Dowling Associates

Transportation Engineering • Planning • Research • Education

KCAG
2008 MODEL UPDATE

MODEL DOCUMENTATION
AND
VALIDATION REPORT

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Table of Contents

List of Figures

List of Tables

Appendices

1. INTRODUCTION AND SUMMARY

The Kings County travel forecasting model maintained by the Kings County Association of Governments (KCAG) has been updated in 2008 with base year 2005.

The purpose of the model is to provide a defensible tool to:

- evaluate the traffic circulation systems of the cities and county;
- provide basic traffic information for environmental analysis and preliminary design work on proposed highway projects;
- evaluate the traffic impacts of large-scale development proposals; and
- provide input into the air quality analysis required by the Clean Air Act Amendments.

The 2008 model update ensures that the model meets the current requirements of the Clean Air Act, updates the base year information used in the model from 1998 to 2005 so that it is within 10 years of the date of any near-term required air quality conformity determination, and enhances certain features in the model to take advantage of recent improvements in software and graphic display capabilities.

This chapter includes a summary of the updated travel model, followed by a description of the Clean Air Act requirements and a brief history of the Kings County model development. The following chapters describe the individual components of the model.

1.1 Summary of KCAG Model

The KCAG regional travel model is a conventional travel model demand forecasting model that is similar in structure to most other current area-wide models used for traffic forecasting. It uses land use, socioeconomic, and road network data to estimate facility-specific roadway traffic volumes.

1.1.1 Travel Demand Model Software

In 1999 the California Air Resources Board provided funds to Central Valley jurisdictions to convert their travel demand models from DOS-based MINUTP software to Windows-based TP+ software. The goal of this conversion was to produce a TP+ travel demand model that paralleled the process of its MINUTP counterpart. These funds provided for the conversion of a single model study year. The KCAG model was converted to TP+ for the 1990 base year only.

The 2001 model update provided a TP+ model system for all forecast years as well as the new 1998 base year. Model networks in the 2001 update are viewed using the Viper software that is associated with TP+. In 2001, the Urban Analysis Group (original developer and supplier of TP+/Viper) merged with the Software Products Division of MVA to become Citilabs. KCAG has a continued maintenance agreement with Citilabs and, with such, is entitled to software upgrades and technical support. The website for Citilabs is www.citilabs.com.

1.1.2 Model Coverage and Traffic Analysis Zones (TAZs)

The study area for the KCAG model covers all of Kings County, including the cities of Avenal, Corcoran, Hanford, Lemoore and unincorporated Kings County. The county is broken up into approximately 700 traffic analysis zones (TAZs).

1.1.3 Socioeconomic Data / Land Use Inputs

The travel demand model land use inputs (socioeconomic data) by TAZ include population related data (household data, broken down by household type and population estimates), and employment related data (broken down into seven employment categories: retail, commercial, industrial, agricultural, government, education, and other). In conjunction with development of population and employment forecasts by TAZ, an evaluation of expected future development in coordination with local officials and planners was made in order to ensure that additional capacity added through the RTP was appropriately balanced to the expected development patterns in Kings County.

The new 2005 base year data was developed by updating the land use assumptions to include Census 2000 data, the commercially purchased InfoUSA database, and KCAG in-house information. Land use conversion factors were developed to determine maximum buildout of available acreage using Assessor's Parcel data and current employee densities. In addition, a factoring process was used to match the employment totals with the EDD and Woods & Poole totals.

Future horizon year (2035) estimates were developed considering estimates/projections of growth consistent with DOF County Population Projections for 1990-2040, State of California Employment Development Department (EDD) labor market data, *County Business Patterns Surveys*, General Plan assumptions and trends in population, housing and employment relationships and input from local jurisdictions. All future interim year (2015-2035) assumptions are estimated using trend lines associated with DOF's population estimates and population/HH and employment/HH assumptions.

1.1.4 Roadway Network Characteristics

The travel demand model roadway network includes nearly 4,000 nodes, and over 10,900 links. Link types include freeway, freeway ramp, highway (multi and two-lane), arterial, collector, rural and local road. Important road network attributes include distances, uncongested speeds, and hourly capacities.

The coordinate system used for the model network provides true spatial placement so that the model network can be viewed together with other geographic information such as street maps, TAZ maps and census information using a GIS package such as ArcView or Viper.

The travel demand model base year and future year road networks were developed considering local agency circulation elements of the general plan, traffic impact studies, capital improvement programs (CIPs) and the State Transportation Improvement Program (STIP).

Separate transit networks have not been developed.

1.1.5 Forecasting Process

Four sequential steps (actually sub-models) are involved in the travel demand forecasting process:

- **Trip Generation.** This initial step translates household and employment data into person trip ends using trip generation rates established during model calibration.

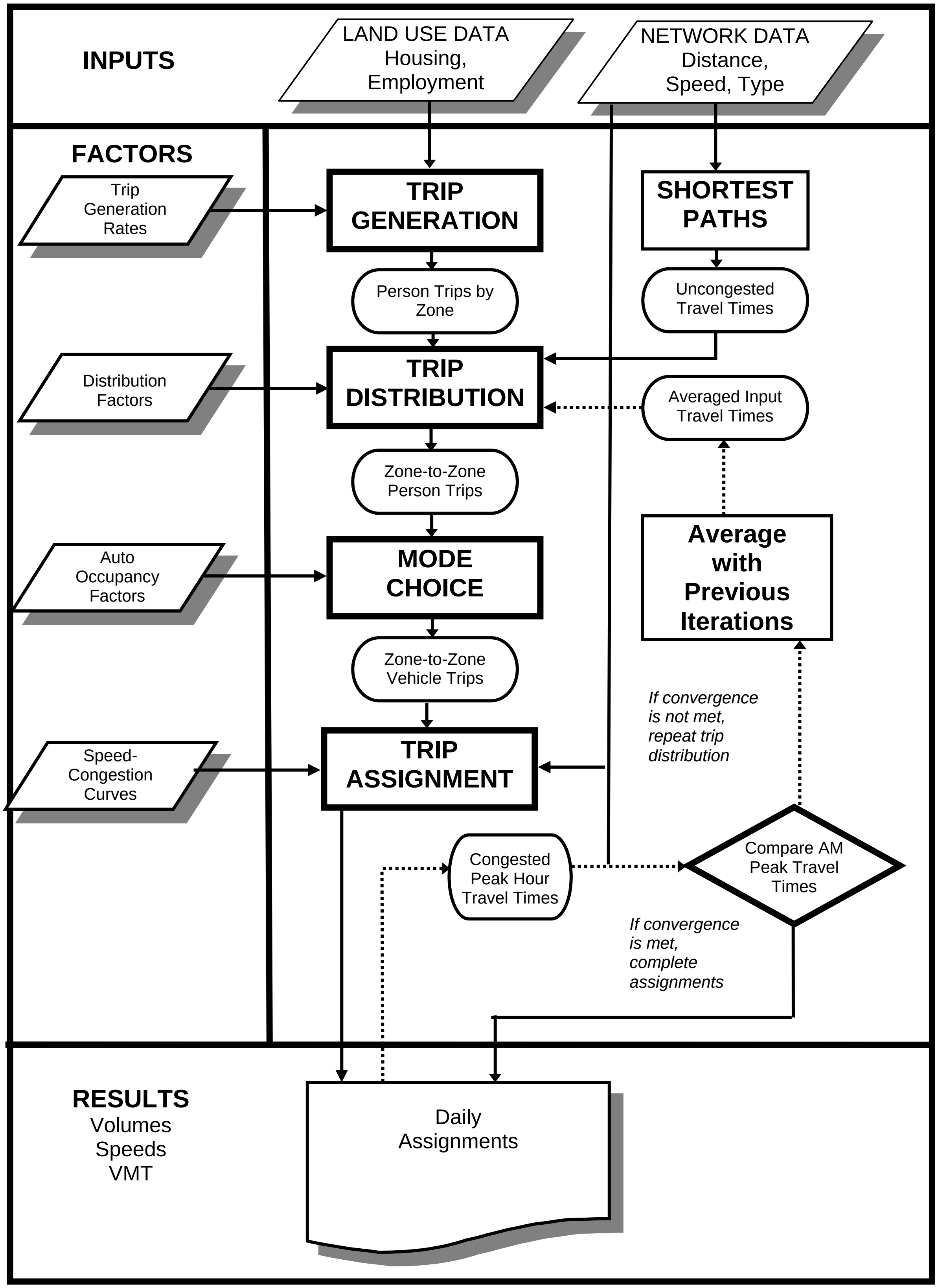
- **Trip Distribution.** The second general step estimates how many trips travel from one zone to any other zone. The distribution is based on the number of trip ends generated in each of the two zones, and on factors that relate the likelihood of travel between any two zones to the travel time between the two zones.

- **Mode Choice.** This step estimates the proportions of the total person trips using single occupant vehicles and ridesharing modes for travel between each pair of zones. The KCAG model uses a factoring procedure rather than a full mode choice analysis step.

- **Trip Assignment.** In this final step, vehicle trips from one zone to another are assigned to specific travel routes between the zones.

A flow chart of the KCAG model process is shown in Figure 1.

Figure 1 KCAG Travel Demand Model Process



1.1.6 Forecast Time Periods

The travel demand model currently estimates daily travel demand and average daily traffic (ADT) and AM and PM peak hour traffic volumes.

1.1.7 Feedback Loops

The KCAG travel model includes a feedback loop that uses the congested speeds estimated from traffic assignment to recalculate the trip distribution. The feedback loop repeats the process iteratively until the congested speeds and traffic volumes do not vary significantly between iterations. This ensures that the congested travel speeds used as input to the air quality analysis (outside the KCAG model) are consistent with the travel speeds used throughout the model process, as required by the Transportation Conformity Rule (40CFR Part 93).

1.1.8 Model Revalidation

The KCAG model was revalidated to 2005 daily counts and VMT. The model estimates of 2005 daily volumes are within all of the FHWA percent difference targets by facility type. The model also met the FHWA targets for percent root mean square error (RMSE) for all facility types, except arterials and collectors (37.8% vs. 35% target for both). However, when volumes were categorized by magnitude, all volume groups met the FHWA percent RMSE targets. Six (6) of the 7 screenlines are within 10 percent of observed counts and all the screenlines except for one are within 30 percent RMSE. Therefore, the model is considered acceptable based on FHWA guidelines.

The model estimated 3,412,881 VMT on the roadway links and 29,517 in intrazonal VMT for a total of 3,442,398 VMT for the 2005 model year. The Caltrans HPMS 2005 estimate of VMT in Kings County was 3,440,000. The model estimate is 0.07% higher than the Caltrans 2005 HPMS VMT, well within the required +/- 3%.

1.2 Transportation Conformity Rule Modeling Requirements

The 2008 model update and enhancements were designed to provide a network based travel model that meets the following Transportation Conformity Rule transportation modeling requirements for serious and above ozone and CO areas with an urbanized population over 200,000[1]:

[1] *Transportation Conformity Rule Amendments: Flexibility and Streamlining*, Federal Register: August 15, 1997, Volume 62, Number 158.

i) Network-based models must be validated against observed counts (peak and off-peak, if possible) for a base year that is not more than ten years prior to the date of the conformity determination. Model forecasts must be analyzed for reasonableness and compared to historical trends and other factors, and the results must be documented.

ii) Land use, population, employment, and other network-based model assumptions must be documented and based on the best available information.

iii) Scenarios of land development and use must be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options must be reasonable.

iv) A capacity-restrained traffic assignment methodology must be used, and emissions estimates must be based on a methodology which differentiates between peak and off-peak volumes and speeds, and which uses speeds based on final assigned volumes.

v) Zone-to-zone travel impedances used to distribute trips between origin and destination pairs must be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. Where use of transit currently is anticipated to be a significant factor in satisfying transportation demand, these times should also be used for modeling mode splits.

vi) Network-based models must be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices.

In response to issues raised by the Sierra Club in their review of other Central Valley models, the 2001 model update of the KCAG travel model incorporates a more comprehensive feedback loop so that the congested travel speeds used for final traffic assignment and as input to an air quality analysis are consistent with the travel speeds used throughout the model process.

2. MODEL STUDY AREA AND ZONE SYSTEM

The study area for the KCAG model covers all of Kings County, including the cities of Avenal, Corcoran, Hanford, Lemoore and unincorporated Kings County. The county is broken up into 1,000 traffic analysis zones (TAZs).Figure 2 shows the travel demand model TAZs and gateways. The TAZs are also color-coded. Zone maps for each jurisdiction can be created by KCAG staff upon request.

The TAZ polygon shapefiles are maintained in ArcView and then are linked to land use database files created by the KCAG model land use workbook (KCAGmodel.xls).

2.1 Internal Zones

Zone numbers 100 to 1,000 are used for internal Kings County zones. Not all zone numbers in this range have been used, allowing for future detailing or expansion of the model. The TAZs are generally smaller in size where land use density is higher, such as in the commercial areas of Hanford and Lemoore, while larger zones are used for the more rural portions of the county. The TAZs are consistent with United States Census tract boundaries, but are generally smaller than census tracts to provide for better allocations of travel demand.

The TAZ allocations are summarized in below in Table 1.

2.2 External Zones

The KCAG model has 99 external cordons (gateways) for representing travel into, out of, and through the region. Zone numbers 1 to 99 are reserved for external cordons. Locations of the currently used external gateways are also shown in Figure 2.

Appendix A lists the external zones, their locations and their assumptions.

Figure 2 KCAG Travel Demand Model TAZs and Gateways

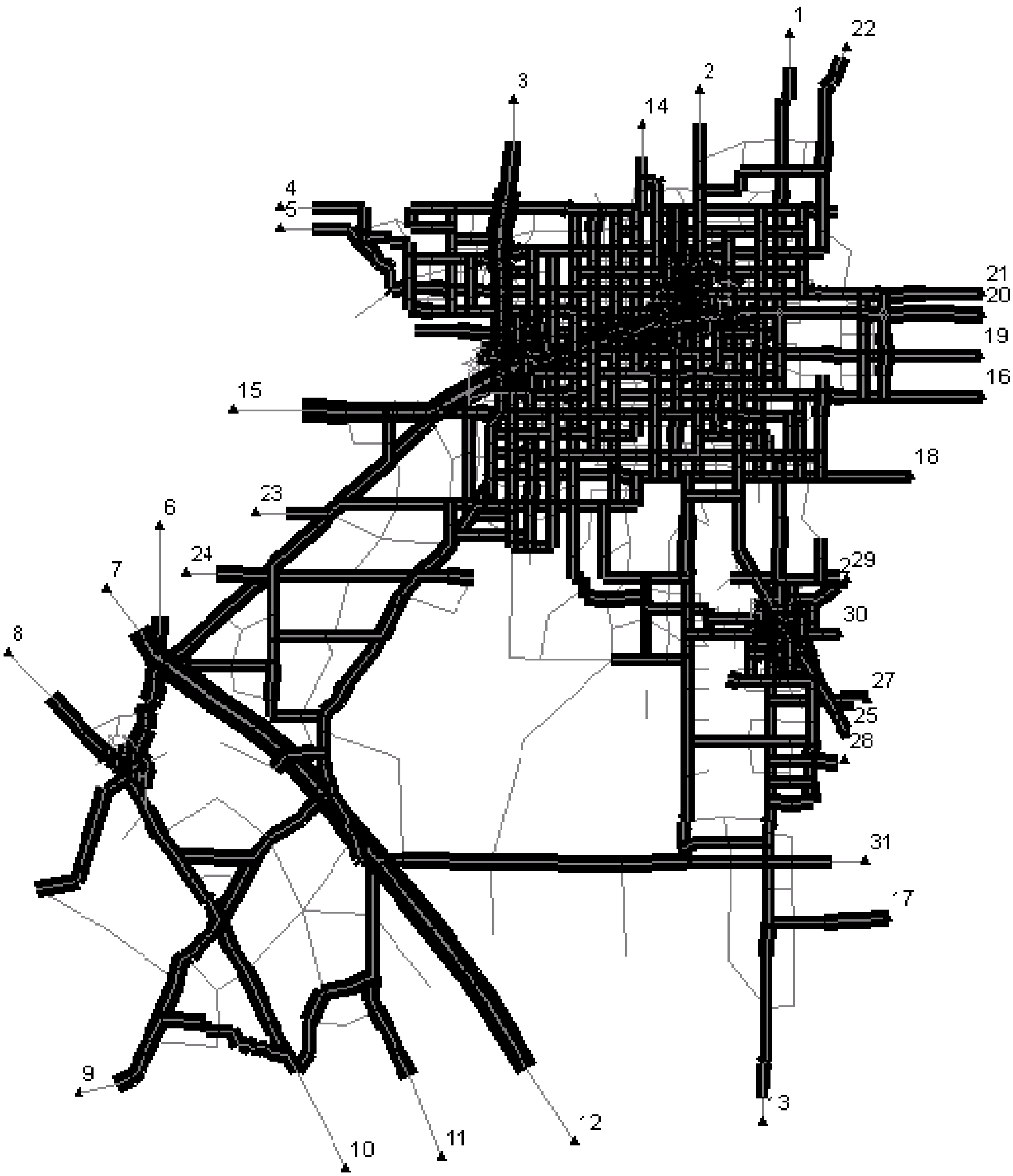


Table 1 KCAG Traffic Analysis Zone Allocations

DESCRIPTION	ZONE NUMBERS
CITIES	
Avenal	101-124
Avenal Prison	125
Corcoran	201-252, 255, 256
Corcoran Prison	253, 254
Hanford	301-490
Lemoore	601-674
Lemoore NAS	691-693
OTHER COMMUNITIES	
Armona	151-161
Home Garden	525, 527
Kettleman	175, 176
Rancheria	950, 951
Stratford	975, 976
RURAL AREAS	261-281, 526, 528-559, 681-684, 701-921 975, 976
UNUSED ZONE NUMBERS	
Internal	100, 126-150, 162-174, 177-200, 257-260, 282-300, 491-524, 560-600, 675-680, 685-690, 694-700, 922-949, 952-974, 977-1000
Gateway	32-99

3. Transportation Networks

The KCAG regional travel model uses coded representations of the region's existing and future roadway networks. As part of the 2001 model update, the roadway network was conflated to State Plane 1983 California Zone 4 coordinates, with measurement in feet. The current version of the KCAG model does not include transit system networks.

3.1 Road Network Elements

The road network is a computerized representation of the major street and highway system within the study area. Generally, most Circulation Element facilities for each local agency are included in the model. However, only the more important streets (generally freeways, expressways, arterials, and major collectors) are explicitly included in the network. The model does not explicitly include minor collector streets or local streets. Minor collector streets, local streets and driveways are instead represented by simplified network links ("zone centroid connectors") that represent local connections to the adjacent major roadway network.

The coded road network is comprised of three basic types of data: nodes, links and turn penalties.

3.1.1 Nodes

Nodes are established at each and every intersection between two or more links. Nodes are assigned numbers, with the first 1,000 node numbers in the KCAG model representing traffic analysis zones as discussed in the previous section.

The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays.

3.1.2 Links

Links represent road segments, and are uniquely identified by the node numbers at each end of the segment (for example, a link may be identified as "1232-1234"). Information is coded for each road link. This is discussed in further detail in Section 3.3.

In the KCAG model, free-flow speeds are coded individually for each road link. Capacities and speed-versus-congestion characteristics are assigned to groups of links based on the road type (see Table 2).

Table 2 Capacities and Speed-Delay Curves by Roadway Type

ROAD TYPE	CAPACITY CLASS (CAPCLASS)	DESCRIPTION	HOURLY CAPACITY (VEHICLES PER LANE)	SPEED-DELAY CURVE (SPDCLASS)
FREEWAY	01	Freeway	2,000	1 (Freeway)
HIGHWAYS	02 02	Two-Lane Multi-Lane	1,145 1,800	2 (Highway)
RURAL	03 03	Two-Lane Multi-Lane	900 1,400	2 (Highway)
ARTERIAL	04	Urban Arterial	750	3 (Arterial/Collector)
COLLECTOR	05	Urban Collector	500	3 (Arterial/Collector)
LOCAL	06	Urban Arterial	350	3 (Arterial/Collector)
RAMP	07	Freeway Ramp	1,500	3 (Arterial/Collector)
ZONE CONNECTOR	10	Zone Connector	9999	3 (Arterial/Collector)
GATEWAY CONNECTOR	11	Gateway Connector	9999	4 (Zone Connector)`

3.1.3 Turn Penalties

Turn penalties are coded in a separate file, and can be used to identify node-to-node movements which are prohibited (such as certain left turns) or which have additional delays. In the KCAG model, turn penalties would primarily be used to represent prohibited left turns to and from ramps at freeway interchanges.

3.2 2005 Base Year Road Network

Development of the 2005 base year road network for this update involved the following modifications to the previous versions of the KCAG road network:

- Addition of new and split zone centroid connectors.
- Update of local jurisdiction streets to reflect the City of Lemoore and the City of Corcoran General Plan Updates.
- Uploading of 2005 daily counts from HPMS and other available traffic count databases to provide comparisons for model validation.

3.3 "Master" Network

As part of the 2001 model update, Dowling Associates developed a "Master" network to store the network related attributes for the base and all future year networks, including number of lanes, facility type. Capacity-increasing roadway network improvements are in the Master network with construction year (project completion) identifiers. All roadway networks used in the travel demand model are "built" from this Master network.

The purpose of creating a Master network was to ease the task of network maintenance. In the past, if a roadway network improvement was to be included in several alternatives (e.g., add a new freeway interchange to the 2010 and all future networks beyond 2010), the same network editing had to be performed individually for each of the network years. With a Master network, the user need only input the improvement in one place with the appropriate year of construction and then all desired network years can be built and will be consistent.

While the creation of a Master network will ease the task of network maintenance, it will require the user to be very aware of how network coding is handled and to be diligent about displaying proper network data.

3.4 Transit Network

The KCAG travel model does not include a separate transit network. Based on the Caltrans *1991 Travel Survey*, transit trips (not including school buses) account for less than 1 percent of trips in Kings County. This percentage is not expected to increase significantly in the future with the current Regional Transportation Plan.

Future regional transportation studies may require more detailed analysis of transit infrastructure investments. If so, the KCAG travel model capabilities could be enhanced by adding separate representation of the transit systems and a mode choice analysis step.

4. DEMOGRAPHIC/LAND USE DATA

Land use and socioeconomic data at the zonal level are used for determining trip generation. The 2008 update of the KCAG model maintains the previous zonal variables for the land use/socioeconomic database, including housing units by single-family and multiple-family use and auto occupancy, and employment by category (retail, service, education, government, and other).

4.1 2005 Base Year Land Use Data

A 2005 land use database was developed to provide inputs to model re-validation. 2005 was selected as the base year since this was the most recent year that HPMS VMT estimates were available. The 2005 land use inputs are used to set up model parameters such as trip generation rates and external gateway trip types and percentages. Once these model parameters are established, they are used in conjunction with future land use data alternatives for model application. The 2005 land use assumptions are summarized in Table 3.

4.1.1 2005 Housing Data

The 2005 total housing units were estimated using the standard KCAG travel model splits into single-family and multiple-family households in conjunction with the 2000 Census data, to distribute households by auto ownership category.

Once a base set of assumptions were developed by TAZ these were distributed to each of the KCAG local jurisdictions for review and comment. All comments were then incorporated into the 2005 base year land use assumptions.

4.1.2 2005 Employment Data

The 2005 employment data in the updated model is primarily based on the InfoUSA commercial employment database, which covers approximately 95% of the employment in the county. Moreover, Dowling Associates directed KCAG staff to make phone calls to determine reasonable estimates of employment. The resultant employment totals were compared with EDD estimates and a factoring process was developed to match EDD and Woods & Poole employment totals.

Table 3 2005 Land Use Summary

Land Use	2005
TOTAL HOUSING	**37,497**
Retail	5,690
Office	1,021
Industrial	7,171
Agricultural	5,204
Government	5,653
Education	3,720
Other	6,563
TOTAL EMPLOYMENT	**35,022**

4.2 Housing and Employment Projections

Projections of housing were based on DOF's " Revised County Population Estimates and Components of Change by County, July 1, 1990-2000. - and Projections for 2000 through 2050"[2] and trends in population per housing unit and single-family vs. multi-family proportions by jurisdiction. Projections of employment were based on previous model assumptions, including rates of employees per housing unit by jurisdiction, and trends in employment growth by category.

Housing units and employment estimates were distributed geographically based on previous model growth assumptions by TAZ (these were based on a combination of overall county growth and local community plans). The overall growth rates for population and employment in Kings County were checked for consistency with historical growth rates. In previous versions of the KCAG model, annual growth rates in excess of 4 percent were used to project future county household and employment totals. For this model update, growth rates range from about 1.9 to 3.3 percent annually overall, more consistent with historical rates.

The KCAG model land use workbook stores all of the land use inputs for interim years between the 2000 base year and the 2030 horizon year All future and interim year assumptions are estimated using trend lines associated with DOF's population estimates and population/housing unit and employment/housing unit assumptions.

[2] State of California, Department of Finance, *Population Projections for California and Its Counties 2000-2050, by Age, Gender and Race/Ethnicity*, Sacramento, California, July 2007..

Table 4 Land Use Projections

Land Use	2005	2010	2025	2030
Total Housing	**37,497**	**41,320**	**58,425**	**64,092**
(Average Growth per Year)		**2.00%**	**2.80%**	**1.90%**
Retail	5,690	6,375	9,440	10,456
Office	1,021	1,200	2,003	2,269
Industrial	7,171	8,227	12,954	14,520
Agricultural	5,204	5,286	5,652	5,773
Government	5,653	6,461	10,075	11,273
Education	3,720	4,090	5,748	6,297
Other	6,563	7,698	12,777	14,460
Total Employment	**35,022**	**39,338**	**58,650**	**65,048**
(Average Growth per Year)		**2.50%**	**3.30%**	**2.20%**

4.3 Special Generators

The revised model incorporates additional "special generators" within Kings County. These represent primarily recreational sites that attract trips unrelated to housing or employment. For these zones, estimated vehicle trips, year of project opening, and trip purpose assumptions are input directly to the model as shown below in Table 5.

Table 5 Special Generators

Zone	Name	Year Opened	Total Daily Vehicle Trips
669	Lemoore College	2005	5,000
669	Lemoore College	2009	3,000
669	Lemoore College	2012	3,000
691	Lemoore NAS	2005	800
692	Lemoore NAS	2005	3,600
693	Lemoore NAS	2005	8,300
865	Rancheria Hospital	2020	1,500
950	Rancheria Casino 1	2000	3,500
950	Rancheria Casino 2	2001	500
950	Rancheria Casino 3	2003	3,000
950	Rancheria Hotel	2004	2,500

5. Trip Generation

The trip generation step quantifies the total magnitude of travel (person trips) generated in each zone based upon land uses within the zone.

5.1 Trip Stratification

Trips are stratified by four trip purposes. The trip ends generated within any area are further classified as either trip end productions or trip end attractions. The four trip purposes are estimated separately and then later combined prior to assignment to the networks.

5.1.1 Trip Purposes

To derive more accurate projections of future travel behavior, the KCAG model stratifies trip ends by four trip purposes:

1. **Home-Work** trips are commute trips between residences and places of employment, including both trips from home to work and from work to home.
2. **Home-Shop** trips are trips between residences and places of retail employment.
3. **Home-Other** trips account for all other trips which begin or end at home, and include school trips, social trips and recreational trips.
4. **Non-Home-Based** trips account for all other "non home based" trips, such as trips between two other stores or long-distance truck trips. They also include trips between places of employment and places other than home, such as driving to a restaurant during a lunch break, driving a delivery truck away from the main office, or stopping at the gas station on the way home from work.

Splitting the trips into purposes allows for a better understanding of the relationship between jobs and housing, by separating commute trips. It also provides more control over the trip distribution, since different types of trips involve different trip lengths.

5.1.2 Productions and Attractions

Consistent with conventional modeling practice, each one-way trip is defined as having two trip ends in the trip generation process:

- **Trip Production**. This is defined as the home end of any home-based trip, regardless of whether the trip is directed to or from home. If neither end of the trip is a home (i.e., non-home based), it is defined as the origin end.
- **Trip Attraction**. This is the non-home end (e.g., place of work, school or shopping) of a home-based trip. If neither end of the trip is a home (i.e., it is a non-home based trip), the trip attraction is defined as the destination end.

In other words, trip productions are generally *home* related while trip attractions are generally related to place of *work*. For example, a typical commute from home to work in the morning and then back home in the evening represents two separate one-way trips, and there are two trip ends *produced* in the home zone and two trip ends *attracted* in the work zone.

5.2 Trip Generation Rates (Person Trips)

Daily trip generation rates (person trips) for the KCAG model were derived from the 2001 Caltrans Statewide Travel Survey wherever possible (the most recent available at the time of this writing), supplemented by information from previously developed models and knowledge about the accuracy of travel surveys. Separate trip generation rates were derived for each auto-ownership category and for each trip purpose (Table 6). The trip generation rates are set so that the model generates total Kings County trips consistent with national trip generation data.

5.3 Cordon or "Gateway" Trips

There are two types of trips at the cordons or "gateways" of the KCAG model, through trips (external-external or X-X) and external trips (external-internal, internal-external or I-X/X-I). Through trips are trips that pass through the model area without stopping (e.g., a trip from Kern County to Fresno County along Interstate 5). External trips have one end in Kings County and one end outside Kings County (e.g., a trip from Bakersfield to Hanford or vice-versa). External trip assumptions are shown in Appendix A.

5.3.1 Through Trips

The largest numbers of through trips pass through the county on Interstate 5 and State Route 41. Daily 2005 vehicle through trips were estimated for Kings County based on actual counts at the gateways and the proportion of trips considered to be through trips in the Caltrans Statewide Model (2000) model. Future through trips were factored from the 2005 base year through trips using growth factors derived from traffic projections in adjacent counties as well as historical traffic growth rates.

5.3.2 External Trips

External trips to and from Kings County were estimated from 2005 traffic counts at the cordon points. Through trips were subtracted from the traffic counts, leaving just the external vehicle trips that have only one end in Kings County. External trips (I-X and X-I) at each of the gateways were split into the four trip purposes (home-shop, home-other, non-home-based) based on Kings County averages.

The external vehicle trips for each trip purpose are multiplied by the appropriate average auto occupancy rate to convert them to person trips. Initial estimates of productions and attractions at each gateway are adjusted to provide an overall balance of gateway person-trip productions and attractions with internal person-trip productions and attractions. These “gateway” trips are then distributed to the model zones along with the internal model area trips.

5.4 Special Generators

As discussed previously (Section 4.3), special generators are used to include trips from land uses that are not well represented by the standard trip rates. In the KCAG model, special generators are used primarily to define Home-Other trips attracted to recreational areas such as parks and golf courses. Typical vehicle trip generation values were estimated for each of these recreational areas based on the *ITE Trip Generation Manual*. The vehicle trips are converted to person trips using average auto occupancy rates. The special generator trips are then added to the appropriate TAZs after trips are calculated using the standard household and employment trip generation rates.

Table 6 KCAG Person Trip Generation Rates

Land Use Category	Description of Use	Quantity	Daily Person Trip Rates											Total Person Trips
			Total	Productions					Attractions					
			Daily	HW	HS	HO	HSC	NHB	HW	HS	HO	HSC	NHB	
Residential	SF 0 Auto	2,541	8.71	0.41	2.08	1.59	2.14	1.00	-	-	0.50	-	1.00	22,131
Residential	SF 1 Auto	5,614	11.07	0.80	1.99	4.28	0.66	1.00	-	-	1.34	-	1.00	62,146
Residential	SF 2+ Autos	14,514	18.67	1.82	2.77	8.44	1.00	1.00	-	-	2.63	-	1.00	270,941
Residential	MF 0 Auto	2,869	6.39	0.80	1.19	1.53	0.40	1.00	-	-	0.48	-	1.00	18,347
Residential	MF 1 Auto	6,780	10.65	0.84	1.19	4.53	0.69	1.00	-	-	1.41	-	1.00	72,228
Residential	MF 2+ Autos	5,178	14.04	1.53	2.09	5.95	0.61	1.00	-	-	1.85	-	1.00	72,687

Land Use Category	Description of Use	Quantity	Daily Person Trip Rates											Total Person Trips
			Total	Productions					Attractions					
			Daily	HW	HS	HO	HSC	NHB	HW	HS	HO	HSC	NHB	
Retail	-	5,690	38.79	-	-	-	-	9.95	1.25	14.04	3.60	-	9.95	220,710
Office	-	1,021	5.08	-	-	-	-	1.05	1.27	-	1.70	-	1.05	5,187
Industrial	-	7,171	3.39	-	-	-	-	0.81	1.27	-	0.50	-	0.81	24,297
Agriculture	-	5,204	3.40	-	-	-	-	0.84	1.22	-	0.50	-	0.84	17,700
Government	-	5,653	18.54	-	-	-	-	5.12	1.32	-	6.97	-	5.12	104,815
Education	-	3,720	34.15	-	-	-	-	4.38	1.25	-	15.30	8.84	4.38	127,052
Other	-	6,563	14.57	-	-	-	-	5.96	1.28	-	1.36	-	5.96	95,621

6. TRIP DISTRIBUTION

The trip distribution process estimates how many trips travel from one zone to another. Consistent with many regional models across the country, the KCAG model uses a method known as the gravity model to estimate trips between zones based on the trip productions and attractions in each zone and on factors that relate the likelihood of travel between zones to the separation between the zones.

6.1 Description of Gravity Model

The gravity model follows the concept of Isaac Newton's Universal Law of Gravitation, which states that the attractive force between two bodies is proportional to the product of their masses and inversely proportional to the square of the distance between them. Similarly, zone-to-zone trip interchanges in the gravity model are directly proportional to the relative attraction or opportunity provided by each of the zones (productions and attractions) and inversely proportional to the spatial separation between zones. Expressed mathematically, the gravity model formula of trip distribution is:

$$T_{ij} = P_I * \frac{A_j F(t_{ij}) K_{ij}}{\text{Sum}_{x=1,n} [A_x F(t_{ij}) K_{ij}]}$$

where:

where:	T_{ij}	= number of trips produced in zone i and attracted to zone j
	P_i	= total number of trips produced in zone i
	A_j	= attractions of zone j
	t_{ij}	= travel time in minutes between zone i and zone j
	$F(t_{ij})$	= the friction factors between zone i and zone j
	K_{ij}	= zone-to-zone adjustment factor
	n	= number of zones

The inputs to the gravity model include the person trip productions and attractions for each zone (as defined earlier in the trip generation step), the zone-to-zone travel times, and friction factors that define the effects of travel time. The zone-to-zone distributions are calculated separately for each trip purpose.

6.2 Zone-To-Zone Travel Times

The travel time between each pair of zones is calculated by determining the shortest time path along the coded road network between the two zones, and accumulating the travel time along that path. The path building process produces a table (skim matrix) of travel times between each pair of zones in the study area. The resulting table of zone-to-zone travel times is then used as an input to the trip distribution analysis.

For this estimation, road travel times are used since the large majority of person-travel is on the road system. Uncongested (free flow) travel times are used in the initial estimates of the trip distribution, but travel times which reflect congestion levels are used for the final trip distribution.

Intrazonal travel times represent the average travel time for trips that stay within a particular zone. They are estimated based on 100 percent of the travel time to the nearest adjacent zone.

6.3 Friction Factors

The effects of spatial separation in the gravity model are represented empirically by “friction factors” that express the effect that travel time exerts on the propensity for making a trip to a given zone. Typically the probability for making a particular trip declines as the travel time increases. For the KCAG model, four sets of friction factors are used, with each set corresponding to one of the four trip purposes. This accounts for the possibility that people may be willing to drive a long distance to go to work, but only short distances for most shopping or school trips.

The friction factors for the KCAG model update are consistent with those used in previous KCAG models and were initially based on the friction factors estimated from more comprehensive travel survey data in the Sacramento region.

7. MODE CHOICE

Since the percent of transit trips is small in Kings County, at this time the KCAG travel model does not include a separate mode choice analysis step. Transit trips currently account for less than one percent of all trips in Kings County, and no major transit investments are planned which would significantly increase transit usage.

7.1 Average Vehicle Occupancy Factors

The KCAG model includes a step to convert person trips to average vehicle trips using the Caltrans travel survey to determine average reported vehicle occupancies for each of the four trip purposes.

The KCAG average vehicle occupancy factors are shown below in Table 7.

Table 7 Average Vehicle Occupancy Rates by Purpose

HBW	HBS	HBO	NHB
1.07	1.26	1.55	1.29

8. TRIP ASSIGNMENT

In this step, zone-to-zone trips from the trip distribution step are assigned to the network. The KCAG model does not currently assign transit trips to a transit network.

8.1 Traffic Assignment

The KCAG model uses a process known as "equilibrium" assignment to assign vehicles. Vehicle trips are initially assigned to the road network using the all-or-nothing method, which assumes that all drivers will use the fastest route without regard to congestion caused by other vehicles. Travel times on the road network are recalculated based on the estimated level of congestion, and trips are reassigned to paths based on the congested speeds. The process is repeated for several iterations. After each iteration, traffic is shifted from congested routes to alternative routes with competitive travel times. The equilibrium assignment method is intended to ultimately assign traffic so that no driver can shift to an alternative route with a faster travel time. The overall road system is considered to be at equilibrium at this point.

8.1.1 Traffic Assignment Time Periods

The KCAG model currently assigns average daily traffic (ADT) and AM and PM peak hour traffic. The KCAG model uses twenty iterations for each final traffic assignment.

8.1.2 Congested Travel Speeds

The relationship of speed to congestion on a particular roadway is based on a set of curves which are included in the traffic assignment model. For example, the curves may indicate that an arterial street with no congestion will operate at 35 miles per hour, while an arterial link with a traffic volume equal to 90 percent of the capacity of the link will operate at about 28 miles per hour. The curves are based on the 1985 *Highway Capacity Manual*.

There are separate curves for the following types of roads:

1. Freeways

2. Rural highways and roads (also used for freeway ramps)

3. Signal-controlled streets, including arterials and collectors

4. Gateway connectors

5. Zone connectors (no delay)

The curves are assigned based on the "speed class" (SPDCLASS) of each link.

8.2 Pricing

The KCAG travel model does not explicitly consider travel cost considerations. Travel costs would include auto operating costs (fuel, insurance, repairs), parking costs, transit fares and tolls. These cost factors become most important when the travel model is considering the trade-offs between autos and other modes such as transit. If a mode choice analysis capability is added to the KCAG model, these cost parameters would be added at the appropriate analysis steps.

9. FEEDBACK MECHANISMS

The KCAG travel model includes a feedback loop that uses congested travel times as an input to the trip distribution step. The feedback loop is intended to ensure that the congested travel impedances (times) used for final traffic assignment and as input to the air quality analysis are consistent with the travel impedances used throughout the model process.

For the KCAG model, the feedback loop is considered to converge when the travel times that result from the congested travel speeds after traffic assignment compare closely with the travel times used as input to the trip distribution process.

9.1 Feedback Loop Alternatives

9.1.1 No Feedback

Many travel models operate with no feedback. In these models, the trip distribution is often based on uncongested or "free-flow" travel speeds on the road network. After traffic assignment, congested speeds are calculated and used as input to evaluations of the road network and to air quality analysis. This procedure does not result in significant errors when there is little congestion on the road network. However, if there is congestion on the road network (usually with future conditions), the trip distribution will be based on optimistic uncongested travel speeds and will often over-estimate the number of long-distance trips.

There is not significant congestion in the 2005 base year in Kings County. Therefore, the model could be run without feedback for the 2005 base year without introducing significant inconsistencies. However, future growth projections can result in much higher levels of congestion and slower road speeds. A feedback system is required to properly evaluate future travel patterns.

9.1.2 Sequential Feedback Loops

The simplest way to operate feedback loops is to take the congested speeds from one cycle of traffic assignment, and use those congested speeds as input to trip distribution and mode choice for the next cycle. The cycles are repeated until the speeds are similar from one cycle to the next.

The drawback to this approach is the number of cycles that may be required to converge. The first trip distribution will be based on uncongested speeds, so it will over-estimate long distance trips. These long-distance trips will create congestion and slow speeds, so the next cycle of the model will most likely under-estimate long-distance trips and congestion. The cycles of over-estimation and under-estimation will continue and may or may not converge to a consistent solution.

9.1.3 Interpolated Feedback Loops

Interpolation is one way to speed up convergence of the feedback mechanism. Rather than using the results of one cycle as input to the next cycle, the results of the latest cycle are combined with the results of the previous cycle and the combination is used as input to the next cycle. The interpolation assumes that the correct solution lies somewhere between the two cycles.

9.1.4 Congested Speeds

There are several variations for the feedback application of congested travel speeds.

Single Speed for All Trip Purposes

The simplest method estimates an average daily congested speed for each link, and uses this average speed as input to the trip distribution for all trip purposes. Another variation uses congested speeds from a peak period or peak hour traffic assignment as input to the trip distribution for all trip purposes. These methods may overestimate the impacts of congestion on non-work (off-peak) travel patterns and/or underestimate the impacts of congestion on work trip patterns.

Peak Speeds for Work Trips

Another variation uses congested speeds from a peak period or peak hour traffic assignment as input to the trip distribution of Home-Work trips, and then uses an off-peak traffic assignment or the original uncongested speeds as input to the trip distribution of non-work trip purposes.

Combine Peak and Off-Peak Speeds

In actuality, about 60 percent of work trips occur during the peak periods and 40 percent occur during off-peak periods. Similarly, about 40 percent of non-work trips occur during the peak periods and 60 percent occur during off-peak periods. Therefore, a weighted average of the peak and off-peak congested speeds could be used to determine the trip distribution for each trip purpose. Given that the "off-peak" speed is already an average of conditions over 18 hours, it is questionable how much additional accuracy this method can provide.

Multimodal Impedance

In some urban areas, transit or ridesharing in HOV lanes can play a significant role in determining travel patterns as well as automobile travel. In these areas, it is worthwhile to consider combining the congested automobile travel times with the transit and HOV travel times to provide inputs to trip distribution. The combined multimodal impedance should provide a better representation of the attractiveness of various trip destinations, and can help the model to explain why there is high demand for travel in corridors with significant traffic congestion but good transit service.

9.2 Kings Model Feedback Loop

Previous versions of the KCAG model applied a simplified feedback loop with one interpolation. The *trip distributions* based on uncongested travel speeds were averaged with the *trip distributions* based on the first estimate of congested speeds. Trips were averaged rather than travel times. The single interpolation was intended to provide a consistent estimate of congested travel speeds, while limiting the amount of additional time required to run the model.

In an effort to meet all Transportation Conformity Rule modeling requirements as part of the 2008 model update, a full feedback loop process was implemented that iterates until it reaches a set of convergence criteria. The convergence criteria are consistent with Transportation Conformity Rule Section 93.12 (b)(1)(v).

9.2.1 Method of Successive Averages

The initial trip distributions for all four trip purposes are calculated using uncongested (free-flow) travel times on the road network. After the initial trip distribution and assignment, an average of congested travel times calculated from the most recent congested traffic assignment and the free-flow assignment are used as input to trip distribution.

The feedback loop convergence criteria are based on closure of the congested travel times. In order to speed up the convergence of the feedback loop, an interpolation method is used. The method of successive averages takes the latest set of congested travel times calculated from the latest traffic assignments, and calculates a weighted average with the latest set of travel times used as input to trip distribution. The weighting is based on the number of iterations. For example, after the fourth pass through the feedback loop, the weighted average would be calculated as one-quarter (0.25) times the latest set of congested travel times plus three-quarters (0.75) times the previous set of congested travel times. This process is repeated until the convergence criteria are met.

9.2.2 Convergence Criteria

A set of convergence criteria were developed specifically for this 2008 model update to ensure that the congested travel speeds used as input to the air quality analysis are consistent with the travel speeds used throughout the model process, as required by the Transportation Conformity Rule.

The congested travel speeds used as input to the air quality analysis come from the final traffic assignments. The congested travel speeds used throughout the model process are those used as input to the trip distribution step (and mode choice step if implemented). Therefore, the convergence criteria are applied by comparing the congested travel speeds from the latest traffic assignments with the congested travel speeds and times most recently used as input to trip distribution.

The KCAG model feedback loop is considered to converge when:

1. Less than 5% of the origin-destination pairs have congested travel times that change by more than 5% between iterations; and
2. The weighted average change in link traffic volumes is less than 5% between iterations (the average percent change is weighted by the link volume).

If the first two criteria do not result in convergence after five iterations through the feedback loop, it indicates that the network is very congested and the traffic assignments are oscillating between one set of routes and another. The following criteria are then used after five feedback iterations:

1. The weighted average change in congested travel times between origin-destination pairs is less than 5% between iterations (average weighted by number of origin-destination trips); and
2. The weighted average change in travel times between origin-destination pairs is less than 5% between iterations (average weighted by vehicle-miles of travel); and
3. The weighted average change in link traffic volumes is less than 5% between iterations (the average percent change is weighted by the link volume).

The second set of convergence criteria were found to close during tests even with very congested future travel demands.

10. MODEL REVALIDATION

This chapter describes the revalidation of the KCAG model against base year (2005) observed data.

Model calibration takes place at each step in the model process and involves initial specification and then refinement of the various parameters and coefficients by comparing model results to observed conditions. Where applicable, calibration of the individual model steps is described in the preceding chapters. The 2008 version of the KCAG model is primarily calibrated to 2000 United States Census data and 2001 Caltrans Statewide Travel Survey data.

Model validation refers to comparing the model outputs (traffic volumes) to observed conditions (traffic counts). During validation, adjustments are primarily made to model inputs, such as the road network and base year land uses, rather than calibrated parameters such as trip generation rates. Once validated, the model can be used to predict future travel patterns with a high degree of confidence.

The KCAG model was revalidated to 2005 daily counts and VMT since this was the most recent year for which HPMS data was available.

10.1 Model Estimates vs. Counts

2005 validation included overall comparisons of model daily link volume estimates to 2005 average daily traffic (ADT) counts (including an overall estimate of the coefficient of determination, R^2) by facility type, volume range and screenline. Traffic counts were assembled from several sources, including those KCAG had in-house and counts compiled by Caltrans in the HPMS database for 2005 conditions.

10.1.1 Facility Type and Volume Range

The KCAG model was revalidated to 2005 daily counts and VMT. The model estimates of 2005 daily volumes are within all of the FHWA percent difference targets by facility type. The model also met the FHWA targets for percent root mean square error (RMSE) for all facility types, except arterials and collectors (37.8% vs. 35% target for both). However, when volumes were categorized by magnitude, all volume groups met the FHWA percent RMSE targets. Six (6) of the 7 screenlines are within 10 percent of observed counts and all the screenlines except for one are within 30 percent RMSE. Therefore, the model is considered acceptable based on FHWA guidelines.

The coefficient of determination (R^2) is 0.97 for all links with traffic counts.

10.1.2 Screenlines

Seven "screenlines" were defined, including several north-south and east-west cut-lines. Screenlines are imaginary lines, often along natural or man-made physical barriers (e.g., rivers, railroad tracks) that have a limited number of crossings. The screenlines "cut" the entire study area, intercepting all travel across them, thereby eliminating issues about individual route choice. Use of a system of screenlines allows systematic comparison of model estimated versus observed travel in different parts of the model area.

Caltrans adapted targets for maximum desirable deviations in total screenline volumes based on the *Highway Traffic Data for Urbanized Area Project Planning and Design* (NCHRP 255). These targets vary by total volume, with smaller deviations allowed for higher volume screenlines (see Table 8). The model is estimating volumes within these targets for all eight screenlines.

It is also common practice to attempt to validate models within 10 percent on all major screenlines. The 2008 update of the KCAG model is within 10% on six out of seven screenlines.

The percent root mean square error (RMSE) provides a measure of accuracy based on the statistical standard deviation. The RMSE is more sensitive on larger errors that may cancel each other out in a percent difference variation. The overall target RMSE is 35%. The 2008 update of the KCAG model is within the target RMSE on five out of seven screenlines.

The screenline results are documented in Appendix B.

10.2 VMT Comparisons

Vehicle Miles Traveled (VMT) were estimated using the travel demand model by multiplying link volumes by link distances. Intrazonal VMT (trips remaining within a TAZ) were estimated by TAZ as the product of intrazonal trips in that TAZ and 50% of the distance to the nearest neighboring TAZ.

The model estimated 3,412,881 VMT on the roadway links and 29,517 in intrazonal VMT for a total of 3,442,398 VMT for the 2005 model year. The Caltrans HPMS 2005 estimate of VMT in Kings County was 3,440,000. The model estimate is 0.07% higher than the Caltrans 2005 HPMS VMT, well within the required +/- 3%.

Table 8 Daily Traffic Validation

Count/ Model Volume Comparison by Facility Type

Facility	Facility Code	Counts	Model Volume	Links	Difference	% Difference Delta2	Percent Difference	FHWA Target	% RMSE Model %RMSE	FHWA Target
Freeways	1	360,000	367,757	28	7,757	25,788,989	2.2%	+/-7%	7.6%	20%
Highways	2	256,700	244,016	54	(12,684)	36,178,534	-4.9%	+/-7%	17.4%	25%
Rural Roads	3	113,291	112,063	62	(1,228)	22,207,042	-1.1%	+/-15-25%	33.0%	50%
Arterials	4	198,066	184,180	50	(13,886)	99,074,140	-7.0%	+/-15%	35.9%	35%
Arterials & Collectors		203,206	194,766	54	(8,440)	107,179,746	-4.2%	+/-15%	37.8%	35%
Sum		933,197	918,602	198	(14,595)	191,354,311	-1.6%		20.9%	

Count/ Model Volume Comparison by Volume Range

Volume Range	Counts	Model Volume	Links	Difference	% Difference Delta2	Percent Difference	FHWA Target	% RMSE Model %RMSE	FHWA Target
1-4,999	309,350	320,962	135	11,612	59,390,042	3.8%	NA	29.1%	65%
5,000-9,999	305,667	282,165	41	(23,502)	91,526,096	-7.7%	NA	20.3%	52%
10,000-14,999	139,430	135,260	11	(4,170)	31,394,498	-3.0%	NA	14.0%	
15,000-19,999	178,750	180,215	11	1,465	9,043,675	0.8%	NA	5.9%	
10,000-19,999	318,180	315,475	22	(2,705)	40,438,173	-0.9%	NA	9.6%	27-34%
Sum	933,197	918,602	198	(14,595)	191,354,311	-1.6%		20.9%	

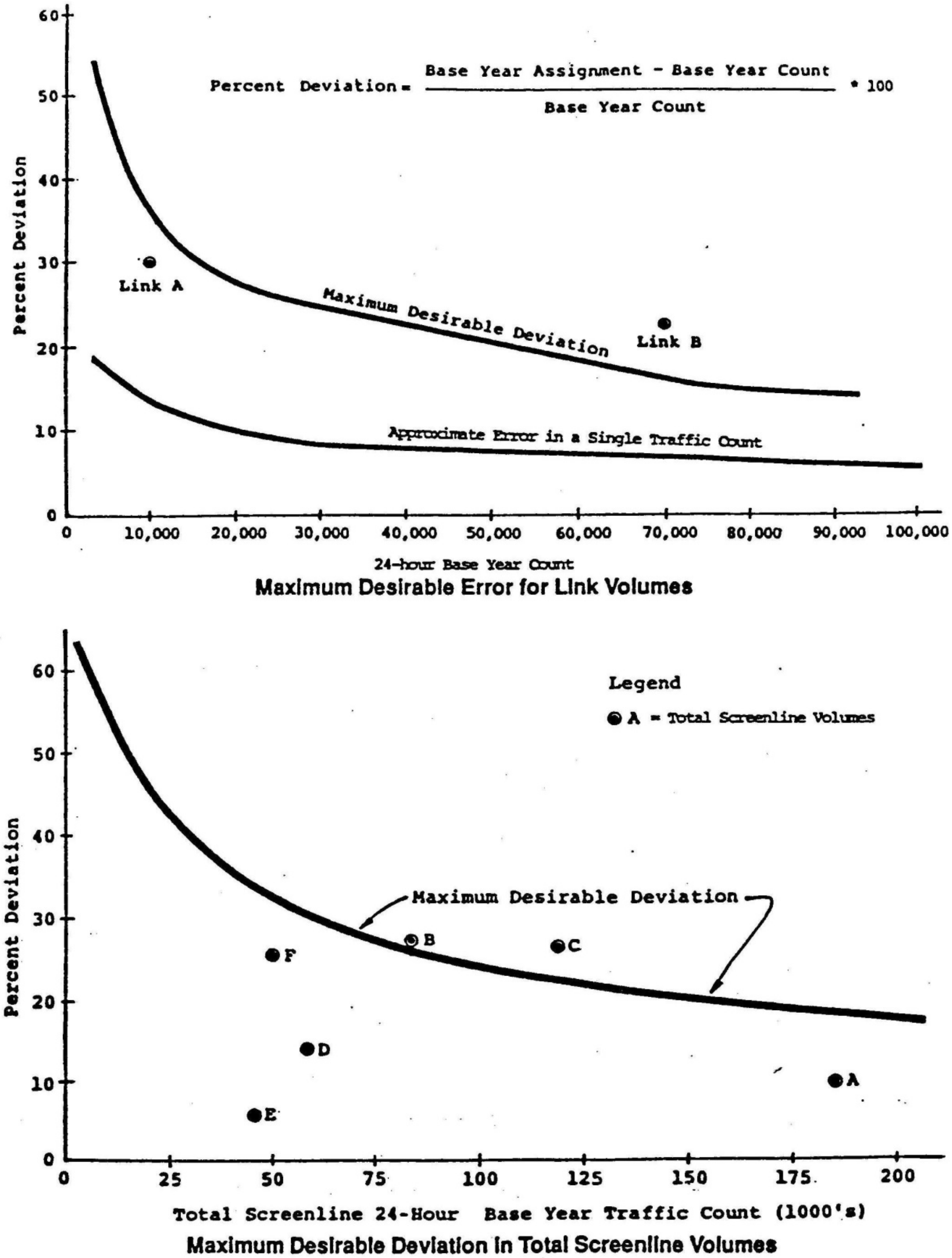
Coefficient of Determination (R^2) Calculation

Model Data		FHWA Target
X=	933,197	
Y=	918,602	
X2=	8,059,333,741	
Y2=	7,838,068,522	
XY=	7,853,023,976	
N=	198	
R^2=	0.97	>0.88

FHWA Link Specific Validation Criteria for Freeways and Principal Arterials

	Model Data	FHWA Target
Non-Collectors	**85.0%**	**75%**
All Facilities	**85.7%**	**None**

Figure 3 Maximum Desirable Error for Links and Screenlines



Source: Caltrans, *Travel Forecasting Guidelines*, 1992

Appendix A

External and Through Trips

KCAG 2008 Model Update - Gateway Assumptions

Zone	Gateway	County	2005 Volume	Annual Growth	2005 % Thru	2005 Thru	2005 I-X / X-I
1	6th Ave N (Road 8)	Tulare County Line	3,055	3%	0%	0	3,055
2	SR 43 N	Fresno County Line	10,500	3%	5%	525	9,975
3	SR 41 N	Fresno County Line	18,000	2%	18%	3,240	14,760
4	Excelsior	Fresno County Line	1,379	3%	0%	0	1,379
5	Grangeville	Grangeville Bypass	3,090	3%	0%	0	3,090
6	SR 269 (Lassen Ave)	Fresno County Line	4,700	3%	30%	1,410	3,290
7	I-5 N	Fresno County Line	33,500	2%	92%	30,820	2,680
8	SR 33 N	Fresno County Line	2,500	3%	65%	1,625	875
9	SR 41 S	Kern County Line	7,400	2%	22%	1,628	5,772
10	SR 33 S	Kern County Line	2,500	3%	85%	2,125	375
11	25th Ave (King Road)	Kern County Line	394	3%	0%	0	394
12	I-5 S	Kern County Line	34,000	2%	97%	32,980	1,020
13	6th Ave S	Kern County Line	2,610	3%	0%	0	2,610
14	12 3/4 Ave	Fresno County Line	4,432	3%	0%	0	4,432
15	SR 198 (Dorris)	Fresno County Line	7,400	2%	50%	3,700	3,700
16	Idaho Ave (Ave 264)	Tulare County Line	98	3%	0%	0	98
17	Virginia Ave (Ave 56)	Tulare County Line	1,392	3%	0%	0	1,392
18	Kansas Ave (Ave 232)	Tulare County Line	2,620	3%	45%	1,179	1,441
19	Houston Ave (Ave 280)	Tulare County Line	3,011	3%	0%	0	3,011
20	SR 198 E (Visalia Hwy)	Tulare County Line	19,000	2%	5%	950	18,050
21	Grangeville Ave (Ave 304)	Tulare County Line	4,404	3%	0%	0	4,404
22	4th Ave N	Tulare County Line	0	3%	0%	0	0
23	Gale Ave	Fresno County Line	0	3%	0%	0	0
24	Nevada Ave/Jayne Ave	Fresno County Line	1,987	3%	0%	0	1,987
25	SR 43 S	Tulare County Line	4,600	2%	0%	0	4,600
26	SR 137/Waukena Ave	Tulare County Line	3,800	3%	0%	0	3,800
27	Quebec Ave (Ave 144)	Tulare County Line	878	2%	0%	0	878
28	Racine/Redding Ave (Ave 120)	Tulare County Line	145	3%	0%	0	145
29	Nevada Ave (Ave 192)	Tulare County Line	1,609	3%	0%	0	1,609
30	Avenue 170	Tulare County Line	0	3%	0%	0	0
31	Utica Ave	Tulare County Line	552	3%	0%	0	552
TOTAL			**179,557**			**80,182**	**99,375**

Appendix B

Screenline Results

KCAG 2008 Model Update
Screenline Validation for 2005 Base Year

Screenline 1 - South of Excelsior Ave / North of Flint Ave

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
SR41	15,500	15,624	1.01	124	15,376
14th Ave	1,180	346	0.29	(834)	695,556
13th Ave	1,120	1,196	1.07	76	5,776
12th Ave	3,960	3,731	0.94	(229)	52,441
11th Ave	3,020	3,323	1.10	303	91,809
SR43	10,800	10,299	0.95	(501)	251,001
6th Ave	1,940	1,472	0.76	(468)	219,024
TOTAL	**37,520**	**35,991**	**0.96**	**(1,529)**	**1,330,983**
Number of Links					**7**
ROOT MEAN SQUARE ERROR					**0.08**

Screenline 2 - North of SR 198

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
SR41	13,900	14,415	1.04	515	265,225
19th Ave	3,360	3,714	1.11	354	125,316
Vine	3,040	6,149	2.02	3,109	9,665,881
18th Ave	10,080	11,831	1.17	1,751	3,066,001
Houston Ave	5,120	5,054	0.99	(66)	4,356
14th Ave	5,880	4,802	0.82	(1,078)	1,162,084
Hanford-Armona	4,800	5,550	1.16	750	562,500
12th Ave	15,940	16,580	1.04	640	409,600
11th Ave	28,580	22,241	0.78	(6,339)	40,182,921
Reddington	3,800	3,492	0.92	(308)	94,864
Douty	8,020	6,823	0.85	(1,197)	1,432,809
10th Ave	19,940	15,805	0.79	(4,135)	17,098,225
SR43	10,000	8,512	0.85	(1,488)	2,214,144
6th Ave	1,840	977	0.53	(863)	744,769
TOTAL	**134,300**	**125,945**	**0.94**	**(8,355)**	**77,028,695**
Number of Links					**14**
ROOT MEAN SQUARE ERROR					**0.24**

Screenline 3 - South of Jackson Ave

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
Avenal Cutoff	5,150	6,351	1.23	1,201	1,442,401
SR41	9,000	8,481	0.94	(519)	269,361
18th Ave	6,200	6,249	1.01	49	2,401
10th Ave	1,460	556	0.38	(904)	817,216
SR43	7,700	7,615	0.99	(85)	7,225
TOTAL	**29,510**	**29,252**	**0.99**	**(258)**	**2,538,604**
Number of Links					**5**
ROOT MEAN SQUARE ERROR					**0.12**

KCAG 2008 Model Update
Screenline Validation for 2005 Base Year

Screenline 4 - North of Kettleman City

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
Avenal Cutoff	4,600	7,378	1.60	2,778	7,717,284
SR41	9,400	9,133	0.97	(267)	71,289
Utica	300	1,094	3.65	794	630,436
TOTAL	**14,300**	**17,605**	**1.23**	**3,305**	**8,419,009**
Number of Links					**3**
ROOT MEAN SQUARE ERROR					**0.35**

Screenline 5 - East of SR 41

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
SR33	2,200	2,550	1.16	350	122,500
I5 WB	34,000	34,811	1.02	811	657,721
Kansas	1,380	809	0.59	(571)	326,041
SR198 WB	20,100	22,621	1.13	2,521	6,355,441
Bush	3,220	4,388	1.36	1,168	1,364,224
Hanford-Armona	7,700	7,502	0.97	(198)	39,204
Lacey	1,760	1,502	0.85	(258)	66,564
Grangeville	4,560	2,985	0.65	(1,575)	2,480,625
Excelsior	2,520	1,895	0.75	(625)	390,625
TOTAL	**77,440**	**79,063**	**1.02**	**1,623**	**11,802,945**
Number of Links					**9**
ROOT MEAN SQUARE ERROR					**0.13**

Screenline 6 - West of 12th Ave

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
Utica	540	1,187	2.20	647	418,609
Pueblo	380	252	0.66	(128)	16,384
Kansas	2,760	3,004	1.09	244	59,536
Houston Ave	2,080	3,005	1.44	925	855,625
Hanford-Armona	5,680	7,036	1.24	1,356	1,838,736
SR198 EB	28,500	30,487	1.07	1,987	3,948,169
Lacey	18,100	16,121	0.89	(1,979)	3,916,441
Grangeville	8,860	9,837	1.11	977	954,529
Fargo	2,360	4,319	1.83	1,959	3,837,681
Excelsior	4,160	4,451	1.07	291	84,681
TOTAL	**73,420**	**79,699**	**1.09**	**6,279**	**15,930,391**
Number of Links					**10**
ROOT MEAN SQUARE ERROR					**0.17**

Screenline 7 - East of 10th Avenue

Cross Street Name	05 Count	05 Model	Ratio	DIFF	DIFF ^2
Kansas	2,840	3,318	1.17	478	228,484
Houston Ave	3,520	2,929	0.83	(591)	349,281
Hanford-Armona	260	400	1.54	140	19,600
SR198 EB	19,200	22,039	1.15	2,839	8,059,921
Lacey	6,100	4,118	0.68	(1,982)	3,928,324
Florinda	2,140	2,841	1.33	701	491,401
Grangeville	5,380	9,796	1.82	4,416	19,501,056
Leland	2,100	4,437	2.11	2,337	5,461,569
Fargo	5,100	4,828	0.95	(272)	73,984
SR43 (Central Valley?)	10,300	4,167	0.40	(6,133)	37,613,689
Excelsior	2,100	1,987	0.95	(113)	12,769
TOTAL	**59,040**	**60,860**	**1.03**	**1,820**	**75,740,078**
Number of Links					**11**
ROOT MEAN SQUARE ERROR					**0.49**