Model Description & Validation Report
Fresno Council of Governments
Travel Demand Model
2008 Base

Prepared for:
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1. INTRODUCTION

This report describes the Fresno Council of Governments Travel Demand Model (Fresno COG Model), as updated in 2013 to reflect 2008 conditions. The year 2008 is the base year and the model was also used to backcast year 2005 as a benchmark for California Senate Bill Number 375. There is also a separate user guide for application of the model using the Cube software, and a description of how the model meets the requirements of California Senate Bill Number 375.

This chapter includes a summary of the Fresno COG Model. The following chapters describe the individual components of the model.

MODEL PURPOSE

The purpose of the Fresno COG Model is to provide a defensible tool to:

- provide input into the air quality analysis required by the Clean Air Act Amendments for transportation improvement plans and projects;
- 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; and
- evaluate the traffic impacts of large-scale development proposals.

SUMMARY OF MODEL

The Fresno COG model is a conventional travel 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 travel patterns, roadway traffic volumes and transit volumes.

The Fresno COG model differs from a basic trip model through the integration of the components.

MODEL COVERAGE AND TRANSPORTATION ANALYSIS ZONES (TAZS)

The study area for the Fresno COG Model covers all of Fresno County. The county is divided into approximately 2,900 transportation analysis

zones (TAZs). Other travel to and from Fresno County is represented by 30 gateway zones at major road crossings of the county line.

LAND USE INPUTS

The travel demand model land use inputs (socioeconomic data) are aggregated by TAZ. Population-related inputs include total population and numbers of households stratified by structure type, household income, age of population in households, and housing density. Employment-related inputs are employee by detailed sector and employment density. In addition to employees, schools are represented by student enrolment. “Special Generators," primarily for unique uses not covered specifically by a standard land use category, are represented as total person trips by purpose. Similarly, interaction with land uses outside the model area are represented by total person productions and attractions by purpose based on the California Statewide Travel Demand Model.

NETWORK CHARACTERISTICS

The model roadway network includes nodes and links. Link types include freeway, highway, expressway, arterial, collector, local, and freeway ramps. The model distinguishes roadways by adjacent development (central business district, fringe, urban, suburban, or rural) and terrain (flat, rolling or mountainous). Transit network have been coded to represent walk/bike access, drive access, park-and-ride lots, highway based (i.e. local bus) and non-highway based (i.e. rail) transit in the model area.

The North American Datum (NAD) 83 State Plane California (feet) coordinate projection is used so that the model network can be viewed together with other GIS data such as street centerlines, TAZ boundaries and Census information.

FORECASTING PROCESS

Four primary sub-models are involved in the travel demand forecasting process:

1. Trip Generation. This initial step calculates person or truck trip ends using trip generation rates established during model calibration, cross-classified residential data, employment, and student enrollment. This step also uses the demographics to determine the household passenger vehicle availability. The land use forecast is implemented prior to trip generation in a pre-processer outside of the model.

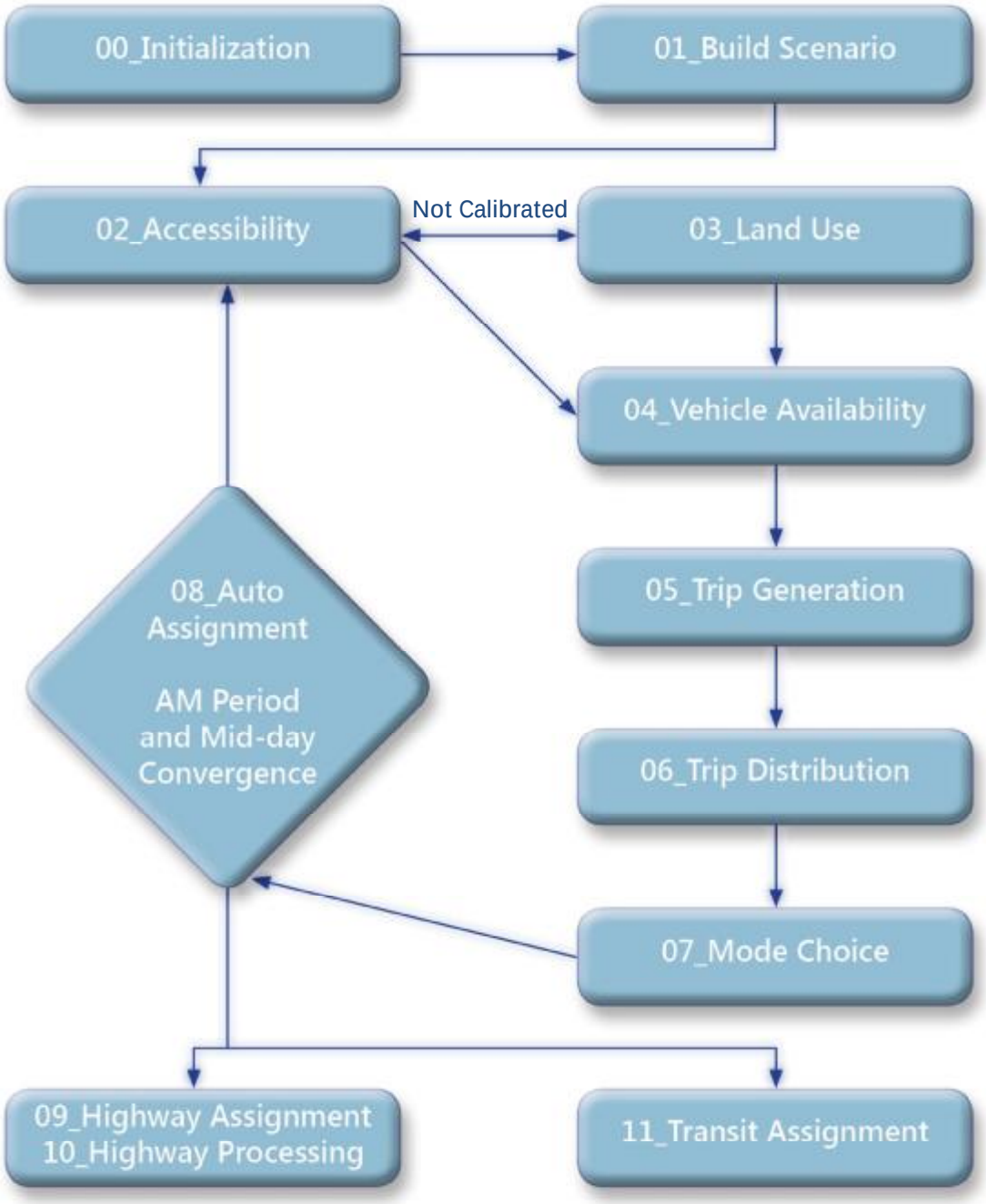
2. Trip Distribution. The second general step estimates how many trips travel from one zone to any other zone. The distribution is based on the number of trip ends generated in each of the two zones, and on factors that relate the likelihood of travel between any two zones to the travel time between the two zones such as distance, cost, time, and varies by accessibility to passenger vehicles, transit, and walking or biking.

3. Mode Choice. This step uses demographics and the comparison of distance, time, cost, and access between modes to estimate the proportions of the total person trips using drive-alone or shared-ride passenger auto, transit, walk or bike modes for travel between each pair of zones.

4. Trip Assignment. In this final step, vehicle trips or transit trips from one zone to another are assigned to specific travel routes between the zones. Congested travel information is used to influence each of the steps described above starting with vehicle availability.

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

Figure 1 Travel Model Process



FORECAST TIME PERIODS

The SJV MIP travel models estimate travel demand and traffic and transit volumes for the average weekday (Monday through Friday). The daily roadway volumes are aggregated from AM and PM peak period, and Mid-day and Evening off-peak periods. The daily transit volumes are aggregated from a peak period and an off-peak period. In addition, AM and PM peak one-hour traffic volume estimates are available for roadways.

FEEDBACK LOOPS

The Fresno COG Model includes a feedback loop that uses the congested speeds estimated from traffic assignment to recalculate the travel time and cost. 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 are consistent with the travel speeds used throughout the model process, as required by the Transportation Conformity Rule (40CFR Part 93).

MODEL VALIDATION

The Fresno COG Model was validated by comparing its estimates of 2008 traffic volumes with 2008 traffic counts. The 2008 validation meets standard criteria for replicating total daily traffic volumes on various road types. The 2008 validation also meets standard criteria for percent error relative to daily traffic counts on eight out of 10 tested groups of roads ("screenlines") throughout Fresno County.

TRAVEL MODEL SOFTWARE

The Fresno COG Model uses the Citilabs Cube software (Version 6) implemented with Scenario Manager and Application Manager for all model components. Model networks may be viewed using the Cube Base component. Most input data files were prepared using ArcGIS or Microsoft Excel.

2. MODEL STUDY AREA AND ZONE SYSTEM

The study area for the Fresno COG Model covers all of Fresno County, including the cities of Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron, Kerman, Kingsburg, Mendota, Orange Cove, Parlier, Reedley, Sanger, San Joaquin, and Selma. The county has been divided into Transportation Analysis Zones (TAZs) that are used to represent origins and destinations of travel. Travel to, from and through Fresno County is represented by external gateway zones.

MODEL COVERAGE AND TRANSPORTATION ANALYSIS ZONES (TAZS)

The model area is divided into transportation analysis zones (TAZs) representing land use within the model area, and by gateway zones at major road crossings of the model boundary. To allow for maximum flexibility in the future and through coordination of each San Joaquin Valley (SJV) model and parallel projects such as the Air Resources Board Eight-County SJV Model, the following gateway, TAZ, and screenline numbering process was developed:

- Gateways external to SJV: Gateways 1-60
- Gateways within the SJV: Gateways 61-100
- TAZs within a model: 101-3,000
    - TAZs allocated alphabetically within each model by sphere of influence
    - Gaps in numbering sequence allow for additional zone detail in the future
- Screenline numbering identical for models that share a boundary and unique number range
    - Hundreds place designates screenline
    - Tens place designates location
        - Odd number: North or East
        - Even number: South or West

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 downtown Fresno, 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 traffic to the street system.

The TAZ map is maintained as a Geographic Information System (GIS) file. The GIS file can be displayed with the travel model road network.

Figure 2 shows the overall TAZ system in the County.

Figure 3 shows a closer view of the Fresno/Clovis urban area. Detailed TAZ maps are available at Fresno COG. The Fresno COG Model currently has 30 external gateways for representing travel into, out of, and through the region (Figure 4 and Table 1). Zone numbers 1 to 100 are reserved for external cordons.

Figure 2 Transportation Analysis Zones (Outlined in Blue), Fresno County

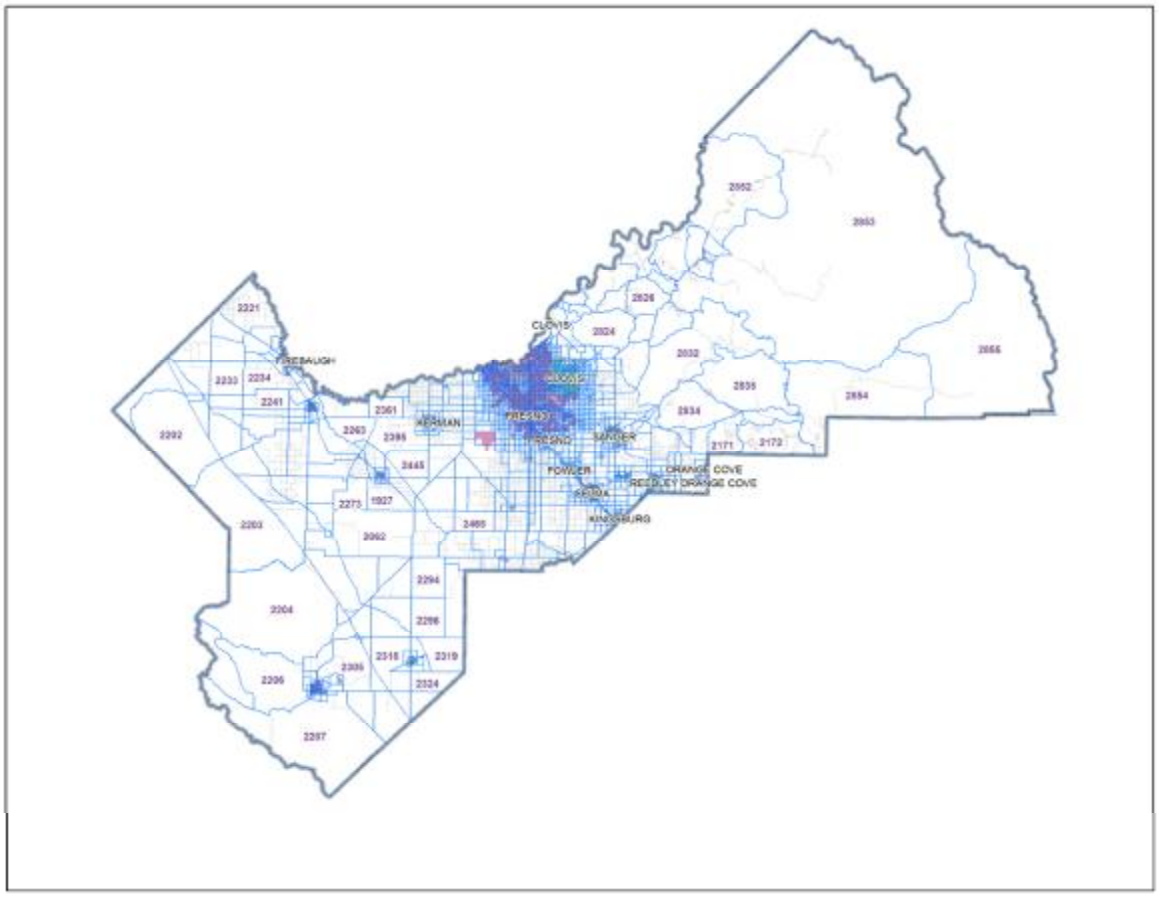


Figure 3 Transportation Analysis Zones (Outlined in Blue), Fresno and Clovis Urban Areas

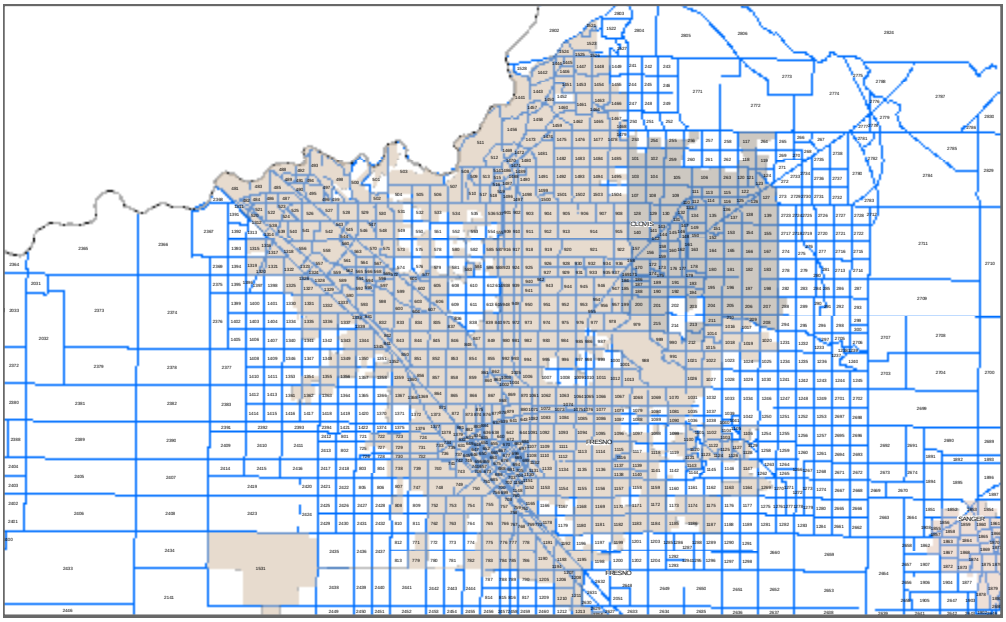


Figure 4 Fresno Model External Gateways

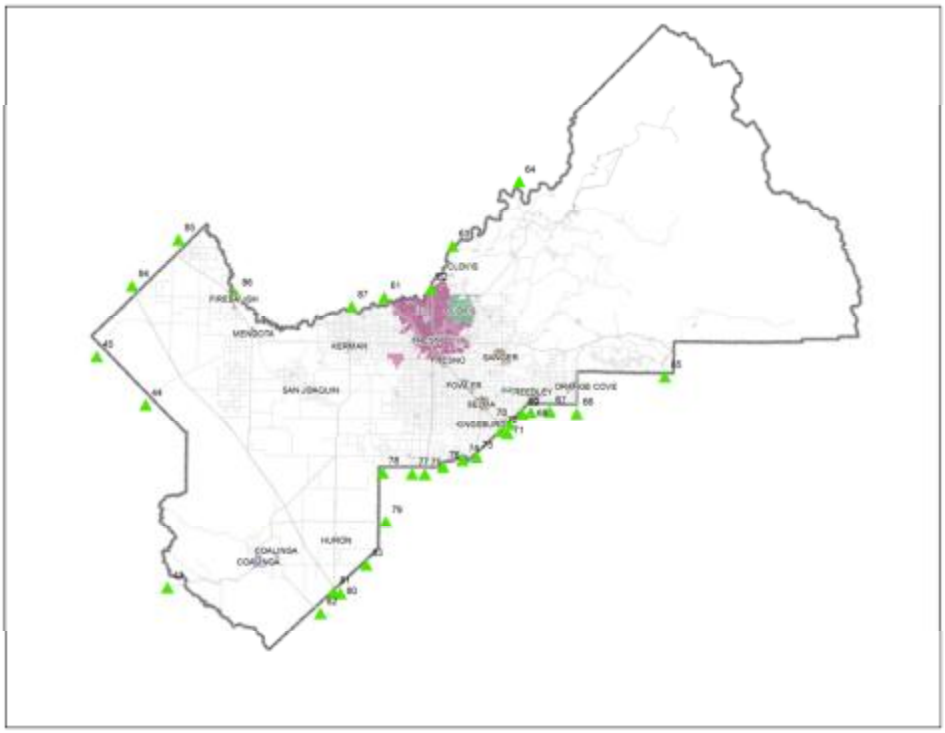


TABLE 1
FRESNO MODEL GATEWAY PRODUCTIONS AND ATTRACTIONS

Zone Number	External County	Gateway	2008	2035
43	Monterey	SR-198	161 (464)	87 (459)
44	San Benito	Panoche Road	13 (39)	4 (17)
45	San Benito	Ltl Panoche Road	121 (348)	148 (434)
61	Madera	SR-99	36,699 (20,113)	44,066 (25,141)
62	Madera	SR-41	30,820 (8,792)	38,525 (10,195)
63	Madera	County Road 206/ Millerton	28,093 (12,911)	29,225 (12,581)
64	Madera	Road 222/ Powerhouse Road	6,052 (1,189)	4,793 (966)
65	Tulare	SR-245	163 (92)	191 (110)
66	Tulare	Hill Valley/ Road 120	4,687 (12,663)	4,377 (10,884)
67	Tulare	Alta Avenue	5,107 (7,099)	3,631 (8,345)
68	Tulare	Reed/Road 52	1,877 (3,196)	2,014 (3,011)
69	Tulare	Mountain View/ Avenue 416	6,972 (4,902)	5,897 (3,989)
70	Tulare	SR 201/Sierra	4,217 (1,876)	4,186 (2,129)
71	Tulare	SR-99	22,365 (15,240)	27,243 (19,050)
72	Tulare	Road 8/10th Avenue	20 (11)	24 (14)
73	Kings	SR-43	8,034 (2,022)	9,825 (2,527)
74	Kings	Fowler Avenue	2,263 (960)	1,882 (1,191)
75	Kings	SR-41	11,704 (3,616)	11,170 (4,418)
76	Kings	Excelsior	99 (16)	85 (17)
77	Kings	Marks Avenue/22nd Avenue	1,743 (739)	1,359 (903)
78	Kings	Paige Avenue/Elder Avenue	790 (129)	986 (162)
79	Kings	SR-198	4,673 (2,142)	5,842 (2,676)
80	Kings	I-5	235 (147)	295 (183)
81	Kings	SR-269	1,478 (940)	1,725 (1,143)

TABLE 1
FRESNO MODEL GATEWAY PRODUCTIONS AND ATTRACTIONS

Zone Number	External County	Gateway	2008	2035
82	Kings	SR-33	7,828 (3,328)	8,988 (3,370)
83	Kings	Jayne Avenue	872 (369)	975 (319)
84	Merced	I-5	222 (207)	277 (257)
85	Merced	SR-33	2,246 (1,353)	0 (0)
86	Madera	13th Street	4,568 (3,000)	2,940 (2,874)
87	Madera	SR-145	15,712 (14,796)	14,830 (13,046)

Notes: Values shown as Production (Attraction)

3. TRANSPORTATION NETWORKS

The Fresno COG Model uses coded representations of the county's existing and future roadway and transit networks.

ROAD NETWORKS

The road network is a computerized representation of the major street and highway system. Only the more important streets (generally freeways, highways, expressways, arterials and collectors) are included in the network. The model does not explicitly include some collector streets or most local streets. Most local streets and driveways are instead represented by simplified network links ("zone centroid connectors") that represent local connections to the coded road network.

MASTER NETWORK

All road network information for all base year and forecast scenarios is contained in a single "master network" file. The master network contains information on the years that various road improvement projects are programmed for implementation. The master network can be used to generate the model road network for any study year between 2005 and 2040.

The purpose of creating a master network was to make the task of network maintenance more efficient. In the past, if a roadway network improvement was to be included in several alternatives (e.g., add a new widening to the near term network and all other future networks), the same network editing had to be performed individually for each of the scenarios. With a master network, the user need only input the improvement in one place with the appropriate scenarios designated and then all scenarios built from the master network will be consistent.

The network node and link variables shown in Table 2 are coded for each master network scenario.

TABLE 2
STANDARD MASTER HIGHWAY NETWORK VARIABLES

Attribute	Description
Nodes	
X	X-coordinate of node in Nad 83
Y	Y-coordinate of node in Nad 83

TABLE 2
STANDARD MASTER HIGHWAY NETWORK VARIABLES

Attribute	Description
N	Node number
TAZ	Traffic Analysis Zone Number
DISTRICT	Super district number used for aggregation
SOI	Sphere of influence used to number TAZs alphabetically
STYINT	Study location number used to record turning movements when non-zero
COUNTY	County where node is located
JURISDICTION	Political jurisdiction where node is located
COMMUNITY	Community/district name
Links	
A	A node
B	B node
DISTANCE	Distance in miles
NAME	Local street name
ROUTE	Numerical state route number
TERRAIN	Terrain (F=Flat , R=Rolling, M=Mountain)
JURISDICTION	Political jurisdiction where link is located location
SCREENLINE	Screenline by direction
XXXX_PRJID	RTP Project ID number
XXXX_PRJYR	RTP Project Opening Year
XXXX_FACTYP	Facility type by year
XXXX_AREATYP	Area type by year
XXXX_LANES	Number of directional through travel lanes by year
XXXX_AUX	Auxiliary lane (0=no, 1=yes)
XXXX_SPEED	Free-flow speed in miles-per hour by year
XXXX_CAPCLASS	Capacity class by year (derived from Terrain, Facility type, and Area Type)
XXXX_CAPACITY	Vehicle per hour (calculated based on Lanes and CapClass)

TABLE 2
STANDARD MASTER HIGHWAY NETWORK VARIABLES

Attribute	Description
XXXX_USE	Identifies vehicle prohibitions by year
XXXX_TOLL	Code used for cost on toll facilities by year
AREATYP	Character to store scenario variable
AIRBASIN	Air basin number for air quality
TSM	Transportation System Management
EJ	Environmental Justice designation (0 or 1)

At the beginning of the model process, the master network is processed to create the individual road network for the desired scenario. Maps and summary tables are created to be reviewed prior to running the full model.

ROAD NETWORK ELEMENTS

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

Nodes

Nodes are established at each and every intersection between two or more links. Nodes are assigned numbers, with node numbers 101-3000 in the Fresno COG Model reserved for centroids of the traffic analysis zones. The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays. The North American Datum (NAD) 83 State Plane California (feet) coordinate projection is used so that the model network can be viewed together with other GIS data such as street centerlines, TAZ boundaries and Census information.

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 including facility type, number of lanes in each direction, and speeds. In the Fresno COG Model, average uncongested speeds are coded individually for each road link. These average uncongested speeds represent the average speeds for all vehicle types (automobiles and trucks), including delays at traffic signals and stop signs, but excluding delays related to other vehicles on the same road segment.

Capacities and speed-versus-congestion characteristics are assigned to groups of links based on the capacity class (Table 3).

The basic information coded in the road network is used to derive additional link characteristics such as capacities and speed/congestion relationships. The capacity of each link is determined based on the terrain, facility type, and area type.

The capacities are based on the capacity formulas for each road type in the 2000 *Highway Capacity Manual* (HCM). Input assumptions are based on HCM defaults wherever possible. The speed characteristics of each link are also determined by terrain, facility type, and area type using Bureau of Public Roads formulas (Table 5 and Table 6).

The capacities in the Fresno COG Model are based on level of service "E/F" capacities representing the maximum flow which can pass through a given segment. However, the model may still estimate traffic demands which exceed these maximum capacities.

TABLE 3
CAPACITY CLASS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Flat					
1. Freeway	1	11	21	31	41
2. Highway	2	12	22	32	42
3. Expressway	3	13	23	33	43
4. Arterial	4	14	24	34	44
5. Collector	5	15	25	35	45
6. Local	6	16	26	36	46
7. Ramp: Freeway-Freeway	7	17	27	37	47
8. Ramp: Slip	8	18	28	38	48
9. Ramp: Loop	9	19	29	39	49
10. Connector: Dist. ≤ 0.25	10	N/A	N/A	N/A	N/A

TABLE 3
CAPACITY CLASS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
11. Connector: Dist. > 0.25	20	N/A	N/A	N/A	N/A
Rolling					
1. Freeway	51	61	71	81	91
2. Highway	52	62	72	82	92
3. Expressway	53	63	73	83	93
4. Arterial	54	64	74	84	94
5. Collector	55	65	75	85	95
6. Local	56	66	76	86	96
7. Ramp: Freeway-Freeway	57	67	77	87	97
8. Ramp: Slip	58	68	78	88	98
9. Ramp: Loop	59	69	79	89	99
10. Connector: Dist. ≤ 0.25	60	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	70	N/A	N/A	N/A	N/A
Mountain					
1. Freeway	101	111	121	131	141
2. Highway	102	112	122	132	142
3. Expressway	103	113	123	133	143
4. Arterial	104	114	124	134	144
5. Collector	105	115	125	135	145
6. Local	106	116	126	136	146
7. Ramp: Freeway-Freeway	107	117	127	137	147
8. Ramp: Slip	108	118	128	138	148

TABLE 3
CAPACITY CLASS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
9. Ramp: Loop	109	119	129	139	149
10. Connector: Dist. ≤ 0.25	110	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	120	N/A	N/A	N/A	N/A

TABLE 4
DEFAULT CAPACITY BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Flat					
1. Freeway	2100	2000	1900	1800	1750
2. Highway	1680	1600	1600	1500	1300
3. Expressway	1155	1100	1000	900	800
4. Arterial	945	900	800	800	750
5. Collector	735	700	700	700	700
6. Local	600	600	600	600	600
7. Ramp: Freeway-Freeway	1900	1800	1800	1800	1800
8. Ramp: Slip	1600	1500	1500	1500	1500
9. Ramp: Loop	1300	1250	1250	1250	1250
10. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A

TABLE 4
DEFAULT CAPACITY BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Rolling					
1. Freeway	1800	1800	1620	1580	1580
2. Highway	1300	1300	1300	1220	1060
3. Expressway	1300	890	810	730	650
4. Arterial	1300	730	730	650	610
5. Collector	1300	570	650	650	570
6. Local	1000	550	640	640	550
7. Ramp: Freeway-Freeway	1800	1800	1500	1500	1500
8. Ramp: Slip	1500	1500	1500	1500	1500
9. Ramp: Loop	1250	1250	1250	1250	1250
10. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A
Mountain					
1. Freeway	1500	1500	1350	1310	1310
2. Highway	700	700	700	660	570
3. Expressway	700	700	440	390	350
4. Arterial	700	390	390	350	330
5. Collector	700	310	350	350	310
6. Local	600	330	380	380	330
7. Ramp: Freeway-Freeway	1500	1500	1500	1500	1500
8. Ramp: Slip	1500	1500	1500	1500	1500
9. Ramp: Loop	1250	1250	1250	1250	1250

TABLE 4
DEFAULT CAPACITY BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
10. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A

Note: Capacity shown as vehicles per hour per lane (VPHPL)

TABLE 5
BUREAU OF PUBLIC ROADS ALPHA AND BETA COEFFICIENTS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Flat					
1. Freeway	0.25 (9)	0.25 (9)	0.25 (9)	0.18 (8.5)	0.1 (10)
2. Highway	0.08 (6)	0.08 (6)	0.34 (4)	0.07 (6)	0.07 (6)
3. Expressway	0.08 (6)	0.08 (6)	0.74 (5)	0.74 (5)	1.16 (6)
4. Arterial	0.07 (6)	0.38 (5)	0.7 (5)	0.7 (5)	1 (5)
5. Collector	0.07 (6)	0.96 (5)	1 (5)	1 (5)	1.4 (5)
6. Local	0.34 (4)	1.11 (5)	1.2 (5)	1.5 (5)	1.5 (5)
7. Ramp: Freeway-Freeway	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)
8. Ramp: Slip	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)
9. Ramp: Loop	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)
10. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
11. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A

TABLE 5
BUREAU OF PUBLIC ROADS ALPHA AND BETA COEFFICIENTS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Rolling					
12. Freeway	0.25 (9)	0.25 (9)	0.18 (8.5)	0.18 (8.5)	0.1 (10)
13. Highway	0.08 (6)	0.08 (6)	0.34 (4)	0.07 (6)	0.07 (6)
14. Expressway	0.08 (6)	0.08 (6)	0.74 (5)	0.74 (5)	1.16 (6)
15. Arterial	0.07 (6)	0.38 (5)	0.7 (5)	0.7 (5)	1 (5)
16. Collector	0.07 (6)	0.96 (5)	1 (5)	1 (5)	1.4 (5)
17. Local	0.34 (4)	1.11 (5)	1.2 (5)	1.5 (5)	1.5 (5)
18. Ramp: Freeway-Freeway	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)
19. Ramp: Slip	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)
20. Ramp: Loop	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)
21. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
22. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A
Mountain					
12. Freeway	0.18 (8.5)	0.18 (8.5)	0.1 (10)	0.1 (10)	0.1 (10)
13. Highway	0.08 (6)	0.08 (6)	0.34 (4)	0.07 (6)	0.07 (6)
14. Expressway	0.08 (6)	0.08 (6)	0.74 (5)	0.74 (5)	1.16 (6)
15. Arterial	0.07 (6)	0.38 (5)	0.7 (5)	0.7 (5)	1 (5)
16. Collector	0.07 (6)	0.96 (5)	1 (5)	1 (5)	1.4 (5)
17. Local	0.34 (4)	1.11 (5)	1.2 (5)	1.5 (5)	1.5 (5)
18. Ramp: Freeway-Freeway	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)	0.08 (6)
19. Ramp: Slip	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)	0.74 (5)
20. Ramp: Loop	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)	0.7 (5)

TABLE 5
BUREAU OF PUBLIC ROADS ALPHA AND BETA COEFFICIENTS BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
21. Connector: Dist. ≤ 0.25	N/A	N/A	N/A	N/A	N/A
22. Connector: Dist. > 0.25	N/A	N/A	N/A	N/A	N/A

Note: Values shown as Alpha Coefficient (Beta Coefficient)

TABLE 6
TYPICAL SPEED RANGES BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Flat					
1. Freeway	70	65-70	55-65	55-65	55-65
2. Highway	40-45	40-45	40-45	40-45	40-45
3. Expressway	55	45-55	45-55	45-55	40-45
4. Arterial	40-45	30-45	25-45	30-45	25-45
5. Collector	50	50	35-40	35-40	35-40
6. Local	25-40	25-40	25-40	25-40	25-40
7. Ramp: Freeway-Freeway	50	50	50	50	50
8. Ramp: Slip	50	50	50	50	50
9. Ramp: Loop	45	45	45	45	45
10. Connector: Dist. ≤ 0.25	35	35	35	35	35
11. Connector: Dist. > 0.25	15	15	15	15	15

TABLE 6
TYPICAL SPEED RANGES BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
Rolling					
1. Freeway	65-70	65-70	65-70	65-70	65-70
2. Highway	40-45	40-45	40-45	40-45	40-45
3. Expressway	50-65	50-65	50-65	50-65	50-65
4. Arterial	30-45	30-45	30-45	30-45	30-45
5. Collector	50	50	50	50	50
6. Local	50	50	50	50	50
7. Ramp: Freeway-Freeway	50	50	50	50	50
8. Ramp: Slip	50	50	50	50	50
9. Ramp: Loop	45	45	45	45	45
10. Connector: Dist. ≤ 0.25	35	35	35	35	35
11. Connector: Dist. > 0.25	15	15	15	15	15
Mountain					
1. Freeway	65	65	65	65	65
2. Highway	40-45	40-45	40-45	40-45	40-45
3. Expressway	40-55	40-55	40-55	40-55	40-55
4. Arterial	30-45	30-45	30-45	30-45	30-45
5. Collector	25-40	25-40	25-40	25-40	25-40
6. Local	25-40	25-40	25-40	25-40	25-40
7. Ramp: Freeway-Freeway	50	50	50	50	50
8. Ramp: Slip	45	45	45	45	45
9. Ramp: Loop	35	35	35	35	35

TABLE 6
TYPICAL SPEED RANGES BY TERRAIN, FACILITY TYPE, AND AREA TYPE

Facility Type	Area Type				
	Rural (R)	Suburban (SU)	Urban (U)	Fringe (F)	Central Business District (CBD)
10. Connector: Dist. ≤ 0.25	15	15	15	15	15
11. Connector: Dist. > 0.25	25	25	25	25	25

Note: Speed shown as miles per hour (MPH)

Turn Penalties

Turn penalties can be used to identify node-to-node movements that are prohibited (such as certain left turns) or that have additional delays. Turn penalties are primarily used to represent prohibited left turns to and from ramps at freeway interchanges, in particular if an interchange has two on-ramps.

TRANSIT NETWORKS

The highway based transit routes are coded into the Cube LIN file format. The Public Transport module of Voyager combines the LIN files with the Transit System (PTS file defining the modes and wait curves), Transit Fare (FAR containing the far system for the modes), and Transit Factors (FAC combines the modes, far system, and time factors for transit). Access to and from each bus stop is generated automatically based on the road network and the "walk" speed of three miles per hour (can be modified in scenario key). The Walk and Drive access BLOCK files control which nodes are park-n-ride and the maximum distance for walk and drive to transit stops. Fresno County transit lines are shown on Figure 5.

BUS SPEEDS

Bus travel times are derived from the road network, with a delay factor to account for stops and slower operating speeds. A factor by facility class increases is used to modify bus speeds, and current factors were calibrated at 1.0.

TRANSFER POINTS

At timed transfer locations, the maximum wait time between buses is set to be 5 minutes rather than one-half the headway. No timed transfer points are designated for the 2008 base year. Timed transfer points can be designated for future year forecasts.

WALK ACCESS

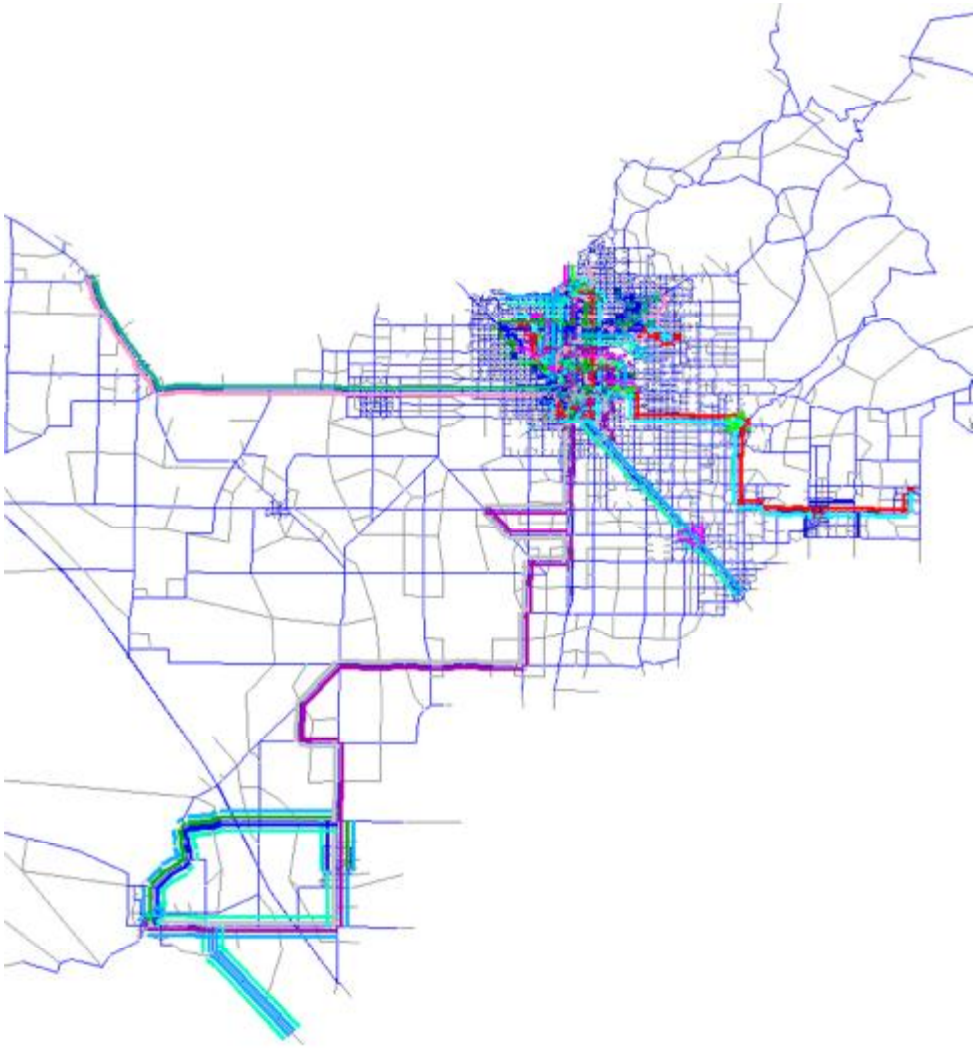
Walk access is allowed for any TAZ centroid within one mile of a transit stop. The walking route and distance is determined automatically along the model road network. An average walking speed of three miles per hour is used to calculate the average walk time to and from transit stops. A given TAZ is assumed to have access to any number of transit stops and lines within one mile.

DRIVE ACCESS

Separate "park and ride" (PNR) nodes are designated to indicate locations where people could use automobiles to access transit, including drop-off or pick-up as well as passengers who park.

Walk and Drive access should be further calibrated with the transit or household survey data.

Figure 5 Fresno County Transit Lines (2008)



4. DEMOGRAPHIC/LAND USE DATA

Land use and socioeconomic data at the zonal level are used for determining trip generation.

LAND USE CATEGORIES

The land use inputs to the model were divided into a number of residential and non- residential categories (Table 7 thru Table 12). The categories represent different levels and types of trip generation per housing unit, employee, or student.

TABLE 7
LAND USE CATEGORIES

Attribute	Description	Units
Residential		
RU [1]	Units in structure	Households
TOTHH	Total Households	Households
INC [2]	Households by Annual Income (2009 Dollars)	Households
RU_AGE [3]	Age of Householder	Households
POP [4]	Population by age range	People
HHPOP	Total Household Population	People
HHSIZE [5]	Average Household Size	People
Non-Residential		
TOTEMP	Total employees	Employees
EMPOTH	Agriculture, Forestry, Fishing and Hunting (11), Construction (23)	Employees
EMPIND	Mining, Quarrying, Oil and Gas Extraction (21), Utilities (22), Manufacturing (31-33), Wholesale Trade (42), Transportation and Warehousing (48-49)	Employees
EMPRET	Retail Trade (44-45)	Employees

TABLE 7
LAND USE CATEGORIES

Attribute	Description	Units
EMPOFC	Information (51), Finance and Insurance (52), Real Estate, Rental and Leasing (53), Professional, Scientific, and Technical Services (54), Management of Companies and Enterprises (55), Administrative/Support, Waste Management & Remediation (56)	Employees
EMPEDU	Educational Services (61)	Employees
EMPMED	Health Care and Social Assistance (62)	Employees
EMPSVC	Arts, Entertainment and Recreation (71), Other Services Except Public Administration (81)	Employees
EMPFOO	Accommodation (721), Food Services (722)	Employees
EMPGOV	Public Administration (92)	Employees
ELEM	Elementary and middle school enrollment	Student Enrollment
HS	High school enrollment	Student Enrollment
COLLEGE	College enrollment	Student Enrollment

1. See Table 8
2. See Table 9
3. See Table 10
4. See Table 11
5. See Table 12

TABLE 8
RESIDENTIAL UNIT TYPES

Category	Description
RU1	1, detached
RU2	1, attached
RU3	2
RU4	3 or 4
RU5	5 to 9
RU6	10 to 19
RU7	20 to 49

TABLE 8
RESIDENTIAL UNIT TYPES

Category	Description
RU8	50 or more
RU9	Mobile home
RU10	Boat, RV, van, etc.

TABLE 9
AVERAGE HOUSEHOLD INCOME

Category	Description
INC1	Less than $19,999
INC2	$20,000 to $39,999
INC3	$40,000 to $59,999
INC4	$60,000 to $99,999
INC5	$100,000 or more

TABLE 10
AGE OF HOUSEHOLDER

Category	Description
Age1524	Householder 15 to 24 years
Age2564	Householder 25 to 64 years
Age6574	Householder 65 to 74 years
Age75	Householder 75 years and over

TABLE 11
POPULATION BY AGE RANGE

Category	Description
POP0005	People under 5 years
POP0514	People 5 to 14 years
POP1517	People 15 to 17 years
POP1824	People 18 to 24 years
POP2554	People 25 to 54 years
POP5564	People 55 to 64 years
POP6574	People 65 to 74 years
POP75	People 75 years and over

TABLE 12
HOUSEHOLD SIZE

Category	Description
HHSIZE1	1 person household
HHSIZE2	2 person household
HHSIZE3	3 person household
HHSIZE4	4 person household
HHSIZE5	5 or more person household

2008 BASE YEAR LAND USE

The 2008 land use database was developed to provide inputs to the 2008 model validation. The 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 2008 population and household inputs were initially developed based on 2000 United States Census information by census block. The increment between the 2000 Census and the 2008 model base year was

determined based on building permits. The Census data and building permits were coded to specific geographic locations. They were then summed into the corresponding TAZs. Households were first stratified by single and multiple housing types and vehicle ownership based on Census data. Later when the MIP (model improvement program) transportation model was used, housing types were expanded to ten categories and vehicle ownership data was used in the mode choice calculation portion of the model.

Employment numbers and locations were initially compiled from a commercial database from InfoUSA. The InfoUSA database included records for 27,113 employment sites in Fresno County. The InfoUSA database was expanded through a significant amount of additional research and phone calls to verify addresses and employment levels. The commercial database is particularly incomplete for public sector employment quantities and locations. Therefore, each local government and school district in Fresno County was contacted to get direct information on employee numbers and locations.

Fresno COG also obtained the rights to use specific employer information from the California Employment Development Department (EDD). The EDD database included records for 28,930 employment sites in Fresno County. The specific employment sites were matched with the InfoUSA database wherever possible. There were many employment sites which were only included in one of the two databases. The combined employment database contains nearly 30,000 employment sites. The totals from the expanded employment site database were compared to the 2008 annual averages from the California EDD as reported in the Current Employment Statistics (CES). The totals were also compared to an independent estimate of Fresno County employment compiled by the private firm Woods and Poole.

The 2008 population and housing unit data was controlled to data based on State of California Department of Finance (DOF) files. Since the DOF files are for January 1 of each year, the files for January 1, 2008 and January 1, 2009 were interpolated to produce a July 1, 2008 estimate by assuming constant rates of growth between the two January 1 dates.

The 2008 employment data was controlled to the employment calculated in the worksheets for Fresno County prepared by The Planning Center for their report *San Joaquin Valley Demographic Forecasts: 2010 to 2050.*

SPECIAL GENERATORS

The special generators in the Fresno COG Model are intended to account for primarily recreational sites that produce and attract trips unrelated to housing or employment. Most of the special generators included for Fresno County are local and regional parks, plus the Table Mountain Casino and the River Place movie theater. For these zones, estimated vehicle trips and trip purpose assumptions are input directly to the model. Daily vehicle trips were estimated based on typical values in the Institute of

Transportation Engineers Trip Generation reference. Daily vehicle trips by special generators are shown in Table 13.

TABLE 13
SPECIAL GENERATOR DAILY PRODUCTIONS AND ATTRACTIONS

Purpose	Productions and Attractions
Home-Work	0 (0)
Home-Shop	0 (0)
Home-K12	0 (0)
Home-College	0 (0)
Home-Other	0 (52,386)
Work-Other	0 (0)
Other-Other	744 (744)
Highway Commercial	0 (0)
Trucks-Small	0 (0)
Trucks-Medium	0 (0)
Trucks-Heavy	0 (0)

Notes: Values shown as Production (Attraction)

FUTURE LAND USE

The land use forecasts for the Fresno COG Model were developed using a combination of:

- Detailed information on available vacant land and individual planned development in each jurisdiction
- Overall growth forecasts for Fresno County

Forecasts were compiled for a 2040 horizon year and all interim years between 2005 and 2040.

Allocations are based on Spheres of Influence rather than current city limits. This allows comparison to General Plans.

Figure 6, Figure 7, and Figure 8 display the spheres of influence and current city limits in Fresno County.

Figure 6 City Limits, Fresno County

Figure 7 City Limits and Spheres of Influence, Fresno/Clovis

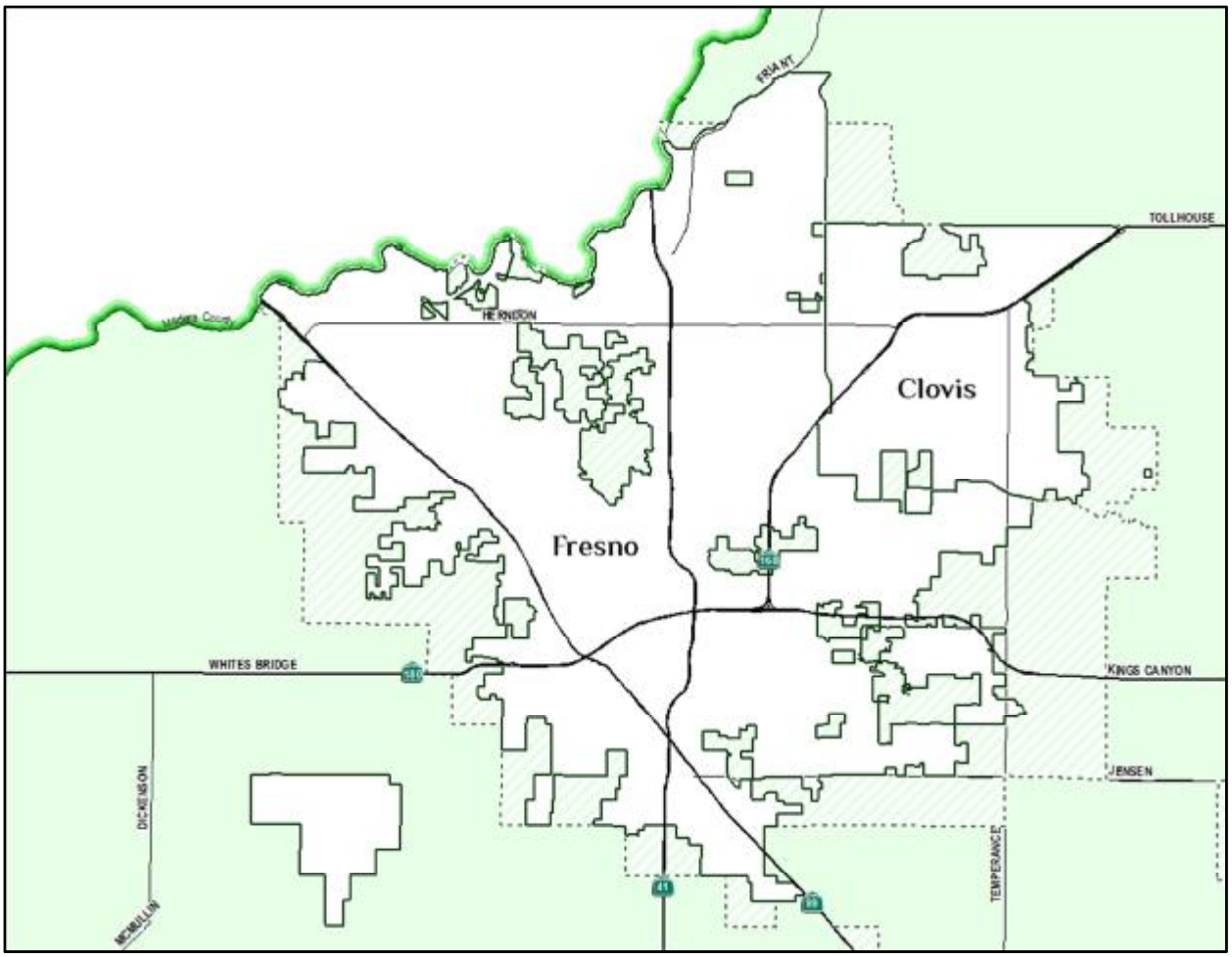


Figure 8 City Limits and Spheres of Influence, Southeast County

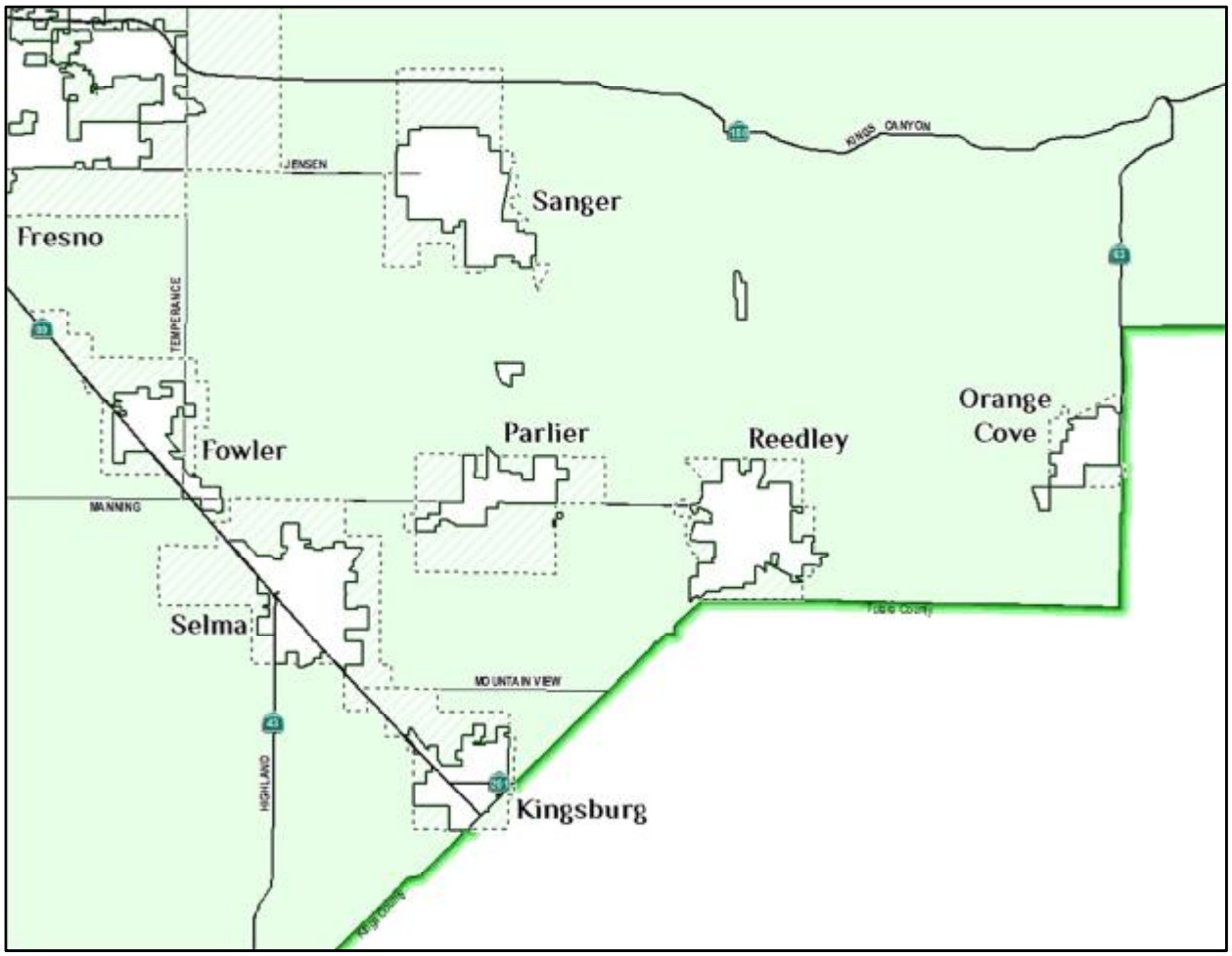


Figure 9 City Limits and Spheres of Influence, West County

Figure 10 City Limits and Spheres of Influence, Southwest County

POPULATION FORECAST

The forecasts used for the Fresno COG Regional Transportation Plan/Sustainable Communities Strategy were from the *San Joaquin Valley Demographic Forecasts: 2010 to 2050* prepared by The Planning Center, March 2012. This forecast was part of a San Joaquin Valley demographic study commissioned by the eight metropolitan planning organizations (MPOs) of the valley, in an effort to obtain recently-prepared projections. The latest State of California Department of Finance (DOF) projection at the time was released in July 2007 and did not take into account the 2007-2008 recession and the subsequent slow economic recovery, thus prompting the need for an updated forecast. In January 2013, the Department of Finance released their latest projection for Fresno County, which differed from The Planning Center forecasts by less than two percent for every year between now and the forecast horizon year of 2050, which helped confirm the validity of the Planning Center forecast for use in the RTP/SCS.

The Planning Center Study *San Joaquin Valley Demographic Forecasts: 2010 to 2050* is attached.

This study includes three primary forecasts of population, households and housing units. Other projections developed by The Planning Center, e.g., age distribution, average household size, household income, household type, race/ethnicity, are derived from the three primary forecasts. The Planning Center forecasts are based on several different projections including household trend, total housing unit trend, housing construction trend, employment trend, cohort-component model, population trend, average household size trend, and household income trend. The least-squares linear curve forms the basis for all projections because the forecasts are long-term and curve-fitting techniques (e.g., parabolic curve, logistic curve) do not provide reasonable long-term results. Three measures evaluate the adequacy of each projection: mean absolute percentage error (MAPE), F-test, and t-test. Population and Employment Forecasts for the SCS/RTP years are shown in Table 14.

TABLE 14
FRESNO COUNTY POPULATION AND EMPLOYMENT FORECASTS

Year	Population	Employment
2005	872,569	335,159
2008	912,521	345,816
2020	1,082,097	363,581
2035	1,300,597	427,727
2040	1,373,679	449,111

EMPLOYMENT FORECAST

Employment was forecast by The Planning Center using the at-place employment data by sector from the State of California Employment Development Department. The model constructs a least-squares line for each economic sector and sums the results to generate a projection for total employment in the County. The least-squares line for total employment in Fresno County produces a MAPE of 2.21% and a standard error of .85%.

The resulting employment forecast is included in the table above.

DEVELOPMENT PROJECTS

Fresno COG staff met with the staffs of each of the sixteen jurisdictions (15 incorporated cities and the County) concerning the types and locations of development expected to occur in the jurisdiction. The

information was then recorded on maps and the staffs from each jurisdiction reviewed the information for accuracy.

JURISDICTION GROWTH FORECAST

Household Population Growth Distribution by Jurisdiction

An initial step in the distribution of housing population growth was the calculation of growth due to the expected increase in household size. According to the San Joaquin Valley Demographic Forecasts: 2010 to 2050 prepared by The Planning Center, household sizes in the San Joaquin Valley are projected to increase steadily—from approx. 3.1298 persons per household in 2008 to approx. 3.3515 in 2035. Thus, some of the expected total growth in household population for Fresno County will manifest not in new development but rather in existing housing units, as each household on average will contain more people.

To calculate the household population growth due to household size increase, Fresno COG used the following formula:

$$HH_{2008}(HHsize_N - HHsize_{2008})$$

Where

HH_{2008} = number of total households in Fresno County in 2008 (the base year) = *308,047*
$HHsize_N$ = projected average countywide household size for target year N
$HHsize_{2008}$ = average countywide household size in 2008 (the base year) = *3.1298*

Therefore, by this formula, the projected household population growth from 2008 to 2035 due to household size increase is *308,047 (3.3515 – 3.1298) = 68,289 persons*. Subtracting this value from the total projected growth in household population for the County represents the household population growth due to new development: *309,851 persons* by 2035.

The housing population growth was distributed to incorporated cities and the unincorporated County using data from three independent sources and combined them in a weighted percentage distribution. The datasets used, their relative significance in the total distribution calculation, and how they were used are as follows:

Decennial Census (45% significance)
Fresno COG compared total household population numbers from the 2000 and 2010 decennial census datasets from the U. S. Census Bureau to determine the share of Fresno County's growth by percentage for each incorporated city and the unincorporated area.

California Department of Finance (45% significance)
The growth in housing units from 2007 to 2012 was used in a similar fashion to create a distribution methodology between the incorporated cities and the unincorporated area.

2008 Base Land Use Modeling Data (10% significance)
The growth results from the first two datasets were slightly weighted by each jurisdiction's share of the existing housing units for 2008, by percent. These numbers were taken from the base land use dataset used by Fresno COG's regional traffic model.

Household Population Growth Distribution to Unincorporated Communities

To further divide the unincorporated growth into communities, only the California Department of Finance methodology was used. The resulting population growth totals were further adjusted through collaboration with Fresno County planning staff to more accurately reflect expected growth for future development sites (such as the Friant Ranch and Millerton communities).

Employment Growth Distribution by Jurisdiction

In a similar manner to the methodology for household population growth distribution, Fresno COG used two methodologies and combined them in a weighted percentage distribution to determine employment growth distribution by jurisdiction. The methodologies used, their relative significance in the total distribution calculation, and how they were used are as follows:

Housing Unit to Employment Ratio (75% significance)
Fresno COG used the 2008 land use dataset from the regional traffic model to determine each incorporated city's ratio of housing units to jobs, and allocated the employment growth projection according to these percentages.

Commute Estimates to the City of Fresno (25% significance)
This method used data from analysis done by Dowling Associates Inc. on the number of employees from each city/community in Fresno County who work in their community of residence compared to the number who commute to the City of Fresno.

Employment Growth Distribution to Unincorporated Communities

To further divide the unincorporated employment growth into communities, two methods were used and weighted evenly:

Commute Estimates to the City of Fresno (50% significance)

See description above.

Direct Relationship to Housing Growth (50% significance)

Each community's respective share in the total unincorporated housing growth was applied to distribute the total unincorporated employment by the same proportion.

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.

TRIP STRATIFICATION

Trips are stratified by 11 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.

TRIP PURPOSES

To derive more accurate projections of future travel behavior, the Fresno COG Model stratifies trip ends by 11 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-K12 trips are trips between residences and schools from kindergarten to 12th grade.
4. Home-College trips are trips between residences and colleges.
5. Home-Other trips account for all other trips that begin or end at home, and include social trips, recreational trips and medical appointments.
6. Work-Other trips are 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.
7. Other-Other trips account for other “non-home-based” trips, such as trips between two stores.
8. Highway Commercial trips account for interaction with the gateways (not currently used).
9. Trucks-Small trips account for delivery truck trips.
10. Trucks-Medium trips account for truck trips between intermodal locations and distribution centers.
11. Trucks-Large trips account for longer distance truck trip, such as between counties or across the country.

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. For a peak period model, it is important to identify the differences in travel characteristics over the day.

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.

TRIP GENERATION RATES

Trip generation rates for the Fresno COG Model were originally derived from the Caltrans 2000/2001 Statewide Travel Survey wherever possible, 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. Daily person trip generation rates are shown in Table 15. Daily truck trip generation rates, which need to be updated, are shown in Table 16.

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
Residential							
RU1_HHSIZE1_INC1	0.17 (0)	0.37 (0)	0 (0)	0 (0)	0.91 (0.33)	0 (0)	0.16 (0.18)
RU1_HHSIZE1_INC2	0.43 (0)	0.45 (0)	0 (0)	0 (0)	0.78 (0.37)	0 (0)	0.19 (0.21)
RU1_HHSIZE1_INC3	0.75 (0)	0.55 (0)	0 (0)	0 (0)	0.56 (0.42)	0 (0)	0.21 (0.23)
RU1_HHSIZE1_INC4	0.76 (0)	0.56 (0)	0 (0)	0 (0)	0.72 (0.46)	0 (0)	0.23 (0.25)
RU1_HHSIZE1_INC5	0.69 (0)	0.4 (0)	0 (0)	0 (0)	0.59 (0.38)	0 (0)	0.19 (0.21)
RU1_HHSIZE2_INC1	0.6 (0)	0.93 (0)	0 (0)	0 (0)	1.1 (0.59)	0 (0)	0.29 (0.33)
RU1_HHSIZE2_INC2	0.82 (0)	0.8 (0)	0 (0)	0 (0)	1.29 (0.65)	0 (0)	0.32 (0.36)
RU1_HHSIZE2_INC3	0.95 (0)	1.08 (0)	0 (0)	0 (0)	1.37 (0.76)	0 (0)	0.38 (0.42)
RU1_HHSIZE2_INC4	1.51 (0)	1.2 (0)	0 (0)	0 (0)	1.43 (0.92)	0 (0)	0.46 (0.51)
RU1_HHSIZE2_INC5	1.57 (0)	1.05 (0)	0 (0)	0 (0)	1.49 (0.92)	0 (0)	0.46 (0.51)
RU1_HHSIZE3_INC1	0.56 (0)	0.78 (0)	0 (0)	0 (0)	1.45 (0.62)	0 (0)	0.31 (0.35)
RU1_HHSIZE3_INC2	0.99 (0)	0.75 (0)	0 (0)	0 (0)	2.47 (0.94)	0 (0)	0.47 (0.52)
RU1_HHSIZE3_INC3	1.82 (0)	1.03 (0)	0 (0)	0 (0)	1.63 (1)	0 (0)	0.5 (0.56)
RU1_HHSIZE3_INC4	1.98 (0)	1.05 (0)	0 (0)	0 (0)	2.29 (1.19)	0 (0)	0.6 (0.66)
RU1_HHSIZE3_INC5	2.44 (0)	0.98 (0)	0 (0)	0 (0)	1.64 (1.13)	0 (0)	0.57 (0.63)

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
RU1_HHSIZE4_INC1	1.16 (0)	1.18 (0)	0 (0)	0 (0)	3.79 (1.37)	0 (0)	0.69 (0.76)
RU1_HHSIZE4_INC2	1.19 (0)	0.92 (0)	0 (0)	0 (0)	3.49 (1.25)	0 (0)	0.63 (0.7)
RU1_HHSIZE4_INC3	1.84 (0)	0.96 (0)	0 (0)	0 (0)	3.36 (1.38)	0 (0)	0.69 (0.77)
RU1_HHSIZE4_INC4	1.91 (0)	0.9 (0)	0 (0)	0 (0)	4 (1.52)	0 (0)	0.76 (0.85)
RU1_HHSIZE4_INC5	2.31 (0)	1.24 (0)	0 (0)	0 (0)	3.11 (1.49)	0 (0)	0.75 (0.83)
RU1_HHSIZE5_INC1	0.89 (0)	0.92 (0)	0 (0)	0 (0)	2.08 (0.87)	0 (0)	0.44 (0.48)
RU1_HHSIZE5_INC2	1.4 (0)	1.12 (0)	0 (0)	0 (0)	4.2 (1.5)	0 (0)	0.75 (0.84)
RU1_HHSIZE5_INC3	2.03 (0)	0.92 (0)	0 (0)	0 (0)	4.32 (1.63)	0 (0)	0.81 (0.9)
RU1_HHSIZE5_INC4	1.79 (0)	1.37 (0)	0 (0)	0 (0)	5.37 (1.91)	0 (0)	0.96 (1.06)
RU1_HHSIZE5_INC5	2.17 (0)	1.29 (0)	0 (0)	0 (0)	5.32 (1.97)	0 (0)	0.98 (1.09)
RU3_HHSIZE1_INC1	0.14 (0)	0.37 (0)	0 (0)	0 (0)	0.75 (0.28)	0 (0)	0.14 (0.16)
RU3_HHSIZE1_INC2	0.63 (0)	0.4 (0)	0 (0)	0 (0)	0.67 (0.38)	0 (0)	0.19 (0.21)
RU3_HHSIZE1_INC3	0.83 (0)	0.6 (0)	0 (0)	0 (0)	1.1 (0.56)	0 (0)	0.28 (0.31)
RU3_HHSIZE1_INC4	1.14 (0)	0.4 (0)	0 (0)	0 (0)	0.29 (0.41)	0 (0)	0.2 (0.23)
RU3_HHSIZE1_INC5	1.23 (0)	0.09 (0)	0 (0)	0 (0)	0.62 (0.43)	0 (0)	0.22 (0.24)
RU3_HHSIZE2_INC1	0.45 (0)	0.11 (0)	0 (0)	0 (0)	0.91 (0.33)	0 (0)	0.16 (0.18)

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
RU3_HHSIZE2_INC2	1.06 (0)	0.55 (0)	0 (0)	0 (0)	1.11 (0.61)	0 (0)	0.3 (0.34)
RU3_HHSIZE2_INC3	0.97 (0)	0.35 (0)	0 (0)	0 (0)	1.34 (0.6)	0 (0)	0.3 (0.33)
RU3_HHSIZE2_INC4	1.99 (0)	0.91 (0)	0 (0)	0 (0)	0.81 (0.83)	0 (0)	0.41 (0.46)
RU3_HHSIZE2_INC5	0.96 (0)	0.65 (0)	0 (0)	0 (0)	1.45 (0.69)	0 (0)	0.34 (0.38)
RU3_HHSIZE3_INC1	0.36 (0)	0.98 (0)	0 (0)	0 (0)	3.12 (1)	0 (0)	0.5 (0.56)
RU3_HHSIZE3_INC2	1.04 (0)	0.81 (0)	0 (0)	0 (0)	2.17 (0.9)	0 (0)	0.45 (0.5)
RU3_HHSIZE3_INC3	1.2 (0)	0.99 (0)	0 (0)	0 (0)	2.73 (1.1)	0 (0)	0.55 (0.61)
RU3_HHSIZE3_INC4	2.06 (0)	0.28 (0)	0 (0)	0 (0)	1.66 (0.9)	0 (0)	0.45 (0.5)
RU3_HHSIZE3_INC5	0.64 (0)	1.8 (0)	0 (0)	0 (0)	1.8 (0.95)	0 (0)	0.47 (0.53)
RU3_HHSIZE4_INC1	1.16 (0)	0.23 (0)	0 (0)	0 (0)	1.52 (0.65)	0 (0)	0.33 (0.36)
RU3_HHSIZE4_INC2	1.41 (0)	0.45 (0)	0 (0)	0 (0)	3 (1.09)	0 (0)	0.54 (0.6)
RU3_HHSIZE4_INC3	1.37 (0)	0.95 (0)	0 (0)	0 (0)	2.05 (0.98)	0 (0)	0.49 (0.54)
RU3_HHSIZE4_INC4	1.39 (0)	0.5 (0)	0 (0)	0 (0)	1.17 (0.68)	0 (0)	0.34 (0.38)
RU3_HHSIZE4_INC5	2.12 (0)	0.59 (0)	0 (0)	0 (0)	0.68 (0.76)	0 (0)	0.38 (0.42)
RU3_HHSIZE5_INC1	0.69 (0)	1.35 (0)	0 (0)	0 (0)	3.24 (1.18)	0 (0)	0.59 (0.66)
RU3_HHSIZE5_INC2	1.63 (0)	1.82 (0)	0 (0)	0 (0)	2.25 (1.28)	0 (0)	0.64 (0.71)

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
RU3_HHSIZE5_INC3	2.06 (0)	1.74 (0)	0 (0)	0 (0)	4.86 (1.94)	0 (0)	0.97 (1.08)
RU3_HHSIZE5_INC4	1.06 (0)	0.94 (0)	0 (0)	0 (0)	1.74 (0.84)	0 (0)	0.42 (0.46)
RU3_HHSIZE5_INC5	0.78 (0)	0.7 (0)	0 (0)	0 (0)	1.29 (0.62)	0 (0)	0.31 (0.34)
RU9_HHSIZE1_INC1	0.33 (0)	0.49 (0)	0 (0)	0 (0)	0.51 (0.3)	0 (0)	0.15 (0.17)
RU9_HHSIZE1_INC2	0.4 (0)	0.32 (0)	0 (0)	0 (0)	0.46 (0.26)	0 (0)	0.13 (0.15)
RU9_HHSIZE1_INC3	1.14 (0)	0.36 (0)	0 (0)	0 (0)	0.41 (0.43)	0 (0)	0.21 (0.24)
RU9_HHSIZE1_INC4	0.96 (0)	0.19 (0)	0 (0)	0 (0)	0.39 (0.35)	0 (0)	0.17 (0.19)
RU9_HHSIZE1_INC5	1.31 (0)	0.39 (0)	0 (0)	0 (0)	0.41 (0.47)	0 (0)	0.24 (0.26)
RU9_HHSIZE2_INC1	0.48 (0)	0.36 (0)	0 (0)	0 (0)	0.54 (0.31)	0 (0)	0.15 (0.17)
RU9_HHSIZE2_INC2	0.43 (0)	0.63 (0)	0 (0)	0 (0)	0.82 (0.42)	0 (0)	0.21 (0.23)
RU9_HHSIZE2_INC3	1.14 (0)	0.66 (0)	0 (0)	0 (0)	0.69 (0.56)	0 (0)	0.28 (0.31)
RU9_HHSIZE2_INC4	1.68 (0)	1.13 (0)	0 (0)	0 (0)	0.22 (0.68)	0 (0)	0.34 (0.38)
RU9_HHSIZE2_INC5	1.35 (0)	2.17 (0)	0 (0)	0 (0)	1.8 (1.19)	0 (0)	0.6 (0.66)
RU9_HHSIZE3_INC1	0.98 (0)	1.8 (0)	0 (0)	0 (0)	2.7 (1.23)	0 (0)	0.61 (0.68)
RU9_HHSIZE3_INC2	0.79 (0)	0.25 (0)	0 (0)	0 (0)	0.73 (0.39)	0 (0)	0.2 (0.22)
RU9_HHSIZE3_INC3	1.52 (0)	1.11 (0)	0 (0)	0 (0)	0.78 (0.76)	0 (0)	0.38 (0.42)

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
RU9_HHSIZE3_INC4	2.11 (0)	1.49 (0)	0 (0)	0 (0)	1.77 (1.2)	0 (0)	0.6 (0.67)
RU9_HHSIZE3_INC5	0.85 (0)	0.9 (0)	0 (0)	0 (0)	5.4 (1.6)	0 (0)	0.8 (0.89)
RU9_HHSIZE4_INC1	0.91 (0)	0.74 (0)	0 (0)	0 (0)	1.37 (0.68)	0 (0)	0.34 (0.38)
RU9_HHSIZE4_INC2	0.39 (0)	0.31 (0)	0 (0)	0 (0)	1.93 (0.59)	0 (0)	0.29 (0.33)
RU9_HHSIZE4_INC3	1.76 (0)	1.24 (0)	0 (0)	0 (0)	1.36 (0.97)	0 (0)	0.49 (0.54)
RU9_HHSIZE4_INC4	1.7 (0)	2.7 (0)	0 (0)	0 (0)	2.7 (1.59)	0 (0)	0.79 (0.88)
RU9_HHSIZE4_INC5	1.83 (0)	1.49 (0)	0 (0)	0 (0)	2.75 (1.36)	0 (0)	0.68 (0.75)
RU9_HHSIZE5_INC1	1.43 (0)	0.35 (0)	0 (0)	0 (0)	5.04 (1.53)	0 (0)	0.76 (0.85)
RU9_HHSIZE5_INC2	1.19 (0)	0.64 (0)	0 (0)	0 (0)	3.2 (1.13)	0 (0)	0.56 (0.63)
RU9_HHSIZE5_INC3	2.21 (0)	0.44 (0)	0 (0)	0 (0)	7.49 (2.27)	0 (0)	1.13 (1.26)
RU9_HHSIZE5_INC4	0.85 (0)	0.4 (0)	0 (0)	0 (0)	3.6 (1.09)	0 (0)	0.54 (0.6)
RU9_HHSIZE5_INC5	1.7 (0)	0.43 (0)	0 (0)	0 (0)	8.1 (2.29)	0 (0)	1.14 (1.27)
Non-Residential (DAYSIM Activity Group Aggregations)							
EMPOTH	0 (0.53)	0 (0.05)	0 (0)	0 (0)	0 (0.12)	0.35 (0.03)	0.24 (0.18)
EMPIND	0 (0.5)	0 (0.42)	0 (0)	0 (0)	0 (0.24)	0.31 (0.14)	0.78 (0.55)
EMPRET	0 (0.59)	0 (2.38)	0 (0)	0 (0)	0 (1.66)	0.3 (0.71)	2.26 (2.25)

TABLE 15
DAILY PERSON TRIP GENERATION RATES

Land Use	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other
EMPOFC	0 (1.01)	0 (0)	0 (0)	0 (0)	0 (0.4)	0.5 (0.17)	0.04 (0.13)
EMPEDU	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
EMPMED	0 (0.94)	0 (0.32)	0 (0)	0 (0)	0 (0.79)	0.32 (0.13)	1.09 (0.91)
EMPSVC	0 (1.41)	0 (0.49)	0 (0)	0 (0)	0 (1.2)	0.28 (0.63)	0.62 (0.75)
EMPFOO	0 (3.4)	0 (6.09)	0 (0)	0 (0)	0 (7.25)	0.21 (1.85)	1.36 (2.46)
EMPGOV	0 (0.79)	0 (0.18)	0 (0)	0 (0)	0 (0.11)	0.37 (0.07)	0.62 (0.5)
School							
ELEM	0 (0.38)	0 (0)	0 (1.22)	0 (0)	0 (0)	0 (0)	0 (0)
HS	0 (0.5)	0 (0)	0 (1.62)	0 (0)	0 (0)	0 (0)	0 (0)
COLLEGE	0 (1.09)	0 (0)	0 (0)	0 (0.98)	0 (0)	0 (0)	0 (0)

Notes: Values shown as Production (Attraction)

TABLE 16
DAILY TRUCK TRIP GENERATION

Land Use	People	Mail	Urban Freight	Construction	Service
Trucks Small					
TOTHH	0.0075	0.00167	0.03551	3.04E-02	0.35243
TOTEMP	0.0121	0.00167	0	3.04E-02	0.32839
RETAIL	0	0	0.12571	0	0
AG	0	0	0.15714	0	0
MINING	0	0	0.15714	0	0
CONSTR	0	0	0.15714	0.03041	0
MFGPROD	0	0	0.13278	0	0
MFGEQUIP	0	0	0.13278	0	0
TRANSP	0	0	0.13278	0	0
WHLSALE	0	0	0.13278	0	0
FINANCE	0	0	0.06186	0	0
EDUGOV	0	0	0.06186	0	0
Trucks Medium					
TOTHH	0.0051	0.00008	0.00719	1.07E-02	0.09483
TOTEMP	0.00158	0.00008	0	1.07E-02	0.0844

TABLE 16
DAILY TRUCK TRIP GENERATION

Land Use	People	Mail	Urban Freight	Construction	Service
RETAIL	0	0	0.01835	0	0
AG	0	0	0.02099	0	0
MINING	0	0	0.02099	0	0
CONSTR	0	0	0.02099	0.0107	0
MFGPROD	0	0	0.01758	0	0
MFGEQUIP	0	0	0.01758	0	0
TRANSP	0	0	0.01758	0	0
WHLSALE	0	0	0.01758	0	0
FINANCE	0	0	0.0049	0	0
EDUGOV	0	0	0.0049	0	0
Trucks Heavy					
TOTHH	0	0.00001	0.00345	0.00394	0.00161
TOTEMP	0	0.00001	0	0.00394	0.00161
RETAIL	0	0	0.00592	0	0
AG	0	0	0.01583	0	0
MINING	0	0	0.01583	0	0

TABLE 16
DAILY TRUCK TRIP GENERATION

Land Use	People	Mail	Urban Freight	Construction	Service
CONSTR	0	0	0.01583	0.00394	0
MFGPROD	0	0	0.00945	0	0
MFGEQUIP	0	0	0.00945	0	0
TRANSP	0	0	0.00945	0	0
WHLSALE	0	0	0.00945	0	0
FINANCE	0	0	0.00081	0	0
EDUGOV	0	0	0.00081	0	0

HOUSEHOLD TRIP PRODUCTIONS

The Caltrans 2000/2001 Statewide Travel Survey was based on households. Therefore, it is most useful for determining travel characteristics at households as opposed to employment. The households in the travel survey were divided into six categories according to housing type and auto ownership.

A standard procedure for "cross-classification" trip generation would be to determine the average trip rate for each of the six household categories. With a small survey sample size, this procedure can result in zero or inconsistent rates for certain household categories. To ensure larger sample sizes, the Fresno COG Model used survey results from four counties: Fresno, Kern, Kings and Tulare. The resulting survey sample sizes are shown in Table 8.

During model validation, the household production rates for the Home-Other trip purpose were increased by 1.8 compared to the household survey results. This increase was intended to bring the household vehicle trip generation rates closer to the averages reported in ITE Trip Generation. It is also probable that these trips are among the most likely to be left out when survey participants are filling out their travel diary forms.

WORK-OTHER TRIP PRODUCTIONS

The Caltrans Statewide Travel Survey can also provide some information on trips made by surveyed workers. For each surveyed person, the work trip characteristics can be correlated to their reported type of employment. These survey records were used to determine Work-Other productions for each of the five types of employment in the Fresno COG Model.

TRIP ATTRACTIONS

Home-Work attractions can be derived from the travel survey. Each person at the surveyed households was also asked about their type of employment. The average number of home-work commute trips for each type of employment can be calculated from these survey records. The Home-Work trip attraction rates from the survey results were factored by 0.92 to better balance with household trip production estimates. See Table 17 for the model trip productions/attractions balance.

TABLE 17
TRIP PRODUCTIONS/ATTRACTIONS BALANCE

Trip Purpose	Evaluation Criterion	Productions	Attractions	P/A Ratio	Difference	Percent Difference
HBW	+/- 10%	484,919	467,649	1.04	-17,269	-3.6%
HBS	+/- 10%	276,845	290,934	0.95	14,089	5.1%
HBO	+/- 10%	1,018,477	1,007,823	1.01	-10,654	-1.0%
NHB	+/- 10%	572,150	561,126	1.02	-11,023	-1.9%

Notes: HBW = home-based-work; HBS = home-based-shopping; HBO = home-based-other; NHB = non-home-based

OTHER-OTHER TRIP RATE ADJUSTMENTS

After adjusting the home-based and work-based trips based on available survey data, the total trip generation rates for several employment categories were still well below the total average vehicle trip generation rates reported in ITE Trip Generation. It is assumed that the most likely trips to be under-reported in the travel survey would be incidental trips, such as a trip between the grocery store and the laundry. These trips mostly fall into the Other-Other category.

The Other-Other production and attraction rates for each employment type were estimated by comparing the trip generation to standard vehicle trip generation rates in Trip Generation. The model person trip generation rates were converted to vehicle trips using average Fresno County auto occupancies for each trip purpose. The vehicle trip rates were compared for each employment type.

The Other-Other trip rates were increased so that the model trip generation rates would replicate the ITE vehicle trip generation rates. The average weekday person trips per household from survey data and the Fresno COG Model are shown in Table 21

TABLE 18
WEEKDAY PERSON TRIPS PER HOUSEHOLD

CHTS	Model
6.8	6.9

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, made by households within the county, weighted by weekday, household-level weights ("HHWDWGT").

EXTERNAL TRIPS

There are two types of external trips at the cordons or "gateways" of a model, through trips (external-external or X-X) and external trips (internal-external, external-internal, I-X/X-I or I-E/E-I). Through trips are trips that pass through the model area without stopping. Daily productions and attractions at gateways are shown in Table 19.

TABLE 19
DAILY PRODUCTIONS AND ATTRACTIONS AT GATEWAYS

Purpose	Productions and Attractions
Home-Work	92,109 (26,049)
Home-Shop	10,056 (10,560)
Home-K12	0 (0)
Home-College	306 (194)
Home-Other	41,353 (26,191)
Work-Other	11,508 (26,719)
Other-Other	39,336 (17,402)
Highway Commercial	4,117 (4,117)
Trucks-Small	1,531 (1,526)
Trucks-Medium	759 (747)
Trucks-Heavy	8,760 (9,192)

Notes: Values shown as Production (Attraction)

STATEWIDE MODEL

The basic source of information for external trips in the Fresno COG Model is the California Statewide Model maintained by Caltrans. The available version of the Statewide Model was initially developed in 2003 and was minimally updated during the MIP to include more current land uses throughout the state to reflect the most recently adopted RTPs.

HIGH SPEED RAIL MODEL

An updated version of the California Statewide Model was prepared for the California High Speed Rail Authority in 2007. The High Speed Rail version was not made available for use in the development of the Fresno COG Model. The High Speed Rail version significantly updated the estimates of long-distance trips and trips to and from the major metropolitan areas (Bay Area, Los Angeles area). However, the High Speed Rail version did not update land uses in the San Joaquin Valley and did not significantly revise the procedures for shorter distance interregional trips compared to the 2003 version of the Statewide Model. Therefore, it is expected that the prior 2003 version of the Statewide Model (with the land use and journey-to-work updates) would provide equal or better estimates of the majority of the external trips affecting Fresno County.

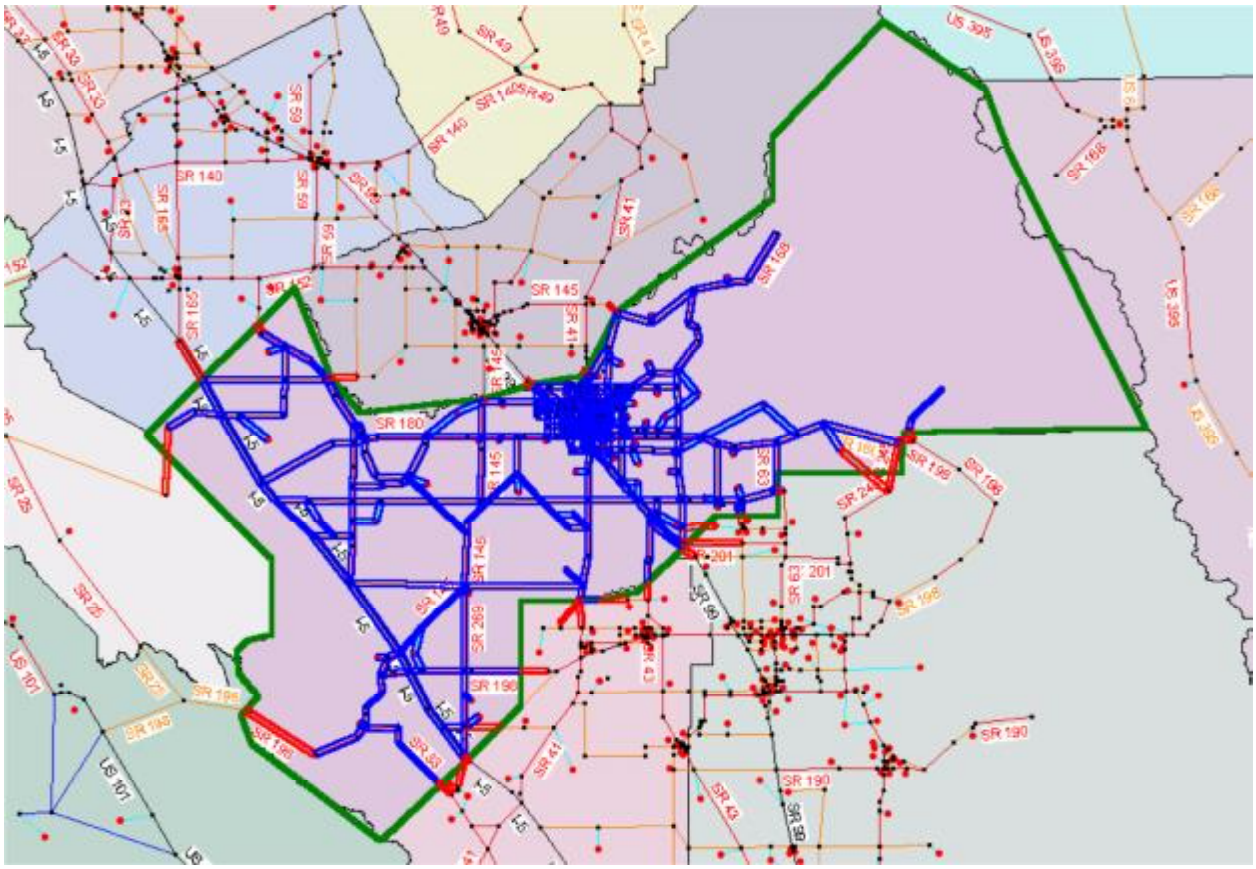
APPLICATION OF STATEWIDE MODEL

The California Statewide Model is not used to provide direct values of external trips for the Fresno COG Model. The following information is extracted from the Statewide model:

- The proportions of through trips versus internal-external trips at each Fresno County gateway.
- Proportions of internal-external trips by each of the five trip purposes and by productions versus attractions (representing in-commute versus out-commute for Fresno County)
- Base through trip patterns from the 2000 model calibration year.
- Annual growth rates for each gateway based on the 2000 and 2025 statewide model estimates.

A “subarea analysis” of Fresno County was used to isolate the statewide trips which pass into, out of or through Fresno County. See Figure 11 for the Fresno subarea used in the analysis.

Figure 11 California Statewide Model Fresno Subarea



The following steps are used in the process:

1. Total gateway traffic volumes for each Fresno COG Model year are estimated by multiplying the 2003 base year traffic count at each gateway by the annual traffic growth rates for each gateway derived from the 2000 and 2025 Statewide Model subarea results.
2. The 2000 and 2025 Statewide Model subarea vehicle trips by purpose at each gateway are interpolated or extrapolated for each Fresno COG Model year.
3. The proportions of through trips versus internal-external trips from the interpolation in Step 2 are used to split the total gateway traffic volumes from Step 1.
4. The estimated through trip totals at each gateway for each Fresno COG Model year from Step 3 are used as control totals to factor the 2000 base year through trip patterns for each Fresno COG Model year.
5. The proportions of trips by trip purpose and productions versus attractions from the interpolation in Step 2 are used to split the total internal-external traffic volumes from Step 3.

6. The internal-external vehicle trips for each trip purpose are multiplied by the appropriate average auto occupancy rate to convert them to person trips.

INTERNAL-EXTERNAL TRIP BALANCING

The initial estimates of productions and attractions at each gateway are added to the Fresno County trips. The model must have a balance between productions and attractions for each trip purpose, as every trip has two ends. Unlike the previous version of the Fresno COG Model where trips are held constant, the external gateway trips are automatically factored to provide an overall balance of person-trip productions and attractions for each trip purpose. The total trips at each gateway by purpose are dynamic and respond to the land use within the model area. These adjusted gateway trips are then distributed to the model zones along with the internal model area trips.

Since the initial estimate of productions and attractions are based on the previous RTPs, significant changes within Fresno or after significant updates to assumptions throughout the valley (land use development or infrastructure projects) should be implemented in the statewide or other multi-region model to obtain new estimates of gateways.

SPECIAL GENERATORS

As discussed above, special generators are used to include trips from land uses that are not well represented by the standard trip rates. In the Fresno COG Model, special generators are used primarily to define Home-Other trips attracted to recreational areas such as parks and golf course. Typical vehicle trip generation values were estimated for each of these recreational areas based on ITE Trip Generation. 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.

6. TRIP DISTRIBUTION

The trip distribution process estimates how many trips travel from one zone to another. The 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.

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 assumed to be proportional to the relative attraction or opportunity provided by each of the zones (productions and attractions) and inversely proportional to the separation between zones. Expressed mathematically, the gravity model formula of trip distribution is:

$$T_{ij} = P_i * \frac{A_j F(t_{ij}) K_{ij}}{\sum_{x=1}^{n} A_x F(t_{ij}) K_{ij}}$$

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 cost 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 travel cost (converted to time using the value of time by purpose), and friction factors that define the effects of travel time. The zone-to-zone distributions are calculated separately for each trip purpose.

TRAVEL TIMES

The travel time between each pair of zones is calculated by determining the shortest time path along the coded 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 model. The resulting table of zone-to-zone travel times is then used as an input to the trip distribution analysis.

INTRAZONAL TRAVEL TIMES

Intrazonal travel times represent the average travel time for trips that stay within a particular zone. For urban areas, intrazonal times are estimated as 100 percent of the average travel time to the nearest adjacent TAZ. For rural areas, the intrazonal times are estimated as one-third the average time to the nearest adjacent TAZ. For larger rural TAZs, the active land uses tend to be clustered together and the total size of the TAZ is not necessarily a good indicator of the trips distances for very local trips.

TERMINAL TIMES

Terminal times are added to represent the average time to access one's vehicle at each end of the trip. The terminal times for the Fresno model were estimated by comparing the model estimate of road network travel times with the reported travel times for trips in Fresno County from the Statewide travel survey. The surveyed trips were stratified by origins and destinations in the Central Business District (CBD) or universities.

The Fresno COG Model assumes one minute at the home (production) end of each trip and two minutes at the non-home (attraction) end for most TAZs. Terminal times of four minutes are assumed at each end of the trip in the Fresno CBD, and a three minute terminal time is assumed at each end of the trips for colleges and universities within the urban area.

TRAVEL COST

Node variables and link variables were added to the highway network to account for travel costs. The node variables can be used to represent point fees such as parking cost on centroids or toll booths. Link variables can be used to represent toll facilities in dollars per mile, supplement to auto ownership costs, or VMT tax.

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 Fresno COG Model, 11 sets of friction factors are used, with each set corresponding to one of the 11 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.

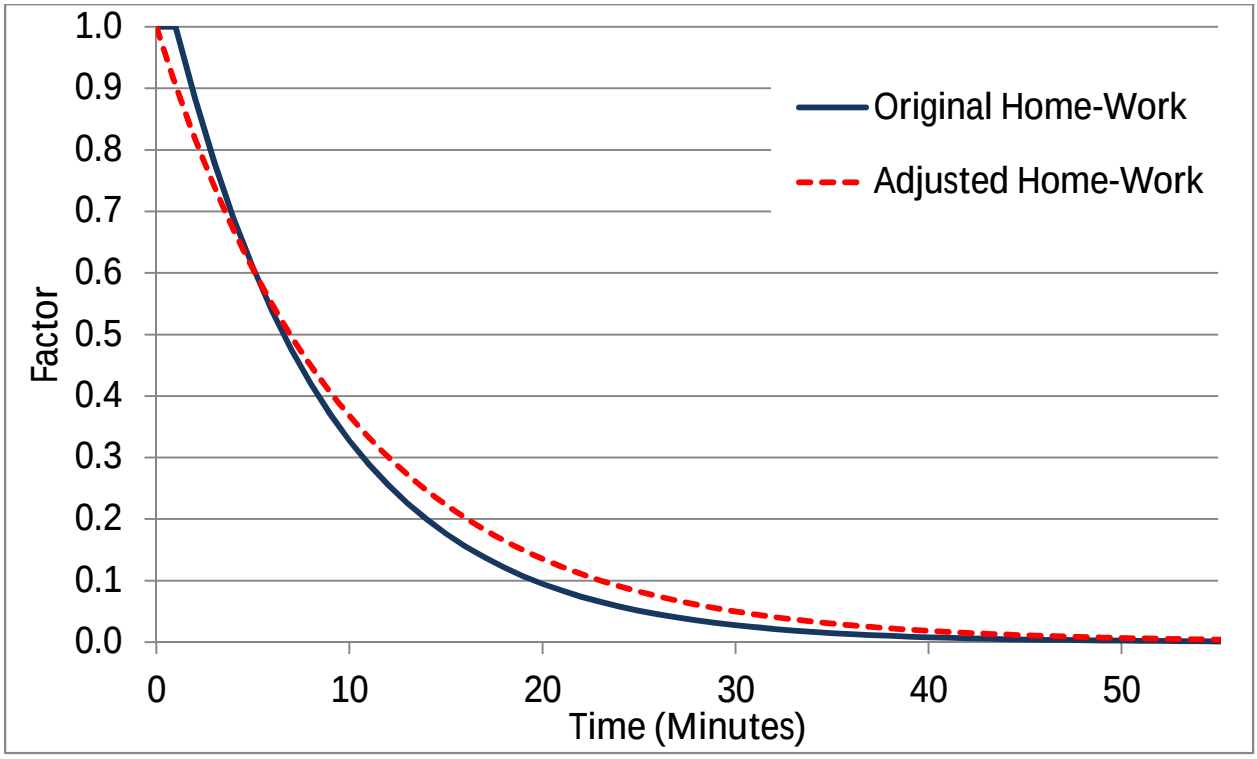
The friction factors for the Fresno COG Model were initially based on the gamma function friction factors reported in NCHRP 365. The trip lengths estimated by the model using these factors were compared to trip lengths reported in the 2001 California travel survey. The friction factors were then adjusted using an iterative process to better replicate the survey trip distribution in each five minute trip length category (Table 20. The original and adjusted friction factors are shown in Figure 12.

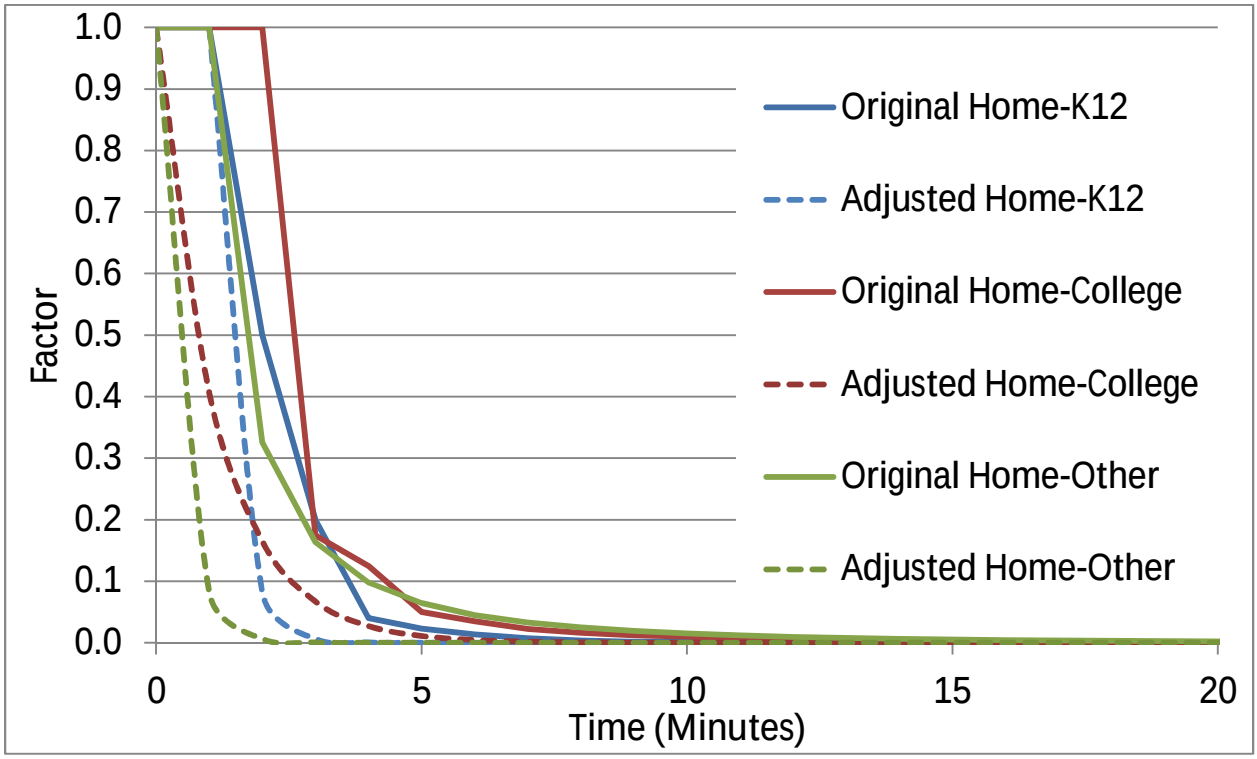
TABLE 20
FRESNO COUNTY FRICTION FACTOR COEFFICIENTS

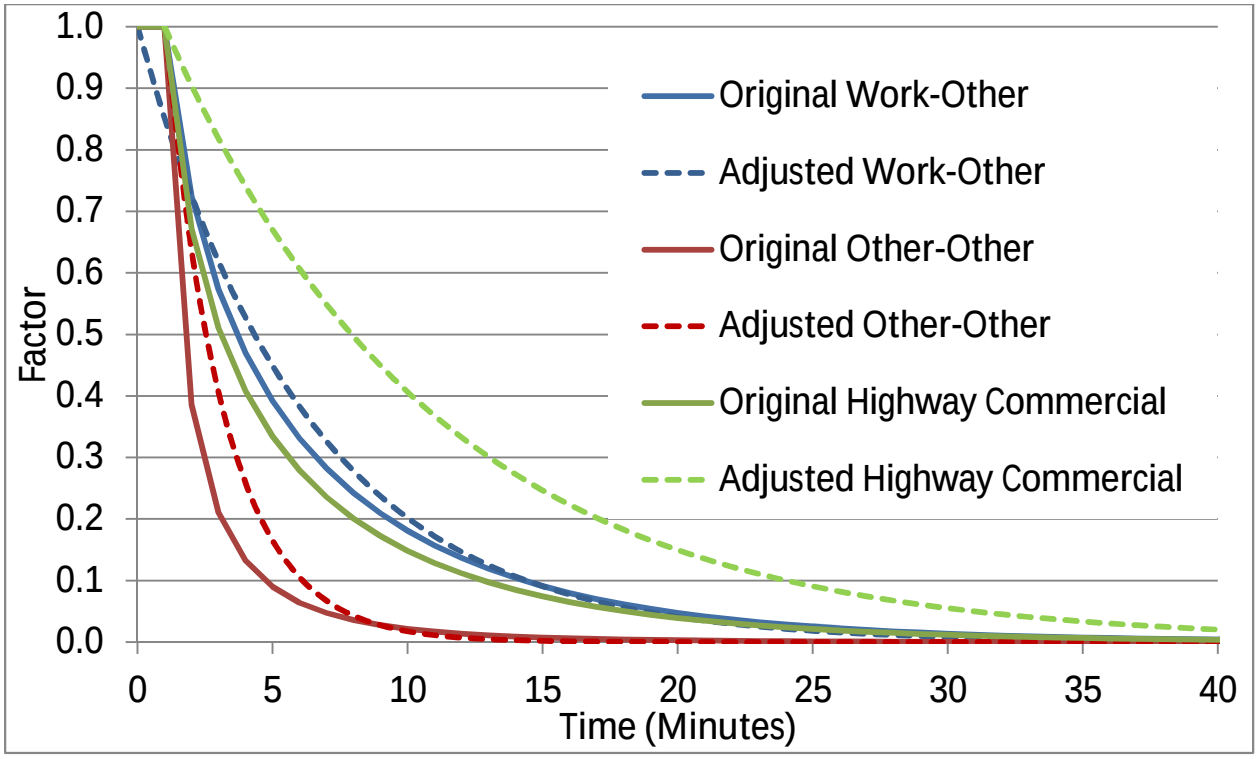
Purpose	Coefficient A	Coefficient B	Coefficient C
Home-Work	1	-0.100	0.000
Home-Shop	1	-2.500	0.000
Home-K12	1	-2.500	0.000
Home-College	1	-0.900	0.000
Home-Other	1	-2.500	0.000
Work-Other	1	-0.160	0.000
Other-Other	1	-0.450	0.000
Highway Commercial	1	-0.100	0.000
Trucks-Small	100000	-0.070	-0.500
Trucks-Medium	100000	-0.070	-0.500
Trucks-Heavy	100000	-0.070	-0.500

Notes: auto friction factor = $A \times e^{B \times x}$ truck friction factor= $A \times x^{C} \times e^{B \times x}$

Figure 12 Fresno County Friction Factors



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0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
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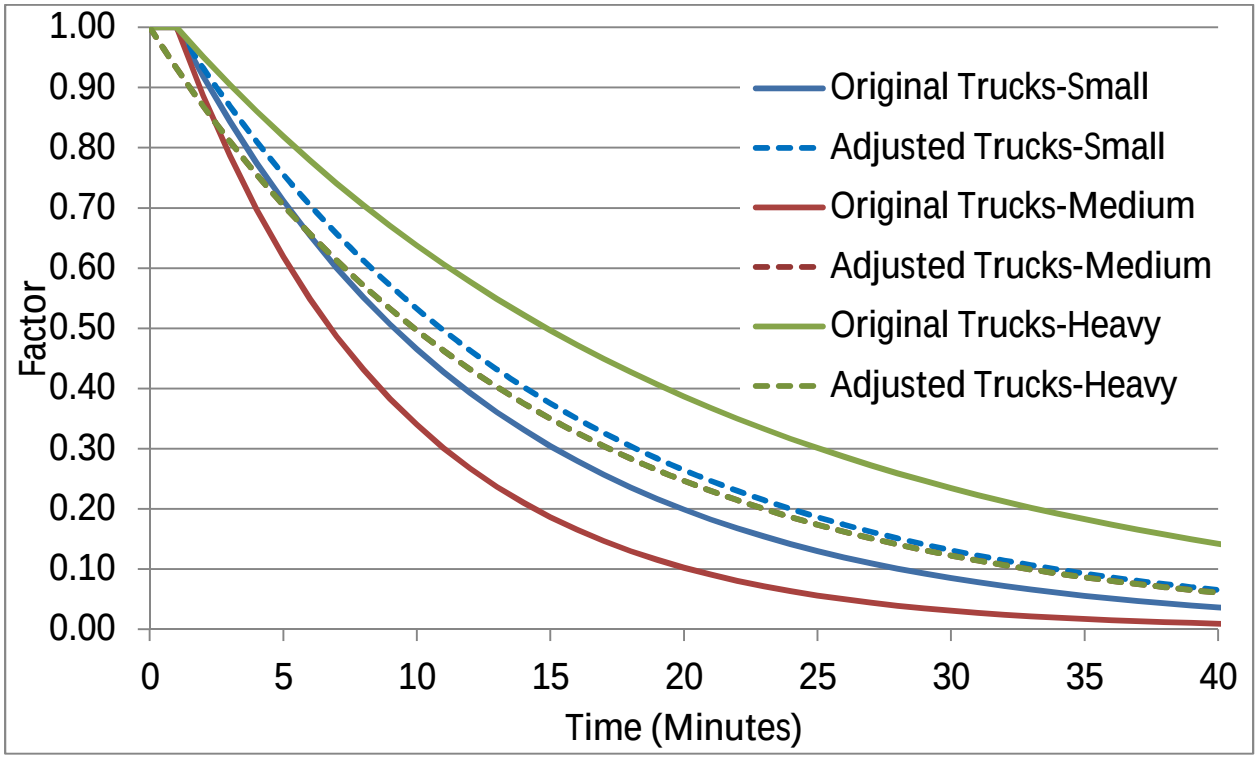
Factor
0
5
10
15
20
25
30
35
40
Time (Minutes)
Original Work-Other
Adjusted Work-Other
Original Other-Other
Adjusted Other-Other
Original Highway Commercial
Adjusted Highway Commercial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0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
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Factor
0
5
10
15
20
25
30
35
40
Time (Minutes)
Original Trucks-Small
Adjusted Trucks-Small
Original Trucks-Medium
Adjusted Trucks-Medium
Original Trucks-Heavy
Adjusted Trucks-Heavy

TABLE 21
TRIP DISTRIBUTION BY PURPOSE (ALL MODES)

Trip Purpose								
	Total		HBW		HBO		NHB	
Trip Type	CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
II	88.2%	95.7%	83.0%	83.1%	91.1%	99.4%	86.8%	98.0%
IX	5.8%	0.9%	9.0%	2.2%	4.5%	0.3%	5.7%	1.0%
XI	6.0%	3.4%	8.0%	14.6%	4.4%	0.3%	7.5%	1.0%

Notes: 2000-2001 California Statewide Household Travel Survey. All modes, weekday trips only. External-to-external (XX) trips are excluded; reported values are percentages of the total of all non- external-to-external weekday trips. Trips are weighted by weekday, trip-level weights ("WDWGT"). Driver trips are adjusted by a factor of 1.647 to correct for underreporting.

TABLE 22
AVERAGE TRAVEL TIME (IN MINUTES) BY TRIP PURPOSE

Trip Purpose					
HBW		HBO		NHB	
CHTS	Model	CHTS	Model	CHTS	Model
20.2	16.4	15.1	20.6	15.5	16.1

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, weighted by weekday, trip-level weights ("WDWGT").

ADJUSTMENT FACTORS

Adjustment Factors ("K factors") are used in gravity model trip distribution calculations where travel time does not fully explain the attractiveness or unattractiveness of certain trips. The adjustments are often used where bridges, other perceived travel barriers or special socioeconomic factors (such as housing prices or campus housing areas) may distort the distribution of trips between specific areas. The K factors are not adjustments to the number of trips, but rather adjustments to the friction factors that represent the attractiveness of a certain trip relative to other trips.

The model does not use K-factors other than the gateways as described below.

GATEWAY ADJUSTMENTS

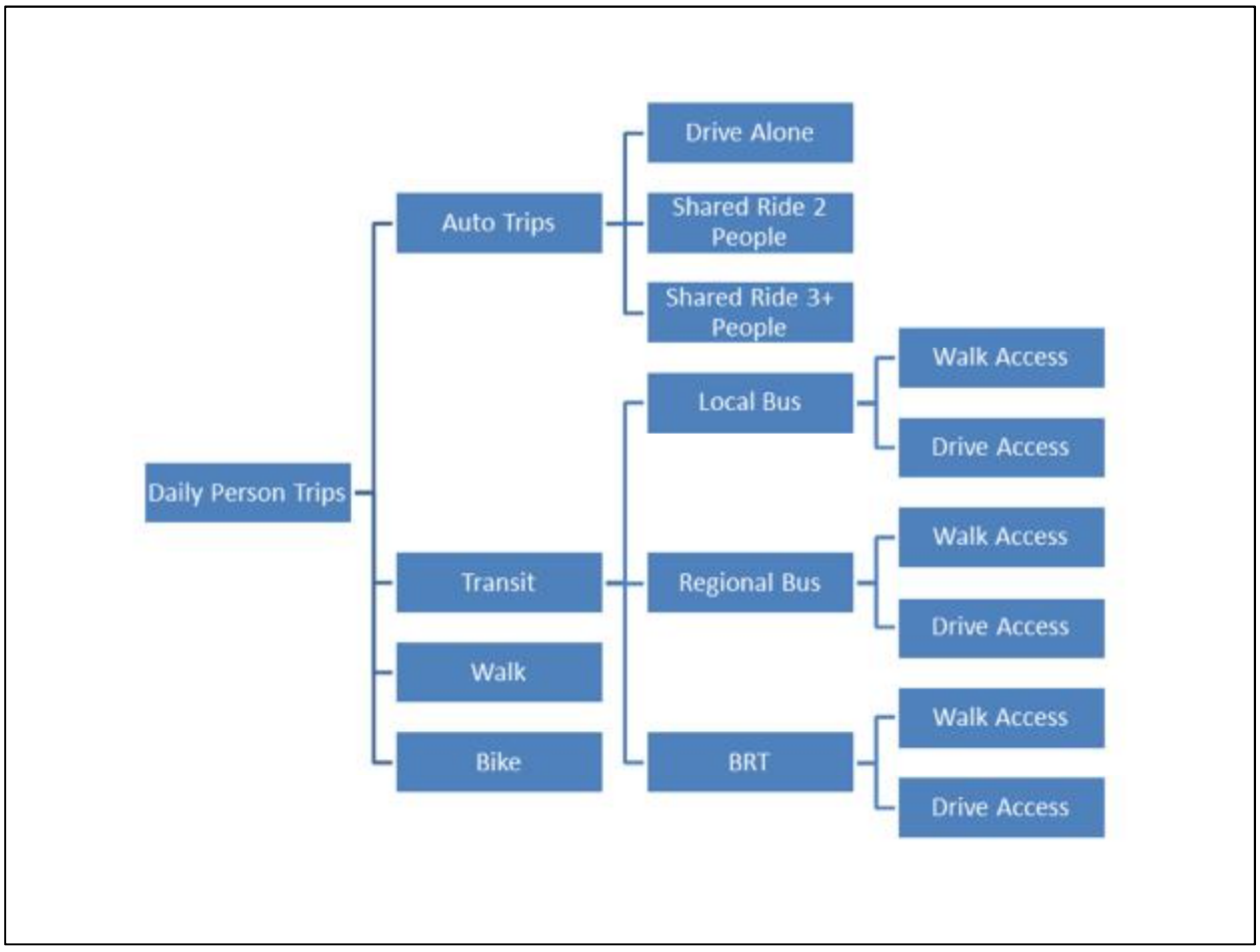
Many of the gateways to and from Fresno County only serve trips in certain parts of the county. For example, it is unlikely that trips to and from the Millerton Lake area would use Route 41 or Route 99 to cross the San Joaquin River, as Friant Road provides a more direct route to and from Madera County. Therefore, K factors are used to prohibit the trips at each gateway to travel to and from other gateways. Trips between gateways are contained in the through trip matrix.

7. MODE CHOICE

The mode choice step estimates how many of the trips between each pair of zones will use each travel mode. The Fresno COG Model includes a mode choice step which divides trips into drive alone, shared ride 2 people, shared ride 3+ people, local bus, regional bus, BRT, walk and bike (Figure 13). For the transit modes, the model further distinguishes between walk access and drive access. The mode choice analysis is accomplished in two steps:

1. The Initial Mode Choice estimates initial mode choice using average ratios of persons to vehicles from travel surveys, in order to estimate vehicle trips and congestion levels for use in the mode choice calculations.
2. The Full Mode Choice uses congested road times from the first step to assess the tradeoffs between autos and other modes.

Figure 13 Mode Choices



MODE CHOICE

The mode choice model in the prior Fresno COG Model was replaced and recalibrated as part of the 2008 base year update.

MODE CHOICE CALIBRATION DATA

The calibration of mode choice models requires data on transit ridership characteristics and automobile occupancy rates. Data sources included:

- 2000/2001 California Statewide Travel Survey
- Annual ridership by route on Fresno Area Express (FAX) transit and Clovis Transit

HOUSEHOLD TRAVEL SURVEY

The California Statewide Travel Survey was used to estimate average vehicle occupancy (Table 26) and trips by vehicle ownership and also to estimate shared ride characteristics by trip purpose.

The household survey provided information on the mode shares of trips made by households with 0 vehicles, 1 vehicle or 2+ vehicles.

TABLE 23
AVERAGE PERSON TO VEHICLE RATIOS

Trip Purpose	Average Ratio of Person Trips to Vehicle Trips
Home-Work	1.14
Home-Shop	1.45
Home-Other	2.321
Work-Other	1.10
Other-Other	1.70
TOTAL	1.74

1. Includes trips by school bus and auto passengers.
Source: 2000/2001 California Statewide Travel Survey results for Fresno County.

TABLE 23
AVERAGE PERSON TO VEHICLE RATIOS

Trip Purpose	Average Ratio of Person Trips to Vehicle Trips
Home-Work	1.14
Home-Shop	1.45
Home-Other	2.32[1]
Work-Other	1.10
Other-Other	1.70
TOTAL	1.74

1. Includes trips by school bus and auto passengers.
Source: 2000/2001 California Statewide Travel Survey results for Fresno County.

TABLE 24
TRIPS BY HOUSEHOLD VEHICLE OWNERSHIP

Travel Mode	Home-Work	Home-Shop	Home-Other	Work-Other	Other-Other	Total Trips
0 AUTO HOUSEHOLDS						
Total Trips	1,100	4,700	24,100	2,700	8,700	41,300
Auto Driver	-	-	4.7%	-	-	2.8%
Auto Passenger	42.7%	-	23.9%	10.7%	31.5%	22.5%
Transit	-	-	2.5%	17.3%	63.2%	15.9%
School Bus	-	-	6.8%	-	-	4.0%
Bicycle	-	26.5%	5.1%	-	-	6.0%
Walk	57.3%	73.5%	57.1%	71.9%	5.3%	48.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
1 AUTO HOUSEHOLDS						
Total Trips	71,700	46,500	123,500	23,500	45,700	310,900
Auto Driver	72.8%	74.9%	43.7%	90.6%	51.1%	59.7%
Auto Passenger	16.3%	16.7%	33.9%	9.4%	28.9%	24.7%

TABLE 24
TRIPS BY HOUSEHOLD VEHICLE OWNERSHIP

Travel Mode	Home-Work	Home-Shop	Home-Other	Work-Other	Other-Other	Total Trips
Transit	0.8%	-	4.5%	-	6.7%	3.0%
School Bus	-	-	6.4%	-	-	2.6%
Bicycle	2.8%	1.3%	2.1%	-	-	1.7%
Walk	7.3%	7.1%	9.4%	-	13.3%	8.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2+ AUTO HOUSEHOLDS						
Total Trips	323,300	169,800	706,300	137,100	242,500	1,579,000
Auto Driver	92.7%	70.8%	43.3%	97.6%	58.6%	63.4%
Auto Passenger	7.1%	28.0%	39.8%	0.7%	35.5%	27.8%
Transit	-	-	-	-	0.2%	-
School Bus	-	-	8.0%	-	3.4%	4.1%
Bicycle	-	-	0.2%	-	-	0.1%
Walk	0.2%	1.3%	8.8%	1.7%	2.2%	4.6%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
ALL HOUSEHOLDS						
Total Trips	396,100	221,000	854,000	163,300	297,000	1,931,200
Auto Driver	88.8%	70.1%	42.3%	95.0%	55.8%	61.5%
Auto Passenger	8.9%	25.0%	38.5%	2.1%	34.3%	27.2%
Transit	0.1%	-	0.7%	0.3%	3.1%	0.8%
School Bus	-	-	7.7%	-	2.8%	3.8%
Bicycle	0.5%	0.8%	0.6%	-	-	0.5%
Walk	1.6%	4.0%	10.2%	2.6%	4.0%	6.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: 2000/2001 California Statewide Travel Survey results for Fresno County.

The household survey also asked respondents to list the number of persons in their vehicle during each trip made during the survey period. This allowed an estimate of vehicle occupancy by trip purpose (Table 25). The percentages shown for school trips only account for vehicles where the driver's trip purpose was "school." There are many other trips where the driver's trip purpose was "non-work" (serving passengers was considered non-work) while their passengers' trip purpose was "school."

TABLE 25
TRIPS BY VEHICLE OCCUPANCY

Persons in Vehicle	Home-Work	Home-Shop	Home-Other	Work-Other	Other-Other	Total Trips
1	81.3%	17.6%	41.3%	56.3%		52%
2	13%	30.8%	32.3%	25.5%		26%
3+	5.7%	51.6%	26.4%	18.2%		22%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: 2000/2001 California Statewide Travel Survey results for Fresno County.

The survey data on household vehicle availability was used to calibrate the Fresno COG Model vehicle availability module (Table 26).

TABLE 26
VEHICLE AVAILABILITY

Vehicle Availability							
0		1		2		3+	
CHTS	Model	CHTS	Model	CHTS	Model	CHTS	Model
11.9%	12.0%	32.5%	29.5%	37.1%	37.7%	18.5%	20.8%

Notes: 2000-2001 California Statewide Household Travel Survey - Weekday Travel Report (June 2003).

BUS RIDERSHIP

Ridership information for the 2008 base year was estimated for each of the transit services. A total of 37,831 average weekday transit boardings are estimated for 2008 on fixed-route services (Table 27). Of those trips, 37,094 are estimated to occur on FAX and 737 are estimated to occur on Clovis Transit. The travel model does not include a choice for demand-responsive services; these trips are assumed as a fixed percentage for each trip purpose based on travel survey information.

Weekday ridership on FAX routes was available from the FAX July 2007- June 2008 fiscal year operating summary.

TABLE 27
DAILY BUS RIDERSHIP

Validation Statistic	Evaluation Criterion	Observed Ridership	Model Ridership	Percentage
Difference between actual ridership to model results for entire system	+/- 20%	37,831	41,617	10%

Notes: Observed Ridership includes Fresno Area Express (FAX) and Clovis Transit average weekday unlinked trips as reported by Fresno Area Express and the City of Clovis for the period of July 2007 - June 2008

Ridership on Clovis Transit fixed routes, which accounts for 2% of the total regional bus ridership, was available for July 2007 – June 2008.

MODE CHOICE MODEL DESCRIPTION

The Fresno County mode choice models use a multinomial logit formulation which is by far the most commonly used model form for operating mode choice models in the United States. The logit model assigns the probability of using a particular travel mode based upon an attractiveness measure ("utility") for that mode in relation to the sum of the attractiveness measures for all modes. The attractiveness measure is expressed as an exponential function of level of service (mostly travel time and cost) and other variables. The mathematical expression for the logit model is as follows:

$$\text{Probability of using Mode 1} = \frac{e^{\text{Utility (Mode 1)}}}{e^{\text{Utility (Mode 1)}} + e^{\text{Utility (Mode 2)}} + e^{\text{Utility (Mode 3)}} + \ldots}$$

Typically, the utility is calculated as a function of the attributes of each mode and each traveler group.

For example, the utility of a transit trip may be expressed as follows:

Utility(Transit) = C1 + [C2 * In-Vehicle Time] + [C3 * Wait+Walk Time]+ [C4 * Fare/Value of Time]

Where:

C1, C2, C3, C4 = Coefficients which are set during calibration

Value of Time = Dollars one would spend to save one minute of travel time (or the inverse of minutes to spend to save one dollar), generally based on the household income.

The coefficient "C1" is referred to as the constant and is used to represent factors other than travel time and cost, such as attitudes towards convenience, reliability and safety. The constant coefficient will be specific to each travel mode, while the coefficients for travel time and cost are generally held constant for all modes for a given trip purpose and population segment. In the Fresno County mode choice model calibration, most coefficients were set based on standard values, and the constants were the focus of the calibration.

MODES REPRESENTED IN THE MODEL

The mode choice model extends the definition of "mode" beyond the basic auto and transit options. In the Fresno COG Model, both 2-person and 3+-person autos are predicted separately so as to retain the capability of analyzing 2- person vs. 3-person minimum carpool occupancy policies for HOV lanes. The model also predicts "walk access" to transit separately from "drive access" to better represent the tradeoffs between access modes, and to provide a clearer analysis of passenger facility usage and requirements at transit stations for walk, feeder bus, park/ride and kiss/ride transit access options. In all, the mode choice model predicts the following seven modes:

1. Drive Alone (D1)
2. 2-Person vehicle (S2)
3. 3+-Person vehicle (S3)
4. Walk to transit (TW)
5. Drive to transit (TD)
6. Bicycle (BK)
7. Walk (WK)

This set of alternative modes permits analysis of the trade-offs that will occur with a wide range of transportation projects or policies.

SCHOOL BUS

School bus trips represent approximately 7.7 percent of Home-Other trips and 2.8 percent of Other-Other trips (some school bus trips are Other-Other if the students go to another location between school and home).

School bus trips are generally not estimated specifically in mode choice models, as they are not generally true "choice" trips and the routes cannot be easily represented in a travel model. Therefore, school bus trips are factored from total person trips prior to the mode choice step.

MODE CHOICE STRATIFICATIONS

The Fresno COG Model performs mode choice calculations separately for eight trip purposes, three household categories and two time periods:

TRIP PURPOSES

1. Home-Work
2. Home-Shop
3. Home-K12
4. Home-College
5. Home-Other
6. Work-Other
7. Other-Other
8. Highway Commercial

HOUSEHOLD CATEGORIES

1. Zero Auto Households
2. One Auto Households
3. Two-Plus Auto Households

During the mode choice, trips are segregated by auto availability and households with zero autos that do not have to drive (DA, SR2, SR3+) as an option.

TIME PERIODS

1. Peak Transit Service (3-hour A.M. and 3-hour P.M. periods)
2. Off-Peak Transit Service (All other 18 hours)

Each of the household categories has a different likelihood of using transit and therefore model constants are estimated separately for each category.

MODE CHOICE STANDARD COEFFICIENTS

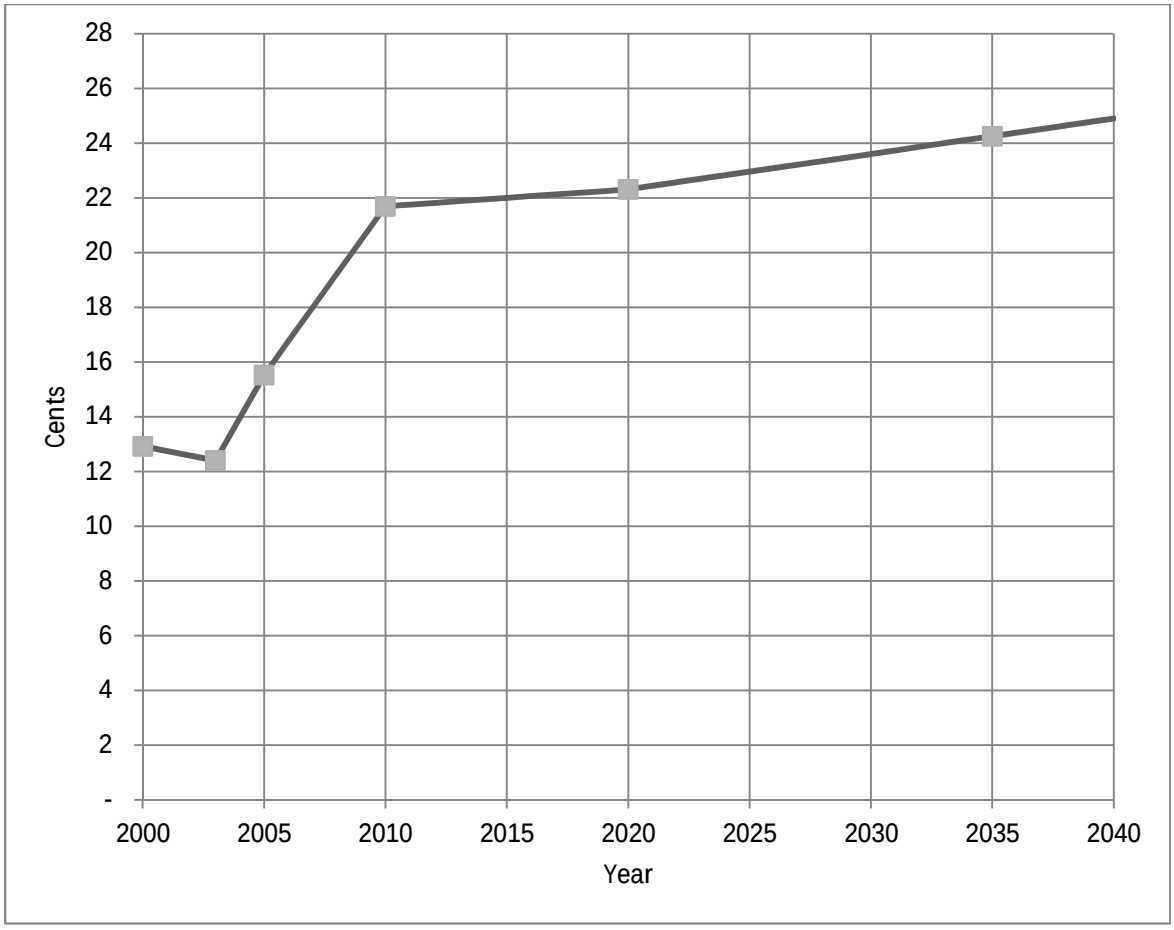
Several basic coefficients and parameters were set based on standard assumptions used in other models. The amount of data and resources required to fully estimate specific coefficients were not available for this model update. However, many of these standard coefficients have been found to not vary significantly between areas.

Coefficient on in-vehicle time (minutes)	-0.025
Coefficient on out-of-vehicle time (minutes)	-0.050 (2x in-vehicle)
Perceived auto operating cost (2000 cents)	15.52 cents per mile (2005) – 24.90 cents per mile (2040) (Figure 14)

Time penalty for shared ride pick-up/drop-off

Shared Ride 2	5 minutes
Shared Ride 3+	7 minutes

Figure 14 Auto Operating Cost by Year (2000 cents)



Source: Metropolitan Transportation Commission 2009 Regional Transportation Plan Analysis.

VALUE OF TIME

Travel costs are converted to time units using a value of time. The average perceived value of time is estimated to be six dollars per hour per person.

The time values are further adjusted from the median for vehicle ownership as follows:

0 Vehicle Household Income = 0.33 * Median for TAZ

1 Vehicle Household Income = 0.63 * Median for TAZ

2+ Vehicle Household Income = 1.17 * Median for TAZ

LOGIT MODEL CALIBRATION

The basic coefficients on time and cost were set to standard values. Therefore, calibration of the mode choice model for the 2008 Base Year update consisted of estimating the constants for each household category and mode. The goal of calibration is for the model-estimated number of trips for each mode to closely replicate "observed" trips from the ridership counts and surveys. The mode choice model was applied iteratively to adjust the various constants until the model-estimated number of trips in each stratification closely approximated the observed number of trips.

The necessary adjustment to each constant was estimated with the equation:

New Constant = Old Constant + ln(observed trips / estimated trips)

Where ln = natural log function

This equation provides an approximate value for the next iteration. Several iterations were necessary because it is only an approximation, and because all of the adjustable constants change simultaneously during the process.

The final mode choice constants are shown in Table 28. The summarized target and estimated mode choice is shown in Table 29.

TABLE 28
FINAL MODE CHOICE CONSTANTS

Purpose	Drive Alone	Shared Ride 2	Shared Ride 3+	Transit Walk	Transit Drive	Bike	Walk
0 VEHICLE HOUSEHOLDS							
Home-Work	0	-3.67	-4.91	-2.13	-3.06	-4.10	-1.56
Home-Shop	0	-0.88	-1.42	-1.80	-2.21	0.12	-0.75
Home-K12	0	-0.45	-1.95	0.51	0.43	-0.56	0.92
Home-College	0	-0.45	-1.95	0.51	0.43	-0.56	0.92
Home-Other	0	-1.69	-1.50	-3.22	0.54	-3.86	1.99
Work-Other	0	-1.48	-1.48	-4.90	-0.41	-3.01	0.24
Other-Other	0	-1.48	-1.48	-4.90	-0.41	-3.01	0.24

TABLE 28
FINAL MODE CHOICE CONSTANTS

Purpose	Drive Alone	Shared Ride 2	Shared Ride 3+	Transit Walk	Transit Drive	Bike	Walk
Highway Commercial	0	-1.48	-2.43	0.35	1.29	-1.01	2.24
1 VEHICLE HOUSEHOLDS							
Home-Work	0	-2.69	-3.26	-2.88	-3.39	-4.39	-1.61
Home-Shop	0	-0.18	-0.54	-2.30	-3.42	-1.44	-2.20
Home-K12	0	1.51	-0.03	-1.64	-2.18	-2.01	-0.06
Home-College	0	1.51	-0.03	-1.64	-2.18	-2.01	-0.06
Home-Other	0	-0.50	-0.03	-3.95	-2.54	-4.50	-0.14
Work-Other	0	-0.14	-0.71	-7.63	-4.76	-4.82	-0.94
Other-Other	0	-0.14	-0.71	-7.63	-4.76	-4.82	-0.94
Highway Commercial	0	-0.14	-1.71	-5.08	-4.76	-3.82	-0.94
2+ VEHICLE HOUSEHOLDS							
Home-Work	0	-2.39	-2.69	-5.25	-7.00	-6.85	-5.16
Home-Shop	0	0.02	-0.15	-4.45	-4.50	-1.50	-4.38
Home-K12	0	1.44	0.64	-1.32	-1.92	-2.82	0.13
Home-College	0	1.44	0.64	-1.32	-1.92	-2.82	0.13
Home-Other	0	0.01	0.45	-4.57	-3.39	-5.48	-0.40
Work-Other	0	-0.74	-0.18	-7.77	-4.82	-6.62	-1.26
Other-Other	0	-0.74	-0.18	-7.77	-4.82	-6.62	-1.26
Highway Commercial	0	0.26	-1.18	-4.80	-4.82	-5.62	-4.37

TABLE 29
MODE CHOICE

	CHTS	Model
Drive Alone	41.7%	38.3%
Shared Ride 2	26.5%	27.3%
Shared Ride 3+	24.3%	26.1%
Transit	1.1%	1.6%
Walk	5.8%	5.0%
Bike	0.6%	1.7%
Total	100.0%	100.0%

Notes: 2000-2001 California Statewide Household Travel Survey. Includes only internal-to-internal, weekday person trips for all modes, weighted by weekday, trip-level weights ("WDWGT"). Transit excludes school bus trips.

8. PEAKING FACTORS

The Fresno COG model has been set up to estimate travel demand during six periods:

- AM peak three-hour period
- PM peak three-hour period
- Off-peak eleven hours
- AM peak hour
- PM peak hour
- Mid-Day seven hours

The traffic volumes projected for the three-hour peak periods, mid-day seven hours, off-peak eleven hours, and remaining hours are added together to create daily traffic projections.

The traffic volumes operating under peak and off-peak speed conditions are identified separately, as route choices between certain origins and destinations may be different in peak and off-peak conditions. The three-hour peak periods were selected to ensure that the model will estimate separate traffic volumes for peak period congested speeds and for off-peak uncongested speeds for future conditions as well as for existing conditions. Currently, peak congested traffic conditions only last for one to two hours in Fresno County. With long-range land use growth, it is possible that congestion would last over two hours during each peak period, as in other urban areas in California. Therefore, three-hour peak periods are used to ensure that the model will identify all of the traffic volumes traveling under congested conditions for future forecasts.

The Fresno COG Model also projects A.M. and P.M. peak hour traffic volumes. Peak one-hour volumes are often required for capacity analysis and local traffic studies.

VEHICLE TIME OF DAY FACTORS

The trips for each time period are calculated by factoring the daily vehicle trips after the trip distribution step and conversion from person trips to vehicle trips. The daily vehicle trips are factored separately for each trip purpose and by departures/returns (Table 30). The percentages are set so that the total percentages for each hour add up to 100 percent between departures and returns.

The time-of-day factors are based on information from the 2000/2001 California Statewide Travel Survey. During model validation, the factors were adjusted from the survey results to better match observed traffic counts.

TABLE 30
VEHICLE TRIP TIME OF DAY FACTORS

Hour of Day	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other	Highway Commercial	Trucks-Small	Trucks-Medium	Trucks-Heavy
Departures											
12am-1am	7%	4%	0%	0%	4%	0%	0%	0%	1%	1%	1%
1am-2am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
2am-3am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
3am-4am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
4am-5am	6%	0%	-2%	-2%	-1%	0%	0%	0%	0%	0%	1%
5am-6am	10%	0%	0%	0%	1%	0%	0%	0%	1%	1%	1%
6am-7am	8%	1%	0%	0%	1%	0%	0%	0%	3%	3%	3%
7am-8am	4%	5%	24%	24%	10%	1%	2%	2%	4%	5%	4%
8am-9am	1%	2%	4%	4%	3%	1%	1%	2%	3%	3%	3%
9am-10am	1%	6%	5%	5%	3%	6%	2%	5%	2%	3%	2%
10am-11am	4%	5%	5%	5%	5%	6%	3%	4%	4%	5%	5%
11am-12pm	2%	4%	2%	2%	3%	6%	5%	4%	2%	3%	2%
12pm-1pm	1%	3%	5%	5%	1%	9%	3%	3%	2%	3%	2%

TABLE 30
VEHICLE TRIP TIME OF DAY FACTORS

Hour of Day	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other	Highway Commercial	Trucks-Small	Trucks-Medium	Trucks-Heavy
1pm-2pm	2%	2%	4%	4%	3%	4%	6%	2%	2%	3%	2%
2pm-3pm	1%	3%	0%	0%	3%	5%	4%	3%	2%	3%	2%
3pm-4pm	1%	2%	0%	0%	3%	7%	4%	2%	2%	3%	2%
4pm-5pm	1%	3%	3%	3%	3%	6%	3%	5%	5%	4%	4%
5pm-6pm	1%	3%	3%	3%	3%	6%	3%	5%	5%	4%	4%
6pm-7pm	1%	3%	3%	3%	3%	6%	3%	5%	5%	4%	4%
7pm-8pm	0%	2%	0%	0%	1%	1%	1%	4%	1%	1%	1%
8pm-9pm	0%	1%	3%	3%	2%	0%	0%	1%	1%	1%	1%
9pm-10pm	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%
10pm-11pm	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%
11pm-12am	0%	0%	0%	0%	2%	0%	0%	0%	1%	1%	1%
Returns											
12am-1am	10%	3%	0%	0%	3%	0%	0%	0%	1%	1%	1%
1am-2am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
2am-3am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
3am-4am	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%

TABLE 30
VEHICLE TRIP TIME OF DAY FACTORS

Hour of Day	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other	Highway Commercial	Trucks-Small	Trucks-Medium	Trucks-Heavy
4am-5am	0%	0%	0%	0%	0%	-1%	-1%	0%	0%	0%	1%
5am-6am	0%	6%	0%	0%	0%	1%	0%	0%	1%	1%	1%
6am-7am	0%	0%	0%	0%	0%	0%	0%	0%	3%	3%	3%
7am-8am	0%	3%	0%	0%	4%	10%	8%	0%	4%	5%	4%
8am-9am	0%	1%	0%	0%	3%	3%	1%	1%	3%	3%	3%
9am-10am	0%	2%	0%	0%	1%	3%	1%	2%	2%	3%	2%
10am-11am	1%	2%	2%	2%	2%	5%	4%	2%	4%	5%	5%
11am-12pm	1%	2%	6%	6%	3%	2%	4%	2%	2%	3%	2%
12pm-1pm	1%	4%	4%	4%	3%	5%	7%	5%	2%	3%	2%
1pm-2pm	1%	3%	7%	7%	2%	3%	5%	3%	2%	3%	2%
2pm-3pm	3%	3%	6%	6%	4%	3%	8%	4%	2%	3%	2%
3pm-4pm	7%	5%	8%	8%	5%	2%	7%	5%	2%	3%	2%
4pm-5pm	7%	5%	2%	2%	3%	0%	5%	5%	5%	4%	4%
5pm-6pm	7%	4%	2%	2%	5%	1%	4%	8%	5%	4%	4%
6pm-7pm	3%	3%	2%	2%	3%	0%	3%	5%	5%	4%	4%
7pm-8pm	2%	3%	2%	2%	1%	0%	2%	5%	1%	1%	1%

TABLE 30
VEHICLE TRIP TIME OF DAY FACTORS

Hour of Day	Home-Work	Home-Shop	Home-K12	Home-College	Home-Other	Work-Other	Other-Other	Highway Commercial	Trucks-Small	Trucks-Medium	Trucks-Heavy
8pm-9pm	1%	1%	0%	0%	3%	1%	0%	2%	1%	1%	1%
9pm-10pm	1%	1%	1%	1%	2%	0%	1%	2%	1%	1%	1%
10pm-11pm	1%	0%	0%	0%	1%	0%	0%	0%	1%	1%	1%
11pm-12am	1%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%

Notes: The same time of day factors were assumed for all modes.

EXTERNAL PEAK FACTOR ADJUSTMENTS

In prior versions of the Fresno COG Model, additional adjustment factors were applied for peak period volumes at each of the model gateways. The 2008 base year model does not use additional adjustments to the peak factors for external trips.

TRANSIT TIME OF DAY FACTORS

Transit trips are split into peak period and off-peak trips so that peak trips can be assigned to peak period transit services. The time of day factors are similar to the vehicle factors (Table 20).

9. TRIP ASSIGNMENT

In this step, zone-to-zone trips from the trip distribution step are assigned to the network.

TRAFFIC ASSIGNMENT

The Fresno COG 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, some traffic is shifted 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 Fresno COG Model is currently set for a maximum of 20 iterations for peak and off-peak period traffic assignments and 50 iterations for peak hour traffic assignments.

CONGESTED TRAVEL SPEEDS

The relationship of speed to congestion on a particular roadway is based on a set of speed-flow curves that 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 Bureau of Public Roads (BPR) formula. The Fresno COG Model uses the BPR formula for all roads, with the coefficients shown in Table 5. Zone connectors are not actual streets and are not assumed to slow down during the assignment process.

FACTORS

The Fresno COG Model assumes the following vehicle occupancy factors for shared-ride 3+ trips:

- Home-Work: 4.35
- Home-Shopping: 3.65
- Home-K12: 4.35
- Home-College: 4.35
- Home-Other: 3.42
- Work-Other: 3.16
- Other-Other: 3.37

The Fresno Cog Model assumes the following passenger car equivalency factors for trucks:

- Small truck: 1
- Medium truck: 1.5
- Heavy truck: 2

TRANSIT ASSIGNMENT

Daily transit trips are assigned to the transit network. Transit trips are assigned to the single best path based on in-vehicle time plus weighted out-of- vehicle times. The transit trips are assigned in four groups:

1. Peak period (A.M. plus P.M.), walk access
2. Peak period (A.M. plus P.M.), drive access
3. Off-peak, walk access
4. Off-peak, drive access

The peak period transit trips represent trips occurring during the A.M. three- hour peak period plus the P.M. three hour peak period. Peak period transit trips are assigned to the peak transit service (peak period

headways) with travel times based on the congested speeds from the A.M. peak period traffic assignment. Off-peak transit trips represent trips during the remaining 18 hours and are assigned to the off-peak transit service (off-peak headways) with travel times based on the congested road speeds from the off-peak traffic assignment.

Transit trips are all assigned as production to attraction rather than origin to destination. For example, a person who uses transit for work will be assigned as two trips from the home TAZ to the work TAZ rather than one trip in each direction. This is done so that the model can keep track of which end of the trip can use drive access. In order to convert to actual directional boardings, the assigned transit trips in each direction must be added together and then divided by two.

The transit vehicle times and drive access times are affected by congestion on the road network.

10. FEEDBACK MECHANISMS

The Fresno COG 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 Fresno COG 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.

In an effort to meet all Transportation Conformity Rule modeling requirements, a full feedback loop process was implemented as of 2001 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).

CONGESTED SKIMS

The initial trip distributions for all trip purposes are calculated using uncongested (free-flow) travel times on the road network. After the initial trip distribution and assignment, the congested travel times calculated from the most recent A.M. peak three-hour period traffic assignment are used as input to the Home-Work trip distribution and the congested travel times from the most recent off-peak 18-hour traffic assignment are used for the other four trip purposes. These feedback loops undergo five iterations.

11. MODEL VALIDATION

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 base Year Fresno COG Model is primarily calibrated to 2000 United States Census data and 2000/2001 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 or peak factors. Once validated, the model can be used to predict future travel patterns with a high degree of confidence.

The Fresno COG Model was validated to 2008 traffic data to conform to the base year land use data. The majority of the traffic count database is from 2008. However, traffic counts from 2007 through 2010 were used, adjusted to 2008 levels based on annual growth rates.

TRAFFIC DATA

Traffic data for validation were obtained from the Fresno COG traffic count database and Caltrans.

LOCAL TRAFFIC COUNTS

The Council of Fresno County Governments maintains a database of local traffic counts for roads within the cities and Fresno County. Daily directional traffic counts from the database were coded to the appropriate road network links by Fresno COG staff.

CALTRANS TRAFFIC COUNTS

Caltrans makes traffic count information available through their internet web site, Traffic Data Branch page. The 2008 two-way total daily and one-way peak hour traffic volumes are posted for each segment of the state highway system. Daily traffic counts are also publicly available for each freeway ramp. More detailed daily and hourly traffic counts from permanent count station locations are available through the Caltrans Performance Measurement System (PeMS).

CALTRANS HPMS

Caltrans prepares estimates of vehicle miles of travel (VMT) for all roads in each California County for the Highway Performance Monitoring System (HPMS). The VMT estimates are based on a traffic counting program on a sample of roads throughout the state. Local jurisdictions provide Caltrans with updates on the number of lane-miles of road within each classification type. Caltrans statistically extrapolates the traffic counts to provide estimates of total traffic volume on all lane-miles of each functional classification, and VMT.

TRAFFIC VALIDATION

The Fresno COG Model traffic validation is based on several criteria, including vehicle-miles of travel, total volume by road type, screenlines, gateways and percent of links within acceptable limits.

VEHICLE MILES OF TRAVEL

Vehicle miles of travel (VMT) were estimated from the travel demand model by multiplying link volumes by link distances. The model estimates intrazonal trips (trips remaining within a TAZ) but does not assign these trips to the model road network. The intrazonal trips were multiplied by the estimated intrazonal distances to calculate intrazonal VMT.

The Caltrans HPMS 2008 estimate of VMT in Fresno County was 22,376,000. The 2008 model base year estimated 22,077,974 VMT on the roadway links and 71,001 in intrazonal VMT for a total of 22,148,975 VMT. The 2008 model estimate is 1% lower than the Caltrans 2008 HPMS VMT target.

OVERALL ROADWAY VALIDATION

TABLE 31
TWO-WAY OVERALL ROADWAY VALIDATION

	Criteria	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off Peak Period	AM Peak Hour	PM Peak Hour
Model/Count Ratio	1.00 ± 0.1	0.99	1.06	0.95	0.94	1.11	0.90	0.93
Percent of Links Within Caltrans Maximum Deviation	>75%	60%	63%	63%	54%	56%	58%	59%
Percent Root Mean Square Error	<40%	36%	42%	35%	38%	66%	44%	38%
Correlation Coefficient	>88%	91%	88%	89%	88%	81%	83%	88%
Percent of Screenlines Within Caltrans Maximum Deviation	100%	80%	70%	70%	70%	60%	90%	70%

The overall (two-way) roadway validation results are shown in Table 31. The model/count ratio criteria are met for all time periods, except for the off peak period which exceeds the criteria by 0.01. Although all the other criteria are not all met for every time period, they are within the allowable error considering the household survey data from 2001 and the count data from 2007 to 2010. Future model calibration and validation using a consistent data set is recommended. The other criteria include percent of links and screenlines within the Caltrans Maximum Deviation. The Caltrans travel forecasting guidelines include a figure showing the maximum desirable deviation for links and screenlines between daily model volumes and traffic counts, where the acceptable deviation is inversely related to the traffic count (Figure 15).

The Caltrans guidelines were used as a baseline to derive similar guidelines for non-daily analysis periods (Table 32). The percent root mean square error (RMSE) provides a measure of accuracy based on the statistical standard error. The RMSE puts a greater emphasis on larger errors (plus or minus) that may cancel each other out in the total validation by road type. The correlation coefficient measures the magnitude of the relationship between the model volumes and traffic counts.

Figure 15 Maximum Desirable Daily Error for Links and Screenlines

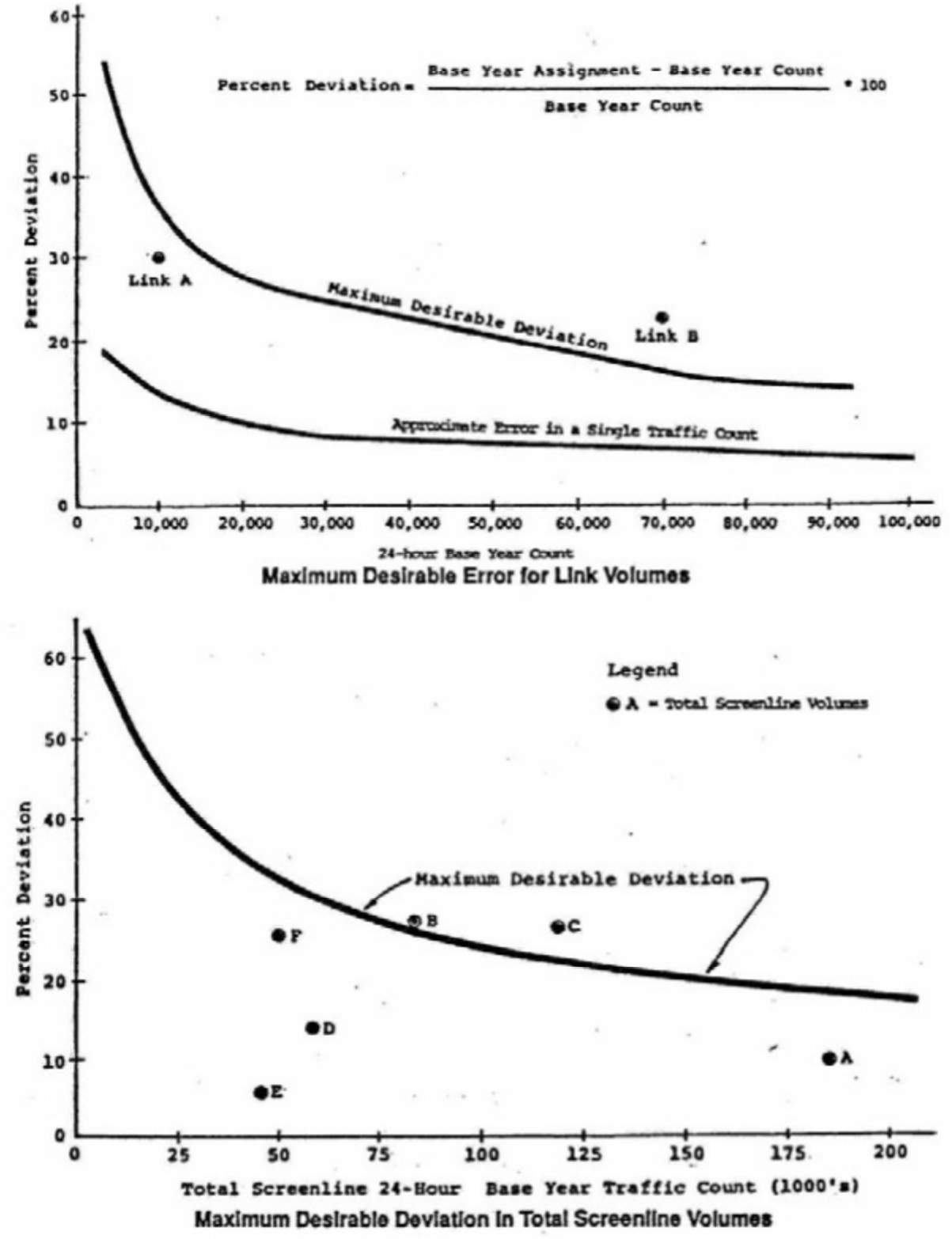


TABLE 32
MAXIMUM DESIRABLE ERROR FOR LINKS AND SCREENLINES BY TIME OF DAY

Percent Deviation	Time of Count					
	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off-Peak Period	Peak Hour
Links						
68%	1	1	1	1	1	1
63%	1,250	313	375	438	375	125
58%	2,500	625	750	875	750	250
52%	3,750	938	1,125	1,313	1,125	375
48%	5,000	1,250	1,500	1,750	1,500	500
44%	6,250	1,563	1,875	2,188	1,875	625
41%	7,500	1,875	2,250	2,625	2,250	750
38%	8,750	2,188	2,625	3,063	2,625	875
36%	10,000	2,500	3,000	3,500	3,000	1,000
34%	11,250	2,813	3,375	3,938	3,375	1,125
33%	12,500	3,125	3,750	4,375	3,750	1,250
31%	13,750	3,438	4,125	4,813	4,125	1,375
30%	15,000	3,750	4,500	5,250	4,500	1,500
29%	16,250	4,063	4,875	5,688	4,875	1,625
29%	17,500	4,375	5,250	6,125	5,250	1,750
28%	18,750	4,688	5,625	6,563	5,625	1,875
28%	20,000	5,000	6,000	7,000	6,000	2,000
27%	21,250	5,313	6,375	7,438	6,375	2,125
27%	22,500	5,625	6,750	7,875	6,750	2,250
26%	23,750	5,938	7,125	8,313	7,125	2,375
26%	25,000	6,250	7,500	8,750	7,500	2,500
25%	26,250	6,563	7,875	9,188	7,875	2,625
25%	27,500	6,875	8,250	9,625	8,250	2,750
24%	28,750	7,188	8,625	10,063	8,625	2,875

TABLE 32
MAXIMUM DESIRABLE ERROR FOR LINKS AND SCREENLINES BY TIME OF DAY

Percent Deviation	Time of Count					
	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off-Peak Period	Peak Hour
24%	30,000	7,500	9,000	10,500	9,000	3,000
24%	32,500	8,125	9,750	11,375	9,750	3,250
23%	35,000	8,750	10,500	12,250	10,500	3,500
22%	37,500	9,375	11,250	13,125	11,250	3,750
22%	40,000	10,000	12,000	14,000	12,000	4,000
21%	42,500	10,625	12,750	14,875	12,750	4,250
21%	45,000	11,250	13,500	15,750	13,500	4,500
20%	47,500	11,875	14,250	16,625	14,250	4,750
20%	50,000	12,500	15,000	17,500	15,000	5,000
20%	52,500	13,125	15,750	18,375	15,750	5,250
19%	55,000	13,750	16,500	19,250	16,500	5,500
19%	57,500	14,375	17,250	20,125	17,250	5,750
18%	60,000	15,000	18,000	21,000	18,000	6,000
18%	62,500	15,625	18,750	21,875	18,750	6,250
17%	65,000	16,250	19,500	22,750	19,500	6,500
17%	67,500	16,875	20,250	23,625	20,250	6,750
16%	70,000	17,500	21,000	24,500	21,000	7,000
16%	72,500	18,125	21,750	25,375	21,750	7,250
15%	75,000	18,750	22,500	26,250	22,500	7,500
15%	77,500	19,375	23,250	27,125	23,250	7,750
15%	80,000	20,000	24,000	28,000	24,000	8,000
14%	82,500	20,625	24,750	28,875	24,750	8,250
14%	85,000	21,250	25,500	29,750	25,500	8,500
14%	87,500	21,875	26,250	30,625	26,250	8,750
14%	90,000	22,500	27,000	31,500	27,000	9,000

TABLE 32
MAXIMUM DESIRABLE ERROR FOR LINKS AND SCREENLINES BY TIME OF DAY

Percent Deviation	Time of Count					
	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off-Peak Period	Peak Hour
14%	92,500	23,125	27,750	32,375	27,750	9,250
14%	95,000	23,750	28,500	33,250	28,500	9,500
14%	97,500	24,375	29,250	34,125	29,250	9,750
14%	100,000	25,000	30,000	35,000	30,000	10,000
Screenlines						
64%	1	1	1	1	1	1
63%	3,000	750	900	1,050	900	300
62%	4,000	1,000	1,200	1,400	1,200	400
61%	5,000	1,250	1,500	1,750	1,500	500
60%	6,000	1,500	1,800	2,100	1,800	600
59%	7,000	1,750	2,100	2,450	2,100	700
58%	8,000	2,000	2,400	2,800	2,400	800
57%	9,000	2,250	2,700	3,150	2,700	900
56%	10,000	2,500	3,000	3,500	3,000	1,000
55%	11,000	2,750	3,300	3,850	3,300	1,100
54%	12,000	3,000	3,600	4,200	3,600	1,200
53%	13,000	3,250	3,900	4,550	3,900	1,300
52%	14,000	3,500	4,200	4,900	4,200	1,400
51%	15,000	3,750	4,500	5,250	4,500	1,500
50%	15,625	3,906	4,688	5,469	4,688	1,563
49%	16,250	4,063	4,875	5,688	4,875	1,625
48%	17,500	4,375	5,250	6,125	5,250	1,750
47%	18,750	4,688	5,625	6,563	5,625	1,875
46%	20,000	5,000	6,000	7,000	6,000	2,000
45%	21,250	5,313	6,375	7,438	6,375	2,125

TABLE 32
MAXIMUM DESIRABLE ERROR FOR LINKS AND SCREENLINES BY TIME OF DAY

Percent Deviation	Time of Count					
	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off-Peak Period	Peak Hour
44%	22,500	5,625	6,750	7,875	6,750	2,250
43%	23,750	5,938	7,125	8,313	7,125	2,375
42%	25,000	6,250	7,500	8,750	7,500	2,500
41%	27,500	6,875	8,250	9,625	8,250	2,750
40%	30,000	7,500	9,000	10,500	9,000	3,000
39%	32,500	8,125	9,750	11,375	9,750	3,250
38%	35,000	8,750	10,500	12,250	10,500	3,500
37%	37,500	9,375	11,250	13,125	11,250	3,750
36%	40,000	10,000	12,000	14,000	12,000	4,000
35%	42,500	10,625	12,750	14,875	12,750	4,250
34%	45,000	11,250	13,500	15,750	13,500	4,500
33%	47,500	11,875	14,250	16,625	14,250	4,750
32%	50,000	12,500	15,000	17,500	15,000	5,000
31%	55,000	13,750	16,500	19,250	16,500	5,500
30%	60,000	15,000	18,000	21,000	18,000	6,000
29%	65,000	16,250	19,500	22,750	19,500	6,500
28%	70,000	17,500	21,000	24,500	21,000	7,000
27%	75,000	18,750	22,500	26,250	22,500	7,500
26%	80,000	20,000	24,000	28,000	24,000	8,000
25%	90,000	22,500	27,000	31,500	27,000	9,000
24%	95,000	23,750	28,500	33,250	28,500	9,500
23%	110,000	27,500	33,000	38,500	33,000	11,000
22%	120,000	30,000	36,000	42,000	36,000	12,000
21%	135,000	33,750	40,500	47,250	40,500	13,500
20%	160,000	40,000	48,000	56,000	48,000	16,000

TABLE 32
MAXIMUM DESIRABLE ERROR FOR LINKS AND SCREENLINES BY TIME OF DAY

Percent Deviation	Time of Count					
	Daily	AM Peak Period	PM Peak Period	Midday Peak Period	Off-Peak Period	Peak Hour
19%	180,000	45,000	54,000	63,000	54,000	18,000
18%	195,000	48,750	58,500	68,250	58,500	19,500
17%	205,000	51,250	61,500	71,750	61,500	20,500

ROAD TYPE VALIDATION

The Federal Highway Administration[1] and Caltrans[2] recommend error limits for total error by functional classification (type of road). Results are evaluated for daily traffic, A.M. and P.M. peak three-hour periods, and A.M. and P.M. peak hours.

Calibration for speed and capacity by functional type, and a consistent count set is recommended for future model updates.

DAILY VOLUMES

The Fresno COG Model daily validation meets all of the FHWA targets for total volume by road type (Table 33). The daily validation also generally meets all targets for RMSE, except for on freeways. Consequently, the overall RMSE slightly exceeds the target.

TABLE 33
DAILY VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Freeway	1,210,764	1,263,585	4%	+/- 7%	25.6%	25.6%	15%
Highway	653,527	648,906	-1%	+/- 10%	38.5%	38.5%	40%
Expressway	887,317	994,077	12%	+/- 15%	29.6%	29.6%	40%

[1] Federal Highway Administration, *Calibration and Adjustment of System Planning Models,* 1990.
[2] California Department of Transportation, *Travel Forecasting Guidelines*, 1992.

TABLE 33
DAILY VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Arterial	4,414,422	4,377,231	-1%	+/- 15%	36.4%	36.2%	40%
Collector	1,105,776	969,523	-12%	+/- 25%	50.2%	48.7%	50%
Freeway Ramp	4,578	5,394	N/A	+/- 25%	N/A	N/A	50%
TOTAL	8,611,599	8,564,481	-1%	+/- 5%	39.3%	38.5%	35%

PEAK PERIOD VALIDATION

The Fresno COG Model A.M. peak three-hour and P.M. peak three-hour validation is shown in Table 34 and Table 35. Both peak periods meet every FHWA target for volume by road type and total volume.

TABLE 34
A.M. PEAK THREE HOUR PERIOD VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Freeway	233,260	231,315	-1%	+/- 7%	29.9%	29.9%	15%
Highway	119,395	122,422	3%	+/- 10%	46.7%	46.7%	40%
Expressway	156,433	176,723	13%	+/- 15%	42.6%	42.6%	40%
Arterial	709,162	766,691	8%	+/- 15%	45.6%	45.1%	40%
Collector	185,723	167,637	-10%	+/- 25%	61.1%	59.4%	50%
Freeway Ramp	875	752	N/A	+/- 25%	N/A	N/A	50%
TOTAL	1,406,904	1,466,995	4%	+/- 5%	50.0%	49.3%	35%

TABLE 35
P.M. PEAK THREE HOUR PERIOD VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Freeway	266,624	267,246	0%	+/- 7%	23.2%	23.2%	15%
Highway	143,635	138,773	-3%	+/- 10%	42.1%	42.1%	40%
Expressway	194,526	203,018	4%	+/- 15%	26.5%	26.5%	40%
Arterial	988,490	926,402	-6%	+/- 15%	36.1%	35.8%	40%
Collector	242,869	223,464	-8%	+/- 25%	54.7%	51.9%	50%
Freeway Ramp	961	1,112	N/A	+/- 25%	N/A	N/A	50%
TOTAL	1,839,630	1,761,946	-4%	+/- 5%	38.6%	37.9%	35%

PEAK HOUR VALIDATION

The Fresno COG Model A.M. peak one hour and P.M. peak one hour validation is shown in Table 36 and Table 37. For the AM peak hour the expressway and arterial road types meet the FHWA target, and the total volume across all road types meets the FHWA target. For the PM peak hour the freeway, expressway, arterial, and collector road types meet the target, and the total volume across all road types meets the target.

TABLE 36
A.M. PEAK ONE HOUR PERIOD VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Freeway	92,165	111,681	21%	+/- 7%	63.4%	63.4%	15%
Highway	41,420	58,912	42%	+/- 10%	83.2%	83.2%	40%
Expressway	66,962	61,249	-9%	+/- 15%	44.9%	44.9%	40%
Arterial	307,301	274,577	-11%	+/- 15%	47.5%	46.8%	40%

TABLE 36
A.M. PEAK ONE HOUR PERIOD VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Collector	83,964	59,405	-29%	+/- 25%	65.6%	62.8%	50%
Freeway Ramp	362	212	N/A	+/- 25%	N/A	N/A	50%
TOTAL	593,065	567,289	-4%	+/- 5%	71.9%	70.4%	35%

TABLE 37
P.M. PEAK ONE HOUR PERIOD VALIDATION BY ROAD TYPE

Road Type	Traffic Volumes				Root Mean Square Error (RMSE)		
	Traffic Count	Counted Links Model Volume	Percent Difference	Target	Model (All)	Model (Count >1000)	Target
Freeway	92,943	98,204	6%	+/- 7%	28.9%	28.9%	15%
Highway	44,756	50,897	14%	+/- 10%	49.0%	49.0%	40%
Expressway	74,077	75,606	2%	+/- 15%	27.2%	27.2%	40%
Arterial	370,446	336,027	-9%	+/- 15%	39.2%	38.7%	40%
Collector	92,620	79,942	-14%	+/- 25%	59.0%	54.8%	50%
Freeway Ramp	331	528	N/A	+/- 25%	N/A	N/A	50%
TOTAL	676,106	641,963	-5%	+/- 5%	43.1%	41.9%	35%

SCREENLINES

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.

The Fresno COG Model has 20 screenlines, including several north-south and east-west cut-lines. The maximum desirable deviation for screenline volumes between model volumes and traffic counts is shown in Figure 15. These targets vary by total volume, with smaller deviations allowed for higher volume screenlines. The model is estimating daily volumes within these targets for 80% of analyzed screenlines (Table 38).

TABLE 38
DAILY SCREENLINE VALIDATION

Screenline	Model (2-Way)	Count (2-Way)	Model Deviation	Max Deviation	Within Deviation?
3	4,632	6,588	30%	60%	Yes
4	10,476	6,635	58%	60%	Yes
6	78,968	40,404	95%	36%	No
7	29,959	25,215	19%	42%	Yes
8	35,671	28,087	27%	41%	Yes
9	75,266	67,731	11%	29%	Yes
10	19,977	30,590	35%	40%	Yes
11	43,678	40,388	8%	36%	Yes
12	21,572	6,272	244%	60%	No
13	16,257	10,722	52%	56%	Yes

Note: screenlines for which 2-way counts were not available at all links were not included

GATEWAYS

Travel to and from Fresno County is represented by gateway zones at major road crossings of the county line. The Fresno COG Model currently has 30 gateways. The daily gateway validation was determined using the same maximum desirable deviation as for screenline volumes between model volumes and traffic counts (Figure 15). The model is estimating daily volumes within these targets for 97% of analyzed gateways (Table 39).

TABLE 39
DAILY GATEWAYS VALIDATION

Zone Number	External County	Gateway	Model Deviation	Max Deviation	Within Deviation?
43	Monterey	SR-198	12%	64%	Yes
44	San Benito	Panoche Road	18%	64%	Yes
45	San Benito	Ltl Panoche Road	12%	64%	Yes
61	Madera	SR-99	7%	30%	Yes
62	Madera	SR-41	5%	36%	Yes
63	Madera	County Road 206/ Millerton	22%	59%	Yes
64	Madera	Road 222/ Powerhouse Road	16%	64%	Yes
65	Tulare	SR-245	1%	64%	Yes
66	Tulare	Hill Valley/ Road 120	18%	63%	Yes
67	Tulare	Alta Avenue	30%	57%	Yes
68	Tulare	Reed/Road 52	20%	62%	Yes
69	Tulare	Mountain View/ Avenue 416	18%	55%	Yes
70	Tulare	SR 201/Sierra	23%	60%	Yes
71	Tulare	SR-99	21%	33%	Yes
72	Tulare	Road 8/10th Avenue	303%	64%	No
73	Kings	SR-43	19%	56%	Yes
74	Kings	Fowler Avenue	51%	64%	Yes
75	Kings	SR-41	29%	51%	Yes
76	Kings	Excelsior	21%	64%	Yes
77	Kings	Marks Avenue/22nd Avenue	29%	64%	Yes
78	Kings	Paige Avenue/Elder Avenue	9%	64%	Yes
79	Kings	SR-198	47%	59%	Yes
80	Kings	I-5	11%	40%	Yes
81	Kings	SR-269	7%	61%	Yes
82	Kings	SR-33	61%	64%	Yes
83	Kings	Jayne Avenue	39%	64%	Yes

TABLE 39
DAILY GATEWAYS VALIDATION

Zone Number	External County	Gateway	Model Deviation	Max Deviation	Within Deviation?
84	Merced	I-5	8%	39%	Yes
85	Merced	SR-33	53%	63%	Yes
86	Madera	13th Street	43%	59%	Yes
87	Madera	SR-145	13%	60%	Yes

PERCENT ERROR

The Caltrans travel forecasting guidelines include a figure showing the maximum desirable deviation for individual daily link volumes between model volumes and traffic counts (Figure 15). The suggested link-specific validation criterion is that 75 percent of freeway and principal arterials meet the maximum desirable deviation. The Fresno COG Model 2008 daily validation has 45 percent of links within the maximum desirable deviation when considering all road segments.

ACCOUNTING FOR TRAFFIC VALIDATION ERROR IN FORECASTS

The traffic validation indicates that the Fresno COG Model provides a good overall estimation of travel demand patterns in Fresno County. However, it is recommended that traffic forecasts on specific road segments use an adjustment process that accounts for validation errors, as described in the next section.

TRANSIT VALIDATION

Transit trips estimated from the mode choice model were assigned to the transit network. The results are summarized in Table 27. The model estimates total transit ridership within 10 percent of average daily observed ridership. This indicates that the model in its current state can provide reasonable overall estimates of changes in transit ridership on a corridor or subarea basis, particularly within the urban areas.

12. FORECAST APPLICATIONS

Potential travel model forecast applications include:

- Regional measures for input to air quality analysis
- Identify traffic "hot spots"
- Forecast effectiveness of major road or transit improvements
- Impacts of land use changes
- Compare land use or transportation policy alternatives using regional measures of effectiveness

ADJUSTMENT OF TRAFFIC ASSIGNMENT RESULTS

This section discusses procedures for adjusting model traffic forecasts for both link and turning movement volumes.

LINK VOLUMES

The raw outputs from the Fresno COG Model should rarely be applied directly in analysis. Although many methods exist and vary by project, three methods for post-processing model volumes are frequently used: the difference method, the ratio method, and the blended method, which is simply an average of the first two methods. In the difference method, forecast traffic volumes are calculated based on the difference between the base year count and model volume:

Adjusted Forecast Volume = Model Forecast Volume + (Base Year Count - Base Year Model Volume)

In the ratio method, forecast traffic volumes are calculated based on the ratio between the base year count and base year model volume:

Adjusted Forecast Volume = Model Forecast Volume × (Base Year Count ÷ Base Year Model Volume)

These methodologies are outlined in NCHRP 255. Although the most appropriate method is left to the judgment of the engineer depending on the project, there are guidelines that the Transportation Research Board has published based on the difference between counts and base model forecast: use ratio method if the difference is less that 50%, use difference method if the difference is greater than 150%, otherwise use a blend of both (average the results of the two methods).

If a new road or ramp connection is tested in a forecast, there would not be an existing traffic count and the model forecast volume would be used directly.

TURNING MOVEMENT VOLUMES

A common methodology for projecting turning movement volumes is to extract turning movements directly from the model, then post-process these volumes for each individual turning movement using the same NCHRP 255 methods described above (ratio, difference, or blended method). In the case of a new intersection or a leg is added to an intersection, adjustments may not be possible because there is no base for comparison. The reasonableness of the outputs should be checked based on knowledge of the area, comparisons to adjacent intersections, off-model calculations of the trip generation, distribution, and assignment of adjacent land use, or other methodologies, as deemed appropriate.

In addition, NCHRP 255 outlines the furnessing process, which may be appropriate if the following conditions are met:

1. The number of approach/departure legs at the intersection are consistent over time
2. The roadway system in the area does not cause traffic patterns to change
3. The land use development in the area does not cause traffic patterns to change

Furnessing is a process that balances the projected growth for each approach\departure of an intersection with the proportion of left, through, and right-turning vehicles, and minimizes the error between the count approach\departure and the forecast.

The Fresno COG staff and Model Steering Committee have developed “Recommended Procedures for Using Traffic Projections from the Fresno COG Travel Model”. This report is available on the Fresno COG web site.

HIGHSPEED RAIL POST-PROCESSER

To reflect travel out of the county that would utilize the Highspeed Rail (HSR) station, a post-processer was developed. The post-processer inputs are the location of the station, the daily boardings/alightings, the gateways the trips would have exited if not on HSR, and the through trips for the gateways that use HSR rather than driving. Drive trips are then assigned to access the HSR station rather than existing via auto, with VMT recalculated at the end of the process.

FORECAST ASSUMPTIONS

An initial set of forecasts for the Fresno COG Model was tested for the 2040 forecast year.

FUTURE ROAD NETWORKS

The future road networks are based on the current adopted Fresno County Regional Transportation Plan update (2011 RTP). Improvements are included in the travel model master road network, and improvements are only included in model forecast years beyond the project completion year.

FUTURE TRANSIT NETWORK

A potential future transit network is based on the draft "No Build" scenario from the Fresno Public Transit Infrastructure Study. The No Build transit network includes committed extensions of the 2009 transit network.

FORECAST RESULTS

The results of the travel forecasts can include the following:

- Traffic volumes on each link
- Congested speeds and travel times on each link
- Comparison of volume to capacity on each link
- Summary measures by TAZ in the geodatabase
- Transit ridership on bus routes
- Traffic volumes by vehicle occupancy (single, two-person, 3+ persons)
- Summary measures of effectiveness (MOE) for the entire county (or subareas) such as vehicle-miles of travel, person-hours of delay or average speed by road type