

**Appendix C:**  
Travel Demand Forecasting  
Methodology Memoranda

# Corridor System Management Plan San Joaquin County I-205 Corridor Phase I

Final  
Travel Demand Forecasting Methodology  
Memorandum

*Prepared for*



State of California  
Department of Transportation

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## **1 INTRODUCTION**

### **1.1 Purpose of the Memo**

The purpose of this document is to describe the tools and procedures that will be used to develop future year forecasts of travel demand within the study corridor. These forecasts will be used as inputs to the operational analysis of alternative future year conditions.

This document satisfies task 7 of the I-205/I-5 Corridor System Management Plan (CSMP), Task Order 205-002, Agreement 51A0369.

The remainder of this memo is divided into three sections:

**Study Context:** This section provides an overview of the project, and describes the demand input requirements for the operational analysis.

**Methodology Overview:** This section summarizes the overall approach that will be used to develop the forecasts of future year travel demand.

**Forecast Procedures:** This section describes the steps that will be taken in developing the future year demand forecasts.



## **2.2 Operational Analysis Network**

The study corridor is broadly defined as including the freeways and adjacent arterial roads of:

- I-205 from I-580 interchange to I-5 interchange; and
- I-5 from I-205 interchange to SR12 interchange.

The study network (the network to be covered by the operational analysis model) has been defined in more detail in a separate memo so as to cover the sections of freeway and arterials that will affect operation on the freeway or will in turn be affected by conditions on the freeways within the corridor. The agreed study network is illustrated in Figure 2.

## **2.3 Operational Analysis Periods**

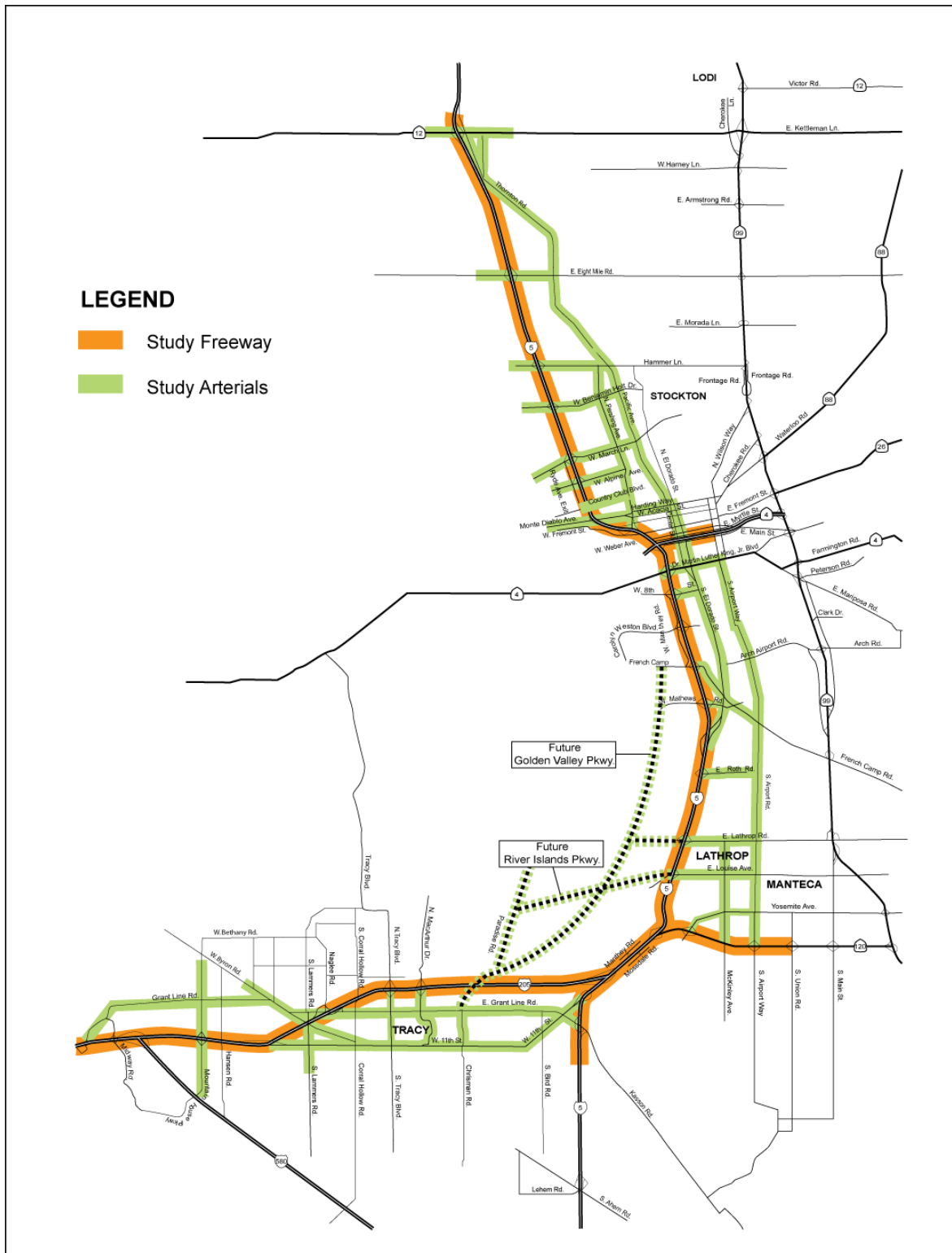
For each alternative, operational analyses will be conducted for two time periods representing the typical mid-week AM and PM peak periods. These periods are defined as:

- 5:00 to 10:00 AM, and
- 2:00 to 7:00 PM.

## **2.4 Operational Analysis Demand Input Requirements**

The operational analysis for this study will be conducted using the CORSIM micro-simulation modeling package. The CORSIM package requires a variety of network, traffic control and traffic demand input. The forecasting procedures discussed in this memo address the development of the necessary future year demand inputs for the CORSIM model. These inputs include:

- Entry link demands – Hourly demand forecasts are required for each entry link in the CORSIM model. These entry links include both the start point for each freeway corridor (i.e. southbound I-5 north of SR 12) and the arterial entry approaches on the boundary of the analysis network. In short, future year entry demands will be calculated by adding travel model forecasted growth to existing counts.
- Freeway ramp demands – Because a focus of the analysis is the operation of the study freeways, it is important to understand where traffic enters and exits the freeway. The off-ramp demands can be entered directly into CORSIM to help define the ratio of mainline traffic that exits at a particular ramp. For this effort, however, the combination of the on-ramp and off-ramp demands will be used to help define origin-destination (OD) matrices for each directional freeway corridor, as discussed below. As with entry demands, future year ramp demands will be calculated by adding travel model forecasted growth to existing counts.



**Figure 2 Agreed Operational Analysis Model Network**

- Freeway OD matrices – Rather than simply defining the ratio of mainline traffic that exits at a particular off-ramp, the definition of freeway ODs allows for control of which vehicles use particular ramps. This can be useful in best simulating the level of merging and weaving that occurs in specific freeway segments. Within CORSIM, this involves defining for each on-ramp the percentage that goes to each downstream exit (off-ramp or mainline end). Separate matrices can be defined for each hour of the analysis period. Both existing and future year freeway OD matrices will be developed using a combination of the OD outputs from the travel demand model and a separate OD matrix estimation (ODME) tool.
- Intersection turn splits – To simulate the operation of intersections, it is necessary to enter the relative turn percentages (or absolute turn splits) for each approach. As with the other inputs, different turn splits can be defined for each hour. Existing conditions turn splits will be derived directly from the turn movement counts at each intersection. This data, along with the forecasted changes in the approach and departure link demands at an intersection, will be used to define the future year turn splits using the Furness matrix estimation procedure.
- HOV percentage – because the future year networks may include HOV lanes and/or HOV preferential lanes at the on-ramps if metering is implemented, it is important to know the number of HOVs within the system. Within CORSIM, this is done by identifying the percentage of HOV at each entry point.
- Truck percentage – Trucks may be specified in CORSIM as a separate vehicle type, and they have an effect on traffic operations. The truck percentage may be specified separately for each turning movement and a separate truck OD matrix may be estimated. These will be developed from information available from the SJCOG study.

The procedures for defining each of these inputs are further described in the following section.

### 3 FORECASTING APPROACH

#### 3.1 Use of Countywide Travel Demand Forecasting Model

Forecasts of travel demand growth can be calculated a number of ways including the use of growth rates based on historical and anticipated future trends, the manual calculation and assignment of new trips associated with future development, and the application of a travel demand forecasting model. For this effort, it is proposed that SJCOG’s countywide travel demand forecasting model be used to estimate the growth in travel demand within the study corridor.

The reasons for utilizing the travel demand model in this study over the traditional method of applying a flat growth rates along the corridors are as follows:

- 1) Because of the rapid growth in the central valley, different land use growth rates are expected in different areas of the county. The rate of growth in traffic is therefore expected to be different by area along the study corridor. The travel demand model can be used to generate traffic forecasts that reflect a more realistic growth pattern along the corridor.
- 2) With the forecasted future growth in the study area, the traffic patterns and distributions within the study corridor can be expected to differ from current patterns based on congestion levels and availability of new facilities. The travel model takes these factors into consideration in assigning trips to the network and therefore generated forecasts that reflect any possible changes in travel patterns along the corridor.

In conjunction with the countywide model, historical and current statewide growth will be reviewed and compared with the model results as a “reasonableness” check of projections. These will be reconciled to gain consensus among the stakeholders about the travel demand projections, before proceeding with the detailed link-by-link forecasting described below.

The key features of this model are presented in Table 1. The large number of available forecast years is a result of air quality conformity requirements.

**Table 1: Current SJCOG County Travel Demand Model**

Area covered	Platform	Forecast Years	Time Periods
San Joaquin County and a northern portion of Stanislaus County	Cube	2006 Base Year 2010 Future Year 2011 Future Year 2013 Future Year 2014 Future Year 2018 Future Year 2020 Future Year 2023 Future Year 2025 Future Year 2030 Future Year	AM Peak Hour; PM Peak Hour; Offpeak; Daily

The current SJCOG model also includes a mode choice component that, if applicable, can be run to estimate any change in mode choice resulting from the improvement strategies that are examined.

### **3.2 Analysis periods**

Consistent with the previously accepted operational analysis methodology, forecasts will be developed for the following periods:

- 5-hour AM peak period (5 to 10 AM)
- 5-hour PM peak period (2 to 7 PM)

As noted above, the travel demand model only provides 1-hour forecasts. The growth rate forecast for the 1-hour period will also be applied to the shoulder hours in the 5-hour period. This procedure is further described in Section 3.5.

### **3.3 Horizon Years**

The guidelines for completing a CSMP do not call out specific requirements for the horizon years that need to be analyzed, but do suggest the need to look beyond the opening year at how the affected facility will be managed, examining both short-term and long-term conditions.

Based on this guidance, the expected completion date for construction of the CMIA project and the forecast years available within the current SJCOG model, the stakeholders have agreed that the following forecast years be used in this effort:

- 2006 Base – this will be used as the base from which the level of growth for each horizon year is determined.
- 2013 – this horizon year represents the approximate “opening year” for the CMIA project and will be used to represent short-term conditions.
- 2023 – this will be used to approximate a 10-year planning horizon for any additional operational strategies that are proposed in addition to the CMIA project.
- 2030 – this year will be used to approximate a 20-year planning horizon for determining LOS for operational strategies defined in the 10-year analysis.

Consideration was given to extrapolating the 2030 forecasts to obtain 2033 forecasts. However, the study team considers that the extra effort required for the extrapolation is not warranted. 2030 will give a good basis for estimating the operation of the network in the future.

### **3.4 Network Scenarios**

In addition to the different horizon years, travel demand forecasts will be developed for different network scenarios. The 2006 model will be used as the base from which the level of growth for each horizon year is determined. For each future year, a base scenario that includes the CMIA project plus other planned/programmed improvements will be run. The results from these runs will be used to develop a base set of demand forecasts that can be used in CORSIM to assess operating conditions under various alternatives including without the CMIA project, with CMIA project, and with the CMIA project plus other potential strategies that are not expected to have a

significant impact on route choice within the study corridor. In this latter case, a localized shift in travel demands patterns may be applied manually in the CORSIM model. However, if a strategy to be tested is expected to have a significant impact on route or mode choice on a corridor-wide level, separate travel demand model networks and travel demand forecasts will be developed. Up to two additional scenarios with the base improvements plus other proposed strategies/improvements will be run for each future year. These scenarios, defined in terms of horizon year and network characteristics, as summarized in Table 2.

**Table 2: Summary of Travel Demand Forecast Network Scenarios**

Year	Network
Base (2006)	Existing
2013	Base - Existing plus CMIA project plus other planned/programmed improvements <sup>1</sup>
2013	Base plus Other Strategies <sup>2</sup>
2023	Base - Existing plus CMIA project plus other planned/programmed improvements <sup>1</sup>
2023	Base plus Other Strategies <sup>2</sup>
2030	Base - Existing plus CMIA project plus other planned/programmed improvements <sup>1</sup>

Notes:

1. Other planned and programmed roadway improvements include those listed in the most recent RTP unrelated to the CMIA project.
2. Up to two scenarios will be run for each forecast year if proposed strategies are expected to have a significant impact on route or mode choice on a corridor-wide level.

As indicated in the Table 2, the 2011 and 2020 base networks will include other planned and programmed roadway improvements within the study corridor and the county that are unrelated to the CMIA project. These other improvements will be consistent with those defined in the 2007 SJCOG RTP project listing. Input from stakeholder agencies will be solicited to confirm improvement plans and timeframes.

### **3.5 Development of Operational Analysis Traffic Demand Inputs**

Results from the travel demand model will not be used directly in the operational analysis. Instead, changes in the forecast demand between the Base model (2006) and each horizon year as produced by the travel demand model will be used to adjust existing traffic demands. The specific procedures for developing the necessary entry demand, ramp demand, freeway OD, intersection turn split forecasts, and HOV percentages for use in the operational analysis are described below.

### 3.5.1 Entry Link Demands

The first demand input component to be developed will be the hourly demands for each entry link. This involves using the travel demand model to forecast the growth in demand from the base (2006) to the forecast year for each entry link. This growth will then be used to adjust the existing hourly demands. A “reasonableness check” of the results will then be conducted, and manual adjustments made to address any unusual changes or results. The specific steps in this process are as follows:

1. Calculate AM and PM peak hour growth level for each entry link based on outputs from the travel demand model and the following equation:

$$\text{Growth} = 20XX \text{ model link forecast} - 2006 \text{ model link forecast}$$

2. Compare the calculated peak hour growth to the existing peak hour demand to determine the corresponding growth rate or percentage for each link. This step is illustrated in the following equation:

$$\text{Growth rate (\%)} = (\text{model growth} / \text{Existing (2008) peak hour demand}) * 100\%$$

For entry links not coded in the travel demand model, a general growth rate will be defined based on growth levels forecast for adjacent links and professional judgment.

3. Calculate horizon year hourly demands by applying the growth rate to existing demands for each link as shown in the following equation:

$$20XX \text{ hourly demand} = \text{Existing hourly demand} * (1 + \text{growth rate})$$

The same growth rate will be applied to all five hours used for the operational analysis.

4. Conduct a reasonableness check of the results and apply manual adjustments as appropriate. For entry links, these adjustments may include:
  - Eliminating significant decreases in demand (“negative growth”), unless such a decrease is relatively small or justifiable.
  - Capping excessive demand growth where such growth is considered unreasonable and significantly exceeds capacity of the entry link. This may involve simply reducing the growth rate for a specific entry link, shift some growth to other entry links, or spreading the growth over other hours in the peak period (peak spreading - see section 3.5.6).
  - Comparison with historical and current statewide growth rates.

### 3.5.2 Ramp Demands

Ramp demands will be estimated following essentially the same process as that used for the entry links and described in the previous section. However, because it is not unusual for a travel demand model to inequitably assign trips across adjacent ramps (i.e. over-assign trips to one ramp and under-assign to another) or to allow for unusual assignment behavior such as vehicles exiting and re-entering the freeway at the same interchange, additional checks will be conducted to assess the reasonableness of the travel demand model outputs. The specific steps in this process are as follows:

1. Calculate AM and PM peak hour growth level for each ramp link based on outputs from the travel demand model and the following equation:

$$\text{Growth} = 20XX \text{ model link forecast} - 2006 \text{ model link forecast}$$

As part of this step, the travel demand model outputs will reviewed and adjusted to account for unusual assignment behavior such as vehicles exiting and re-entering the freeway at the same interchange.

2. Compare the calculated peak hour growth to the existing peak hour peak demand to determine the corresponding growth rate or percentage for each ramp. This step is illustrated in the following equation:

$$\text{Growth rate (\%)} = (\text{model growth} / \text{Existing (2008) peak hour demand}) * 100\%$$

3. Calculate horizon year hourly demands by applying the growth rate to existing demands for each ramp as shown in the following equation:

$$20XX \text{ hourly demand} = \text{Existing hourly demand} * (1 + \text{growth rate})$$

The same growth rate will be applied to all five hours used for the operational analysis.

4. Conduct a reasonableness check of the results and apply manual adjustments as appropriate. For entry links, these adjustments may include:
  - Eliminating significant decreases in demand (“negative growth”), unless such a decrease is relatively small or justifiable.
  - Capping excessive demand growth where such growth is considered unreasonable and significantly exceeds capacity of the ramp. This may involve simply reducing the growth rate for a specific ramp, shift some growth to adjacent ramps, or spreading the growth over other hours in the peak period (peak spreading - see section 3.5.6).
  - Comparison with historical and current statewide growth rates.

### **3.5.3 Freeway O/D**

Once the ramp demand forecasts are developed, a set of hourly freeway OD matrices will be developed. This process will involve the use of an ODME program to generate the initial matrices.

The steps in the freeway OD matrix process may be summarized as follows:

1. Utilize ODME program to generate hourly OD matrices based on freeway entry (mainline start and on-ramp) and exit (off-ramps and mainline end) demand forecasts.
2. Conduct a reasonableness check of results and make manual adjustments to reflect any observed OD patterns.

### **3.5.4 Intersection Turn Splits**

The intersections included in the CORSIM may be categorized as follows:

- major – those that are explicitly modeled in the travel demand and CORSIM models, and have existing year counts; and

- minor – those included in the CORSIM model, but not explicitly modeled in the travel demand model and/or do not have existing year counts.

For major intersections, a Furness process will be applied to generate forecast year turn splits. The steps in the process may be summarized as follows:

1. Output base and future year raw demand forecasts for all intersection approach and departure link from the travel demand model.
2. Modify raw forecasts as appropriate by eliminating projected decreases in demand (“negative growth”), unless such a decrease was relatively small or justifiable.
3. Apply Furness matrix program to generate future year splits using existing turn movement counts, and base and future year link forecasts.
4. Modify forecasts for intersections that include a freeway ramp to conform to the adjusted ramp demands, in order to maintain consistency in the forecast estimates.
5. Adjust forecasts to provide reasonable consistency in the traffic demand flows between adjacent intersections (i.e. balancing the departing demands at one intersection and approach demands at a downstream intersection) in order to provide a balance in the forecast demands.
6. Conduct final reasonableness check.

For minor intersections, existing turn splits were maintained except where deemed appropriate to provide reasonable consistency in the traffic demand flows between adjacent intersections (i.e. balancing the departing demands at one intersection and approach demands at a downstream intersection).

### **3.5.5 HOV Percentage**

Counts of existing HOVs will be used to develop HOV percentages for use in the Existing Conditions CORSIM models, covering each section of I-5 and I-205. The travel demand model will then be used to determine the forecasted change in this percentage for each future year scenario. Similar to the traffic demand forecast procedure presented above, the future year HOV percentages will be determined by applying the change in HOV percentage from the travel demand model to existing observed HOV percentage values within the study corridor. The specific steps in this process are:

1. Output base and future year SOV and HOV link demands for selected links from the travel demand model.
2. Compute change in HOV percentage for those links based on the travel demand model outputs.
3. Apply calculated change to existing HOV percentage assumptions.

### **3.5.6 Truck Percentage**

Counts of existing trucks will be used to develop truck percentages for use in the Existing Conditions CORSIM models. The SJCOG truck study will be used to determine the percentage for each future year scenario. Similar to the traffic demand forecast procedure presented above, the future year truck percentages will be determined by applying the change in truck percentage

from the truck study data to existing observed truck percentage values within the study corridor. The specific steps in this process are:

1. Estimate base and future year truck demands for selected links from the truck study.
2. Compute change in truck percentage for those links.
3. Apply calculated change to existing truck percentage.

### **3.5.7 Peak Spreading**

Peak spreading is the result of two phenomena that occur when the capacity of the network is not sufficient to accommodate travel demands during certain hours of the day:

- As congestion increases and travel times increase, the peak spreads simply because vehicles are using the facility for a greater length of time; and
- As a result of the increased travel time, some travelers choose to postpone their trips or travel earlier to avoid severe congestion.

A travel demand model forecasts the “demand” to use a transportation network during a specific time period. As a result, it is usual for some links in a travel demand model to have volumes in excess of capacity (a V/C ratio greater than one). This phenomenon is not realistic, however, because the number of vehicles passing through a roadway segment cannot exceed the roadway capacity. In reality, these excessive demands cause congestion to spill back upstream. A simulation model captures this reality and hence the travel demands estimated by a travel demand model cannot be used directly in a simulation model especially for a congested network. There is a need for a peak-spreading process to refine demands temporally.

Because temporal origin count profiles (from observations) are not available for the CSMP future analysis year, the base-year profiles will be carried over by implicitly assuming that peak periods are not significantly changed. It is possible that forecasted demands might be much greater than existing demands and demands will exceed link capacity during a peak interval. In this situation, the excess demand will be distributed to adjacent time intervals. If all intervals are fully loaded, the analysis periods might be extended to realistically handle excess demand.



## DRAFT MEMORANDUM

TO:

FROM: Britt Fugitt

DATE: February 25, 2010

SUBJECT: Caltrans CSMP I-5/I-205 Corridor  
Travel Demand Model Methodology

P/A No. 08076-041-004

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The *Travel Demand Forecasting Methodology Memorandum* described the initial planned process to be used to develop base year and future year forecasts of travel demand within the I-5 and I-205 study corridors. After an analysis of the travel forecasting model and additional conversations with the team; minor model adjustments and an agreed on set of procedures were implemented to produce the future year travel demand to be used as inputs for the CORSIM micro-simulation traffic modeling efforts.

This memo documents the methodology and specific procedures used to estimated future year travel demand within the study area corridor. This includes:

- Travel demand model refinements.
- Not allowing study area gateway traffic volumes to exceed the roadways capacity.
- The post-processing procedures used for developing future year travel demand freeway OD matrices and roadway intersection turning movement splits (or proportions).
- Using the adjusted AM and PM peak hour travel demand forecast to develop a 5-hour AM peak period (5 to 10 AM) and a 5-hour PM peak period (2 to 7 PM) CORSIM inputs.

### **Methodology**

#### Model Refinements

As stated in *Travel Demand Forecasting Methodology Memorandum*, it was determined that SJCOG's countywide AM and PM peak hour travel demand model be used to estimate the peak hour growth in travel demand for future year analysis. The year 2024 travel demand analysis started with the 2023 land use and network model inputs. Additional network details were coded to more accurately replicate the corridor's freeway, interchanges, ramps, and intersections. Also

network link attributes like number of lanes and capacities were updated to reflect the most up-to-date planning documents. In addition to the regional network, a subarea network of only the freeway and ramp links was extracted for producing the freeway OD hourly demands.

### Post Processing

Growth in travel demand from a travel model is calculated by taking the difference between the future year demand and base year demand. This peak hour growth is then added to the existing hourly demands (computed from counts) to estimate future peak hour demands. This is known as the difference method and is illustrated by the following equation:

$$\text{future peak hour demand} = \text{existing hourly demand} + \text{model growth}$$

The difference method was used at the OD level to produce year 2024 travel demand freeway OD matrices. The difference method was also applied at an intersection turn level to produce year 2024 intersection turning movement splits.

### Volume Capping Adjustment

After the post processing operation was performed, a “reasonableness check” of the year 2024 freeway OD demands revealed an excessive amount of growth in demand at the I-205 entry/exit-link (Altamont Pass) on the west edge of the study corridor and an excessive amount of growth in demand at the I-5 entry/exit-link (to/from Sacramento) on the north edge of the study corridor. An algorithm was developed to restrict the year 2024 I-205 western entry/exit-link to 12,000 vehicles per hour and restrict the year 2024 I-5 northern entry/exit-link to 5,000 vehicles per hour.

The evaluation process uncovered that the excessive growth was caused by three limitations in the SJCOG’s countywide AM and PM peak hour travel demand model. First the analysis showed high percent of county trips exiting the county. Although it made sense for growth in home-base-work (HBW) trips to commute outside the County, the majority of other trip purposes generated in the County, like school and shop, would remain internal to the County. The second cause is the SJCOG model’s process of estimating mode split. The mode split uses a static one percent factor to estimate transit trips. A similar process is used to estimate shared-ride vehicle trips. Depending on trip purpose, the person trip to shared-ride factor ranges from 0.609 to 0.989. For both transit and shared-ride, the same factor was applied for future year forecast as in the base year. Unlike more advanced travel demand mode split models, the process does not use travel time, favoring use of transit or shared-ride in congested corridors. The third is a common limitation of peak hour models in areas where individual trip travel times can exceed one hour. Although a proportion of the trip exists in the peak hour, the model assumes the entire trip begins and ends in a single peak hour. If the area's congestion significantly increases like is expected in San Joaquin County, then this limitation becomes an issue.

DKS developed a post model iterative algorithm to address the three observed limitations for the year 2024 forecast. The algorithm implements a capacity threshold within the trip tables and then re-assigns the trips to other portions of the network (i.e., to other destinations). The process also shifts a portion of the peak hour trip to other hours within the peak period. This process increases internal trips within the county, increases transit and shared-ride trips, and shifts trips to shoulder hours of the peak hour.

### Peak Hour to Peak Period

The analysis for the CSMP I-5/I-205 corridor study is based on a 5-hour AM peak period (5 to 10 AM) and a 5-hour PM peak period (2 to 7 PM). As discussed above, the SJCOG's countywide travel demand model produces peak hour demands. Therefore a process was developed to factor the model's peak hour demands to 5-hour peak period demands. These peak hour to peak period factors were derived from exiting traffic counts. For each hour in the peak period, a ratio was calculated where the representative hour was the numerator and the peak hour was the denominator. Ratios were then adjusted to reflect the "long travel time trips" that were shifted out of the peak hour and into shoulder hours as discussed in the capping adjustment section.