Appendix B: KCAG 2001 Model Update

Dowling Associates

Transportation Engineering • Planning • Research • Education

KCAG
2001 MODEL UPDATE

MODEL DOCUMENTATION
AND
VALIDATION REPORT

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November 8, 2001

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) was updated in 2001.

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 2001 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 1990 to 1998 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 transit and roadway traffic volumes.

1.1.1 Travel Demand Model Software

In 1999 the California Air Resources Board provided funds to the Central Valley jurisdictions to convert their travel demand models from the DOS-based MINUTP software to the 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 provides a TP+ model system that works for all forecast years as well as the new 1998 base year. Model networks 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 350 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 starting point for the socioeconomic data by traffic analysis zone (TAZ) was the 1990 and 2020 land use used in previous versions of the KCAG model. These housing forecasts were based on the 1990 Census and DOF projections. The employment forecasts were developed primarily from general plan land use data applying estimates of market absorption rates and past growth patterns. Kings County jurisdictions distributed the population and employment growth based on local data and a consensus process.

The new 1998 base year data was updated considering estimates/projections of growth consistent with State of California Department of Finance (DOF) figures, State of California Employment Development Department (EDD) labor market data, *County Business Patterns Surveys*, and input from local jurisdictions.

Future horizon year (2030) estimates were developed based on the DOF County Population Projections for 1990-2040 and previous travel demand model inputs for 2020, including General Plan assumptions and trends in population, housing and employment relationships. All future interim year (2000-2030) assumptions are estimated using trend lines associated with DOF's population estimates and population/HH and employment/HH assumptions.

It should be noted that the DOF population projections released in November 1998 predicted substantially lower populations for Kings County compared with previous DOF projections.

1.1.4 Roadway Network Characteristics

The travel demand model roadway network includes nearly 1,700 nodes, and over 4,600 links. Link types include freeway, freeway ramp, highway (multi and two-lane), arterial, collector, and rural road. Important road network attributes include distances, uncongested speeds, and hourly capacities.

The 2001 model update revised the coordinate system used for the model network 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. This improves the model estimates of link distances since the roadway network is spatially correct.

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.

1.1.6 Forecast Time Periods

The travel demand model currently estimates only daily travel demand and average daily traffic (ADT) volumes.

1.1.7 Feedback Loops

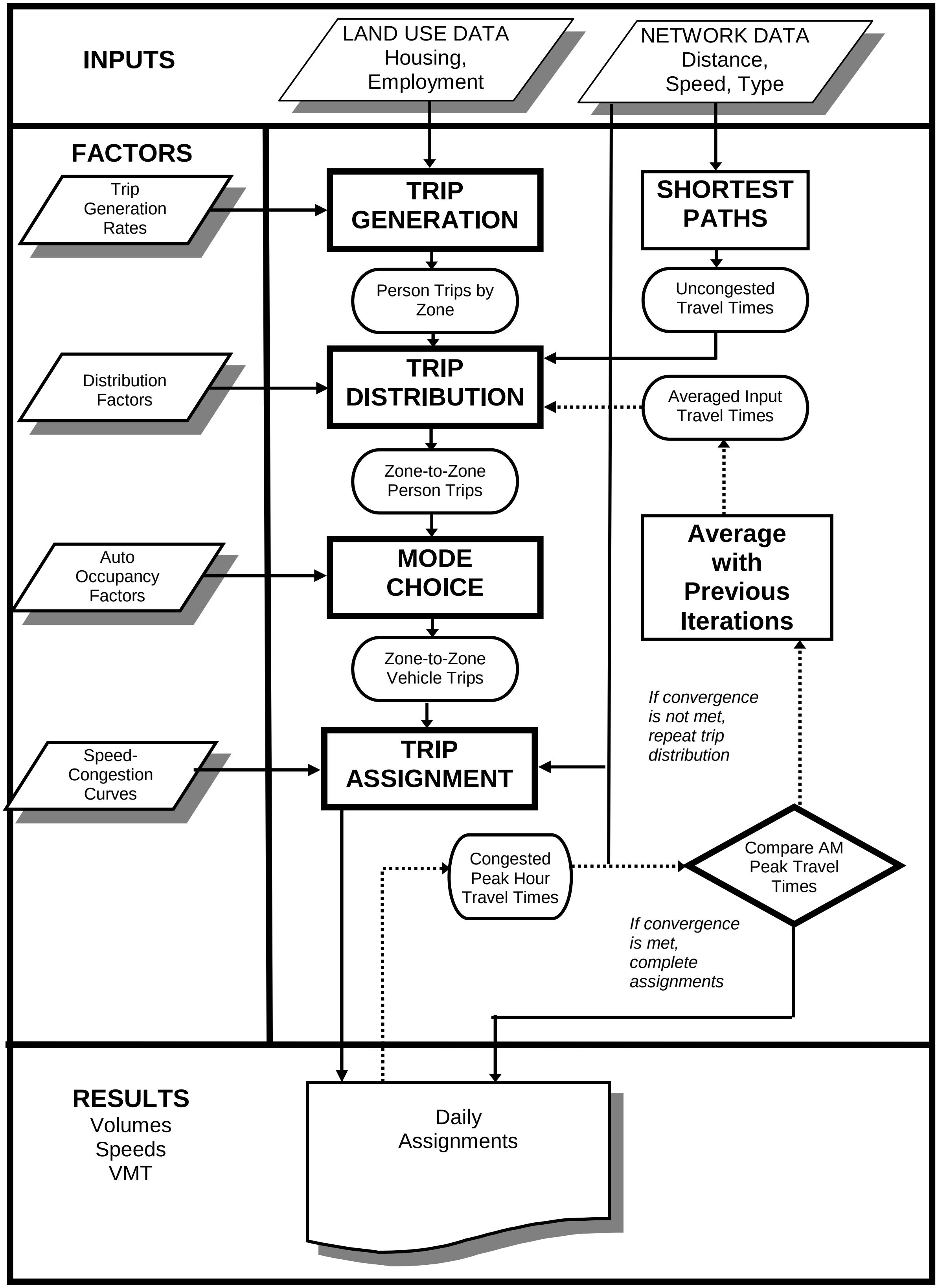
The KCAG travel model includes a feedback loop that uses the congested speeds estimated from traffic assignment to recalculate the trip distribution. The feedback loop repeats the process iteratively until the congested speeds and traffic volumes do not vary significantly between iterations. This ensures 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 1998 daily counts and VMT. The model estimates of 1998 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 highways (29.9% vs. 25% target). However, when volumes were categorized by magnitude, all volume groups met the FHWA percent RMSE targets. Seven (7) of the 8 screenlines are within 10 percent of observed counts and all screenlines are within 30 percent RMSE. Therefore, the model is considered acceptable based on FHWA guidelines.

The model estimated 2,951,783 VMT on the roadway links and 34,265 in intrazonal VMT for a total of 2,986,048 VMT for the 1998 model year. The Caltrans HPMS 1998 estimate of VMT in Kings County was 2,978,800. The model estimate is 0.2% higher than the Caltrans 1998 HPMS VMT, well within the required +/-3%.

Figure 1 KCAG Travel Demand Model Process



1.2 Transportation Conformity Rule Modeling Requirements

The 2001 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]:

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.

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

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 approximately 350 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 1 to 300 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 50 external cordons (gateways) for representing travel into, out of, and through the region. Zone numbers 301 to 350 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

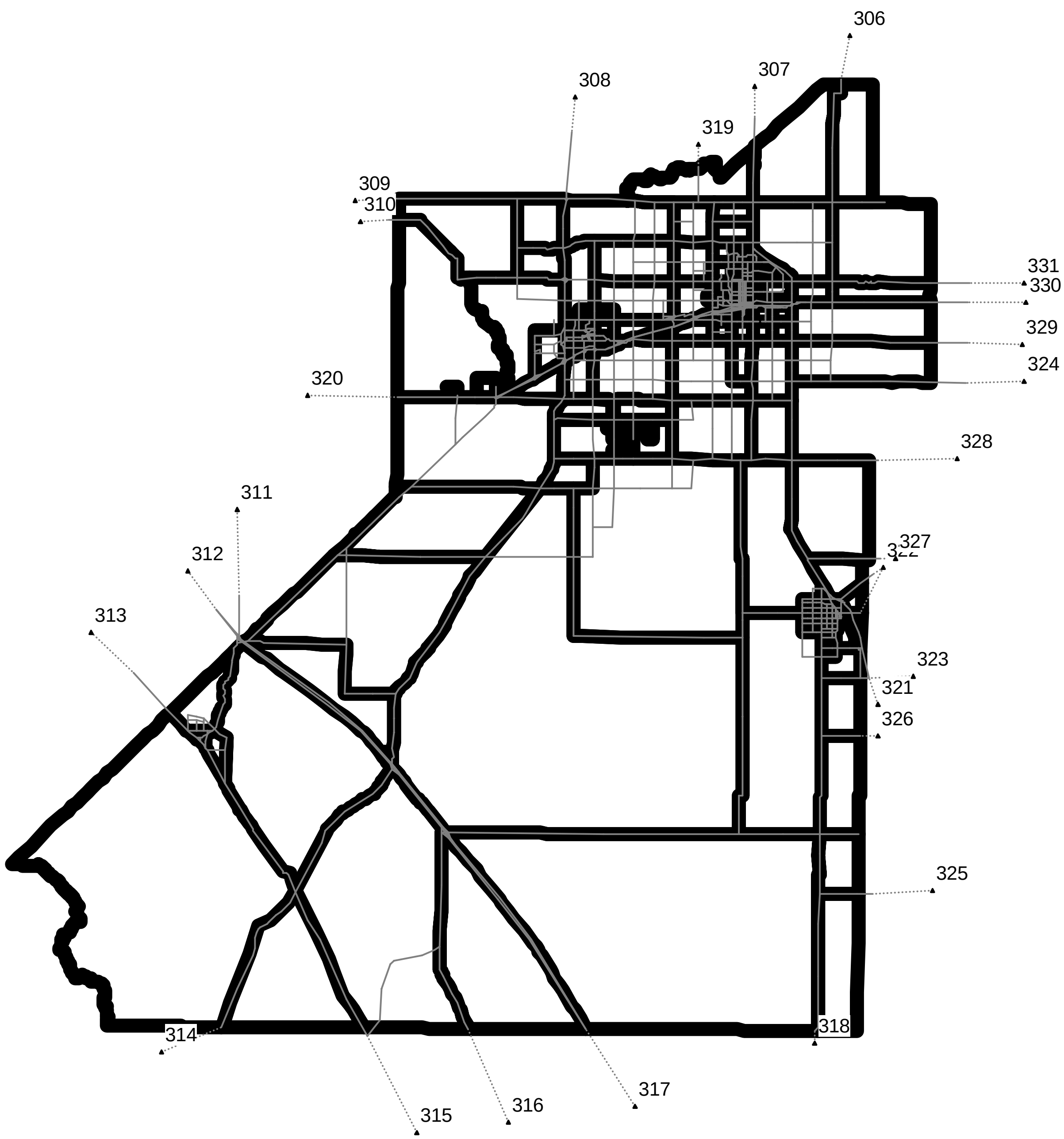


Table 1 KCAG Traffic Analysis Zone Allocations

DESCRIPTION	ZONE NUMBERS
CITIES	
Avenal	11, 23, 54-56
Avenal Prison	1
Corcoran	16, 19, 57-91, 93
Corcoran Prison	92
Hanford	96-150, 152, 172, 196, 202-204, 209, 219-221
Lemoore	30, 39, 153-171, 198, 205-207
Lemoore NAS	33, 191-192
OTHER COMMUNITIES	
Armona	195
Home Garden	151
Kettleman	199
Rancheria	210-212
RURAL AREAS	2-10, 12-15, 17-18, 20-22, 24-29, 31-32, 34-38, 40-53, 94-95, 173-175, 194, 197, 200-201, 208, 215
UNUSED ZONE NUMBERS	
Internal	176-190, 193, 213-214, 216-218, 222-250
Gateway	301-305, 332-350

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 350 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 1998 Base Year Road Network

The first step of the model update process was to develop a 1998 roadway network for use in the model calibration process.

The 1998 road network was actually coded using KCAG's previous model future 2020 road network as a starting point since this network included zone splits and network enhancements that were not included in prior coded versions of the 1990 road network. Dowling Associates started with the most up-to-date 2020 network and "backed out" improvements to create a 1998 base year network.

Development of the 1998 base year road network for this update involved the following modifications to the previous versions of the KCAG road network:

- Conflation (projection to a real world coordinate system) so that the network correctly overlays with other geographic information such as street maps, TAZ maps and census data
- Addition of new and split zone centroid connectors
- Assignment of representative distances and speeds for gateway zones
- Uploading of 1998 daily counts from HPMS and other available traffic count databases to provide comparisons for model validation
- Creation of a "Master" network (see below for more details)

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 1998 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 2001 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 1998 Base Year Land Use Data

A 1998 land use database was developed to provide inputs to model re-validation. 1998 was selected as the base year since this was the most recent year that HPMS VMT estimates were available. The 1998 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 1998 land use assumptions are summarized in Table 3.

4.1.1 1998 Housing Data

The 1998 total housing units were developed using official state estimates for January 1, 1998[2]. This data is available by city for single and multiple family units. Dowling Associates assumed a straight-line growth factor between the previous model 1990 and 2010 estimates by jurisdiction to match these estimates. The resultant assumptions by TAZ were then provided to each of the KCAG local jurisdictions for review and comment. All comments were then incorporated into the 1998 base year land use assumptions.

4.1.2 1998 Employment Data

The 1998 employment data in the updated model is primarily based on the land use database from the previous version of the model. The land use database in the previous version of the KCAG model was based on an extensive compilation of acreages by community plan land use category in each community. Occupied acreages were converted to building area and numbers of employees using standard density factors.

The most recent available information on the numbers of Kings County employees in each employment category were obtained from the State of California Employment Development Department (EDD). The EDD data are not readily available by TAZ or census tract. Factors were applied so that the countywide totals of each employee type would match 1998 employment totals reported by EDD.

[2] State of California, Department of Finance, City/County Population and Housing Estimates, January 1, 1998. Sacramento, California, May 1998.

Table 3 1998 Land Use Summary

Land Use	1998
TOTAL HOUSING (Average Growth per Year)	**35,525**
Retail	9,874
Office	3,634
Industrial	4,849
Agricultural	6,625
Government	6,177
Education	3,500
Other	8,329
TOTAL EMPLOYMENT (Average Growth per Year)	**42,989**

4.2 Housing and Employment Projections

Projections of housing were based on DOF's "County Population Projections with Race/Ethnic Detail, Estimated July 1, 1990-1996 and Projections for 1997 through 2040"[3] 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 2.4 to 3.4 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.

[3] State of California, Department of Finance, County Population Projections with Race/Ethnic Detail. Sacramento, California, December 1998.

Table 4 Land Use Projections

Land Use	1990	2000	2010	2025	2030
TOTAL HOUSING	**31,545**	**37,703**	**46, 621**	**62,635**	**68,738**
(Average Growth per Year)		**2.0%**	**2.4%**	**2.8%**	**2.9%**
Retail	7,105	10,359	12,347	15,916	17,276
Office	3,014	3,905	5,015	7,008	7,768
Industrial	3,234	5,933	10,369	18,335	21,321
Agricultural	5,932	6,613	6,568	6,486	6,455
Government	5,862	6,471	7,675	9,836	10,660
Education	2,599	3,706	4,549	6,061	6,638
Other	8,383	8,797	10,713	14,153	15,464
TOTAL EMPLOYMENT	**36,229**	**45,785**	**57,236**	**77,796**	**85,632**
(Average Growth per Year)		**2.6%**	**2.9%**	**3.3%**	**3.4%**

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
109	Health/Med Center	2001	2,200
126	Hospital/Med/Govt	2005	11,486
210	Rancheria Casino 1	2000	3,000
210	Rancheria Casino 2	2001	500
210	Rancheria Casino 3	2003	2,500
210	Rancheria Hotel	2004	2,500
211	Rancheria Residential	2002	1,060
211	Rancheria Recreation	2005	500
212	Rancheria Hospital	2020	1,500
221	Hospital/Medical	1990	8,000

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 1991 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 land use 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 99. Daily 1998 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 (1995) model. Future through trips were factored from the 1998 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 1998 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

Hanford/Lemoore Area = 1

			Productions				Attractions				Person Trips	Vehicle Trips
Land Use		Quantity	HBW	HBS	HBO	NHB	HBW	HBS	HBO	NHB	RATE	RATE
Housing Units	HH	40,129	1.60	1.80	3.85	0.75	0.00	0.00	0.90	0.75	9.65	7.15
Retail Employment	Retail	13,742	0.00	0.00	0.00	13.50	1.31	6.00	4.60	13.50	38.91	29.88
Commercial Employment	Office	5,977	0.00	0.00	0.00	1.80	1.31	0.00	1.90	1.80	6.81	5.24
Industrial Employment	Indust	12,234	0.00	0.00	0.00	0.75	1.31	0.00	0.56	0.75	3.37	2.74
Agricultural Employment	AG	899	0.00	0.00	0.00	0.75	1.31	0.00	1.90	0.75	4.71	3.61
Government Employment	Govt	1,991	0.00	0.00	0.00	1.80	1.31	0.00	1.90	1.80	6.81	5.24
Education Employment	Educ	4,208	0.00	0.00	0.00	2.70	1.31	0.00	5.71	2.70	12.42	9.09
Other Employment	Other	7,630	0.00	0.00	0.00	0.75	1.31	0.00	0.56	0.75	3.37	2.74

Rural Area = 2

			Productions				Attractions				Person Trips	Vehicle Trips
Land Use		Quantity	HBW	HBS	HBO	NHB	HBW	HBS	HBO	NHB	RATE	RATE
Housing Units	HH	16,614	1.53	1.50	3.27	0.38	0.00	0.00	0.90	0.38	7.96	5.90
Retail Employment	Retail	2,258	0.00	0.00	0.00	6.80	1.17	5.70	5.33	6.80	25.80	19.60
Commercial Employment	Office	1,373	0.00	0.00	0.00	1.53	1.17	0.00	1.90	1.53	6.14	4.70
Industrial Employment	Indust	7,751	0.00	0.00	0.00	0.64	1.17	0.00	0.56	0.64	3.01	2.45
Agricultural Employment	AG	4,917	0.00	0.00	0.00	0.64	1.17	0.00	0.56	0.64	3.01	2.45
Government Employment	Govt	638	0.00	0.00	0.00	1.53	1.17	0.00	1.90	1.53	6.14	4.70
Education Employment	Educ	1,148	0.00	0.00	0.00	2.30	1.17	0.00	5.71	2.30	11.48	8.34
Other Employment	Other	5,440	0.00	0.00	0.00	0.64	1.17	0.00	0.56	0.64	3.01	2.45

Naval Air Station Area = 3

			Productions				Attractions				Person Trips	Vehicle Trips
Land Use		Quantity	HBW	HBS	HBO	NHB	HBW	HBS	HBO	NHB	RATE	RATE
Housing Units	HH	2,882	1.53	0.89	1.54	0.45	0.00	0.00	0.54	0.45	5.40	4.17
Retail Employment	Retail	493	0.00	0.00	0.00	7.38	1.83	4.55	3.20	7.38	24.34	18.82
Commercial Employment	Office	-	0.00	0.00	0.00	1.08	1.83	0.00	1.14	1.08	5.13	4.12
Industrial Employment	Indust	-	0.00	0.00	0.00	0.45	1.83	0.00	0.34	0.45	3.06	2.62
Agricultural Employment	AG	-	0.00	0.00	0.00	0.45	1.83	0.00	0.34	0.45	3.06	2.62
Government Employment	Govt	2,983	0.00	0.00	0.00	1.08	1.83	0.00	1.14	1.08	5.13	4.12
Education Employment	Educ	421	0.00	0.00	0.00	1.62	1.83	0.00	3.43	1.62	8.49	6.43
Other Employment	Other	1,502	0.00	0.00	0.00	0.45	1.83	0.00	0.34	0.45	3.06	2.62

Prisons Area = 4

			Productions				Attractions				Person Trips	Vehicle Trips
Land Use		Quantity	HBW	HBS	HBO	NHB	HBW	HBS	HBO	NHB	RATE	RATE
Housing Units	HH	9	1.53	1.78	3.85	0.75	0.00	0.00	0.90	0.75	9.56	7.07
Retail Employment	Retail	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial Employment	Office	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Employment	Indust	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agricultural Employment	AG	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Government Employment	Govt	4,750	0.00	0.00	0.00	0.20	1.20	0.00	0.20	0.20	1.80	1.56
Education Employment	Educ	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Employment	Other	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Corcoran/Avenal Area = 5

			Productions				Attractions				Person Trips	Vehicle Trips
Land Use		Quantity	HBW	HBS	HBO	NHB	HBW	HBS	HBO	NHB	RATE	RATE
Housing Units	HH	9,103	1.53	1.78	3.85	0.75	0.00	0.00	0.90	0.75	9.56	7.07
Retail Employment	Retail	783	0.00	0.00	0.00	12.30	1.31	6.50	5.33	12.30	37.74	28.89
Commercial Employment	Office	418	0.00	0.00	0.00	1.80	1.31	0.00	1.90	1.80	6.81	5.24
Industrial Employment	Indust	1,386	0.00	0.00	0.00	0.75	1.31	0.00	0.56	0.75	3.37	2.74
Agricultural Employment	AG	639	0.00	0.00	0.00	0.75	1.31	0.00	1.90	0.75	4.71	3.61
Government Employment	Govt	298	0.00	0.00	0.00	1.80	1.31	0.00	1.90	1.80	6.81	5.24
Education Employment	Educ	862	0.00	0.00	0.00	2.70	1.31	0.00	5.71	2.70	12.42	9.09
Other Employment	Other	892	0.00	0.00	0.00	0.75	1.31	0.00	0.56	0.75	3.37	2.74

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.

The KCAG model uses eight iterations for each final traffic assignment.

8.1.1 Traffic Assignment Time Periods

The KCAG model currently assigns only average daily traffic (ADT).

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 1998 base year in Kings County. Therefore, the model could be run without feedback for the 1998 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 2001 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 2001 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 (1998) 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 2001 version of the KCAG model is primarily calibrated to 1990 United States Census data and 1991 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 1998 daily counts and VMT since this was the most recent year for which HPMS data was available.

10.1 Model Estimates vs. Counts

1998 validation included overall comparisons of model daily link volume estimates to 1998 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 1998 conditions.

10.1.1 Facility Type and Volume Range

The KCAG model was revalidated to 1998 daily counts and VMT. The model estimates of 1998 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 highways (29.9% vs. 25% target). However, when volumes were categorized by magnitude, all volume groups met the FHWA percent RMSE targets. Seven (7) of the 8 screenlines are within 10 percent of observed counts and all screenlines are within 30 percent RMSE. Therefore, the model is considered acceptable based on FHWA guidelines.

The coefficient of determination (R^2) is 0.94 for all links with traffic counts.

10.1.2 Screenlines

Eight "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 2001 update of the KCAG model is within 10% on seven out of eight 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 2001 update of the KCAG model is within 23% RMSE on all 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 2,951,783 VMT on the roadway links and 34,265 in intrazonal VMT for a total of 2,986,048 VMT for the 1998 model year. The Caltrans HPMS 1998 estimate of VMT in Kings County was 2,978,800. The model estimate is 0.2% higher than the Caltrans 1998 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	Delta2	% Difference Percent Difference	FHWA Target	MSE	% RMSE Model %RMSE	FHWA Target
Freeways	1	171,545	179,180	21	7,635	29,002,887	4.5%	+/-7%	1,450,144	14.7%	20%
Highways	2	187,490	183,498	28	(3,992)	108,395,998	-2.1%	+/-7%	4,014,667	29.9%	25%
Rural Roads	3	241,640	194,695	122	(46,945)	101,722,429	-19.4%	+/-15-25%	840,681	46.3%	50%
Arterials	4	316,030	299,454	53	(16,576)	160,119,208	-5.2%	+/-15%	3,079,216	29.4%	35%
Collectors	5	58,620	62,086	29	3,466	16,725,388	5.9%	+/-25%	597,335	38.2%	50%
Sum		**975,325**	**918,913**	**253**	**(56,412)**	**415,965,910**	**-5.8%**		**1,650,658**	**33.3%**	

Count/ Model Volume Comparison by Volume Range

Volume Range	Counts	Model Volume	Links	Difference	Delta2	% Difference Percent Difference	FHWA Target	MSE	% RMSE Model %RMSE	FHWA Target
1-4,999	350,080	314,622	180	(35,458)	149,770,094	-10.1%	NA	836,704	47.0%	65%
5,000-9,999	362,935	347,899	52	(15,036)	166,567,654	-4.1%	NA	3,266,032	25.9%	52%
10,000-19,999	262,310	256,392	21	(5,918)	99,628,162	-2.3%	NA	4,981,408	17.9%	27-34%
Sum	**975,325**	**918,913**	**253**	**(56,412)**	**415,965,910**	**-5.8%**		**1,650,658**	**33.3%**	

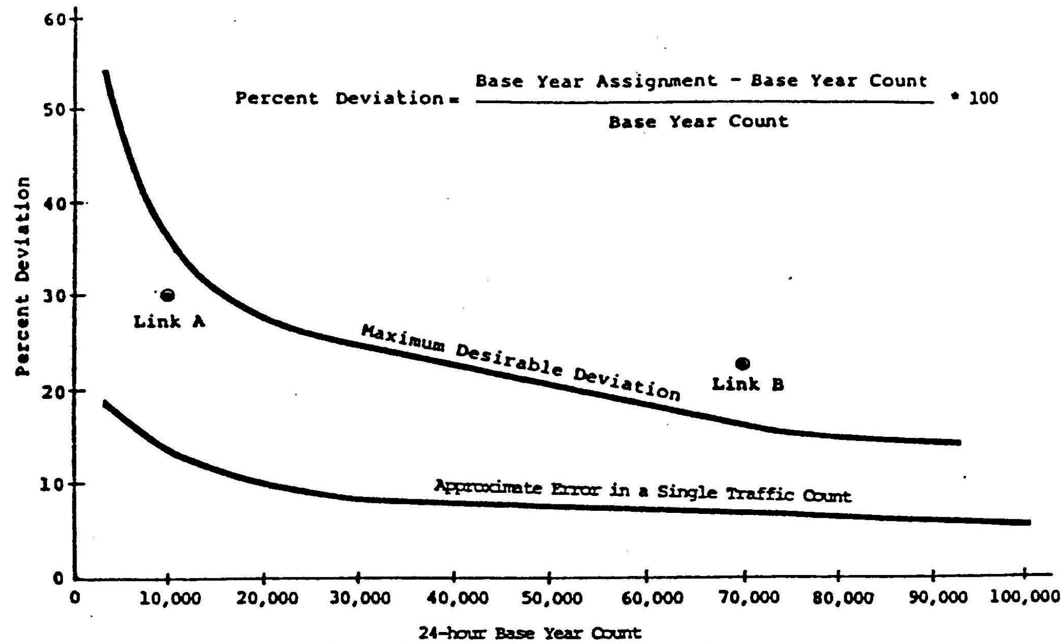
Coefficient of Determination (R^2) Calculation

	Model Data	FHWA Target
X=	975,325	
Y=	918,913	
X2=	6,956,839,175	
Y2=	6,811,410,105	
XY=	6,676,141,685	
N=	253	
R^2=	**0.94**	**>0.88**

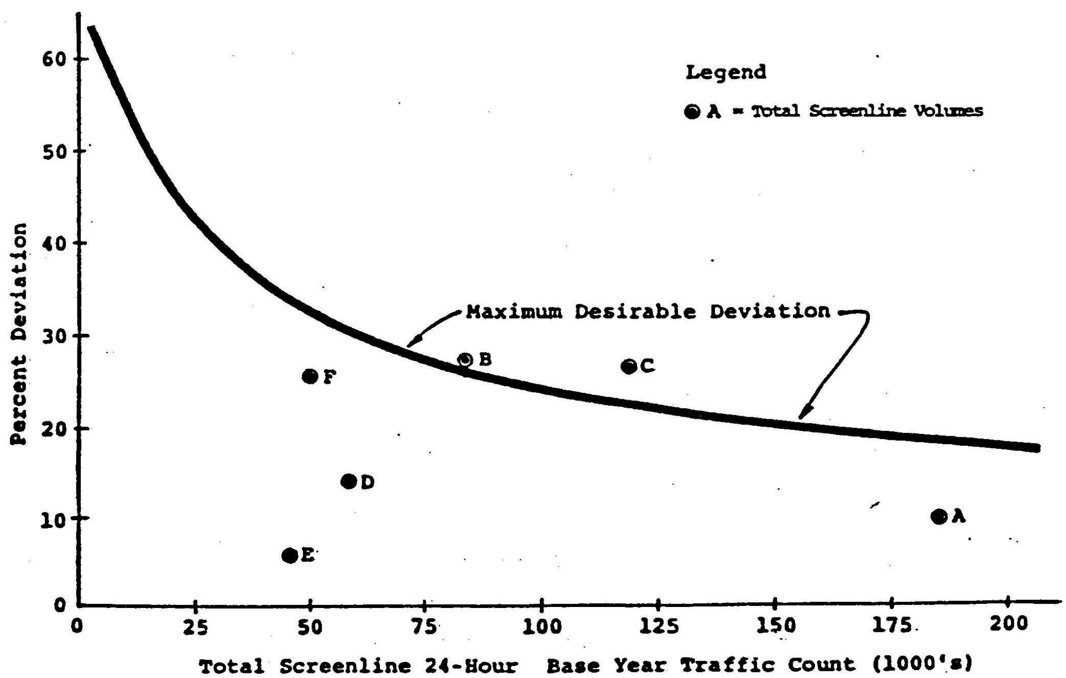
FHWA Link Specific Validation Criteria for Freeways and Principal Arterials

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

Figure 3 Maximum Desirable Error for Links and Screenlines



Maximum Desirable Error for Link Volumes



Maximum Desirable Deviation in Total Screenline Volumes

Source: Caltrans, *Travel Forecasting Guidelines*, 1992

10.3 Validation Issues

The 2001 update of the KCAG model meets the important validation criteria. There are validation issues that could be investigated further when the model is updated again. Most of the validation issues relate to data availability and cannot be fully addressed until more current data becomes available from the 2000 United States Census, particularly the detailed Journey-to-Work data, and the 2001 Caltrans Statewide Travel Survey.

It is recommended that the base year land use database be updated for the year 2000 or 2001, based on 2000 Census data for housing and a commercial database (D&B or other) for employment. Additional effort will be required to obtain full information on government and education employment.

When new household survey data becomes available from the 2001 Caltrans travel survey, it would be useful to investigate whether further stratification of housing types should be used in future model updates.

Appendix A

External and Through Trips

KCAG 2001 Model Update - Gateway Assumptions

			1998	1998	1998	Annual	2030	Estimated Trip Purpose Percentages				
Zone	Gateway	Count Location	Volume	% Thru	Thru	Growth	I-X / X-I	HBW	HBS	HBO	NHB	Total
301	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
302	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
303	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
304	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
305	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
306	6th Ave N (Road 8)	Tulare County Line	2,600		0	2.5%	4,680	18.5%	12.1%	33.6%	35.8%	100%
307	SR 43 N	Fresno County Line	8,970	4%	386	4.0%	19,572	20.1%	11.0%	30.0%	38.9%	100%
308	SR 41 N	Fresno County Line	10,030	33%	3,350	3.0%	13,093	20.1%	11.0%	30.0%	38.9%	100%
309	Excelsior	Fresno County Line	1,140		0	3.0%	2,234	20.1%	11.0%	30.0%	38.9%	100%
310	Grangeville	Grangeville Bypass	3,730		0	3.0%	7,311	20.1%	11.0%	30.0%	38.9%	100%
311	SR 269 (Lassen Ave)	Fresno County Line	1,560	4%	59	3.1%	2,978	20.1%	11.0%	30.0%	38.9%	100%
312	I-5 N	Fresno County Line	24,600	99%	24,379	2.5%	399	20.1%	11.0%	30.0%	38.9%	100%
313	SR 33 N	Fresno County Line	1,780	48%	856	3.0%	1,811	20.1%	11.0%	30.0%	38.9%	100%
314	SR 41 S	Kern County Line	5,900	37%	2,183	1.5%	5,501	18.2%	13.1%	32.2%	36.5%	100%
315	SR 33 S	Kern County Line	1,980	69%	1,360	1.5%	917	18.2%	13.1%	32.2%	36.5%	100%
316	25th Ave (King Road)	Kern County Line	320		0	3.3%	658	18.2%	13.1%	32.2%	36.5%	100%
317	I-5 S	Kern County Line	23,700	99%	23,368	1.5%	491	18.2%	13.1%	32.2%	36.5%	100%
318	6th Ave S	Kern County Line	820		0	3.3%	1,686	18.2%	13.1%	32.2%	36.5%	100%
319	12 3/4 Ave	Fresno County Line	3,600		0	3.3%	7,402	20.1%	11.0%	30.0%	38.9%	100%
320	SR 198 (Dorris)	Fresno County Line	5,900	36%	2,112	2.9%	7,303	20.1%	11.0%	30.0%	38.9%	100%
321	SR 43 S	Tulare County Line	2,250	20%	457	2.2%	3,056	18.5%	12.1%	33.6%	35.8%	100%
322	SR 137 (Corcoran Highway)	Tulare County Line	2,700	2%	46	0.8%	3,334	18.5%	12.1%	33.6%	35.8%	100%
323	Quebec Ave (Ave 144)	Tulare County Line	770	0%	0	2.0%	1,263	18.5%	12.1%	33.6%	35.8%	100%
324	Idaho Ave (Ave 264)	Tulare County Line	80		0	3.3%	164	18.5%	12.1%	33.6%	35.8%	100%
325	Virginia Ave (Ave 56)	Tulare County Line	1,150	0%	0	3.0%	2,254	18.5%	12.1%	33.6%	35.8%	100%
326	Racine/Redding Ave (Ave 120)	Tulare County Line	120		0	3.0%	235	18.5%	12.1%	33.6%	35.8%	100%
327	Nevada Ave (Ave 192)	Tulare County Line	1,330		0	3.0%	2,607	18.5%	12.1%	33.6%	35.8%	100%
328	Kansas Ave (Ave 232)	Tulare County Line	2,700	26%	705	3.0%	3,911	18.5%	12.1%	33.6%	35.8%	100%
329	Houston Ave (Ave 280)	Tulare County Line	3,230		0	1.7%	4,987	18.5%	12.1%	33.6%	35.8%	100%
330	SR 198 E (Visalia Hwy)	Tulare County Line	12,000	7%	804	2.9%	21,586	18.5%	12.1%	33.6%	35.8%	100%
331	Grangeville Ave (Ave 304)	Tulare County Line	3,640		0	3.0%	7,134	18.5%	12.1%	33.6%	35.8%	100%
332	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
333	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
334	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
335	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
336	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
337	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
338	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
339	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
340	FUTURE GATEWAY				0		0	18.5%	12.1%	33.6%	35.8%	100%
			126,600		**60,065**		**66,535**					

Appendix B

Screenline Results

KCAG 2001 Model Update
Screenline Validation for 1998 Base Year

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

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
SR 41	1	8086	7859	8,500	8,194	0.96	(306)	93,636
14th Ave	1	4064	3830	1,900	1,140	0.60	(760)	577,600
13th Ave	1	3862	1357	800	1,461	1.83	661	436,921
12th Ave	1	4088	3871	4,100	2,204	0.54	(1,896)	3,594,816
11th Ave	1	4051	7856	2,190	535	0.24	(1,655)	2,739,025
SR 43	1	3877	4093	9,300	10,939	1.18	1,639	2,686,321
6th Ave	1	3903	4095	1,050	1,082	1.03	32	1,024
TOTAL				**27,840**	**25,555**	**0.92**	**(2,285)**	**10,129,343**
Number of Links								**7**
ROOT MEAN SQUARE ERROR					1990	1.23		**0.30**

Screenline 2 - North of SR 198

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
SR 41	2	1342	4317	7,800	6,866	0.88	(934)	872,356
19th Ave	2	3870	1435	4,200	202	0.05	(3,998)	15,984,004
Vine	2	4044	8370	2,640	2,213	0.84	(427)	182,329
18th/Lemoore Ave	2	1391	7923	6,600	6,925	1.05	325	105,625
Houston Ave	2	3823	3864	5,100	2,905	0.57	(2,195)	4,818,025
14th	2	5170	3896	4,800	3,802	0.79	(998)	996,004
Hanford-Armona	2	1438	4319	3,800	4,501	1.18	701	491,401
12th Ave	2	1562	8494	14,150	13,362	0.94	(788)	620,944
11th Ave	2	3925	1297	15,800	19,296	1.22	3,496	12,222,016
Reddington St	2	3978	1303	3,800	4,131	1.09	331	109,561
Douty St	2	3959	4242	7,400	8,608	1.16	1,208	1,459,264
10th Ave	2	4251	1336	12,000	10,989	0.92	(1,011)	1,022,121
SR 43	2	3928	3935	9,300	9,533	1.03	233	54,289
6th Ave	2	3923	3912	1,300	1,298	1.00	(2)	4
TOTAL				**98,690**	**94,631**	**0.96**	**(4,059)**	**38,937,943**
Number of Links								**14**
ROOT MEAN SQUARE ERROR					1990	0.89		**0.24**

Screenline 3 - South of Jackson Ave

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
Avenal Cutoff	3	3711	8120	4,000	3,906	0.98	(94)	8,836
SR 41	3	3797	3732	6,430	5,925	0.92	(505)	255,025
18th Ave	3	8008	3736	1,000	1,548	1.55	548	300,304
10th Ave	3	3743	3805	1,100	375	0.34	(725)	525,625
SR 43	3	3750	3801	8,080	10,611	1.31	2,531	6,405,961
TOTAL				**20,610**	**22,365**	**1.09**	**1,755**	**7,495,751**
Number of Links								**5**
ROOT MEAN SQUARE ERROR					1990	1.06		**0.30**

Screenline 4 - North of Kettleman City

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
Avenal Cutoff	4	3664	3768	4,000	4,738	1.18	738	544,644
SR 41	4	3637	8184	5,300	4,927	0.93	(373)	139,129
Utica Ave	4	3640	7896	1,600	774	0.48	(826)	682,276
TOTAL				**10,900**	**10,439**	**0.96**	**(461)**	**1,366,049**
Number of Links								**3**
ROOT MEAN SQUARE ERROR					1990	1.10		**0.19**

Screenline 5 - Southwest of I-5

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
Skyline Blvd	5	8039	8217	7,200	7,440	1.03	240	57,600
SR 41	5	8127	8126	5,200	3,989	0.77	(1,211)	1,466,521
TOTAL				**12,400**	**11,429**	**0.92**	**(971)**	**1,524,121**
Number of Links								**2**
ROOT MEAN SQUARE ERROR					1990	1.05		**0.14**

KCAG 2001 Model Update

Screenline Validation for 1998 Base Year

Screenline 6 - East of SR 41

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
SR 33	6	8029	3607	1,980	1,447	0.73	(533)	284,089
I-5 EB	6	7891	7900	13,000	12,690	0.98	(310)	96,100
I-5 WB	6	7899	7894	13,000	12,662	0.97	(338)	114,244
Kansas Ave	6	3797	3716	2,400	679	0.28	(1,721)	2,961,841
SR 198 EB	6	3833	3781	6,885	6,033	0.88	(852)	725,904
SR 198 WB	6	1396	1397	6,885	6,199	0.90	(686)	470,596
Bush St	6	8094	4285	2,800	809	0.29	(1,991)	3,964,081
Hanford-Armona	6	3819	4279	3,000	3,358	1.12	358	128,164
Lacey Blvd	6	1428	3838	1,600	824	0.52	(776)	602,176
Grangeville Rd	6	4009	8473	3,800	4,015	1.06	215	46,225
Excelsior Ave	6	7860	3828	2,200	2,520	1.15	320	102,400
TOTAL				**57,550**	**51,236**	**0.89**	**(6,314)**	**9,495,820**
Number of Links								**11**
ROOT MEAN SQUARE ERROR					1990	1.13		**0.18**

Screenline 7 - West of 12th Ave

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
Utica Ave	7	3640	3616	1,600	715	0.45	(885)	783,225
Pueblo Ave	7	3657	3666	800	784	0.98	(16)	256
Kansas Ave	7	3786	7982	2,400	1,085	0.45	(1,315)	1,729,225
Houston Ave	7	3759	3773	2,000	1,081	0.54	(919)	844,561
Hanford-Armona	7	1544	4321	3,870	3,352	0.87	(518)	268,324
SR 198 EB	7	8048	1411	10,500	11,226	1.07	726	527,076
SR 198 WB	7	1410	8047	10,500	11,004	1.05	504	254,016
Lacey Blvd	7	1551	1494	10,200	10,787	1.06	587	344,569
Grangeville Rd	7	3856	1558	5,100	6,511	1.28	1,411	1,990,921
Fargo Ave	7	2007	1560	800	1,337	1.67	537	288,369
Excelsior Ave	7	4331	4091	4,200	5,114	1.22	914	835,396
TOTAL				**51,970**	**52,996**	**1.02**	**1,026**	**7,865,938**
Number of Links								**11**
ROOT MEAN SQUARE ERROR					1990	0.94		**0.18**

Screenline 8 - East of 10th Avenue

NAME		A-NODE	B-NODE	COUNT	VOLUME	RATIO	DIFF	DIFF ^2
Kansas Ave	8	3745	3780	2,000	1,252	0.63	(748)	559,504
Houston Ave	8	3853	4272	2,500	2,190	0.88	(310)	96,100
Hanford-Armona Rd	8	3909	4263	2,590	3,915	1.51	1,325	1,755,625
SR 198 EB	8	8237	1352	7,250	8,914	1.23	1,664	2,768,896
SR 198 WB	8	4213	8236	7,250	9,407	1.30	2,157	4,652,649
Lacey Blvd	8	4202	3943	5,400	4,858	0.90	(542)	293,764
Florinda St	8	4029	3906	3,000	2,128	0.71	(872)	760,384
Grangeville Rd	8	4150	4020	4,300	5,564	1.29	1,264	1,597,696
Leland Ave	8	1340	4053	1,800	1,526	0.85	(274)	75,076
Fargo Ave	8	4080	7925	5,000	4,930	0.99	(70)	4,900
SR 43	8	2008	8305	4,700	3,844	0.82	(856)	732,736
Excelsior Ave	8	3898	4093	1,800	2,207	1.23	407	165,649
TOTAL				**47,590**	**50,735**	**1.07**	**3,145**	**13,462,979**
Number of Links								**12**
ROOT MEAN SQUARE ERROR					1990	1.13		**0.27**

				327,550	**319,386**	**0.98**	**(8,164)**	**90,277,944**
								65
								0.23