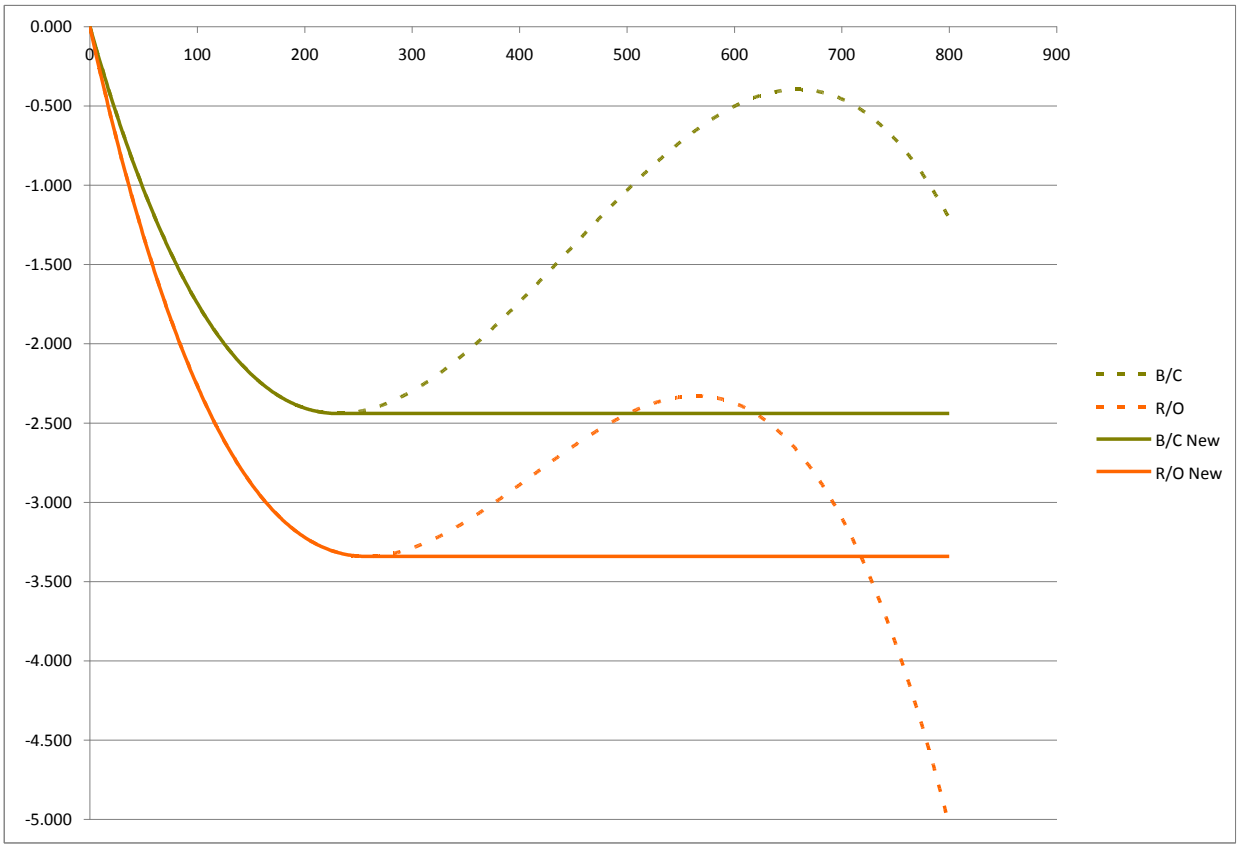


**Figure 1 "Capping" Process for Distance Parameter in Destination Choice Models**

Note: B/C = Business / Commute function; R/O = Recreation / Other function

Area Types are defined by Persons per square mile are based on either the population or employment in a zone, whichever is higher:

- Rural – Less than 1,000 persons per square mile;
- Low Suburban – 1,000 to 6,000 persons per square mile;
- High Suburban – 6,000 to 10,000 persons per square mile;
- Urban – 10,000 to 20,000 persons per square mile; and
- Urban Core – More than 20,000 persons per square mile.

The size variable is added to the utility for each destination zone. For the business / commute model, it is applied for Low Income households by adding:

Size term = 1.000 *

ln((1.0000 * Other Emp) + Retail Emp Low Inc * $e^{(1.0607)}$

**+** Service Emp Low Inc * $e^{(0.5468)}$ )

For Medium and High Income households the respective size terms are:

**+** Retail Emp Med Inc * $e^{(2.2319)}$

**+** Service Emp Med Inc * $e^{(0.8293)}$

and:

**+** Retail Emp High Inc * $e^{(1.9930)}$

**+** Service Emp High Inc * $e^{(0.9261))}$

For the recreation / other model, it is applied for Low Income households by adding:

Size term = 1.000 *

ln((1.0000 * Households) + Retail Emp Low Inc * $e^{(-0.0410)}$

**+** Service Emp Low Inc * $e^{(-1.2501)}$

For Medium and High Income households the respective size terms are:

**+** Retail Emp Med Inc * $e^{(-0.1627)}$

**+** Service Emp Med Inc * $e^{(-0.9850)}$

and:

**+** Retail Emp High Inc * $e^{(0.3256)}$

**+** Service Emp High Inc * $e^{(-0.9331))}$

## 5. Main Mode Choice Models

The main mode choice models are applied using logit models to predict the probability that a person will select a particular mode to the chosen destination. Four modes are available – car, air, conventional rail, & high speed rail. 2 separate models, one for business / commute trips, and one for recreation / other trips, are applied.

For the Business / Commute purpose main mode model a nested logit model is applied, with the public transit modes (Air, Conventional Rail, & High Speed Rail in one nest, with a nesting coefficient of 0.6922. Table 4a summarizes the utility equations for main mode choice, for the business / commute purpose.

**Table 4: Main Mode Choice Models Utilities: Business / Commute Purpose**

| Parameter | Car | Air | Conventional Rail | High Speed Rail |
|---|---|---|---|---|
| ***Accessibility*** | | | | |
| Cost ($) | -0.0169 | -0.0169 | -0.0169 | -0.0169 |
| In Vehicle Time (mins) | -0.0179 | -0.0179 | -0.0179 | -0.0179 |
| Headway (mins) | | -0.0179 | -0.0179 | -0.0179 |
| Reliability (% on time) | 0.0230 | 0.0230 | 0.0230 | 0.0230 |
| Access Mode Logsum | n/a | 0.1362 | 0.1362 | 0.1362 |
| Egress Mode Logsum | n/a | 0.1707 | 0.1707 | 0.1707 |
| ***Person / HH*** | | | | |
| Travel in a Group | 1.0857 | -0.3556 | | |
| Household Size (max. 3) | 0.1825 | | | |
| Fewer than 2 cars (HH size > 1 person) | | | | |
| High Income | | 1.1799 | 0.6128 | 1.1474 |
| ***Constant*** | 0.0000 | -10.2689 | -4.6197 | -6.7570 |
| ***Airport Interchange*** | | | | |
| LA to SFO | | 5.0000 | | |
| SFO to LA | | 5.0000 | | |
| LA to Oakland | | 5.0000 | | |
| Oakland to LA | | 5.0000 | | |
| LA to San Jose | | 5.0000 | | |
| San Jose to LA | | 5.0000 | | |
| LA to Sacramento | | 5.0000 | | |
| Sacramento to LA | | 5.0000 | | |
| Burbank to SFO | | 4.1507 | | |
| SFO to Burbank | | 5.3628 | | |

| | | | | |
|---|---|---|---|---|
| Burbank to Oakland | | 2.0320 | | |
| Oakland to Burbank | | 4.1448 | | |
| Burbank to San Jose | | 3.7571 | | |
| San Jose to Burbank | | 5.0000 | | |
| Burbank to Sacramento | | 5.6016 | | |
| Sacramento to Burbank | | 1.4210 | | |
| Ontario to SFO | | 5.0000 | | |
| SFO to Ontario | | 5.0000 | | |
| Ontario to Oakland | | 2.2335 | | |
| Oakland to Ontario | | 2.2692 | | |
| Ontario to San Jose | | 3.2629 | | |
| San Jose to Ontario | | 5.0000 | | |
| Ontario to Sacramento | | 5.9074 | | |
| Sacramento to Ontario | | 3.7872 | | |
| Santa Ana to SFO | | 4.6523 | | |
| SFO to Santa Ana | | 2.4090 | | |
| Santa Ana to Oakland | | -0.2309 | | |
| Oakland to Santa Ana | | -2.8518 | | |
| Santa Ana to San Jose | | 4.3485 | | |
| San Jose to Santa Ana | | 2.9628 | | |
| Santa Ana to Sacramento | | 3.5711 | | |
| Sacramento to Santa Ana | | -1.9965 | | |
| San Diego to SFO | | 5.0000 | | |
| SFO to San Diego | | 5.0000 | | |
| San Diego to Oakland | | 1.7037 | | |
| Oakland to San Diego | | 1.9518 | | |
| San Diego to San Jose | | 5.0000 | | |
| San Jose to San Diego | | 5.0000 | | |
| San Diego to Sacramento | | 5.0000 | | |
| Sacramento to San Diego | | 5.6865 | | |

The business / commute main mode model is applied with AM peak period auto & rail travel skims. Air travel characteristics are applied for one representative time period.

The “Travel in a Group” 0-1 variable is specified as 0 for the business and recreation purposes and 1 for the commute and other purposes.

For the recreation / other purpose main mode model a nested logit model is applied, with the public transit modes (Air, Conventional Rail, & High Speed Rail in one nest, with a nesting coefficient of 0.7385. Table 4b summarizes the utility equations for main mode choice, for the recreation / other purpose.

**Table 5: Main Mode Choice Models Utilities: Recreation / Other Purpose**

| Parameter | Car | Air | Conventional Rail | High Speed Rail |
|---|---|---|---|---|
| ***Accessibility*** | | | | |
| Cost ($) | -0.0346 | -0.0346 | -0.0346 | -0.0346 |
| In Vehicle Time (mins) | -0.0107 | -0.0107 | -0.0107 | -0.0107 |
| Headway (mins) | | -0.0107 | -0.0107 | -0.0107 |
| Reliability (% on time) | 0.0050 | 0.0050 | 0.0050 | 0.0050 |
| Access Mode Logsum | n/a | 0.2043 | 0.2043 | 0.2043 |
| Egress Mode Logsum | n/a | 0.3987 | 0.3987 | 0.3987 |
| ***Person / HH*** | | | | |
| Travel in a Group | 1.4305 | -0.5047 | | |
| Household Size (max.3) | 0.2963 | | | |
| Fewer than 2 cars (HH size >1 person) | -0.3075 | | | |
| High Income | | | | |
| ***Constant*** | 0.0000 | -4.6833 | 1.2723 | -0.7132 |
| ***Airport Interchange*** | | | | |
| LA to SFO | | 5.0000 | | |
| SFO to LA | | 5.0000 | | |
| LA to Oakland | | 5.0000 | | |
| Oakland to LA | | 5.0000 | | |
| LA to San Jose | | 5.0000 | | |
| San Jose to LA | | 5.0000 | | |
| LA to Sacramento | | 5.0000 | | |
| Sacramento to LA | | 5.0000 | | |
| Burbank to SFO | | 4.1507 | | |
| SFO to Burbank | | 5.3628 | | |
| Burbank to Oakland | | 2.0320 | | |
| Oakland to Burbank | | 4.1448 | | |
| Burbank to San Jose | | 3.7571 | | |
| San Jose to Burbank | | 5.0000 | | |
| Burbank to Sacramento | | 5.6016 | | |
| Sacramento to Burbank | | 1.4210 | | |
| Ontario to SFO | | 5.0000 | | |
| SFO to Ontario | | 5.0000 | | |
| Ontario to Oakland | | 2.2335 | | |

| | | | | |
|---|---|---|---|---|
| Oakland to Ontario | | 2.2692 | | |
| Ontario to San Jose | | 3.2629 | | |
| San Jose to Ontario | | 5.0000 | | |
| Ontario to Sacramento | | 5.9074 | | |
| Sacramento to Ontario | | 3.7872 | | |
| Santa Ana to SFO | | 4.6523 | | |
| SFO to Santa Ana | | 2.4090 | | |
| Santa Ana to Oakland | | -0.2309 | | |
| Oakland to Santa Ana | | -2.8518 | | |
| Santa Ana to San Jose | | 4.3485 | | |
| San Jose to Santa Ana | | 2.9628 | | |
| Santa Ana to Sacramento | | 3.5711 | | |
| Sacramento to Santa Ana | | -1.9965 | | |
| San Diego to SFO | | 5.0000 | | |
| SFO to San Diego | | 5.0000 | | |
| San Diego to Oakland | | 1.7037 | | |
| Oakland to San Diego | | 1.9518 | | |
| San Diego to San Jose | | 5.0000 | | |
| San Jose to San Diego | | 5.0000 | | |
| San Diego to Sacramento | | 5.0000 | | |
| Sacramento to San Diego | | 5.6865 | | |

The recreation / other main mode model is applied with Midday period auto & rail travel skims. Air travel characteristics are applied for one representative time period.

Reliability indices are used as explanatory parameters to explain long distance trip mode choice for air, conventional rail & auto modes.

- For **Air**, reliability is defined as the percentage of flights arriving within one hour of scheduled arrival time. For the year 2000 data for each of the 114 routes was obtained from the 10% ticket sample data. Values range from 88% (San Francisco / Los Angeles) to 95% (Oakland / Santa Ana).
- For **Conventional Rail**, reliability is defined as the percentage of services arriving at the destination station within one hour of scheduled arrival time. In the original HSR model for the year 2000 values were estimated from information provided from the train operators, as follows:

    - 94% for Pacific Surfliner;

- 94% for Amtrak Capital Corridor;
- 89% for Amtrak San Joaquin Valley.

For the current implementation of the LDPTM a constant conventional rail reliability of 94% is used for the year 2000 and 2008 scenarios, partly because of the difficulty in assigning reliability for trips involving transfers between operators.

- For **High Speed Rail**, the HSR model assumed a 99% reliability**.**
- **For Auto,** a reliability measure is used that was developed by Cambridge Systematics and applied in the HSR model, representing that the probability that an auto traveller arrives within 60 minutes of the congested travel time, based on non-recurrent incident delay concepts, was applied for each O-D pair for peak & off-peak travel times:

$$P = 100\% \times \frac{T_C + 60}{T_C + 0.0073 \times \left[\left(\frac{\frac{T_C}{T_0} - 1}{0.18}\right)^{0.117647}\right]^{5.2695} \times 60 \times T_0}$$

Where:

$T_0$ = Free-flow (off-peak) travel time in minutes

$T_C$ = Congested (peak) travel time in minutes

The resulting percent reliability estimates for a trip from Los Angeles to San Francisco are in the range of 67 to 92 percent, depending on the specific details of a trip. Trips with no congestion have 100 percent reliability.

These models use the AM peak period travel skims for the business / commute model; & Midday travel skims for the recreation / other model.

# 6. Access & Egress Mode Choice Models

The access and egress mode choice models are applied using logit models to predict the probability that a person will select a particular mode to access / egress the main mode. Six modes are available – car & park, rental car, drop off/pick up, taxi, local transt & walk. 2 separate models, one for business / commute trips, and one for recreation / other trips, are applied.

For the Business / Commute purpose ***access*** mode model a nested logit model is applied, with the non-car modes (Taxi, Transit & Walk) in one nest, with a nesting coefficient of 0.3870. Table 5a summarizes the utility equations for access mode choice, for the business / commute purpose.

**Table 6: Access Mode Choice Models Utilities: Business / Commute Purpose**

| Parameter | Car & Park | Rental Car | Drop Off | Taxi | Transit | Walk |
|---|---|---|---|---|---|---|
| ***Accessibility*** | | | | | | |
| Cost ($) | -0.0750 | -0.0750 | -0.0750 | | -0.0750 | |
| In Vehicle Time (mins) | -0.0600 | -0.0600 | -0.0600 | -0.0600 | -0.0600 | |
| In Vehicle Time (mins) | | | -0.0142 | | | |
| Auto Distance (miles) | | | | -0.0841 | | |
| Out of Vehicle Time (mins) | | | | | -0.1467 | -0.1467 |
| Airport is LAX (0/1) | -3.1285 | | | | | |
| Airport is SFO (0/1) | -4.0822 | | | | | |
| Airport is SAN (0/1) | -1.4100 | | | | | |
| Airport is SJC (0/1) | | | | | | |
| To Airport (0/1) | | | | | | -3.0000 |
| To Conventional Rail (0/1) | | -3.0000 | | -2.8266 | | |
| ***Person / HH*** | | | | | | |
| Travel Alone | | | | | | |
| Household Size | | | 0.6059 | | | |
| No Cars in HH | | 5.1097 | | | | |
| Fewer than 2 cars (HH size > 1 person) | -1.5472 | | | | 1.4803 | |
| Low Income | -2.7411 | | | -3.0102 | | |
| High Income | 0.7091 | 2.9526 | | | | |
| ***Constant*** | 4.9231 | -5.5471 | 0.0000 | 1.7710 | 4.3900 | 5.0000 |

For the Recreation / Other purpose ***access*** mode model a nested logit model is applied, with 2 modes (transit & walk) in one nest, with a nesting coefficient of 0.4505. (Note: this nesting structure is different from that used for the Business / Commute Purpose). Table 5b summarizes the utility equations for access mode choice, for the recreation / other purpose.

**Table 7: Access Mode Choice Models Utilities: Recreation / Other Purpose**

| Parameter | Car & Park | Rental Car | Drop Off | Taxi | Transit | Walk |
|---|---|---|---|---|---|---|
| ***Accessibility*** | | | | | | |
| Cost ($) | -0.1200 | -0.1200 | -0.1200 | | -0.1200 | |
| In Vehicle Time (mins) | -0.0300 | -0.0300 | -0.0300 | -0.0300 | -0.0300 | |
| In Vehicle Time (mins) | | | -0.0314 | | | |
| Auto Distance (miles) | | | | -0.0705 | | |
| Out of Vehicle Time (mins) | | | | | -0.0828 | -0.0828 |
| Airport is LAX (0/1) | -1.2751 | | | | | |
| Airport is SFO (0/1) | -3.0358 | | | | | |
| Airport is SAN (0/1) | -1.3705 | | | | | |
| Airport is SJC (0/1) | -1.4792 | | | | | |
| To Airport (0/1) | | | | | | -2.6345 |
| To Conventional Rail (0/1) | | -5.0000 | | -2.2650 | | |
| To High Speed Rail (0/1) | | | | -1.0924 | | |
| ***Person / HH*** | | | | | | |
| Travel Alone | -1.9254 | | | -0.8774 | 1.5689 | |
| Household Size | | | 0.4778 | | | |
| No Cars in HH | | | | | 1.4388 | |
| Fewer than 2 cars (HH size > 1 person) | -1.9027 | | | | | |
| Low Income | -1.9595 | | | | 0.8456 | |
| High Income | 0.3387 | | | 0.8494 | | |
| ***Constant*** | 4.3564 | -5.0000 | 0.0000 | -2.1553 | -1.9075 | 4.6959 |

For the Business / Commute purpose ***egress*** mode model a nested logit model is applied, with the non-car modes (Taxi, Transit & Walk) in one nest, with a nesting coefficient of 0.2798. Table 5c summarizes the utility equations for egress mode choice, for the business / commute purpose.

**Table 8: Egress Mode Choice Models Utilities: Business / Commute Purpose**

| Parameter | Car & Park | Rental Car | Pick Up | Taxi | Transit | Walk |
|---|---|---|---|---|---|---|
| ***Accessibility*** | | | | | | |
| Cost ($) | -0.0750 | -0.0750 | -0.0750 | | -0.0750 | |
| In Vehicle Time (mins) | -0.0600 | -0.0600 | -0.0600 | -0.0600 | -0.0600 | |
| In Vehicle Time (mins) | | | | | | |
| Auto Distance (miles) | | | | -0.1262 | | |
| Out of Vehicle Time (mins) | | | | | -0.1395 | -0.1395 |
| From Airport (0/1) | | | | | | -2.0742 |
| From Conventional Rail (0/1) | -9.4896 | -3.5218 | | | 3.5798 | |
| From High Speed Rail (0/1) | -2.2514 | | | 2.5066 | 0.5920 | |
| ***Person / HH*** | | | | | | |
| Travel Alone | | | | | | |
| Household Size | | | 0.9739 | | | |
| Low Income | -18.0058 | -2.0823 | | -3.0025 | | |
| ***Constant*** | 1.7505 | 5.9786 | 0.0000 | 5.0000 | 5.0000 | 5.0000 |

For the Recreation / Other purpose ***egress*** mode model a nested logit model is applied, with 2 modes (transit & walk) in one nest, with a nesting coefficient of 0.4696. (Note: this nesting structure is different from that used for the Business / Commute Purpose). Table 5d summarizes the utility equations for egress mode choice, for the recreation / other purpose.

**Table 9: Egress Mode Choice Models Utilities: Recreation / Other Purpose**

| Parameter | Car & Park | Rental Car | Pick Up | Taxi | Transit | Walk |
|---|---|---|---|---|---|---|
| ***Accessibility*** | | | | | | |
| Cost ($) | -0.1200 | -0.1200 | -0.1200 | | -0.1200 | |
| In Vehicle Time (mins) | -0.0300 | -0.0300 | -0.0300 | -0.0300 | -0.0300 | |
| In Vehicle Time (mins) | | | -0.0151 | | | |
| Auto Distance (miles) | | | | -0.0519 | | |
| Out of Vehicle Time (mins) | | | | | -0.0600 | -0.0600 |
| From Airport (0/1) | | | | | | |
| From Conventional Rail (0/1) | | -1.1757 | | | 1.8297 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| From High Speed Rail (0/1) | | -0.5518 | | | 1.0319 | |
| ***Person / HH*** | | | | | | |
| Travel Alone | | -2.5876 | | -2.7675 | | |
| Household Size | | | | | | |
| Low Income | -1.2630 | -1.8905 | | -1.0375 | 1.2161 | |
| ***Constant*** | -5.4182 | 1.8267 | 0.0000 | 1.0547 | -3.6551 | 3.0764 |

The business / commute models uses AM peak period travel skims. The recreation / other models uses Midday period skims.

The “Travel Alone” 0-1 variable is specified as 1 for the business and recreation purposes and 0 for commute and other purposes.

## 7. Car Occupancy / Time of Day / Direction Factors

The factors used for car occupancy, time of day and direction in the LDPTM are based on those used in the original HSR model. Fixed car occupancy factors, by purpose, are used to convert forecast car person trips to car vehicle trips by the SOV (single-occupancy vehicle), HOV2 (high-occupancy vehicle with 2 occupants), and HOV3 (high-occupancy vehicle with 3 or more occupants) categories. The car occupancy factors are applied to the LDPTM by dividing the car person trips so that the average occupancy matches the car occupancy factor. It is assumed that the average occupancy for an HOV3 vehicle is 3.36 and that high occupancy vehicles are divided evenly into HOV2 and HOV3. These Car Occupancy factors are given in Table 6.

**Table 10: Car Occupancy Factors by Trip Purpose**

| Factor | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| Car Occupancy | 1.1872 | 1.1118 | 1.7304 | 1.3107 |

Daily trip tables predicted from the home zone of the population are also split by direction & time period (peak / off-peak), by purpose. These factors add to 100% for each daily trip table by purpose, & are given in Table 7.

**Table 11: Peaking & Directional Factors by Trip Purpose**

| Trip Type | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| AM Peak From Home | 0.24 | 0.37 | 0.08 | 0.19 |
| Off-Peak From Home | 0.04 | 0.01 | 0.12 | 0.07 |
| PM Peak From Home | 0.22 | 0.12 | 0.30 | 0.24 |
| AM Peak To Home | 0.02 | 0.04 | 0.05 | 0.02 |
| Off-Peak To Home | 0.16 | 0.16 | 0.11 | 0.12 |
| PM Peak To Home | 0.32 | 0.30 | 0.34 | 0.36 |

The peaking and directional factors are applied assuming:

- All Off-Peak trips **from** Home take place in the CSTDM midday time period (10AM to 3PM), for all purposes;
- 80% of Off-Peak trips **to** Home take pace in the midday period; & 20% in the CSTDM off-peak (after 7PM).

## 8. Model Calibration to Year 2000 Targets

The LDPTM was calibrated to match calibration targets for:

- Trip Frequency;
- Destination Choice;
- Main Mode Choice;
- Access Mode Choice;
- Egress Mode Choice.

Model calibration targets are documented in the CSTDM Working Paper “Tasks 9 and 11: Prepare Calibration and Validation Targets.”. They were from the August 2006 HSR Model Development Report, together with the associated July 2007 Statewide Model Validation Report, which describes the validation of the HSR model.

Calibration was performed by running the model for the entire state, and comparing model results to target values. Where differences occurred, model constants were adjusted, and the model run again. This process was repeated until satisfactory calibration results were obtained.

Tables 8 through 12 compare “observed target” and model results for the above sub-models. They show a good fit between model and target / observed flows and shares in all sub- model categories.

### Trip Frequency Calibration

Tables 8a to 8c summarize the "observed target", LDPTM model forecast, and model-target ratios for trip frequency by trip purpose, by major origin regions:

**Table 12: "Observed Target" Year 2000 Long Distance Trips by Purpose/Region**

| Purpose | SACOG | SANDAG | MTC | SCAG | OTHER | TOTAL |
|---|---|---|---|---|---|---|
| Business | 6,200 | 6,250 | 8,350 | 23,000 | 19,550 | 63.350 |
| Commute | 18,200 | 21,750 | 15,800 | 48,700 | 82,900 | 187,350 |
| Recreation | 15,800 | 21,500 | 96,250 | 54,750 | 15,200 | 203,500 |
| Other | 5,050 | 7,000 | 16,250 | 15,650 | 1,200 | 45,150 |
| TOTAL | 45,250 | 56,500 | 136,650 | 142,100 | 118,850 | 499,350 |

Source: Table 3.2 Frequency Model results for Long Trips, HSR Model Validation Report

**Table 13: LDPTM Year 2000 Forecast Long Distance Trips by Purpose/Region**

| Purpose | SACOG | SANDAG | MTC | SCAG | OTHER | TOTAL |
|---|---|---|---|---|---|---|
| Business | 6,204 | 6,264 | 8,359 | 23,008 | 19,530 | 63.365 |
| Commute | 18,192 | 21,738 | 15,800 | 48,715 | 82,925 | 187,370 |
| Recreation | 15,784 | 21,533 | 96,235 | 54,771 | 15,217 | 203,540 |
| Other | 5,050 | 6,976 | 16,269 | 15,644 | 1,202 | 45,141 |
| TOTAL | 45,230 | 56,511 | 136,663 | 142,138 | 118,874 | 499,416 |

**Table 14: Ratio Model to Target Year 2000 Long Distance Trips: Purpose/Region**

| Purpose | SACOG | SANDAG | MTC | SCAG | OTHER | TOTAL |
|---|---|---|---|---|---|---|
| Business | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Commute | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Recreation | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Other | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| TOTAL | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

### Destination Choice Calibration

Tables 9a to 9c summarize the "observed target", LDPTM model forecast, and model-target ratios for selected origin-destination sectors by trip purpose.

**Table 15: "Observed Target" Year 2000 Long Distance Region-Region Trips**

| Region – Region | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| LA to Sacramento | 2,100 | 5,000 | 4,050 | 1,250 |
| LA to San Diego | 10,650 | 29,000 | 66,550 | 19,700 |
| LA to San Francisco | 7,850 | 16,250 | 26,200 | 4,600 |
| Sacramento to San Francisco | 6,750 | 16,300 | 31,350 | 7,000 |
| Sacramento to San Diego | 300 | 1,050 | 1,300 | 400 |
| San Diego to San Francisco | 1,350 | 4,450 | 7,800 | 1,350 |
| LA / SF to San Joaquin Valley | 12,200 | 38,100 | 23,950 | 3,350 |
| Other to San Joaquin Valley | 3,300 | 12,850 | 50 | 50 |
| To / From Monterey/ Central Coast | 10,750 | 35,200 | 27,950 | 4,850 |
| To / From Far North | 6,150 | 22,650 | 9,300 | 1,800 |
| To / From W. Sierra Nevada | 1,950 | 6,500 | 5,000 | 800 |
| Total | 63,350 | 187,350 | 203,500 | 45,150 |

Source: Table 4.1 Destination Choice Model Results, HSR Model Validation Report

**Table 16: LDPTM Forecast Year 2000 Long Distance Region-Region Trips**

| Region – Region | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| LA to Sacramento | 2,093 | 4,987 | 4,063 | 1,271 |
| LA to San Diego | 10,660 | 29,009 | 66,529 | 19,715 |
| LA to San Francisco | 7,865 | 16,231 | 26,210 | 4,592 |
| Sacramento to San Francisco | 6,775 | 16,299 | 31,373 | 7,007 |
| Sacramento to San Diego | 307 | 1,041 | 1,280 | 405 |
| San Diego to San Francisco | 1,351 | 4,456 | 7,794 | 1,338 |
| LA / SF to San Joaquin Valley | 12,186 | 38,124 | 23,967 | 3,346 |
| Other to San Joaquin Valley | 3,290 | 12,860 | 57 | 39 |
| To / From Monterey/ Central Coast | 10,739 | 35,188 | 27,953 | 4,858 |
| To / From Far North | 6,143 | 22,659 | 9,289 | 1,792 |
| To / From W. Sierra Nevada | 1,956 | 6,516 | 5,025 | 778 |
| Total | 63,365 | 187,370 | 203,540 | 45,141 |

**Table 17: Ratio Model/Target Year 2000 Long Distance Region-Region Trips**

| Region – Region | Business | Commute | Recreation | Other |
|---|---|---|---|---|
| LA to Sacramento | 1.00 | 1.00 | 1.00 | 1.00 |
| LA to San Diego | 1.00 | 1.00 | 1.00 | 1.00 |
| LA to San Francisco | 1.00 | 1.00 | 1.00 | 1.00 |
| Sacramento to San Francisco | 1.00 | 1.00 | 1.00 | 1.00 |
| Sacramento to San Diego | 1.00 | 1.00 | 1.00 | 1.00 |
| San Diego to San Francisco | 1.00 | 1.00 | 1.00 | 1.00 |
| LA / SF to San Joaquin Valley | 1.00 | 1.00 | 1.00 | 1.00 |
| Other to San Joaquin Valley | 1.00 | 1.00 | 1.00 | 1.00 |
| To / From Monterey/ Central Coast | 1.00 | 1.00 | 1.00 | 1.00 |
| To / From Far North | 1.00 | 1.00 | 1.00 | 1.00 |
| To / From W. Sierra Nevada | 1.00 | 1.00 | 1.00 | 1.00 |
| Total | 1.00 | 1.00 | 1.00 | 1.00 |

**Main Mode Calibration**

Tables 10a to 10c summarize the "observed target", LDPTM model forecast, and model-target ratios for main mode share by trip purpose.

**Table 18: "Observed Target" Year 2000 Long Distance Trip Mode Share**

| Mode | Business / Commute | Recreation / Other | Total |
|---|---|---|---|
| Car | 89.2% | 86.8% | 88.0% |
| Air | 10.4% | 11.4% | 10.9% |
| Rail | 0.4% | 1.8% | 1.1% |

**Table 19: LDPTM Forecast Year 2000 Long Distance Trip Mode Share**

| Mode | Business / Commute | Recreation / Other | Total |
|---|---|---|---|
| Car | 89.2% | 86.8% | 88.0% |
| Air | 10.4% | 11.4% | 10.9% |
| Rail | 0.4% | 1.8% | 1.1% |

**Table 20: Ratio Model / Target Year 2000 Long Distance Trip Mode Share**

| Mode | Business / Commute | Recreation / Other | Total |
|---|---|---|---|
| Car | 1.00 | 1.00 | 1.00 |
| Air | 1.00 | 1.00 | 1.00 |
| Rail | 1.00 | 1.00 | 1.00 |

### Access Mode Calibration

Tables 11a to 11c summarize the "observed target", LDPTM model forecast, and model-target ratios for access mode share to air / rail by trip purpose.

**Table 21: "Observed Target" Year 2000 Long Distance Trip Access Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 59.7% | 24.1% |
| Rental Car | 2.6% | 1.3% |
| Drop Off | 20.2% | 57.4% |
| Taxi | 6.8% | 7.9% |
| **SUB-TOTAL Auto** | **89.3%** | **90.7%** |
| Transit | 8.2% | 5.6% |
| Walk / Bike | 2.5% | 3.7% |
| **SUB-TOTAL Non-Auto** | **10.7%** | **9.3%** |

Source: Table 5.5 Observed Access and Egress Mode Shares by Mode and Purpose, HSR Model Validation Report

**Table 22: LDPTM Forecast Year 2000 Long Distance Trip Access Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 59.7% | 24.1% |
| Rental Car | 2.6% | 1.3% |
| Drop Off | 20.2% | 57.4% |
| Taxi | 6.8% | 7.9% |
| **SUB-TOTAL Auto** | **89.3%** | **90.7%** |
| Transit | 8.2% | 5.6% |
| Walk / Bike | 2.5% | 3.7% |
| **SUB-TOTAL Non-Auto** | **10.7%** | **9.3%** |

**Table 23: Ratio Model/Target Year 2000 Long Distance Trip Access Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 1.00 | 1.00 |
| Rental Car | 1.00 | 1.00 |
| Drop Off | 1.00 | 1.00 |
| Taxi | 1.00 | 1.00 |
| **SUB-TOTAL Auto** | **1.00** | **1.00** |
| Transit | 1.00 | 1.00 |
| Walk / Bike | 1.00 | 1.00 |
| **SUB-TOTAL Non-Auto** | **1.00** | **1.00** |

### Egress Mode Calibration

Tables 12a to 12c summarize the "observed target", LDPTM model forecast, and model-target ratios for egress mode share from air / rail by trip purpose.

**Table 24: "Observed Target" Year 2000 Long Distance Trip Egress Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 12.6% | 2.3% |
| Rental Car | 47.6% | 34.4% |
| Pick Up | 22.4% | 33.1% |
| Taxi | 16.6% | 26.3% |
| **SUB-TOTAL Auto** | **99.2%** | **96.1%** |
| Transit | 0.8% | 3.6% |
| Walk / Bike | 0.0% | 0.3% |
| **SUB-TOTAL Non-Auto** | **0.8%** | **3.9%** |

Source: Table 5.5 Observed Access and Egress Mode Shares by Mode and Purpose, HSR Model Validation Report

**Table 25: LDPTM Forecast Year 2000 Long Distance Trip Egress Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 12.6% | 2.3% |
| Rental Car | 47.6% | 34.4% |
| Pick Up | 22.4% | 33.1% |
| Taxi | 16.6% | 26.3% |
| **SUB-TOTAL Auto** | **99.2%** | **96.1%** |
| Transit | 0.8% | 3.6% |
| Walk / Bike | 0.0% | 0.3% |
| **SUB-TOTAL Non-Auto** | **0.8%** | **3.9%** |

**Table 26: Ratio Model/Target Year 2000 Long Distance Trip Egress Mode Share**

| Mode | Business / Commute | Recreation / Other |
|---|---|---|
| Drive and Park | 12.6% | 1.00 |
| Rental Car | 47.6% | 1.00 |
| Pick Up | 22.4% | 1.00 |
| Taxi | 16.6% | 1.00 |
| **SUB-TOTAL Auto** | **99.2%** | **1.00** |
| Transit | 0.8% | 1.00 |
| Walk / Bike | 0.0% | 1.00 |
| **SUB-TOTAL Non-Auto** | **0.8%** | **1.00** |

# 9. Implementation in CSTDM09 Model Framework

The LDPTM model is implemented using a specially-written java script program. It requires the following inputs:

- **A control file** that specifies the directories and files where the other inputs can be found, the output directory and filenames, and other run parameters. The name of the control file is passed as a command-line argument.
- A **coefficients** file containing all the model coefficients.
- A **zone properties** file in the HDF5 format containing the populations and other properties of the TAZs.
- **Skims** files in the HDF5 format.

## 9.1 Control File

The control file is a simple ASCII text file. Each line of the control file consists of an eight-character key and an arbitrary-length value, separated by any number of spaces. The keys that must be present in the control file, and the meaning of the associated values, are:

- RUNLABEL: the name of the run (e.g. California Long Distance Personal Travel Model: Base Year 2000 Validation).
- RUNDIREC: the directory in which the zone properties file and coefficients file are found.
- PRINTFIL: the name of the print file that any debug output will be printed to.
- COEFFFIL: the name of the coefficients file.
- CARDIREC: the directory in which the car skims are found.
- CARLOSPK: the name of the peak period car skims file.
- CARLOSOP: the name of the off-peak period car skims file.
- AIRDIREC: the directory in which the airport skims are found.
- AIRPORTS: the name of the file containing the airport codes, airport numbers, airport node numbers, and the zones the airports are located in.
- AIRNODPK: the name of the file containing the origin and destination airports used for each zone pair in the peak period.

- AIRNODOP: the name of the file containing the origin and destination airports used for each zone pair in the off-peak period.
- AIRLOSPK: the name of the peak period airport-to-airport skims file.
- AIRLOSOP: the name of the off-peak period airport-to-airport skims file.
- AIRACCPK: the name of the peak period airport access skims file.
- AIRACCOP: the name of the off-peak period airport access skims file.
- AIREGRPK: the name of the peak period airport egress skims file.
- AIREGROP: the name of the off-peak period airport egress skims file.
- CVRDIREC: the directory in which the rail skims are found.
- CVRSTATS: the name of the file containing the rail station numbers, rail station node numbers, and the zones the stations are located in.
- CVRNODPK: the name of the file containing the origin and destination stations used for each zone pair in the peak period.
- CVRNODOP: the name of the file containing the origin and destination stations used for each zone pair in the off-peak period.
- CVRLOSPK: the name of the peak period station-to-station skims file.
- CVRLOSOP: the name of the off-peak period station-to-station skims file.
- CVRACCPK: the name of the peak period station access skims file.
- CVRACCOP: the name of the off-peak period access skims file.
- CVREGRPK: the name of the peak period station egress skims file.
- CVREGROP: the name of the off-peak period station egress skims file.
- ZONEDATA: the name of the zone properties file.
- OUTDIREC: the directory that the outputs will be written to. The program cannot create this directory; i.e. it must exist already in the file structure.
- TRIPLIST: the name of the file that the trip list will be written to.
- FUELCOST: the cost of gasoline in cents per mile (in year $2000 values).
- HSRAVAIL: set as 0 for HSR not available, 1 for HSR available.
- NTHREADS: the number of threads to run.
- TESTORIG and TESTDEST: normally set both as -1. If debug output is needed, each must be a list of zone numbers. The program will print debug output for

trips from each origin zone in TESTORIG to the corresponding destination zone in TESTDEST. For example, TESTORIG 100, 101, 102 and TESTDEST 305, 306, 307 will produce debug output for zone 100 to zone 305, zone 101 to zone 306, and zone 102 to zone 307.

If any of these keys are missing, the program will halt and report an error.

Notes:

- **If HSRAVAIL is set to 1**, the control file must provide the location of HSR skims in addition to the car, air, and rail skims, using the keys HSRDIREC, HSRSTATS, HSRNODPK, HSRNODOP, HSRLOSPK, HSRLOSOP, HSRACCPK, HSRACCOP, HSREGRPK, and HSREGROP. These keys work the same way as the similar keys for conventional rail.
- The directory names must end in a backslash (e.g. “C:\LDPTM\Auto\” not “C:\LDPTM\Auto”).
- The directory names and the run label can have spaces in them. The filenames must not contain spaces.

### 9.2 Coefficients File

The coefficients file is written in the output format used by ALOGIT, as that was the source of most of the coefficients. Tables 13a through 13d show which coefficient number in the ALOGIT file corresponds to each coefficient in the specifications.

The trip frequency models use coefficients from ALOGIT file models 22, 23, 24, and 25 for business, commute, recreation, and other, respectively.

**Table 27: Coefficients File Numbers – Trip Frequency Models**

| Parameter | Coefficient Number | Coefficient Name |
|---|---|---|
| Intra-Region Accessibility | 1 | regacc |
| Logsum Destination Choice | 3 | llogsum |
| 1-Person HH | 5 | onephh |
| 3+ Person HH | 6 | threephh |
| Ratio Workers / Size | 12 | wkrspps |
| No Workers in HH | 16 | nowkrs |
| Medium Income | 7 | medinc |
| High Income | 8 | highinc |
| Cars < Workers | 11 | carsltw |
| SACOG Resident | 13 | sacog |
| SANDAG Resident | 14 | sandag |
| MTC Resident | 15 | mtc |
| SCAG Resident | 17 | scag |
| 1 Trip | 21 | const1 |
| 2 Trips | 22 | const2 |

The destination choice models use coefficients from model 16 for business/commute and model 17 for recreation/other.

**Table 28: Coefficients File Numbers – Destination Choice Models**

| Parameter | Coefficient Number | Coefficient Name |
|---|---|---|
| Mode Choice Logsum | 1 | mlogsum |
| Distance (Miles) | 2 | distance |
| Distance Squared | 3 | distsqu |
| Distance Cubed | 4 | distcub |
| Urban Destination | 5 | durban |
| Rural Destination | 6 | drural |
| Urban to Urban | 7 | urburb |
| Suburban to Suburban | 8 | subsub |
| Rural to Rural | 9 | rurrur |
| AMBAG | 41 | AMBAG |
| Central Coast | 42 | CC |
| Far North | 43 | FN |
| Fresno | 44 | FM |
| Kern | 45 | Kern |
| Merced | 46 | Merced |
| S. San Joaquin | 47 | SSJ |
| SACOG | 48 | SACOG |
| SANDAG | 49 | SANDAG |
| San Joaquin | 50 | SJ |
| Stanislaus | 51 | Stan |
| W. Sierra Nevada | 52 | WSN |
| Alameda | 53 | MTC |
| Contra Costa | 54 | MTC |
| Marin/Sonoma/Napa | 55 | MTC |
| San Francisco | 56 | MTC |

| | | |
|---|---|---|
| San Mateo | 57 | MTC |
| Santa Clara | 58 | MTC |
| Solano | 59 | MTC |
| Los Angeles | 61 | SCAG |
| Orange | 62 | SCAG |
| Riverside | 63 | SCAG |
| San Bernardino | 64 | SCAG |
| Ventura | 65 | SCAG |
| Imperial | 60 | SCAG |
| MTC to SCAG | 71 | mtcscag |
| SCAG to MTC | 75 | scagmtc |
| MTC to SANDAG | 72 | mtcsandag |
| SANDAG to MTC | 77 | sandagmtc |
| MTC to SACOG | 79 | mtcsacog |
| SACOG to MTC | 80 | sacogmtc |
| SCAG to SANDAG | 81 | scagsandag |
| SANDAG to SCAG | 82 | sandagscag |
| SCAG to SACOG | 76 | scagsacog |
| SACOG to SCAG | 73 | sacogscag |
| SANDAG to SACOG | 78 | sandagsac |
| SACOG to SANDAG | 74 | sacogsand |
| Retail Emp – Low Income | 101 | loincret |
| Retail Emp – Medium Income | 103 | mdincret |
| Retail Emp – High Income | 105 | hiincret |
| Service Emp – Low Income | 102 | loincsvc |
| Service Emp – Medium Income | 104 | mdincsvc |
| Service Emp – High Income | 106 | hiincsvc |

The main mode choice models use coefficients from model 11 for business/commute and model 12 for recreation/other.

**Table 29: Coefficients File Numbers – Main Mode Choice Models**

| Parameter | Coefficient Number | Coefficient Name |
|---|---|---|
| Money Cost (Dollars) | 1 | cost |
| In-Vehicle Time (Minutes) | 2 | time |
| Headway (Minutes) | 4 | freq |
| Reliability (% on time) | 3 | reli |
| Access Mode Logsum | 5 | accls |
| Egress Mode Logsum | 6 | egrls |
| Travel in a Group – Car | 104 | c-group |
| Travel in a Group – Air | 210 | a-group |
| Household Size (max. 3) – Car | 107 | c-hhsize |
| Fewer than 2 Cars (HH size > 1 Person) – Car | 106 | c-carslt2 |
| High Income – Air | 208 | a-hiinc |
| High Income – Conventional Rail | 408 | r-hiinc |
| High Income – High-Speed Rail | 308 | h-hiinc |
| Air Constant | 200 | a-const |
| Conventional Rail Constant | 400 | r-const |
| High-Speed Rail Constant | 300 | h-const |
| LAX to SFO | 211 | {lax-sfo} |
| SFO to LAX | 212 | {sfo-lax} |
| LAX to OAK | 213 | {lax-oak} |
| OAK to LAX | 214 | {oak-lax} |
| LAX to SJC | 215 | {lax-sjc} |
| SJC to LAX | 216 | {sjc-lax} |
| LAX to SAC | 217 | {lax-sac} |
| SAC to LAX | 218 | {sac-lax} |
| BUR to SFO | 221 | {bur-sfo} |
| SFO to BUR | 222 | {sfo-bur} |
| BUR to OAK | 223 | {bur-oak} |

| | | |
|---|---|---|
| OAK to BUR | 224 | {oak-bur} |
| BUR to SJC | 225 | {bur-sjc} |
| SJC to BUR | 226 | {sjc-bur} |
| BUR to SAC | 227 | {bur-sac} |
| SAC to BUR | 228 | {sac-bur} |
| ONT to SFO | 231 | {ont-sfo} |
| SFO to ONT | 232 | {sfo-ont} |
| ONT to OAK | 233 | {ont-oak} |
| OAK to ONT | 234 | {oak-ont} |
| ONT to SJC | 235 | {ont-sjc} |
| SJC to ONT | 236 | {sjc-ont} |
| ONT to SAC | 237 | {ont-sac} |
| SAC to ONT | 238 | {sac-ont} |
| SNA to SFO | 241 | {sna-sfo} |
| SFO to SNA | 242 | {sfo-sna} |
| SNA to OAK | 243 | {sna-oak} |
| OAK to SNA | 244 | {oak-sna} |
| SNA to SJC | 245 | {sna-sjc} |
| SJC to SNA | 246 | {sjc-sna} |
| SNA to SAC | 247 | {sna-sac} |
| SAC to SNA | 248 | {sac-sna} |
| SAN to SFO | 251 | {san-sfo} |
| SFO to SAN | 252 | {sfo-san} |
| SAN to OAK | 253 | {san-oak} |
| OAK to SAN | 254 | {oak-san} |
| SAN to SJC | 255 | {san-sjc} |
| SJC to SAN | 256 | {sjc-san} |
| SAN to SAC | 257 | {san-sac} |
| SAC to SAN | 258 | {sac-san} |

The access and egress mode choice models use coefficients from models 1, 2, 3, and 4 for business/commute access, business/commute egress, recreation/other access, and recreation/other egress, respectively.

**Table 30: Coefficients File Numbers – Access/Egress Mode Choice Models.**

| Parameter | Coefficient Number | Coefficient Name |
|---|---|---|
| Money Cost (Dollars) | 2 | cost |
| In-Vehicle Time (Minutes) | 1 | ivt |
| In-Vehicle Time (Minutes) for Pick Up/Drop Off | 4 | aivt-pkup |
| Auto Distance (Miles) | 5 | adis-taxi |
| Out of Vehicle Time | 12 | ovt |
| Airport is LAX – Drive and Park | 111 | dp-laxacc |
| Airport is SFO – Drive and Park | 112 | dp-sfoacc |
| Airport is SAN – Drive and Park | 115 | dp-sanacc |
| Airport is SJC – Drive and Park | 114 | dp-sjcacc |
| Main Mode is Air – Walk | 603 | wk-air |
| Main Mode is Conventional Rail – Drive and Park | 103 | dp-cvr |
| Main Mode is Conventional Rail – Rental Car | 203 | rc-cvr |
| Main Mode is Conventional Rail – Taxi | 403 | tx-cvr |
| Main Mode is Conventional Rail – Transit | 503 | tr-cvr |
| Main Mode is High-Speed Rail – Drive and Park | 104 | dp-hsr |
| Main Mode is High-Speed Rail – Rental Car | 204 | rc-hsr |
| Main Mode is High-Speed Rail – | 404 | tx-hsr |

| | | |
|---|---|---|
| Taxi | | |
| Main Mode is High-Speed Rail – Transit | 504 | tr-hsr |
| Travel Alone – Drive and Park | 105 | dp-alone |
| Travel Alone – Rental Car | 205 | rc-alone |
| Travel Alone – Taxi | 405 | tx-alone |
| Travel Alone – Transit | 505 | tr-alone |
| Household Size – Pick Up/Drop Off | 302 | sp-hhsize |
| No Cars in HH – Rental Car | 206 | rc-nocars |
| No Cars in HH – Transit | 506 | tr-nocars |
| Fewer than 2 Cars in HH (HH size > 1 Person) – Drive and Park | 107 | dp-carsltw |
| Fewer than 2 Cars in HH (HH size > 1 Person) – Transit | 507 | tr-carsltw |
| Low Income – Drive and Park | 108 | dp-lowinc |
| Low Income – Rental Car | 208 | rc-lowinc |
| Low Income – Taxi | 408 | tx-lowinc |
| Low Income – Transit | 508 | tr-lowinc |
| High Income – Drive and Park | 109 | dp-hiinc |
| High Income – Rental Car | 209 | rc-hiinc |
| High Income – Taxi | 409 | tx-hiinc |
| High Income – Transit | 509 | tr-hiinc |
| Drive and Park Access Constant | 101 | dp-acc |
| Drive and Park Egress Constant | 102 | dp-egr |
| Rental Car Access Constant | 201 | rc-acc |
| Rental Car Egress Constant | 202 | rc-egr |
| Taxi Access Constant | 401 | tx-acc |
| Taxi Egress Constant | 402 | tx-egr |
| Transit Access Constant | 501 | tr-acc |

| | | |
|---|---|---|
| Transit Egress Constant | 502 | tr-egr |
| Walk Access Constant | 601 | wk-acc |
| Walk Egress Constant | 602 | wk-egr |

### 9.3 Zone Properties File

The zone properties file is an HDF5 file with a record for each TAZ in the zone system. Table 14 summarizes the fields that should appear in each record in the order given.

**Table 31: Fields in the Zone Properties File**

| Column Header | Field Description |
|---|---|
| FINAL_TA | The TAZ number |
| COUNTY | The county |
| REGION | The region in the 14-region system: 1=AMBAG, 2=Central Coast, 3=Far North, 4=Fresno, 5=Kern, 6=Merced, 7=South San Joaquin, 8=SACOG, 9=SANDAG, 10=San Joaquin, 11=Stanislaus, 12=West Sierra Nevada, 13=MTC, 14=SCAG |
| DISTRICT | The district in the 25-district system: 1-12=same as region, 13=Alameda, 14=Contra Costa, 15=Marin/Sonoma/Napa, 16=San Francisco, 17=San Mateo, 18=Santa Clara, 19=Solano, 20=Imperial, 21=Los Angeles, 22=Orange, 23=Riverside, 24=San Bernardino, 25=Ventura |
| ATYPE | The density of the zone: 1=Urban Core, 2=Urban, 3=High Suburban, 4=Low Suburban, 5=Rural |
| RET | The total number of retail jobs in the zone |
| SER | The total number of service jobs in the zone |
| OTH | The total number of other jobs in the zone |
| SQAREMIL | The area of the zone in square miles |
| TOT_POP | The total population in the zone |
| TOT_HH | The total number of households in the zone |
| HHSx_NWy_z | A series of 99 columns, each giving the number of households in particular household segment in the zone. In the column header name, x=household size, y=number of workers, z=1 for low income, 4 for medium income, 7 for high income, plus the number of cars. |

### 9.4 Skims Files

The skims files are all HDF5 files with various record structures. They are divided into 5 types: car skims, station correspondence files, passenger mode stops files, station-to-station skims, and access/egress skims.

The car skims provide the level of service by car between every pair of zones. There is a car skims file for the peak period and another for the off-peak period. Table 15a shows the fields that should appear in each record in the order given.

**Table 32: Fields in the Car Skims Files**

| Column Header | Field Description |
|---|---|
| I | The TAZ number of the origin zone |
| J | The TAZ number of the destination zone |
| TIME | The travel time by car between the zones, in minutes |
| TOLL | The total road toll between the zones, in dollars |
| DIST | The road distance between the zones, in miles |

Each airport and rail station has both an internal station number (usually the numbers from 1 to the number of airports/stations) and a node number used in the network encoding. The station correspondence files map these two representations to each other, and tell which zone each airport/station is in. Table 15b shows the fields that should appear in each record in the order given.

**Table 33: Fields in the Station Correspondence Files**

| Column Header | | Field Description |
|---|---|---|
| **Airport File** | **Station File** | |
| AIRPORT | RAIL_STA | The 3-letter airport code (left blank for rail stations) |
| NUMBER | RAIL_STA_N | The internal station number |
| NODE | RAIL_NOD | The node number |
| TAZ | NEW_TAZ | The TAZ that the airport/station is located in |

The passenger mode stops files tell which airports/stations will be used for trips between each pair of zones for which that mode is available. There is an airport stops file and a rail station stops file for both the peak period and the off-peak period. The fields are listed in Table 15c.

**Table 34: Fields in the Passenger Mode Stops Files**

| Column Header | Field Description |
|---|---|
| I | The TAZ number of the origin zone |
| J | The TAZ number of the destination zone |
| ACC_STATION | The node number of the airport/station where the passenger transfers from the access mode to the main mode (the *origin* airport/station) |
| EGR_STATION | The node number of the airport/station where the passenger transfers from the main mode to the egress mode (the destination airport/station) |

The station-to-station skims files provide the level of service by air or rail between each pair of airports/stations. There is an airport-to-airport file and a rail station-to-station file for both the peak period and the off-peak period. The fields are listed in Table 15d.

**Table 35: Fields in the Station-to-Station Skims Files**

| Column Header | Field Description |
|---|---|
| I | The internal station number (NOT the node number) for the origin airport/station |
| J | The internal station number for the destination airport/station |
| FARE | The fare, in dollars, to ride the passenger mode between the two airports/stations |
| IVTIMES | The travel time in minutes between the two airports/stations – zero indicates no route available |
| HEADWAY | The average time, in minutes, between departures from the origin airport/station to the destination airport/station |
| RELIABILITY | The percent reliability of trips from the origin airport/station to the destination airport/station, as defined in the specifications |

The access/egress skims files provide the level of service for access and egress trips, both by car and by transit. Both access and egress skims are listed as zone-to-zone skims; they refer to the zone containing the airports/stations rather than the airports/stations themselves. There is an airport access/egress file and a rail station access/egress file for both the peak period and the off-peak period. The fields are listed in Table 15e.

**Table 36: Fields in the Access/Egress Skims Files**

| Column Header | Field Description |
|---|---|
| I | The origin zone number for the access/egress trip. For access trips, this is the origin zone for the overall trip, while for egress trips, this is the zone containing the destination airport/station. |
| J | The destination zone number for the access/egress trip. For access trips, this is the zone containing the origin airport/station, while for egress trips, this is the destination zone for the overall trip. |
| TRA_FARE | The fare, in dollars, to ride local transit between the two zones |
| TRA_IVT | The in-vehicle time in minutes for the transit trip between the two zones – zero indicates transit not available |
| TRA_OVT | The time in minutes spent waiting for transit or walking to or from transit in the course of the transit trip between the two zones |
| AUTO_DIST | The distance by car between the zones, in miles |
| AUTO_TIME | The travel time by car between the zones, in minutes |
| AUTO_TOLL | The total road toll between the zones, in dollars |

### 9.4 Output

The output for the LDPTM consists of a trip list in the HDF5 format; each record is a single trip. The fields used for the trip list are consistent with the other components of the CSTDM. Table 16 lists the fields and explains how they are adapted to the LDPTM.

**Table 37: Fields in the LDPTM Output Format**

| Column Header | Field Description |
|---|---|
| Model | Always 2 for the LDPTM |
| SerialNo | A unique number assigned to each trip, starting at 1 and incrementing |
| Person | Always 1 for the LDPTM |
| Trip | Always 1 for the LDPTM |
| Tour | Always 1 for the LDPTM |
| HomeZone | The origin zone for the trip |
| ActorType | Always “Person” for the LDPTM |
| OPurp | The purpose of the trip: “Bus” for business, “Com” for commute, “Rec” for recreation, “OtL” for other |
| DPurp | Same as OPurp for the LDPTM |
| I | The origin zone for the trip if the direction is “from home”, otherwise the destination zone for the trip |
| J | The destination zone for the trip if the direction is “from home”, otherwise the origin zone for the trip |
| Time | The time period that the trip occurs in: 2 for AM peak, 3 for midday, 4 for PM peak, 5 for late off-peak |
| Mode | The main mode, with occupancy indicated for car trips: “SOV”, “HOV2”, or “HOV3” for car trips of the corresponding occupancy, “Air” for air, “Rail” for rail, “HSR” for high-speed rail |
| AccMode | “Park” for Drive and Park, “Rent” for Rental Car, “Drop” for Drop Off, “Taxi” for Taxi, “Trans” for Transit, “Walk” for Walk |

| | |
|---|---|
| EgrMode | “Park” for Drive and Park, “Rent” for Rental Car, “Drop” for Pick Up, “Taxi” for Taxi, “Trans” for Transit, “Walk” for Walk |
| HHSize | Household size (1, 2, 3, or 4; 4 indicates 4 or more) |
| HHWks | Number of workers in household (0, 1, or 2; 2 indicates 2 or more) |
| HHInc | “Low” for low income, “Med” for medium income, “High” for high income |
| HHCars | Number of cars in the household (0, 1, or 2; 2 indicates 2 or more) |
| OSNode | The origin airport/station Cube node number for the trip by air/rail |
| OStation | The origin airport/station internal reference number |
| DSNode | The destination airport/station Cube node number for the trip by air/rail |
| DStation | The destination airport/station internal reference number |

Note: The Access and Egress modes given in the output are those used for the original outbound trip from home to the airport / rail station, even when the trip record contains data on the return trip back to home.

The car trips for each car mode and time period in the above trip list are combined with car trips from the other model components of the CSTDM, and assigned to the road networks for each time period.

The current implementation of the LDPTM does not explicitly extract (and provide for assignment) the car mode components of the access and egress choice for air and rail trips.