Model Documentation

Madera County Travel Demand Model

March, 2014

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TRANSPORTATION ENGINEERING/PLANNING

Draft Model Documentation

Madera County Travel Demand Model

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1. INTRODUCTION

This report describes the Madera County travel demand forecast model. The report also includes a user guide for application of the model using the Cube software.

MODEL PURPOSE

The Madera County travel model is intended to provide reliable traffic forecasts to support the participating agencies in transportation and land use studies.

SUMMARY OF MODEL

The Madera County travel 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 performance measures.

Model Coverage and Transportation Analysis Zones (TAZs)

The study area for the Madera County travel model covers all of Madera County. The county is divided into approximately 570 transportation analysis zones (TAZs). Other travel to and from Madera County is represented by 16 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 numbers of housing units stratified by 10 types. Employment-related inputs include employment by 21 employment categories. There are additional inputs possible for "special generators," which would primarily be recreational uses.

Land uses outside of Madera County are represented by existing and projected traffic counts on the gateway roads at the county line.

Network Characteristics

The travel model roadway network includes nodes and links. Link types include freeway, highway, expressway, arterial, collector and freeway ramps. The model distinguishes between urban, suburban and rural areas. Important road network attributes include distances, number of lanes, uncongested speeds and terrain (flat, rolling or mountain).

Transit service is represented by attributes of each TAZ. If a TAZ is accessible to transit, the peak and off-peak average transit service frequencies are used to estimate transit times.

The NAD 83 State Plane California Zone 3 coordinate projection is used for the model networks so that the model network can be viewed together with other geographic information (GIS) such as street maps, TAZ maps and census information.

Forecasting Process

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

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

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.

3. **Mode Choice.** This step estimates the proportions of the total person trips using drive-alone or shared-ride auto, transit or non-motorized 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.

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

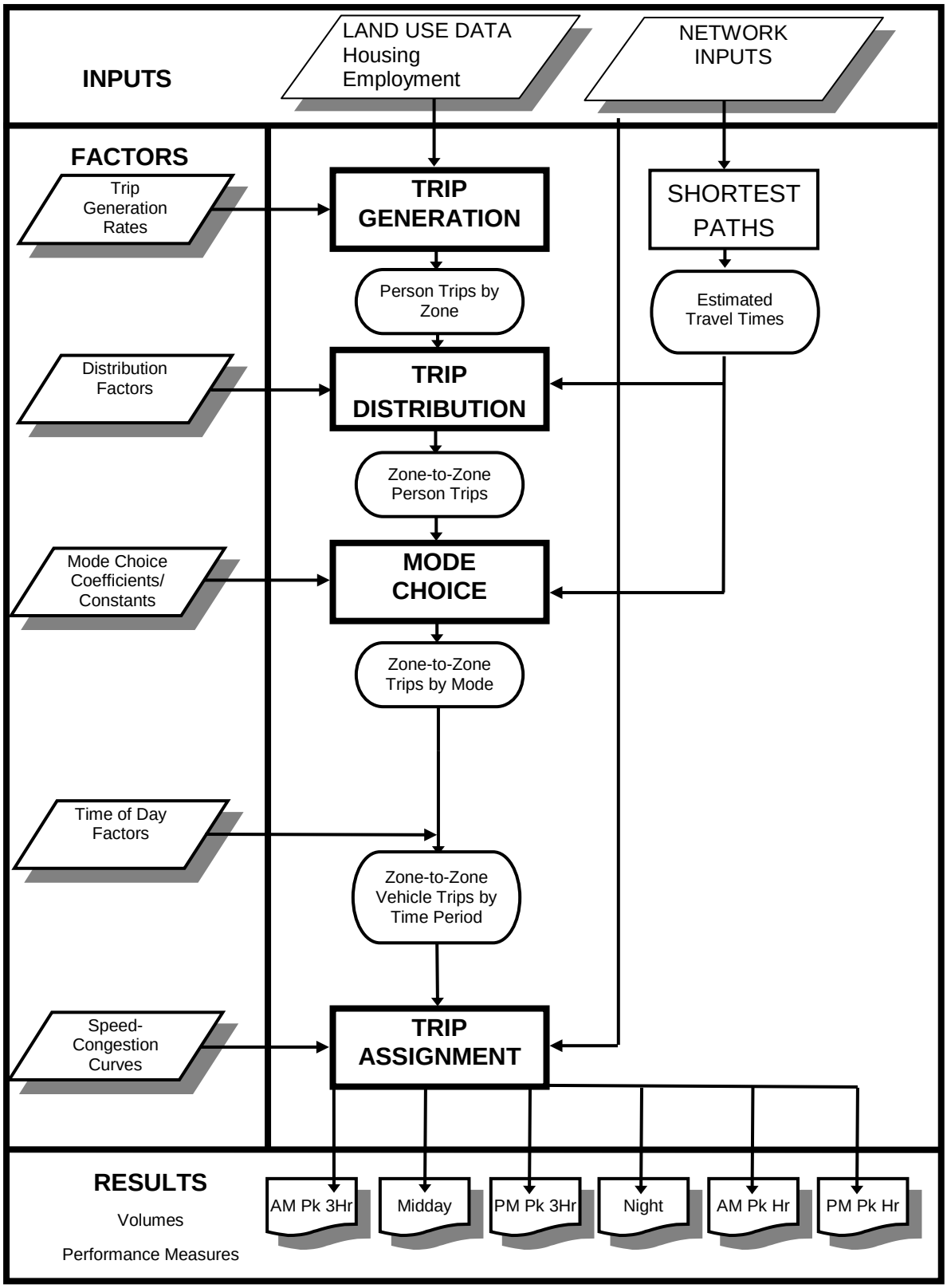
Forecast Time Periods

The Madera County travel model estimates travel demand and traffic volumes for the average weekday (Monday through Friday) daily time period, and traffic volumes for the A.M. and P.M. peak commute 3-hour periods and peak hours. Weekend peak traffic volumes could be estimated based on the weekday traffic volume forecasts and ratios of existing weekend-to-weekday traffic volumes measured from traffic counts.

Feedback Loops

The Madera County travel model includes a feedback loop that uses the congested speeds estimated from traffic assignment to recalculate the trip distribution. The feedback loop is also used to input congested road speeds to the mode choice process.

Figure 1: Travel Model Process



Model Validation

The Madera County travel model was validated by comparing its estimates of year 2010 traffic volumes with approximately 460 traffic counts from comparable years (2007-2010). The validation is compared to standard criteria for replicating total traffic volumes on various road types and for percent error on links.

Travel Model Software

The Sonoma County travel model uses the Citilabs Cube Voyager (version 6.1.1) software for all model components. Many input data files were prepared using ArcView GIS or Microsoft Excel.

2. MODEL STUDY AREA AND ZONE SYSTEM

The study area for the Madera County travel model covers all of Madera County. The county has been divided into Transportation Analysis Zones (TAZs) that are used to represent origins and destinations of travel. Travel to and from Madera County is represented by external gateway zones.

INTERNAL ZONES

Zone numbers 101 to 805 are used for internal Madera County zones. Not all zone numbers in this range have been used, allowing for future detailing or expansion of the model. The TAZs are generally smaller in size where land use density is higher, such as in downtown areas, while larger zones are used for the more rural portions of the county.

The TAZ map is maintained as a Geographic Information System (GIS) file using an ArcView polygon shapefile. The GIS file can be displayed with the travel model road network. Figure 2 shows the overall TAZ system in the County.

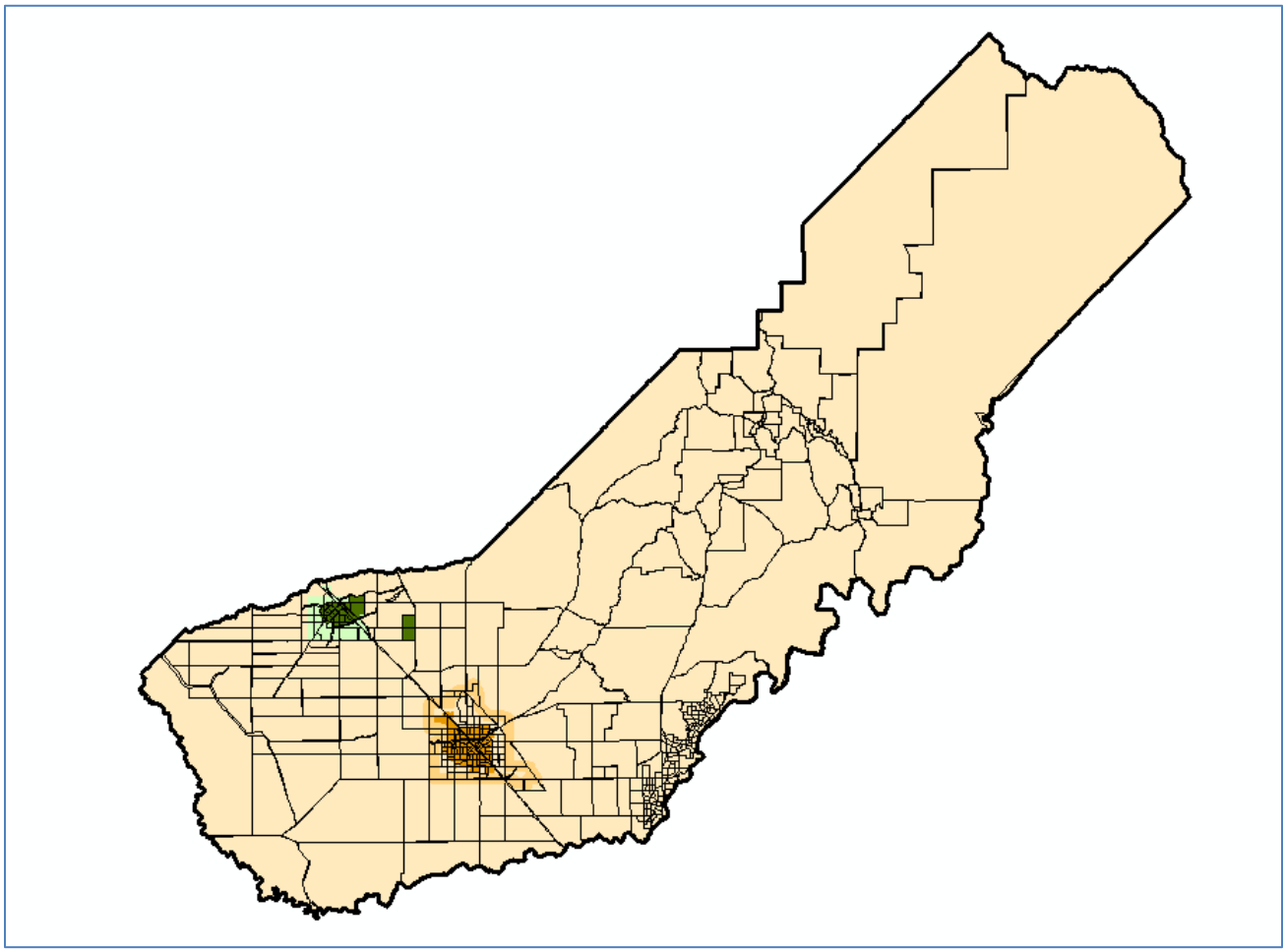
Numbering

There are 573 active TAZs. The numbering covers the range from 101 to 805 (Table 1).

Table 1: Madera County Model TAZs

Jurisdiction	Area	TAZ Range	Unused
Chowchilla	Chowchilla	101-124,144-200	146-200
Madera County	Chowchilla Sphere	125-143	
Madera County	Chowchilla Plan Area	672,708-712	
Madera	Madera	201-300,313	247,257,277,291-300
Madera County	Madera Sphere	301-312,314-347,350-400, 573	350-400
Madera County	Madera Planning Area	348-349,571-572,576, 603,605-606,608-609, 612-616,684-692,753-754	
Madera County	Rio Mesa	402-407,409-550	434-443,522,542-550
Madera County	Madera County	401,408,551-570,574-575, 577-602,604,607,610-611, 617-671,673-683,693-707, 713-752,755-805	566,574-575,578-600, 626-650,698,700,713-750, 767,781

Figure 2: Transportation Analysis Zones, Madera County



EXTERNAL ZONES

The Madera County travel model has 16 external gateways for representing travel into, out of, and through the county (Figure 3 and Table 2). Zone numbers 1 to 100 are reserved for external cordons. The numbers 1 to 60 are intended for gateways that lead to counties outside the eight San Joaquin Valley counties; these gateway numbers are common to all models in the San Joaquin Valley. The numbers 61 to 100 are for gateways between Madera County and other San Joaquin Valley counties.

Table 2 lists both base year traffic counts and future year traffic estimates. The future year traffic estimates are based on the California Statewide Travel Model and the methodology is described in a later section of this report.

Figure 3: Madera Model External Gateways

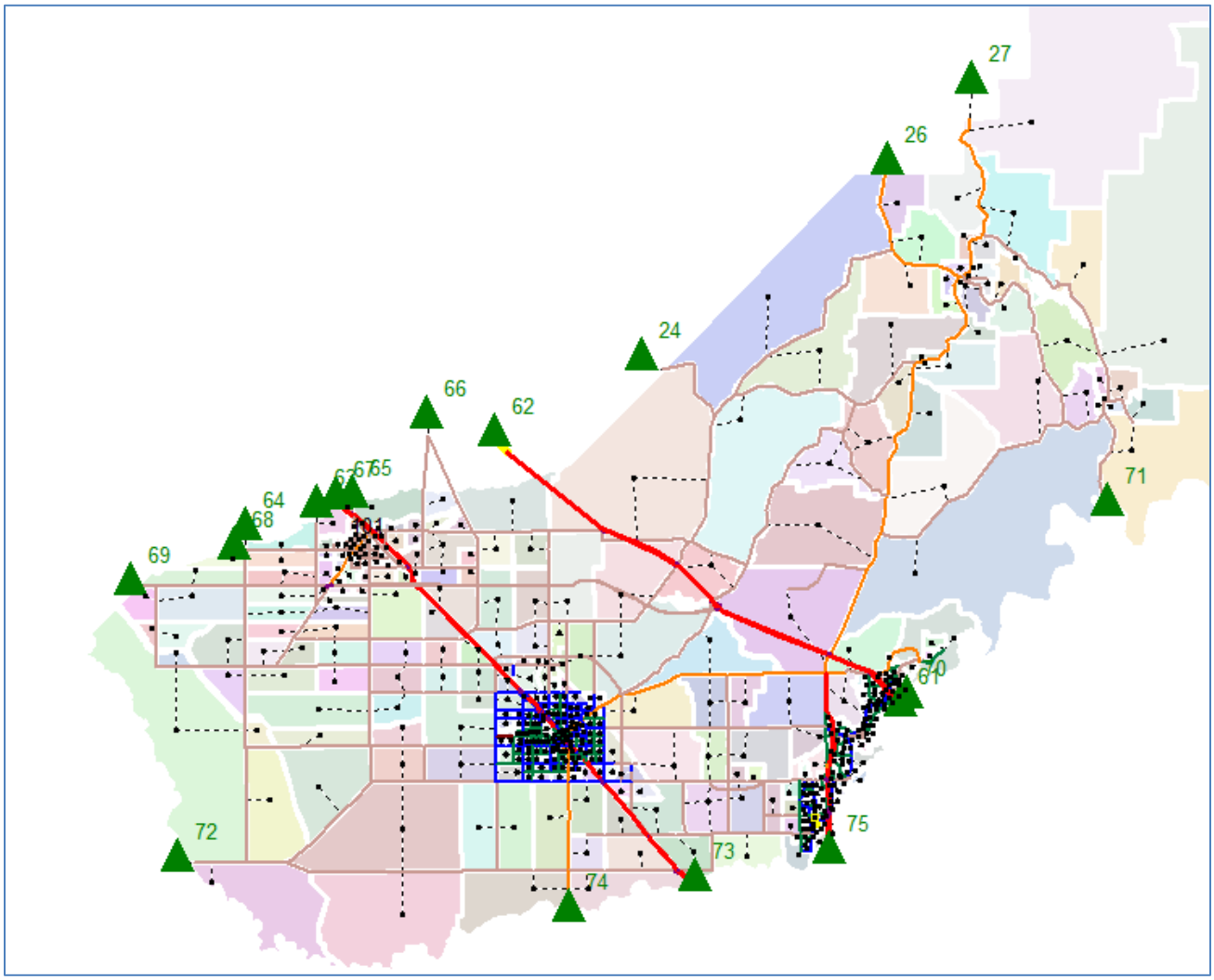


Table 2: Madera Model Gateway Volumes

Zone Number	Gateway	Location	2010 Volume	2040 Projection
24	Green Mountain/Ben Hur	Mariposa Co. Line	400	660
26	SR 49	Mariposa Co. Line	4,200	6,890
27	SR 41 North	Mariposa Co. Line	5,300	7,930
61	SR 65 South (future)	Fresno Co. Line	0	0
62	SR 65 North (future)	Merced Co. Line	0	0
63	Road 13	Merced Co. Line	100	130
64	Hemlock/Bliss	Merced Co. Line	700	2,020
65	Minturn Road	Merced Co. Line	1,200	1,970
66	Santa Fe Avenue	Merced Co. Line	1,000	1,050
67	SR 99 North	Merced Co. Line	37,500	40,890
68	Washington Road	Merced Co. Line	100	130
69	SR 152	Merced Co. Line	17,000	19,420
70	Road 206/Friant	Fresno Co. Line	7,900	23,660
71	Road 222/Powerhouse	Fresno Co. Line	1,400	1,750
72	Firebaugh/13th	Fresno Co. Line	7,200	11,820
73	SR 99 South	Fresno Co. Line	64,000	84,540
74	SR 145	Fresno Co. Line	6,300	17,750
75	SR 41 South	Fresno Co. Line	42,000	82,250

3. TRANSPORTATION NETWORKS

The Madera County travel 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 scenarios that correspond to various road improvement projects. The master network is currently set up for the following scenarios:

- 2010 Base Year
- Improvement 1
- Improvement 2

Other network scenarios can be added as necessary.

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 following network link variables are coded for each master network scenario:

- Road type (FACTYP)
- Area type (AREATYP)
- Lanes
- Auxiliary lanes (AUX)

- Speed
- Use (2 or 3 if the facility is designated for HOVs)
- Toll

At the beginning of the model process, the master network is processed to create the individual road network for the desired year and scenario.

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 the first 10,000 node numbers in the Madera County travel model reserved for the centroids of the TAZs, and non-TAZ nodes numbered from 10,001 to 11,856. The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays. The nodes representing TAZs contain additional information on the jurisdiction and subarea (Table 3).

Table 3: Master Network Node Attributes

Network Variable	Description
N*	Node number
X*	X-coordinate in feet (NAD 83 California State Plane Zone 3)
Y*	Y-coordinate in feet (NAD 83 California State Plane Zone 3)
OLDNODE	Node number from pre-MIP model
JURIS	Jurisdiction (Chowchilla, Madera, Madera County)
SOI	Sphere of influence (Chowchilla, Madera, Madera County)
SUBAREA	Planning area (such as city General Plan planning area outside SOI)
STDYINT	Placeholder to mark study intersections

*Network variables that are not edited by model users

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 "10232-10234"). Information is coded for each road link such as distance, facility type and speed (Table 4).

Turn Penalties. Turn penalties can be used to identify node-to-node movements which are prohibited (such as certain left turns) or which 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.

Table 4: Master Network Link Attributes

Network Variable	Description
A*	A node number
B*	B node number
DISTANCE*	Distance in miles (calculated from coordinates)
DIST_ADJ	Manual distance to override straight-line distance from coordinates
NAME	Road name
ROUTE	State route number if applicable
TERRAIN	F (Flat), R (Rolling) or M (Mountainous)
AREATYP	SUPERSEDED BY BASE_AREATYP
JURISDICTION	Within city limit or county
2010 BASE YEAR ATTRIBUTES	
BASE_FACTYP	Facility Type code representing the road type for 2010 Base Year (see Table 5)
BASE_AREATYP	Area Type code representing the 2010 Base Year: R = Rural SU = Suburban U = Urban F = Fringe (of the CBD) CBD = Central Business District
BASE_LANES	Number of through lanes in each direction for 2010 Base Year
BASE_AUX	Proportion of lane capacity to represent auxiliary lane in addition to BASE_LANES (recommended default is 0.5 if an auxiliary lane is present)
BASE_SPEED	Uncongested speed in miles per hour for 2010 Base Year
BASE_USE	Use code for vehicles allowed to use link: 0 or 1 = General purpose lane, all vehicle types permitted 2 = HOV lane, 2 or more person carpools only 3 = HOV lane, 3 or more person carpools only 4 = Large (combination) trucks prohibited 5 = Bike/walk only
BASE_TOLL	Toll in 2010 dollars to traverse link
ATTRIBUTES FOR ROAD IMPROVEMENT 1	
IMP1_PRJID	Identification number for improvement project 1 (optional)
IMP1_PRJYR	Year that link will be modified
IMP1_DESC	Description of Improvement 1 (optional)
IMP1_FACTYP	Facility Type code representing the road type for Improvement 1
IMP1_AREATYP	Area Type code for Improvement 1 (generally same as BASE_AREATYP unless area is developing from rural to urban)
IMP1_LANES	Number of through lanes in each direction for Improvement 1
IMP1_AUX	Proportion of lane capacity to represent auxiliary lane in addition to IMP1_LANES
IMP1_SPEED	Uncongested speed in miles per hour for Improvement 1
IMP1_USE	Use code for vehicles allowed to use link with Improvement 1
IMP1_HOV	Segment used by HOVs only for Improvement 1
IMP1_TOLL	Toll in 2010 dollars to traverse link with Improvement 1
ATTRIBUTES FOR ROAD IMPROVEMENT 2	
IMP2_xxxx	Same descriptions as IMP1

*Network variables that are not edited by model users

Capacity

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 road type (FACTYP), the area type and the terrain type (Table 5). The capacities are based on the capacity formulas for each road type in the *Highway Capacity Manual* (HCM). Input assumptions are based on HCM defaults wherever possible.

The Madera County travel model uses level of service "E/F" capacities representing the maximum flow. However, the model may still estimate traffic *demands* which exceed these maximum capacities.

Table 5: Capacities by Road Type

Facility Type (FACTYP)	Road Type	Terrain	Area Type	Capacity (Vehicles per Lane per Hour)
1	Freeway	Flat	Rural	2100
			Suburban	2000
			Urban	1900
			Fringe	1800
			CBD	1750
		Rolling	Rural, Suburban	1800
			Urban	1620
			Fringe, CBD	1580
		Mountain	Rural, Suburban	1500
			Urban	1350
			Fringe, CBD	1310
2	Highway	Flat	Rural, Suburban	1600/2000
			Urban	1600
			Fringe	1500
			CBD	1300
		Rolling	Rural, Suburban	1300/1800
			Urban	1300
			Fringe	1220
			CBD	1060
		Mountain	Rural, Suburban	700/1400
			Urban	700
			Fringe	660
			CBD	570
3	Expressway	Flat	Rural	1600/2000
			Suburban	1100
			Urban	1000
			Fringe	900
			CBD	800
		Rolling	Rural	1300/1800
			Suburban	890
			Urban	810
			Fringe	730
			CBD	650
		Mountain	Rural, Suburban	700/1400
			Urban	440
			Fringe	390
			CBD	350

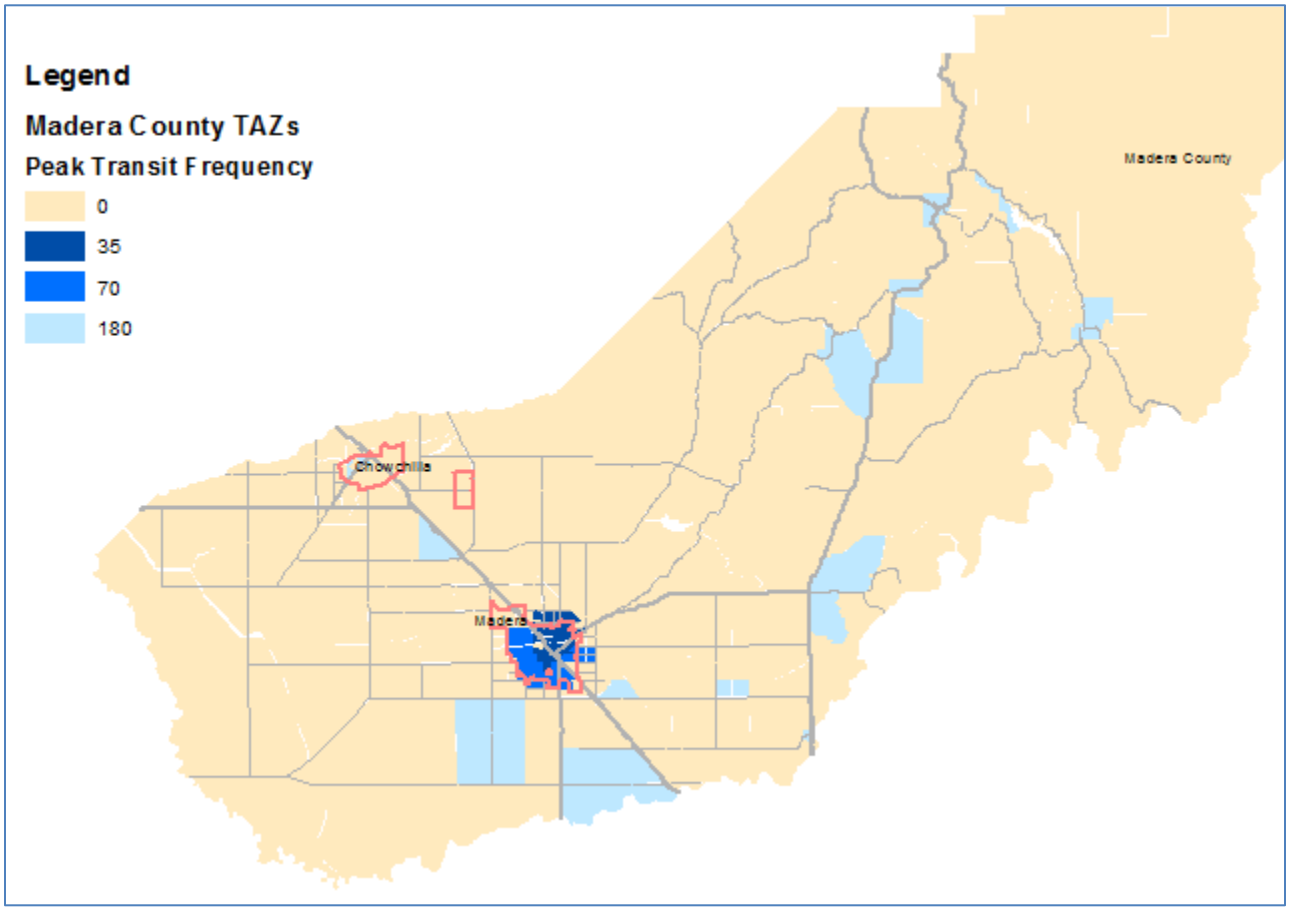
Table 6: Capacities by Road Type (continued)

Facility Type (FACTYP)	Road Type	Terrain	Area Type	Capacity (Vehicles per Lane per Hour)
4	Arterial	Flat	Rural	1600/1800
			Suburban	900
			Urban, Fringe	800
			CBD	750
		Rolling	Rural	1300/1700
			Suburban, Urban	730
			Fringe	650
			CBD	610
		Mountain	Rural	700/1400
			Suburban, Urban	390
			Fringe, CBD	350
5	Collector	Flat	Rural	1600/1800
			Suburban, Urban, Fringe, CBD	700
		Rolling	Rural	1300/1700
			Suburban	570
			Urban, Fringe	650
			CBD	570
		Mountain	Rural	700/1400
			Suburban	310
			Urban, Fringe	350
			CBD	310
6	Local	Flat	Rural	1100/1700
			Suburban, Urban, Fringe, CBD	600
		Rolling	Rural	1000/1600
			Suburban	550
			Urban, Fringe	640
			CBD	550
		Mountain	Rural	600/1300
			Suburban	330
			Urban, Fringe	380
			CBD	330
7	Ramp: Freeway-to-Freeway	All	All	1800
8	Ramp: Slip	All	All	1500
9	Ramp: Loop	All	All	1250
10	Zone Connector	All	All	0

TRANSIT SERVICE

The current version of the Madera County model estimates transit travel times based on service frequency and auto times. Bus routes are not directly coded into the model. Instead, each TAZ is designated by the average frequency of peak and off-peak transit service provided within walking distance of the TAZ (Figure 4).

Figure 4: Madera County Transit Service Areas



Bus Speeds

Bus travel times are derived from the road network. A factor of 2.0 times the travel time for vehicles traveling at the prevailing road speed was found to generally match scheduled bus operating speeds.

Wait Times

Average wait times for bus trips are estimated as one-half of the maximum of the transit frequencies at the origin and destination of each trip. For example, if a particular trip has 70 minute service at the origin end and 35 minute service at the destination end, the average wait time will be estimated as one-half of 70 minutes (the maximum of 70 and 35) or 35 minutes average wait time.

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 10 residential, 21 non-residential and three school categories (Table 7).

Residential Categories

The 10 residential categories correspond to the categories used by the United States Census to classify unit type. Since this information was available for the 2010 base year from the 2010 Census, all 10 categories were used for the 2010 base year inventory, and then estimated for future residential land uses based on the 2010 proportions. However, not all 10 categories need to be used for future forecasts. The trip generation rates in the model are essentially the same for the following three groupings:

1. Single family: RU1 and RU2
2. Multi-family: RU3 through RU8
3. Mobile: RU9 and RU10

Only these three basic categories are required for correct operation of the model. The model will provide the same results if all single-family housing is assigned to RU1, all multi-family housing assigned to RU3 and all mobile housing assigned to RU9.

Household Stratification

Each of the major household types (single-family, multi-family, mobile home) are further stratified into 25 household categories, based on five household size categories and five household income categories. The 2010 household stratification by category is listed in Table x.

The model user does not need to enter this detailed household stratification information. The percentages of households in each category were derived from the 2005-2009 American Community Survey (ACS) Public User Microdata Sample (PUMS). These percentages were calculated at the census block group level. The numbers of households in each TAZ are automatically multiplied by the appropriate percentages for the census block group containing that TAZ. This essentially assumes that the household stratification in each area will remain constant in the future. The 2005-2009 percentages can be overruled for some or all of the TAZs if a different household stratification needs to be tested.

Table 7: Land Use Categories

Land Use Code	Land Use Category	Forecast Category	Units	Comments
RU1	Single Family Detached	Single Family	Dwelling Units	
RU2	Single Family Attached	Single Family	Dwelling Units	
RU3	Multi Family 2 Unit	Multi Family	Dwelling Units	Duplexes
RU4	Multi Family 3 or 4 Unit	Multi Family	Dwelling Units	
RU5	Multi Family 5-9 Units	Multi Family	Dwelling Units	
RU6	Multi Family 10-19 Units	Multi Family	Dwelling Units	
RU7	Multi Family 20-49 Units	Multi Family	Dwelling Units	
RU8	Multi Family 50 or More Units	Multi Family	Dwelling Units	
RU9	Mobile Home	Mobile Home	Dwelling Units	
RU10	Boat, RV, Van, etc…	Mobile Home	Dwelling Units	
AGRICULTUR	Agriculture, Forestry, Fishing and Hunting (11)	Agriculture	Employees	Includes packing but not processing, landscape services, veterinary
MINING	Mining, Quarrying, Oil and Gas Extraction (21)	Other	Employees	
UTILITIES	Utilities (22)	Other	Employees	Electric, gas, phone, etc…
CONSTRUCTN	Construction (23)	Other	Employees	
MANUFACTUR	Manufacturing (31-33)	Industrial	Employees	
WHOLESALE	Wholesale (42)	Other	Employees	
RETAIL	Retail (44-45)	Retail	Employees	Not including restaurants
WAREHOUSE	Transportation and Warehousing (48-49)	Other	Employees	Trucking
INFORMATN	Information (51)	Office	Employees	Media, public relations
FINAN_INSR	Finance and Insurance (52)	Office	Employees	
REALESTATE	Real Estate, Rental and Leasing (53)	Office	Employees	
SVC_PROF	Professional, Scientific, and Technical Services (54)	Office	Employees	Accounting, architects, engineering
SVC_MNGMNT	Management of Companies and Enterprises (55)	Office	Employees	
SVC_ADMIN	Administrative/Support, Waste Management & Remediation (56)	Office	Employees	Includes office temporary services
EDUCATION	Educational Services (61)	Service	Employees	K-12, colleges, driving schools, music lessons, etc….
HEALTH	Health Care and Social Assistance (62)	Service	Employees	Hospitals, clinics, dentists, residential care
ENT_REC	Arts, Entertainment and Recreation (71)	Service	Employees	Movies, golf courses, casinos
ACCOMODTNS	Accommodations (721)	Service	Employees	Hotel, motel
FOOD	Food Services (722)	Service	Employees	Restaurants, catering
SVC_OTHER	Other Services Except Public Administration (81)	Service	Employees	Churches, auto repair, cleaning, etc…
PUBLIC	Public Administration (92)	Government	Employees	

Table 7: Land Use Categories

Land Use Code	Land Use Category	Forecast Category	Units	Comments
ELEM	Elementary and middle school enrollment	School	Students	Also accounts for employee trips
HS	High school enrollment	School	Students	Also accounts for employee trips
COLLEGE	College enrollment	School	Students	Also accounts for employee trips

2010 BASE YEAR LAND USE DATA

A 2010 land use database was developed to provide inputs to the 2010 model validation. The 2010 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.

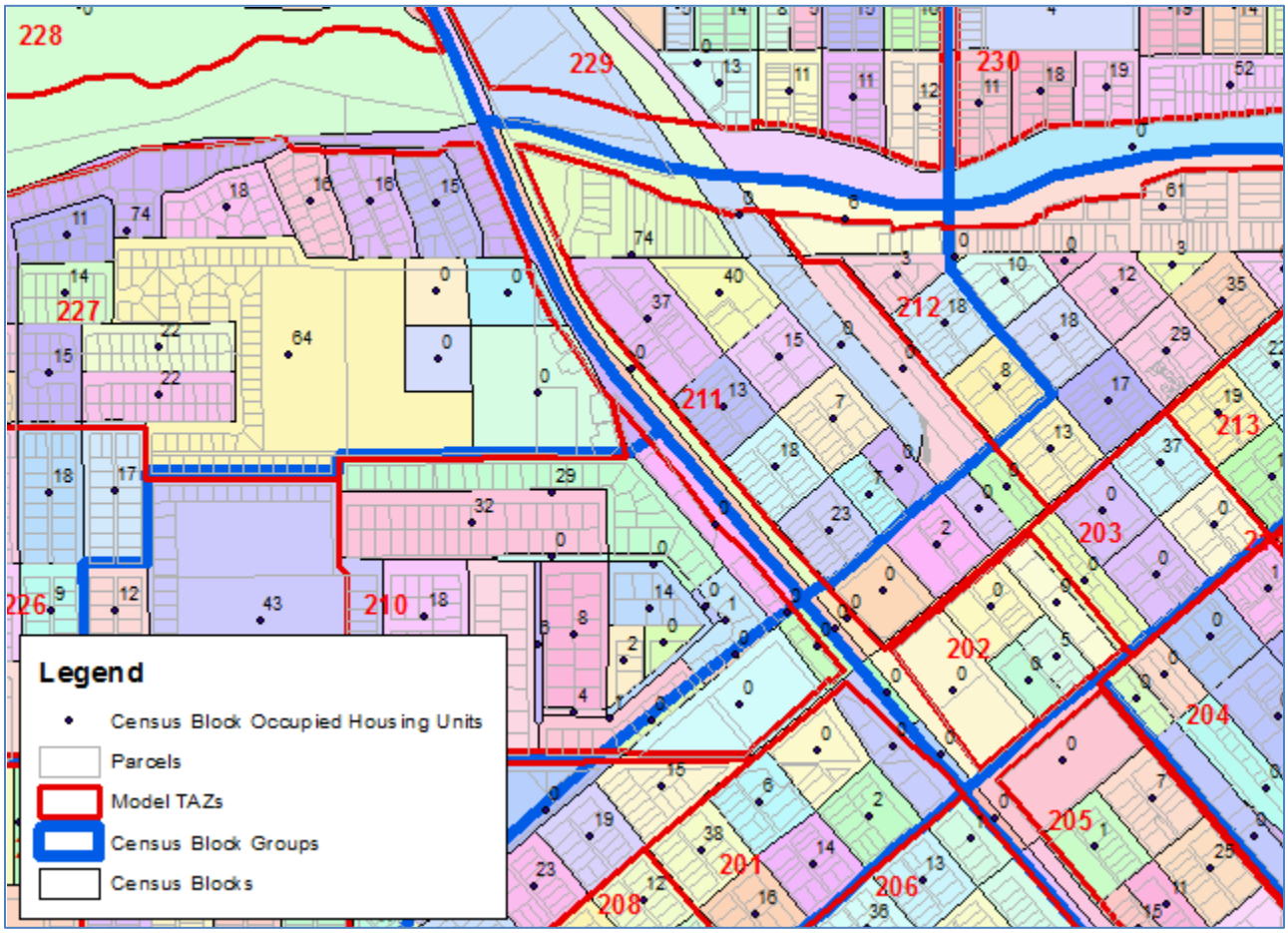
2010 Housing Data

The 2010 household inputs were developed based on 2010 United States Census information by census block and block group. At the more detailed block level, information was available on total, occupied and vacant housing units. At the block group level, additional information was available on the 10 housing categories. For each block group, the proportions of housing units in each of the 10 categories were applied to the occupied housing units for each census block within the block group. Therefore, the numbers of households are correct at the detailed block level, and the proportions of housing types are correct at the block group level, but the proportions by type may be somewhat high or low for individual blocks within each block group.

A "centroid" was identified for each census block. The 2010 housing for each TAZ was calculated by summing the 2010 census block data (occupied housing units divided into 10 categories) for each census block centroid that was within the TAZ boundary (Figure 5). Additional correspondence effort was required because the Madera County TAZ map contains some gaps between TAZs, so that some census block centroids did not initially fall within a TAZ. Those census block centroids were then assigned to the nearest TAZ.

In most parts of Madera County, the census blocks nest within TAZ boundaries. In a few locations, a census block boundary may extend beyond a TAZ boundary, and it is possible that some housing units were assigned to an incorrect adjacent TAZ. However, the total number of housing units in the vicinity would be correct.

Figure 5: Example Census Housing Tabulation



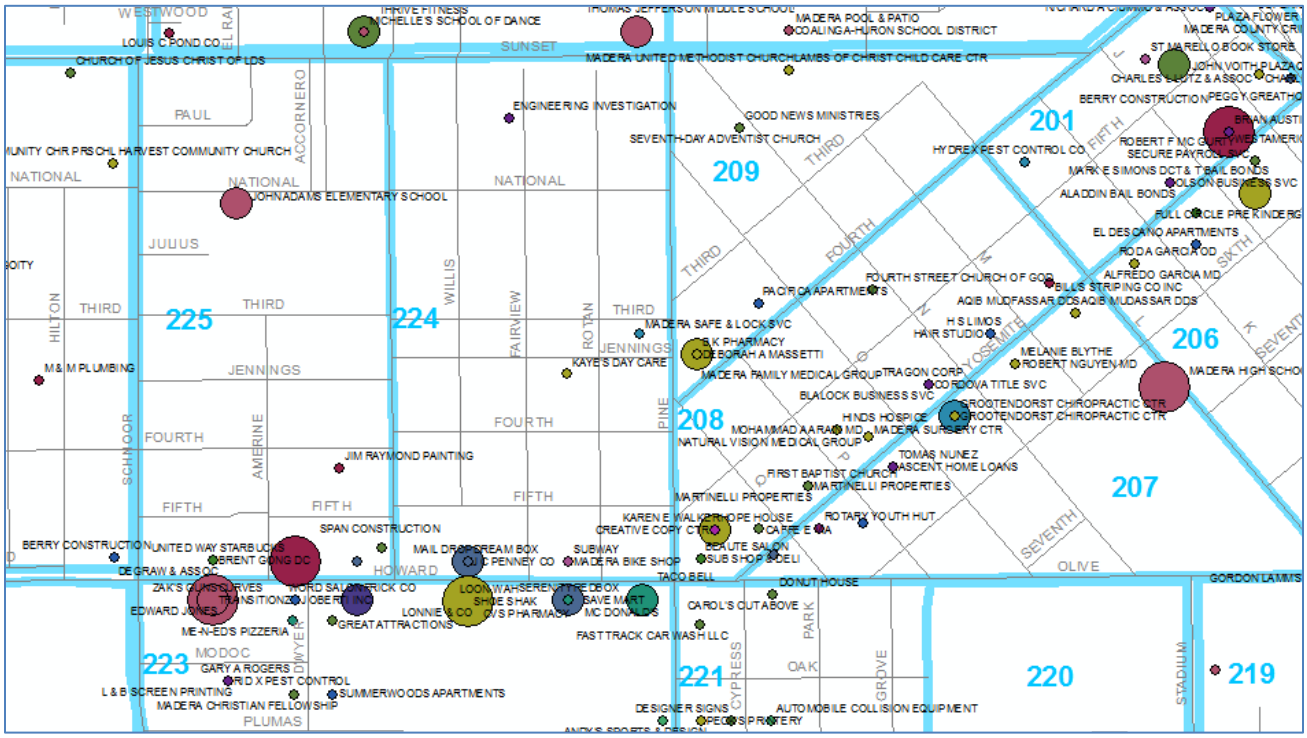
2010 Employment Data

Employment numbers and locations were initially compiled from a commercial database from InfoUSA. The commercial 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 Madera County was contacted to get direct information on employee numbers and locations.

The employer addresses in the expanded InfoUSA database were geocoded to specific points on the Madera County street network (Figure 6).

The totals from the expanded InfoUSA database were compared to the 2010 annual averages from the California Employment Development Department (EDD) (Table 8). Adjustment factors were applied to the numbers of employees at each employment site so that the total employees in each category would be consistent with the EDD annual totals. The inventory based on InfoUSA represents all employees at a site, including both full-time and part-time, while the EDD totals represent full-time equivalent employment. Therefore, the adjustment factors for categories with more seasonal and part-time employees, such as construction and food services, tend to reduce the total inventory.

Figure 6: Example Employment Geocoding with TAZs



Agricultural Employment

Much of the agricultural employment in Madera County cannot be attributed to a specific address. The employees that could be attributed to a specific address were allocated to those address locations without adjustment. The difference between those 2,690 employees and the EDD annual average of 10,292 agricultural employees were assumed to have employment locations consistent with the locations of croplands in Madera County. A GIS layer of cropland was superimposed with the Madera County model TAZ system (Source: California Department of Conservation, ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/2010/). The 7,602 unassigned employees were allocated to TAZs based on the proportion of total cropland acreage in each TAZ relative to the county total cropland acreage (Figure 7).

2010 School Enrollment

School enrollment for the 2010 base year was compiled for 116 public, private and parochial schools in Madera County. The enrollment was allocated to TAZs based on geocoding of the school addresses.

SPECIAL GENERATORS

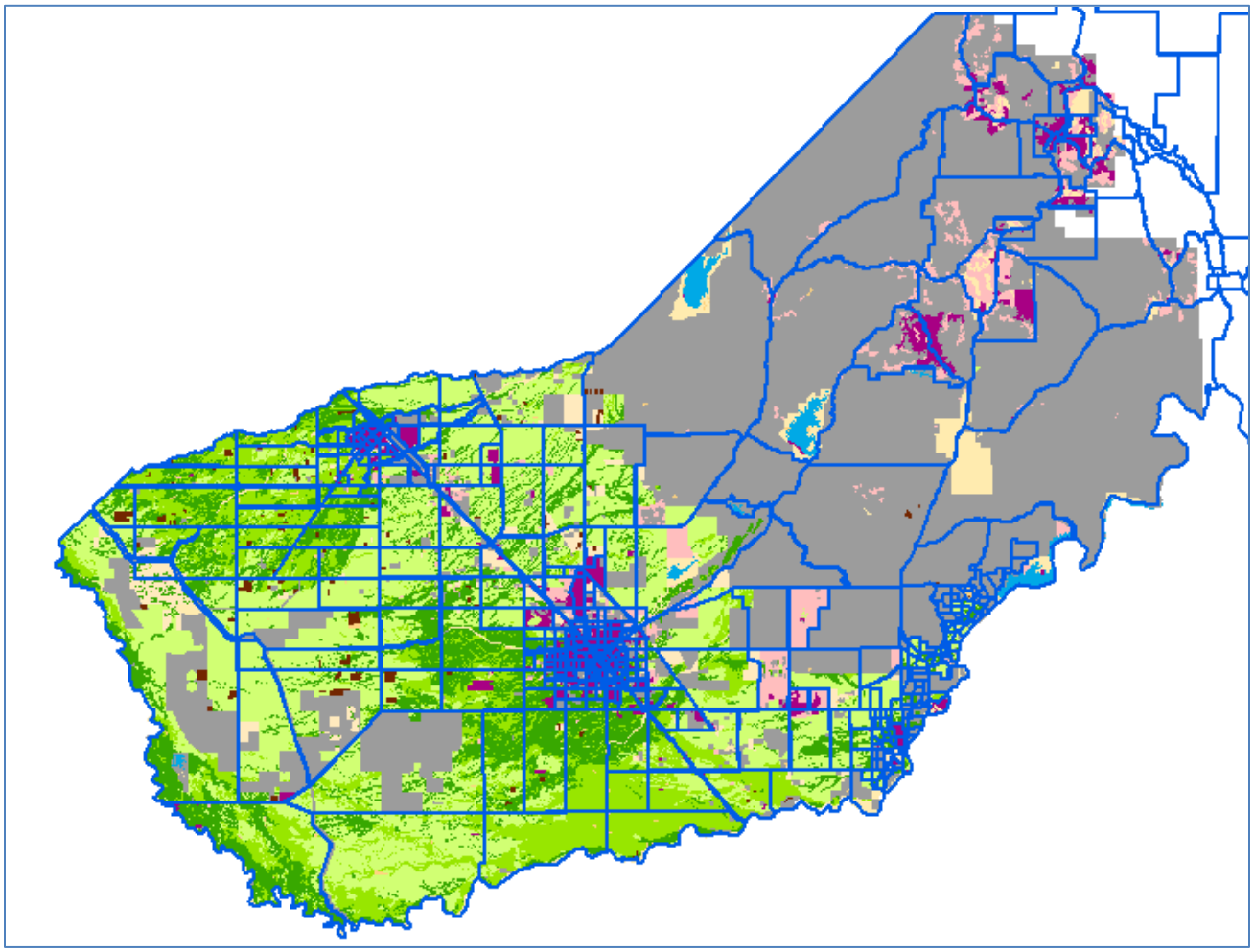
Special generators are intended to account for trips that are not primarily related to employment. No special generators are currently assumed in the Madera County travel model.

Table 8: 2010 Employment Comparison

Category	2010 EDD Annual Average	2010 Inventory	2010 Inventory with Valid Address	Adjustment Factor	2010 Adjusted Inventory
Agriculture	10,292	2,761	2,690	1.000	10,292*
Mining		6	0	0.691	0
Construction		2,088	1,653	0.691	1,163
Subtotal	*1,142*	*2,094*	*1,653*		*1,163*
Utilities		100	95	1.044	97
Warehouse		766	719	1.044	743
Subtotal	*850*	*866*	*814*		*840*
Manufacturing	2,783	3,692	3,656	0.761	2,796
Wholesale	625	777	686	0.911	645
Retail	3,417	4,083	3,945	0.866	3,461
Post Office		190	171	1.257	216
Education		3,253	3,213	1.257	4,043
Public		5,276	5,220	1.257	6,574
Subtotal	*10,817*	*8,719*	*8,604*		*10,833*
Information	400	574	542	0.738	398
Finance/Insurance		737	681	0.460	294
Real Estate		976	859	0.460	351
Subtotal	*708*	*1,713*	*1,540*		*645*
Professional Services		1,017	873	1.003	873
Management Services		2	0	1.003	0
Administrative Services		808	662	1.003	662
Other Services		2,093	1,939	1.003	1,939
Subtotal	*3,483*	*3,920*	*3,474*		*3,474*
Health	5,650	6,576	6,464	0.874	5,732
Entertainment/Recreation	275	1,974	1,949	0.141	273
Accommodations		821	806	0.702	566
Food		2,483	2,471	0.702	1,737
Subtotal	*2,300*	*3,304*	*3,277*		*2,303*
TOTAL	**42,742**	**41,064**	**39,294**		**42,855**

*Includes farm employees allocated to crop lands.

Figure 7: Madera County Crop Lands and TAZs



FUTURE HOUSING AND EMPLOYMENT

The land use forecasts for the Madera County travel model were developed using a combination of:

- Overall growth forecasts for Madera County from several sources
- Detailed information on individual planned development in each jurisdiction

Forecasts were compiled for specific horizon years up to 2040 as well as an estimate of full buildout of all zoning.

Additional Land Use Modeling

This report documents the initial development of the land use forecasts. These initial forecasts were used as a starting point for two land use modeling tools: Cube Land and UPlan.

Cube Land Model

The Cube Land application was developed, calibrated and tested as part of this model update process, but ultimately was not used for Regional Transportation Plan (RTP) scenario development. Information on the Cube Land model is included in the Appendix.

UPlan Model

The UPlan land use modeling tool was eventually used to develop a revised 2040 base case "status quo" scenario, and then to develop alternative future land use scenarios for RTP evaluation. The UPlan model started with the same control totals by jurisdiction and subarea as the initial land use forecasts documented in this report, but reallocates the specific future land uses to geographic areas based on various rules and attractors (such as new transportation facilities). These land use scenarios developed using UPlan will be documented in the RTP.

Countywide Growth Forecasts

The overall growth forecasts for Madera County are based on the California Department of Finance (DOF) Demographic Research Institute "Interim Projections of Population for California: State and Counties, July 1, 2015 to 2050 (in 5-year increments)" released on May 7, 2012. The DOF forecasts provide population totals for each county in California in 5-year increments up to 2050. The DOF forecasts do not provide population in county subareas, or forecasts of housing or employment.

The Madera County Transportation Commission developed forecast control totals based on the DOF countywide population forecasts and 2010 Census information. Countywide population was allocated to the two incorporated city areas and the unincorporated county area based on the proportions of population in the 2010 Census. The 2010 Census countywide total ratio of 3.48 persons per household was applied to develop housing forecasts for each subarea. The 2010 countywide total ratio of 0.99 employees per population was developed based on the 2010 population from the Census and the 2010 employment total from California EDD. The 0.99 ratio was then used to develop the employment forecast for each county subarea (Table 9).

Buildout Capacity

The land use allocation for each TAZ was based on first assessing the total development capacity of each area based on planned or allowable uses. A different procedure was used for each jurisdiction and subarea.

Table 9: Madera County Growth Forecasts

Year	2010	2020	2035	2040
POPULATION				
Chowchilla (Households)	11,317[1]	13,628[3]	18,044[3]	19,727[3]
Chowchilla (Prisons)	7,403[1]			
Madera	61,416[1]	74,571[3]	98,734[3]	107,943[3]
Unincorporated	70,729[1]	94,977[3]	125,752[3]	137,481[3]
Total	**150,865**[1]	**183,176**[2]	**242,530**[2]	**265,151**[2]
HOUSEHOLDS				
Chowchilla	3,673[1]	3,912[4]	5,179[4]	5,662[4]
Madera	15,938[1]	21,405[4]	28,340[4]	30,984[4]
Unincorporated	23,706[1]	27,262[4]	36,096[4]	39,462[4]
Total	**43,317**[1]	**52,758**	**69,615**	**76,108**
EMPLOYMENT				
Chowchilla	2,508[5]	3,871[6]	5,126[6]	5,604[6]
Madera	19,834[5]	21,183[6]	28,047[6]	30,662[6]
Unincorporated	20,513[5]	26,979[6]	35,721[6]	39,053[6]
Total	**42,855**	**52,033**	**68,894**	**75,319**

Sources:

1. California Department of Finance based on 2010 United States Census.

2. California Department of Finance Projections (2012 release).

3. Madera County Transportation Commission, allocation of county total based on 2010 proportions.

4. Madera County Transportation Commission, based on 2010 countywide ratio of 3.48 persons per household.

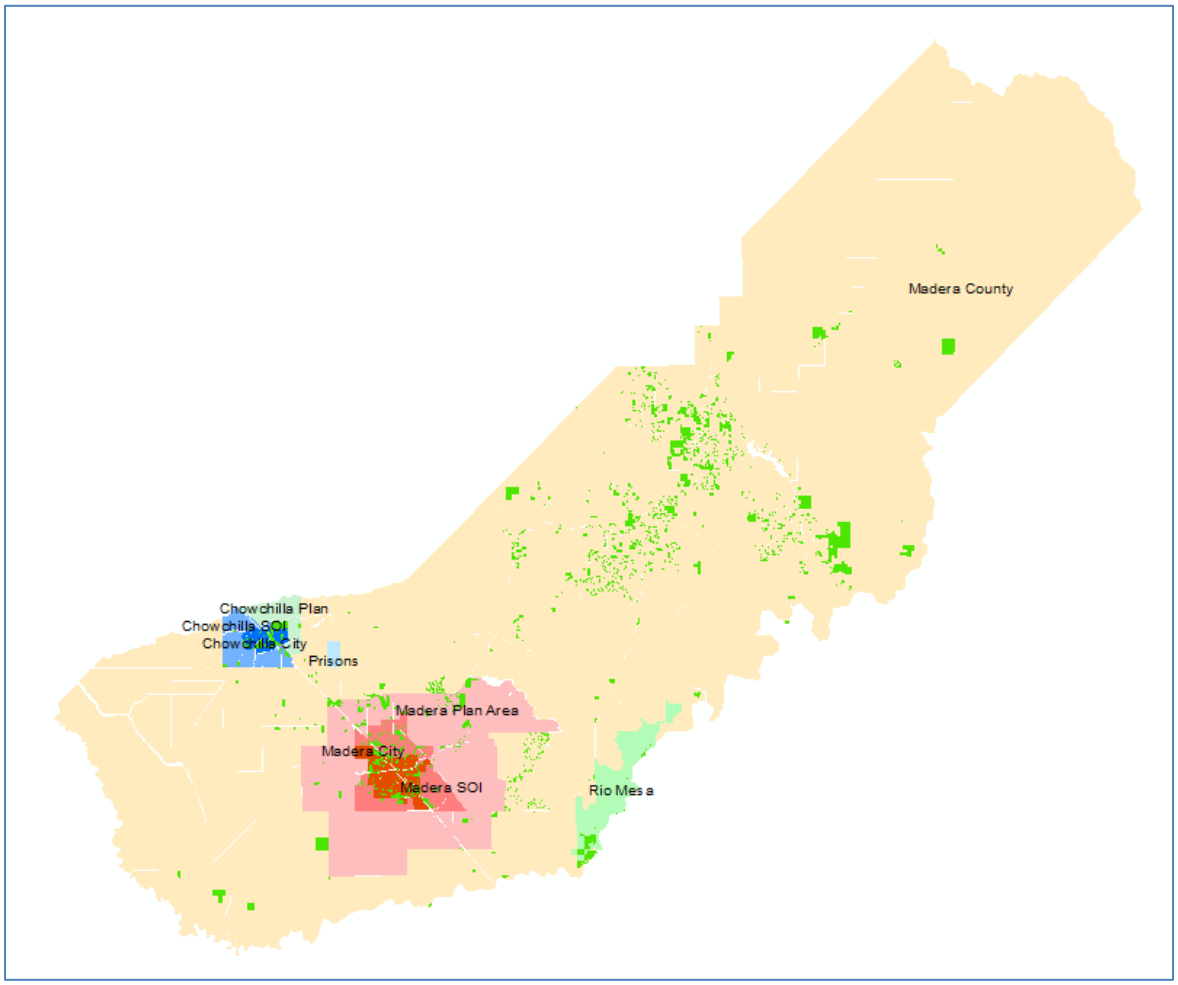
5. 2010 employment inventory based initially on InfoUSA.

6. Madera County Transportation Commission, based on 2010 countywide ratio of 0.99 employees per household.

Madera County Buildout

The initial estimate of buildout potential was based on an Assessor's Parcel map provided by Madera County (current as of February, 2011). All parcels with a Use Code corresponding to "vacant land" were identified (Figure 8) and the acreages tabulated. These parcels were then overlaid with the General Plan maps from Madera County and City of Madera (the Chowchilla General Plan maps were not available in GIS format and the comparisons were done manually). The most likely uses were assigned to each vacant parcel based on the plan map. The numbers of housing units and/or employees for each vacant parcel were then estimated by multiplying acreage times factors documented in the Madera County General Plan.

Figure 8: Madera County Parcels with Vacant Land Designation



The initial tabulations of vacant land capacity based on the county information indicated that this parcel map did not fully account for all developable land in the Chowchilla or Madera planning areas, or within the Rio Mesa development area. Therefore, the tabulation of vacant land from the county parcel map was only used to estimate development potential for the following areas:

- City of Madera, vacant parcels within current city limits
- City of Chowchilla, vacant parcels within current city limits
- Madera County excluding Chowchilla and Madera planning areas and Rio Mesa

The factors used to estimate housing and employment capacity are listed for residential (Table 10) and non-residential (Table 11) categories. The range of residential units per acre and the assumed housing units per acre (generally the midpoint of the range) are from the Madera County General Plan. The assumed employees per acre and percentages of employees by type for each non-residential category are based on a detailed analysis of employment types and zoning categories conducted for the Fresno Council of Governments; these factors would be expected to be similar in Madera County.

Table 10: Madera County Residential Capacity Factors

Label	Land Use Designation	Residential Density	Assumed Housing Units per Acre
AGRICULTURE			
AE	Agriculture Exclusive	1-2 du per 36 ac min parcel	0.04
A	Agriculture	1-2 du per 18 ac min parcel	0.08
OS	Open Space	0.05 du per ac	0.05
RESIDENTIAL			
AR	Agricultural Residential	1-2 du per 10 ac min parcel	0.15
RER	Rural Estate Residential	1-2 du per 5 ac min parcel	0.30
RR	Rural Residential	0.5 du/ac	0.5
VLDR	Very Low Density Residential	2 du/ac	1.5
LDR	Low Density Residential	1.0-7.5 du/ac	5
MDR	Medium Density Residential	5.0-12.0 du/ac	8.5
HDR	High Density Residential	12.0-25.0 du/ac	17.5

Source: Madera County General Plan (1995)

Table 11: Madera County Employment Capacity Factors

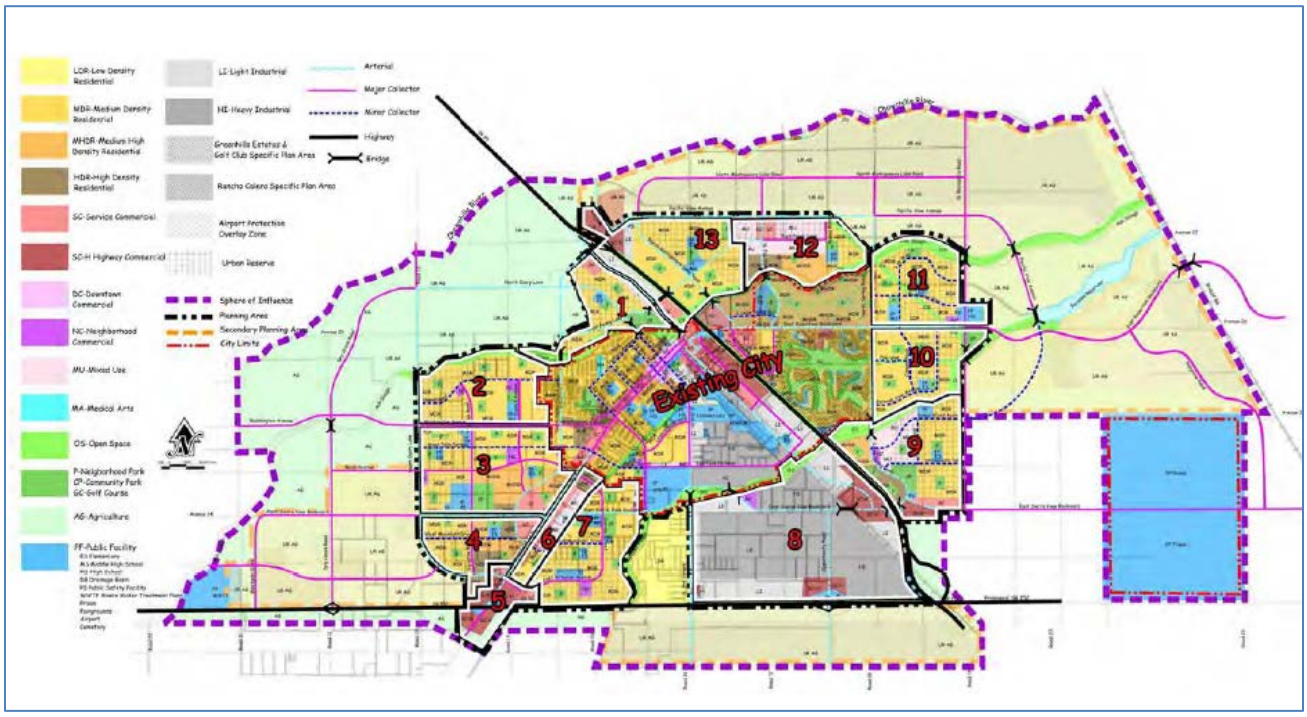
			Percentage of Employees by Type							
Label	Land Use Designation	Emps per Acre	Retail	Office	Serv	Educ	Govt	Agr	Indust	Other
PO	Professional Office	42.0	1.7%	57.1%	16.0%	7.4%	5.7%	1.7%	1.0%	9.5%
NC	Neighborhood Commercial	18.0	38.3%	6.7%	34.4%	1.1%	1.7%	0.0%	0.0%	17.8%
CC	Community Commercial	14.0	67.1%	5.7%	15.7%	1.4%	2.1%	0.0%	0.0%	7.9%
HSC	Highway Strip Commercial	16.0	35.0%	2.5%	38.8%	1.9%	1.9%	0.0%	0.0%	20.0%
LI	Light Industrial	12.0	5.8%	2.5%	28.3%	0.8%	4.2%	3.3%	20.8%	34.2%
HI	Heavy Industrial	8.0	3.8%	0.0%	5.0%	1.3%	0.0%	23.8%	33.8%	32.5%
PI	Public	28.4	0.1%	0.0%	7.1%	22.6%	53.5%	0.0%	0.0%	16.6%
AE	Agricultural	0.1	0.0%	0.0%	0.0%	0.0%	0.0%	100%	0.0%	0.0%

Source: Kittelson & Associates, 2012

City of Chowchilla Buildout

The development potential for the Chowchilla planning area was primarily based on the Chowchila General Plan. The General Plan listed capacity for 13 growth areas (Figure 9 and Table 12). These growth areas were overlaid with the model TAZs, and the proportions of each growth area in each TAZ were estimated. The growth area land uses were then allocated to TAZs based on the specific locations of the various land uses.

Figure 9: Chowchilla General Plan and Growth Areas



For potential development within the current city limits, the vacant parcel tabulations from Madera County were used as described above, with the Chowchilla General Plan used to define the land use types for vacant parcels.

City of Madera Buildout

The development capacity for the City of Madera was estimated differently for areas within the existing city limits, and for areas outside the city limits but within the city's planning area.

For areas within the city limits, information from the City of Madera (transmitted May 2013) was used to identify vacant parcels and General Plan zoning (Figure 10). The vacant parcels were assigned a land use classification based on the General Plan zoning.

For areas outside of city limits but within the planning area covered by the Madera General Plan, it was assumed that all land would ultimately develop according to the General Plan designations. Instead of tabulating vacant acreage, all land area was assumed to be available for development and tabulated.

Table 12: Chowchilla General Plan Growth Area Capacity

Growth Area	Acreage	Dwelling Units	Industrial/Commercial Square Feet	Park Acres
1	511	936	348,262	15
2	684	1,944	235,224	30
3	1,015	3,316	805,860	45
4	633	3,580	47,916	45
5	253	1	155,945	0
6	247	1,190	1,031,936	16
7	748	1,860	196,020	24
8	2,092	0	5,287,531	0
9	1,047	3,435	1,404,157	43
10	624	1,464	0	19
11	634	1,328	117,612	19
12	604	1,930	3,777,523	22
13	1,017	2,441	1,625,441	33
TOTAL	**10,109**	**23,425**	**15,033,427**	**311**

Source: Chowchilla General Plan Table LU-5

The Madera General Plan (outside current city limits) includes approximately 63 acres in the category of Neighborhood Mixed Use (NMU), 36 acres in Village Mixed Use (VMU) and over 5,600 acres in Village Reserve.

- **Mixed Use:** The NMU and VMU mixed use categories were assumed to be 50 percent residential and 50 percent commercial, with the average residential density assumed to be consistent with the Medium Density residential category (recognizing that mixed use areas may include a variety of housing densities).
- **Village Reserve:** The Village Reserve areas were assumed to develop at 50 percent of their maximum land area, in order to achieve housing unit capacity totals more consistent with the General Plan EIR. The average residential density for Village Reserve was assumed to be consistent with the Low Density residential category. For commercial areas, one percent (1%) of the Village Reserve land area was assumed to develop as commercial uses, consistent with descriptions provided in the Madera General Plan.

For the vacant land within city limits and all land within the planning area but outside city limits, the acreages were aggregated to TAZs and converted to potential housing units and employment using the factors listed in Table 13 and Table 14. This calculation provided the estimates of buildout capacity for the City of Madera planning area.

Figure 10: City of Madera Vacant Land

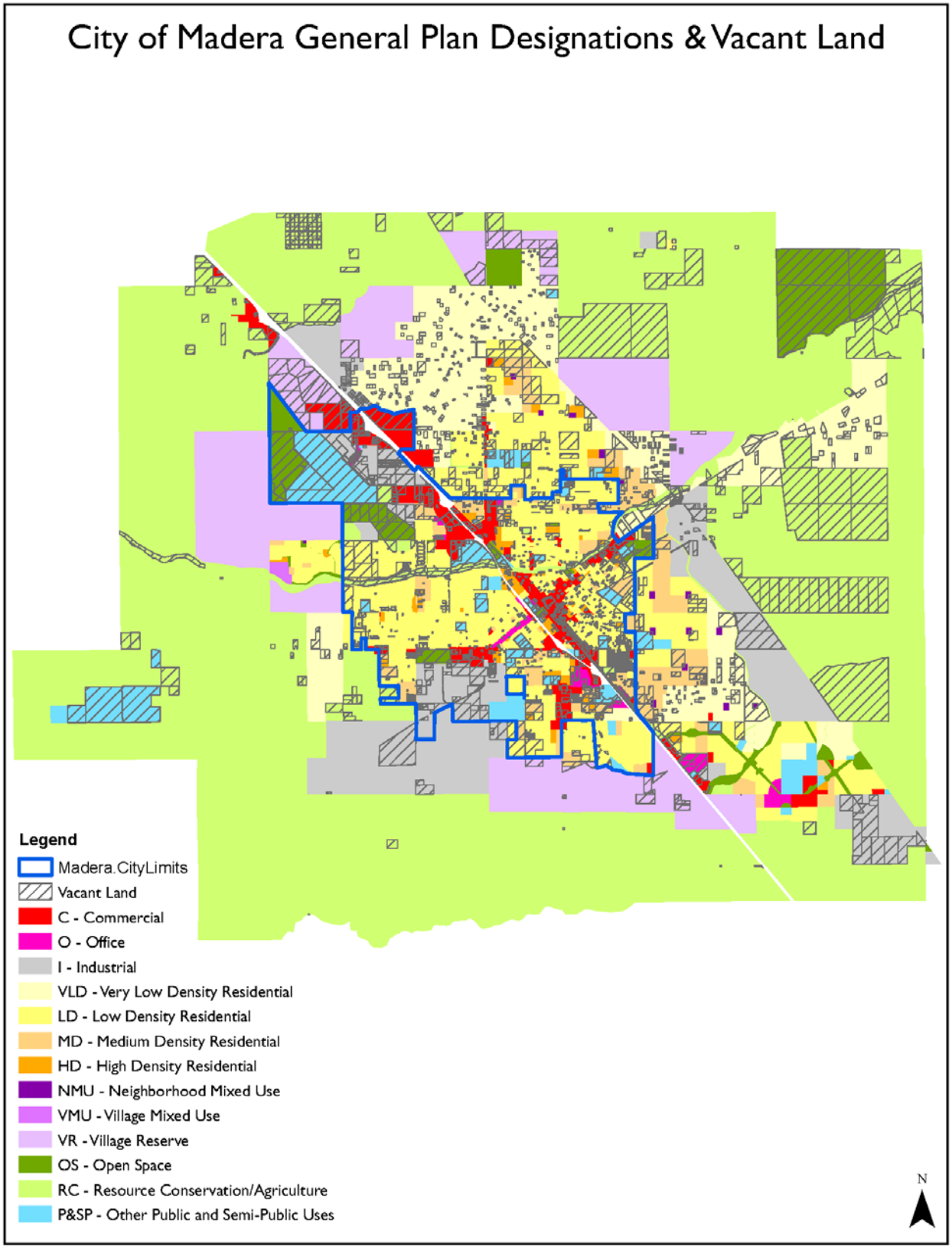


Table 13: City of Madera Residential Capacity Factors

Label	Land Use Designation	Housing Units per Acre	Land Coverage	Assumed Housing Units per Acre
VLD	Very Low Density	1.5	100%	1.5
LD	Low Density	5.25	100%	5.25
MD	Medium Density	11.25	100%	11.25
HD	High Density	22.5	100%	22.5
NMU	Neighborhood Mixed Use	11.25	50%	5.625
VMU	Village Mixed Use	11.25	50%	5.625
VR	Village Reserve	5.25	50%	2.625

Sources: City of Madera General Plan, Kittelson & Associates

Table 14: City of Madera Employment Capacity Factors

			Percentage of Employees by Type							
Label	Land Use Designation	Emps per Acre	Retail	Office	Serv	Educ	Govt	Agr	Indust	Other
C	Commercial	14.0	67.1%	5.7%	15.7%	1.4%	2.1%	0.0%	0.0%	7.9%
GOLF	Golf Course	0.4	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%
I	Industrial	12.0	5.8%	2.5%	28.3%	0.8%	4.2%	3.3%	20.8%	34.2%
O	Office	42.0	1.7%	57.1%	16.0%	7.4%	5.7%	1.7%	1.0%	9.5%
OS(P&R)	Parks	1.0	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%
RC(AG)	Resrce./Ag.	0.1	0.0%	0.0%	0.0%	0.0%	0.0%	100%	0.0%	0.0%
VR	Village Res.	0.14	67.1%	5.7%	15.7%	1.4%	2.1%	0.0%	0.0%	7.9%
PUBLIC & SEMI-PUBLIC (P&SP)										
CC	Civic Center	28.4	0.1%	0.0%	7.1%	22.6%	53.5%	0.0%	0.0%	16.6%
CO	Govt. Office	28.4	0.1%	0.0%	7.1%	22.6%	53.5%	0.0%	0.0%	16.6%
CY	Corp. Yard	28.4	0.1%	0.0%	7.1%	22.6%	53.5%	0.0%	0.0%	16.6%
ES	Elem. School	8.0	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%
FAIR	Fairgrounds	1.0	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%	0.0%
HOSP	Hospital	89.0	0.1%	0.1%	87.2%	0.2%	12.1%	0.0%	0.0%	0.2%
HS	High School	6.0	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%
JH	Jr. Hi. School	5.0	0.0%	0.0%	0.0%	100%	0.0%	0.0%	0.0%	0.0%

Source: Kittelson & Associates, 2012

Rio Mesa

The buildout capacity for the Rio Mesa planning area was provided by the Madera County Transportation Commission, and is consistent with the 2030 assumptions for the Rio Mesa area used in prior versions of the transportation model. For the TAZs within the Rio Mesa area, the Rio Mesa buildout assumptions were used to override calculations based on the Madera County vacant land tabulations.

Total Buildout Capacity

The total capacity for each TAZ was estimated by combining the capacity estimates for the City of Chowchilla planning area, City of Madera planning area, Madera County and Rio Mesa. The assumptions for the city planning areas and Rio Mesa were given priority for TAZs which are in county jurisdiction but within specified planning areas. The buildout capacity totals are listed in the final column of Table 15.

Land Use Allocations by Year

Once the capacity of each county subarea and TAZ was established, the amount of growth needed to be determined to match the control totals for each study year established by Madera CTC. A two step process was used, starting with an initial allocation and then adjusting based on the capacity of each TAZ.

Initial Allocation

Two factors were considered in the initial allocation:

1. Capacity: The percentage of total county subarea buildout capacity contained in a given TAZ.
2. Prior Allocation: The percentage of the 2005 to 2035 growth assumed in each county subarea that was contained in a given TAZ.

The prior forecast was considered because it represents a prior consensus on the most likely areas where growth will occur. The initial allocation of total subarea growth was based on the average of these two percentages. The percentages were calculated separately for housing growth, retail employment growth and non-retail employment growth.

For example, TAZ 104 is one of 25 TAZs in the Chowchilla City subarea. This TAZ contained 1.5 percent of the Chowchilla City capacity for housing growth, 8.3 percent of the retail employment capacity and 6.5 percent of the non-retail employment capacity. In the prior Madera CTC land use forecasts for 2005 to 2035, TAZ 104 received 13.3 percent of the housing growth in the Chowchilla City subarea, 7.8 percent of the retail growth and 2.4 percent of the non-retail growth. The initial allocation for each study year for TAZ 104 was therefore 7.4 percent (average of 1.5 and 13.3) of the Chowchilla City housing growth, 8.1 percent of the retail growth and 4.5 percent of the non-retail growth.

Table 15: Madera County Growth Allocations

Year	2010	2020	2035	2040	Buildout
POPULATION					
Chowchilla City*	18,720	19,277	20,287	20,671	36,564
Chowchilla Plan Area	900	4,730	11,836	14,554	81,291
Madera City	61,416	64,410	69,914	72,005	100,270
Madera Plan Area	17,870	29,499	50,851	58,973	183,190
Rio Mesa	1,290	12,014	31,659	39,153	117,979
Other Unincorporated	50,670	53,247	57,984	59,796	93,258
Total	**150,865**	**183,176**	**242,530**	**265,151**	**612,551**
HOUSEHOLDS					
Chowchilla City	3,680	3,840	4,130	4,240	7,500
Chowchilla Plan Area	300	1,400	3,440	4,220	23,570
Madera City	15,990	16,850	18,430	19,030	26,500
Madera Plan Area	5,970	9,310	15,440	17,770	55,200
Rio Mesa	430	3,510	9,150	11,300	34,050
Other Unincorporated	16,930	17,670	19,030	19,550	30,490
Total	**43,300**	**52,580**	**69,620**	**76,110**	**177,290**
EMPLOYMENT					
Chowchilla City	4,720	5,360	6,520	6,960	12,770
Chowchilla Plan Area	580	1,440	3,000	3,600	40,890
Madera City	12,760	13,820	15,760	16,500	26,080
Madera Plan Area	7,070	10,980	18,150	20,890	49,490
Rio Mesa	2,880	5,190	9,450	11,070	40,350
Other Unincorporated	14,840	15,250	16,020	16,310	25,450
Total	**42,860**	**52,040**	**68,900**	**75,330**	**195,030**

*Includes prison population.

Source: Kittelson & Associates

Adjusted Allocation

The initial allocations were compared to the capacity of each TAZ. If the initial allocation exceeded the buildout capacity of a TAZ for any of the three land use types, the allocation was reset to equal the buildout capacity.

After this adjustment of capping each TAZ at capacity, the county subarea totals were lower than the target totals. The residual housing or employment growth, required to match the target, was proportioned to the TAZs by county subarea based on the amount of remaining capacity after the initial allocation.

The results of this process were housing and employment allocations in each TAZ that added up to the correct county subarea totals for each study year of 2020, 2035 and 2040 (Table 15).

Model Land Use Categories

The final step in the allocation process was to allocate the housing and employment to the more detailed categories used in the travel model. The two forecast categories for housing (single family and multi-family) and the eight forecast categories for employment (retail, office, service, education, government, agriculture, industrial, other) were allocated to the corresponding detailed model land use categories (correspondence listed in Table 7 on page 17) according to the proportions for each TAZ in the 2010 base year land use inventory. If a particular land use type did not exist in a TAZ in 2010, the detailed category allocation was based on the countywide average for that particular forecast land use category.

Schools and Education

Education employment (representing primarily employment other than specific public or private K-12 schools) is represented in the land use forecasts primarily as a subset of service employment, and is allocated as described above. Where specific school sites have been identified in a general plan, the corresponding education employment has been assigned to specific TAZs, in addition to the more automated GIS-based allocation process described in the previous sections.

The trips in the travel model generated by K-12 school activity are primarily correlated to school enrollment. The increases in school enrollment for each jurisdiction (Chowchilla, Madera, Madera County) were estimated based on the population increase in each jurisdiction. The school enrollment in each TAZ for each forecast year was estimated by multiplying the 2010 school enrollment times the ratio of forecast year population to 2010 population for the appropriate jurisdiction.

The enrollment estimates based on population growth assume that most school activities will continue to occur at existing sites. The process does not explicitly account for enrollment at new school sites (although the employment at new school sites is accounted for). The school enrollment forecasts could be manually reallocated to new sites as new school sites are confirmed.

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 11 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 Madera County travel model stratifies trip ends by 11 trip purposes:

1. **Home-Work (HW):** Commute trips between residences and places of employment, including both trips from home to work and from work to home.
2. **Home-Shop (HS):** Trips between residences and places of retail employment, including both trips from home to shopping and from shopping to home.
3. **Home-K12 (HK):** Trips between residences and elementary/grade schools, middle schools or high schools.
4. **Home-College (HC):** Trips between residences and colleges or universities.
5. **Home-Other (HO):** All other trips that begin or end at home, and include social trips, recreational trips and medical appointments.
6. **Work-Other (WO):** 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 (OO):** All other "non-home-based" trips, such as trips between two stores.
8. **Highway Commercial (HY):** A portion of home-shop and other-other trips in specific TAZs that are oriented towards the external gateways rather than other TAZs within the model area.
9. **Small Trucks (TS):** Trips made by 2-axle trucks, not including standard pickup trucks and vans.
10. **Medium Trucks (TM):** Trips made by 3-axle trucks.
11. **Heavy Trucks (TH):** Trips made by 4 or more axle trucks, including tractor-trailer combination trucks.

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 for different purposes 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 Madera County travel model were based on several sources:

- Household travel survey data from the Caltrans 2000/2001 Statewide Travel Survey (the reporting for the 2010-2012 Household Survey was finalized in June, 2013 and was not available for this model update).
- ITE *Trip Generation* (8th Edition), 2008.
- *Travel Estimation Techniques for Urban Planning*, National Cooperative Highway Research Report 365, 1998 (NCHRP 365), which includes a summary of rates used in travel models for other metropolitan areas.

Total daily person trip generation rates are summarized in Table 16. The model actually uses separate trip generation rates for each trip purpose

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 75 categories according to housing type, household size and income level.

Table 16: Trip Generation Rates

Land Use Code	Land Use Category	Units	Daily Person Trip Rate	Estimated Daily Vehicle Trip Rate
RU1	Single Family	Dwelling Units	8.03	5.53
RU3	Multi Family	Dwelling Units	5.45	3.88
RU9	Mobile Home	Dwelling Units	4.28	2.98
AGRICULTUR	Agriculture, Forestry, Fishing and Hunting (11)	Employees	2.07	1.77
MINING	Mining, Quarrying, Oil and Gas Extraction (21)	Employees	2.05	1.74
UTILITIES	Utilities (22)	Employees	2.21	1.93
CONSTRUCTN	Construction (23)	Employees	2.09	1.78
MANUFACTUR	Manufacturing (31-33)	Employees	2.17	1.80
WHOLESALE	Wholesale (42)	Employees	8.11	5.85
RETAIL	Retail (44-45)	Employees	27.65	17.64
WAREHOUSE	Transportation and Warehousing (48-49)	Employees	4.20	3.19
INFORMATN	Information (51)	Employees	4.36	3.07
FINAN_INSR	Finance and Insurance (52)	Employees	4.37	3.12
REALESTATE	Real Estate, Rental and Leasing (53)	Employees	4.34	3.09
SVC_PROF	Professional, Scientific, and Technical Services (54)	Employees	4.37	3.12
SVC_MNGMNT	Management of Companies and Enterprises (55)	Employees	4.28	2.99
SVC_ADMIN	Administrative/Support, Waste Management & Remediation (56)	Employees	4.37	3.09
EDUCATION	Educational Services (61)	Employees	0.00	0.00
HEALTH	Health Care and Social Assistance (62)	Employees	5.96	4.17
ENT_REC	Arts, Entertainment and Recreation (71)	Employees	39.84	24.85
ACCOMODTNS	Accommodations (721)	Employees	14.49	9.42
FOOD	Food Services (722)	Employees	71.37	44.62
SVC_OTHER	Other Services Except Public Administration (81)	Employees	27.58	17.70
PUBLIC	Public Administration (92)	Employees	33.05	20.71
ELEM	Elementary and middle school enrollment	Students	1.78	0.49
HS	High school enrollment	Students	2.36	0.64
COLLEGE	College enrollment	Students	2.71	2.22

Sources: Fehr & Peers Associates, Kittelson Associates

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 types of employment in the Madera County 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 adjusted to better balance with household trip production estimates.

Trip attractions for other purposes are difficult to derive directly from limited travel survey data. Several metropolitan areas have been able to estimate trip attraction rates based on much larger survey sample sizes. The Home-Shop, Home-Other, Work-Other and Other-Other trip attraction rates for the Madera County model are based on the average rates presented in NCHRP 365. The rates were adjusted to better balance with trip productions from the travel survey.

CORDON OR "GATEWAY" TRIPS

There are two types of trips at the cordons or "gateways" of a model, through trips (external-external or X-X) and external trips (external-internal, internal-external or I-X/X-I). Through trips are trips that pass through the model area without stopping. The external trips for the Madera County travel model were estimated using a version of the California Statewide Travel Model.

Statewide Model

The basic source of information for external trips in the Madera County model is the California Statewide Model maintained by Caltrans. A new California Statewide Model has been developed. The new model is an activity-based model rather than a trip-based model. The new statewide model was calibrated to 2008 conditions. However, travel forecasts to estimate future external trips were not available from the new statewide model.

The available version of the Statewide Model was initially developed in 2003. It was updated during the San Joaquin Valley Model Improvement Program to incorporate the 2008 base year land use inventories from the new Statewide Model, and the most current 2035 land use forecasts from each MPO or county as of mid-2011. The networks and TAZ system from the new Statewide Model were also incorporated with the trip-based model system. The trip-based Statewide Model was revalidated to replicate 2008 traffic counts on major roads, with a particular focus on the validation in the San Joaquin Valley.

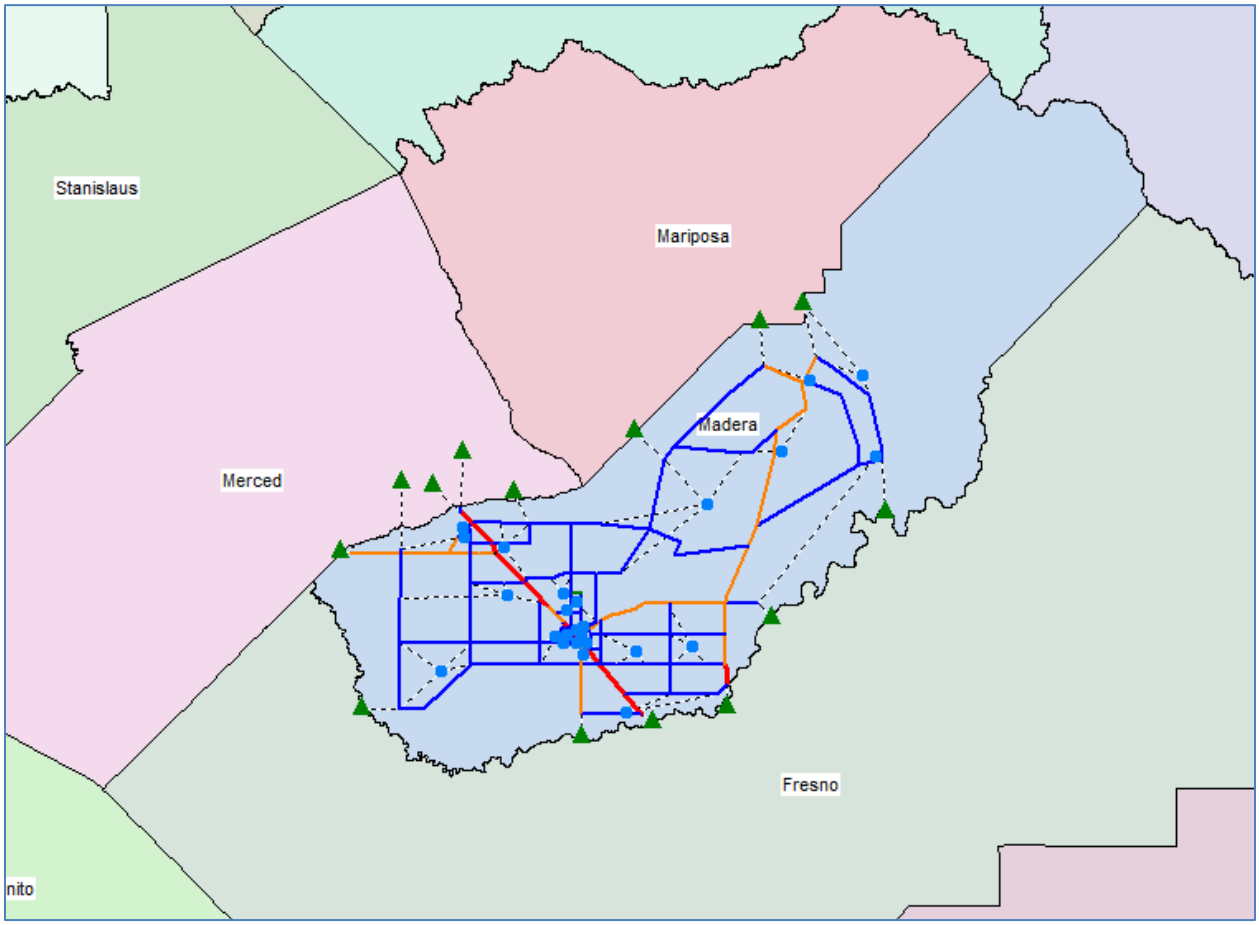
Application of Statewide Model

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

- The proportions of through trips versus internal-external trips at each Madera County gateway.
- Proportions of internal-external trips by each of the trip purposes and by productions versus attractions (representing in-commute versus out-commute for Madera County)
- Base through trip patterns from the 2008 model calibration year.
- Annual growth rates for each gateway based on the 2008 and 2035 statewide model estimates.

A "subarea analysis" of Madera County was used to isolate the statewide trips which pass into, out of or through Madera County (Figure 11).

Figure 11: Statewide Model Subarea Network



Internal-External Trip Balancing

The initial estimates of productions and attractions at each gateway are added to the Madera County trips. The model must have a balance between productions and attractions for each trip purpose, as every trip has two ends. The Madera County trips are held constant, and the external gateway trips are adjusted by shifting gateway trips between productions and attractions to provide an overall balance of person-trip productions and attractions for each trip purpose. The total trips at each gateway by purpose are held constant during this process. The balancing process occurs within the Parameters workbook for each scenario. These adjusted gateway trips are then distributed to the model zones along with the internal model area trips.

SPECIAL GENERATORS

Special generators are used to include trips from land uses that are not well represented by the standard trip rates. Trips to and from special generators are input directly and there are no trip generation rates. Trip generation for special generators would typically be estimated based on the Institute of Transportation Engineers (ITE) *Trip Generation* reference.

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

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

where:

T_{ij} = number of trips produced in zone i and attracted to zone j

P_i = total number of trips produced in zone I

A_j = attractions of zone j

t_{ij} = travel time in minutes between zone i and zone j

$F(t_{ij})$ = the friction factors between zone i and zone j

K_{ij} = zone-to-zone adjustment factor

n = number of zones

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

TRAVEL IMPEDANCES

The travel impedances used in the Madera County model represent a weighted composite of the times and costs for each travel mode. The use of a composite impedance rather than the more traditional auto travel time allows the model to reflect the attractiveness of different trip destinations based on improvements in transit, bicycle or walk accessibility.

Auto Travel Times

The auto 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 times and costs (from tolls, etc…) along that path. The path building process produces a table (skim matrix) of travel times and costs between each pair of zones in the model. The paths are calculated separately for drive-alone vehicles, 2-person carpools and 3+ person carpools reflecting the different lane restrictions if there are HOV facilities in the network. The resulting tables of zone-to-zone travel times and costs are then used as an input to the impedance calculations.

Auto Intrazonal Travel Times

Intrazonal travel times represent the average travel time for trips that stay within a particular zone. The Madera County model estimates intrazonal times as 100 percent of the travel time to the nearest adjacent TAZ.

Auto Terminal Times

Terminal times are added to represent the average time to access one's vehicle at each end of the trip. The Madera County model assumes one minute at each end of each trip for most TAZs.

Transit Times

The Madera County model does not have a separate coded transit network. Transit times between TAZs are estimated using the road travel times and inputs describing the transit service coverage.

A factor is used to estimate the ratio of bus travel times to auto travel times on the road network. This factor has generally been found to be approximately 1.9, but a factor of 1.0 was used for the development of the Madera County model.

The transit coverage is indicated by inputting the average frequency (headway) of peak period and off-peak period bus service at each TAZ. The bus route maps in Madera County were compared to the TAZ map, and an average bus frequency was assigned to each TAZ. If a TAZ was more than 0.5 miles from any bus route, it was assigned a frequency of zero, indicating no transit service. If a TAZ was served by a route with 30 minute average frequencies during the peak periods and 120 minutes during off-peak periods, it was assigned frequencies of 30 and 120, respectively. The transit times between TAZs were

only calculated for pairs of TAZs which had non-zero frequencies at both ends of the trip. The average passenger wait time was estimated by taking half of the headway, using the maximum of the headways at the origin and destination TAZs.

Non-Motorized Travel Times

The travel times for the bicycle and walk modes are estimated using a road network that excludes freeways. Average travel times are input for each mode. The Madera County model assumes average speeds of 10 miles per hour for bicycles and 3 miles per hour for walking.

Composite Impedance

The travel times for all modes are combined into a single composite impedance for use in the trip distribution and mode choice steps. The composite impedance is not a straight average of the travel times for different modes, but a weighted average based on the denominator of the mode choice model described in the next section. Because it is calculated as the sum of the logarithims of the time/cost "utilities" for each mode, the composite impedance is often referred to as a "logsum" value.

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 Madera County 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.

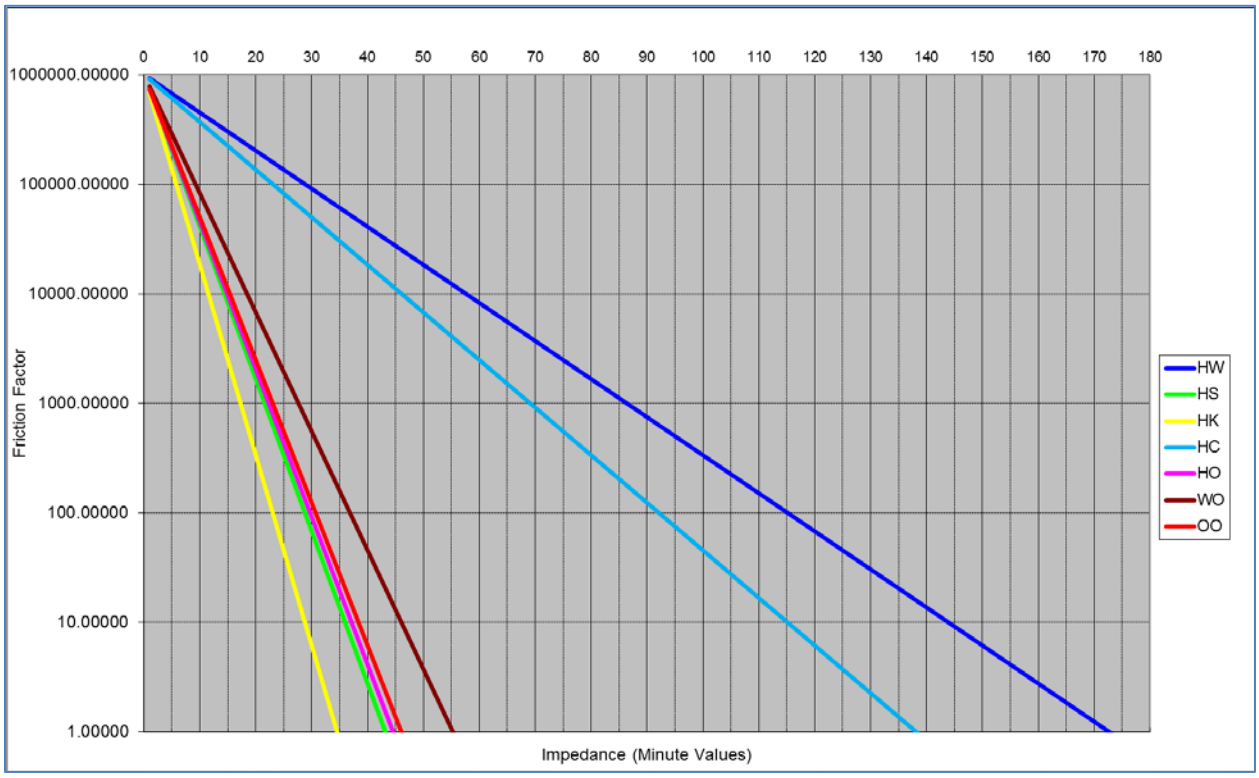
The friction factors for the Madera County travel model were initially based on the friction factors from NCHRP 365. The friction factors were iteratively adjusted to better replicate the trip lengths from the household travel survey (Figure 12).

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 Madera County model only uses "K Factors" to prohibit illogical trips between gateways.

Figure 12: Madera County Model Friction Factors



7. MODE CHOICE

The mode choice step estimates how many of the trips between each pair of zones will use each travel mode. The Madera County travel model includes a mode choice step which divides trips into drive alone, shared ride, transit and non-motorized modes.

MODE CHOICE MODEL DESCRIPTION

The Madera 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:

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

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:

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

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 Madera 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 Madera County 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 (DA)
2. 2-Person vehicle (SR2)
3. 3+-Person vehicle (SR3)
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.

Mode Choice Stratifications

The Madera County model performs mode choice calculations separately for eight trip purposes (not including the three truck 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

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 Variables

The variables that are used for each travel mode are summarized in Table 17.

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.

- Coefficient on in-vehicle time (minutes) -0.025
- Coefficient on out-of-vehicle time (minutes) -0.050 (2x in-vehicle)
- Perceived auto operating cost (differs for each year)
  - 2010 18.01 cents per mile
  - 2040 19.20 cents per mile
- Time penalty for shared ride pick-up/drop-off
  - Shared Ride 2 5 minutes
  - Shared Ride 3+ 7 minutes

Value of Time

Travel costs are converted to time units using a value of time. The perceived value of time in dollars per hour is input as follows:

- 0 Auto Households $6 per hour
- 1 Auto Households $12 per hour
- 2+ Auto Households $18 per hour

Logit Model Calibration

The basic coefficients on time and cost were set to standard values. Therefore, calibration of the mode choice model 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 and each category 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.

Table 17: Variables for Mode Choice Model

Variable	Modes						
	Drive Alone (D1)	Shared Ride 2 (S2)	Shared Ride 3+ (S3)	Transit Walk (TW)	Transit Drive (TD)	Walk (WK)	Bike (BK)
IN-VEHICLE TIMES							
Auto Time	X	X	X		X		
Carpool Pick-Up Time		X	X				
Transit In-Vehicle Time				X	X		
OUT-OF-VEHICLE TIMES							
Production Terminal Time	X	X	X				
Attraction Terminal Time	X	X	X				
Walk Time				X	X	X	
Bike Time							X
Wait & Transfer Time				X	X		
COSTS							
Auto Operating (per mile)	X	Divide by 2	Divide by Avg. Occ.		X		
Parking (half per trip)	X	Divide by 2	Divide by Avg. Occ.				
Transit Fare				X	X		

8. PEAKING FACTORS

The Madera County model estimates vehicle trips for four time periods that add up to the daily total:

- A.M. peak 3-hour period (6:00 to 9:00 AM)
- Midday (9:00 AM to 4:00 PM)
- P.M. peak 3-hour period (4:00 to 7:00 PM)
- Night (7:00 PM to 6:00 AM)

The model also estimates trips for two peak one-hour periods:

- A.M. peak 1-hour (7:00 to 8:00 AM)
- P.M. peak 3-hour period (5:00 to 6:00 PM)

The peak and off-peak period trips are calculated by factoring the daily vehicle trips after mode choice.

PEAK HOUR FACTORS

Daily trips are factored separately for each trip purpose using average areawide factors. The factors for the Madera County model were derived from the 2000/2001 California Household Travel Survey. The factors were adjusted for selected trip purposes based on comparisons to traffic counts during model validation.

The peak hour factors are listed in Table 18. School trips have the highest proportion of their trips during the AM peak hour compared to the other trip purposes, while shopping trips are relatively low. During the PM peak hour, work trips average more than 10 percent of daily trips, while the percentages for most non-work purposes (excluding school) are in the 6 to 8 percent range.

The model applies similar factors for the 3-hour AM and PM peak periods, the 7-hour midday period and the 11-hour night period.

Table 18: Peak Hour Percent of Daily Trips

Trip Purpose	Production to Attraction	Attraction to Production	Total Percent of Daily
AM PEAK HOUR			
Home-Work	13.9%	0.04%	13.9%
Home-Shop	1.2%	0.12%	1.3%
Home-K12	20.0%	0.0%	20.0%
Home-College	20.0%	0.0%	20.0%
Home-Other	4.0%	1.0%	5.0%
Work-Other	0.6%	3.0%	3.6%
Other-Other	1.4%	4.4%	5.8%
Highway Commercial	1.2%	0.12%	1.3%
Truck Small	1.6%	1.6%	3.2%
Truck Medium	2.6%	2.6%	5.2%
Truck Heavy	2.2%	2.2%	4.4%
PM PEAK HOUR			
Home-Work	0.2%	11.9%	12.1%
Home-Shop	3.2%	5.0%	8.2%
Home-K12	0.6%	1.9%	2.5%
Home-College	0.6%	1.9%	2.5%
Home-Other	3.1%	3.8%	6.9%
Work-Other	6.9%	0.3%	7.2%
Other-Other	3.1%	5.2%	8.3%
Highway Commercial	3.2%	5.0%	8.2%
Truck Small	4.2%	4.2%	8.4%
Truck Medium	3.0%	3.0%	6.0%
Truck Heavy	2.6%	2.6%	5.2%

9. TRIP ASSIGNMENT

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

TRAFFIC ASSIGNMENT

The Madera County travel 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 Madera County model is currently set for a maximum of 50 iterations for each peak hour or peak period traffic assignment, and 20 iterations for each off-peak (midday, night) traffic assignment.

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 2000 *Highway Capacity Manual*, Appendix C, Exhibits C30-1 and C30-2.

The curves are assigned based on the facility type, area type and terrain of each link. Zone connectors are not actual streets and are not assumed to slow down during the assignment process.

TRANSIT ASSIGNMENT

The Madera County model currently does not include specific transit networks. Therefore, transit trips are not assigned to a network. The model does estimate transit travel times, and uses those times to estimate the mode choice and the percentage of persons who would be likely to use transit between each pair of TAZs. This transit trip information is summarized at the TAZ level and can be reviewed as one of the model outputs.

10. FEEDBACK MECHANISMS

The Madera County travel model includes a feedback loop that uses congested travel times as an input to the trip distribution and mode choice steps. 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.

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.

The current version of the Madera County model loops includes two loops, the first with uncongested travel times as input to trip distribution and mode choice, and the second with congested times. The following sections also describe how additional convergence criteria could be implemented.

CONGESTED TRAVEL TIMES

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. The congested travel times from the most recent midday 7-hour traffic assignment are used for the other trip purposes. At the beginning of each loop, a network file containing the latest AM and Midday traffic assignments is copied to a standard file name (SMLO00A.NET) and is used for calculation of zone-to-zone travel times for all modes.

INTERPOLATION METHOD

The Madera County model, consistent with the other MIP models, does not currently use an interpolation method to estimate the travel times for the next loop iteration. The travel times based on the traffic assignment from the previous loop are used directly in the trip distribution and mode choice calculations for the current loop.

Prior to the MIP model updates, several models in the San Joaquin Valley used an interpolation method (Method of Successive Averages). The interpolation method speeds up the convergence of the feedback loop. Implementation of this interpolation method could be considered in future model updates.

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

CONVERGENCE CRITERIA

The current Madera County model does not use convergence criteria to determine when feedback loops should be stopped. Rather, the model loops twice through the trip distribution and mode choice steps, the second loop using congested travel times from the first loop. This is consistent with the model scripts used in the other MIP models.

Prior to the MIP model updates, several models in the San Joaquin Valley used a set of convergence criteria developed specifically to ensure that the congested travel speeds used as input to the air quality analysis are consistent with the travel speeds used throughout the model process, as required by the Transportation Conformity Rule. Implementation of these convergence criteria could be considered in future model updates.

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

The model feedback loop is considered to converge when:

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

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

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

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

11. MODEL VALIDATION

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.

TRAFFIC DATA

Traffic data for validation representing the 2010 base validation year were obtained from Madera CTC, the cities of Madera and Chowchilla, Madera County and Caltrans.

TRAFFIC VALIDATION

The Madera County travel model traffic validation is based on several criteria, including vehicle miles of travel (VMT), total volume by road type, and percent of links within acceptable limits.

Vehicle Miles of Travel

The Caltrans Highway Performance Monitoring System (HPMS) estimates vehicle miles of travel for each county based on a sample of traffic counts on various road types. Vehicle miles of travel (VMT) were estimated from the travel demand model by multiplying link volumes by link distances (Table 1).

Table 19: Daily Validation by Vehicle Miles of Travel (VMT)

Evaluation Criterion	HPMS	Model	% Deviation
+/- 5%	4,785,470	4,636,110	-3.1%
Notes: Daily Vehicle Miles Traveled. Highway Performance Management System – 2010 California Public Road Data, Table 11.			

The Madera Model VMT estimate is 3.1 percent lower than the Caltrans HPMS target. This is within the target of +/- 5.0 percent.

Total Volume

Traffic model estimates are compared to traffic counts for all road segments with available counts. The results are compared for daily total traffic and A.M. and P.M. peak hour traffic.

Caltrans Maximum Deviation

The Caltrans travel forecasting guidelines include a figure showing the maximum desirable deviation for individual link volumes between model volumes and traffic counts (Figure 13). The suggested link-specific validation criterion is that 75 percent of freeway and principal arterials meet the maximum desirable deviation.

Root Mean Square Error

The root mean square error (RMSE) provides a measure of accuracy based on the statistical standard deviation. The RMSE puts a greater emphasis on larger errors that may cancel each other out in the total validation by road type described previously. The overall target RMSE is 30 percent.

Correlation Coefficient

Another measure of the statistical fit between model estimates and traffic counts is the correlation coefficient. The correlation coefficient is related to the R^2 value often used for statistical estimates. The recommended criteria is for the correlation coefficient to be greater than 0.88.

Daily Volume

The Madera model is within two percent of total daily traffic counts (Table 20). This is within the target of +/- 5.0 percent for overall traffic volume.

Table 20: Daily Total Volume Validation

Daily Assignment	Value	Criterion
Model/Count Ratio =	1.02	< +/- 5%
Percent Within Caltrans Maximum Deviation =	66%	> 75%
Percent Root Mean Square Error =	50%	< 30%
Correlation Coefficient =	92%	> 0.88

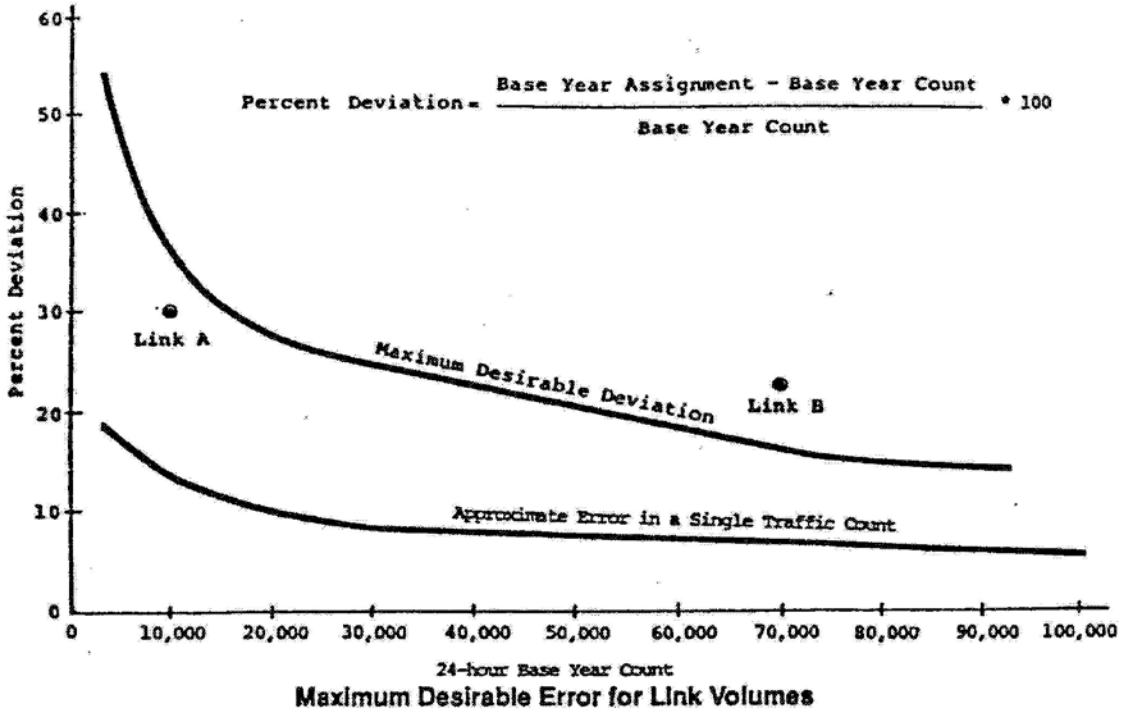
The Madera County travel model meets the Caltrans criteria for daily traffic volumes on 66 percent of all links, which is below the target.

The Madera County model is higher than the 30 percent RMSE validation criteria for daily traffic (50%). This indicates that the model is generating the correct amount of total traffic on Madera County roads, but there are approximately an equal number of road segments where the model is high and where the model is low relative to traffic counts.

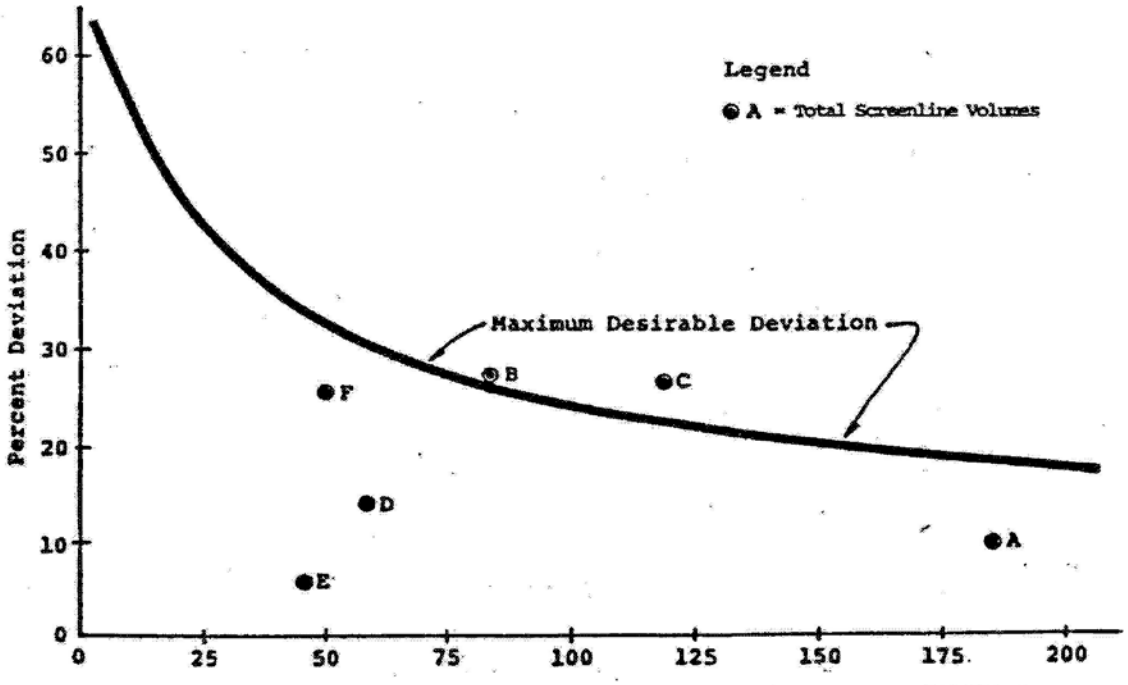
The Madera County model correlation coefficient of 0.92 exceeds the criteria of 0.88.

The relationship between model volumes and daily traffic counts is illustrated in Figure 14.

Figure 13: Caltrans Maximum Desirable Error for Links and Screenlines

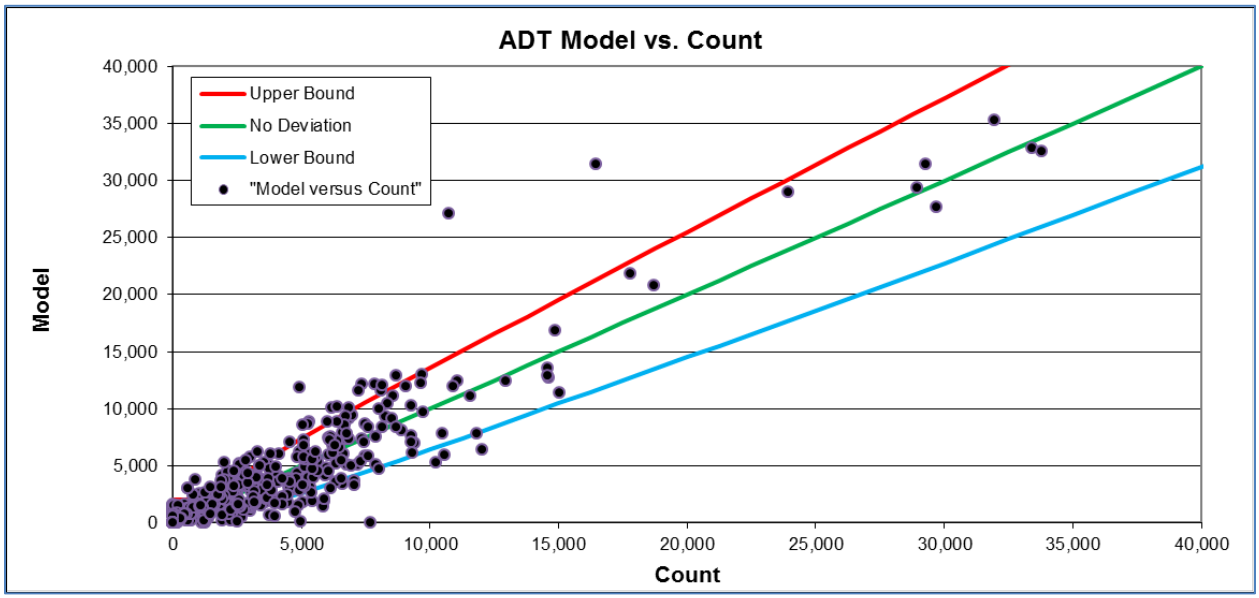


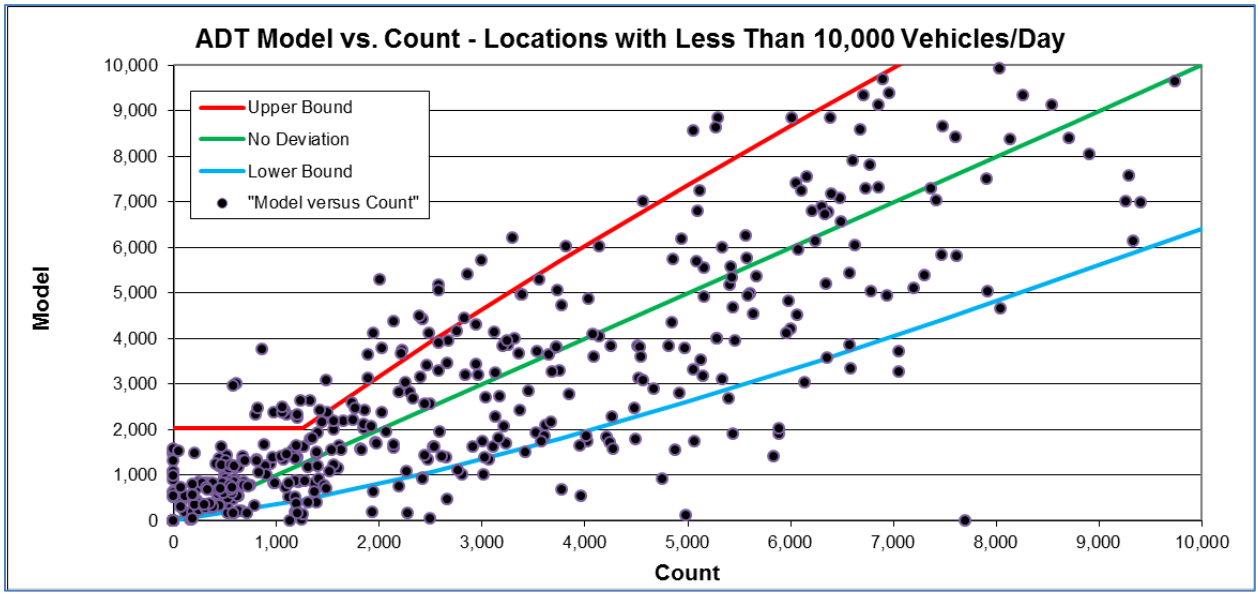
Maximum Desirable Error for Link Volumes



Maximum Desirable Deviation in Total Screenline Volumes

Figure 14: Daily Model Volumes and Traffic Counts





A.M. Peak Hour Volume

The Madera model is within 1.0 percent of total A.M. peak hour traffic counts (Table 21). This is within the target of +/- 5.0 percent for overall traffic volume.

The Madera County travel model meets the Caltrans criteria for A.M. peak hour traffic volumes on 39 percent of all links, which is well below the target of 75 percent.

Table 21: A.M. Peak Hour Total Volume Validation

AM Peak Hour (7- 8 AM)	Value	Criterion
Model/Count Ratio =	0.99	< +/- 5%
Percent Within Caltrans Maximum Deviation =	39%	> 75%
Percent Root Mean Square Error =	112%	< 30%
Correlation Coefficient =	0.74	> 0.88

The Madera County model is higher than the 30 percent RMSE validation criteria for A.M. peak hour traffic (112%). This indicates that the model is generating the correct amount of total traffic on Madera County roads, but many of the road segments are very high or very low relative to traffic counts.

The Madera County model correlation coefficient of 0.74 for the A.M. peak hour does not meet the criteria of 0.88.

P.M. Peak Hour Volume

The Madera model is 11 percent higher than total P.M. peak hour traffic counts (Table 22). This exceeds the target of +/- 5.0 percent for overall traffic volume.

Table 22: P.M. Peak Hour Total Volume Validation

PM Peak Hour (5 - 6 PM)	Value	Criterion
Model/Count Ratio =	1.11	< +/- 5%
Percent Within Caltrans Maximum Deviation =	52%	> 75%
Percent Root Mean Square Error =	53%	< 30%
Correlation Coefficient =	0.84	> 0.88

The Madera County travel model meets the Caltrans criteria for P.M. peak hour traffic volumes on 52 percent of all links, which is below the target of 75 percent.

The Madera County model is higher than the 30 percent RMSE validation criteria for P.M. peak hour traffic (53%). The Madera County model correlation coefficient of 0.84 for the P.M. peak hour is just below the criterion of 0.88.

Functional Classification

The Federal Highway Administration and Caltrans recommend error limits for total error by functional classification (type of road):

- Freeways Less than 7 percent
- Principal Arterials Less than 10 percent
- Minor Arterials Less than 15 percent
- Collectors Less than 25 percent
- Frontage Roads Less than 25 percent

The criterion for Principal Arterials is assumed to apply to highways and expressways. The criterion for Minor Arterials is assumed to apply to local arterial roads and freeway ramps.

The Madera Model validation meets the FHWA targets for total volume by road type (Table 23) for arterials, and is very close to the targets for highways, collector streets and freeway ramps. The model tends to be low on higher volume roads and low on lower volume roads. This is typical of regional travel models that may not contain all of the individual driveway-level detail that can strongly influence the estimates of traffic volumes on more minor street types.

Table 23: Daily Validation by Functional Class

ADT Model/Count by Functional Class			
Functional Class	**Criteria**	**Model**	**Meets Criteria**
Freeway	+/- 7%	+16.2%	No
Highway	+/- 10%	+11.0%	No
Arterial	+/- 15%	-3.2%	**Yes**
Collector/Local	+/- 25%	-29.2%	No
Ramps	+/- 15%	-16.1%	No

12. FORECAST APPLICATIONS

Potential travel model forecast applications include:

- Identify traffic "hot spots"
- Forecast effectiveness of major road improvements
- Impacts of land use changes
- Compare land use or transportation policy alternatives using regional measures of effectiveness

ADJUSTMENT OF TRAFFIC ASSIGNMENT RESULTS

It is recommended that traffic forecasts on specific road segments use an adjustment process that accounts for validation errors. Where base year traffic counts are available, forecast traffic volumes are calculated based on the increment between the base year and future year model results:

Adjusted Forecast Volume = Base Year Count +

(Model Forecast Volume - Base Year Model Volume)

An incremental adjustment is recommended instead of an adjustment based on ratios. A ratio adjustment factor does not guarantee continuity of traffic volumes between adjacent road segments, and can result in very large adjustments on low-volume links. However, there are circumstances where a ratio or growth factor adjustment is appropriate. For example, a growth factor based on daily model volumes can be applied to peak hour traffic counts to generate approximate peak hour forecasts.

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.

FORECAST RESULTS

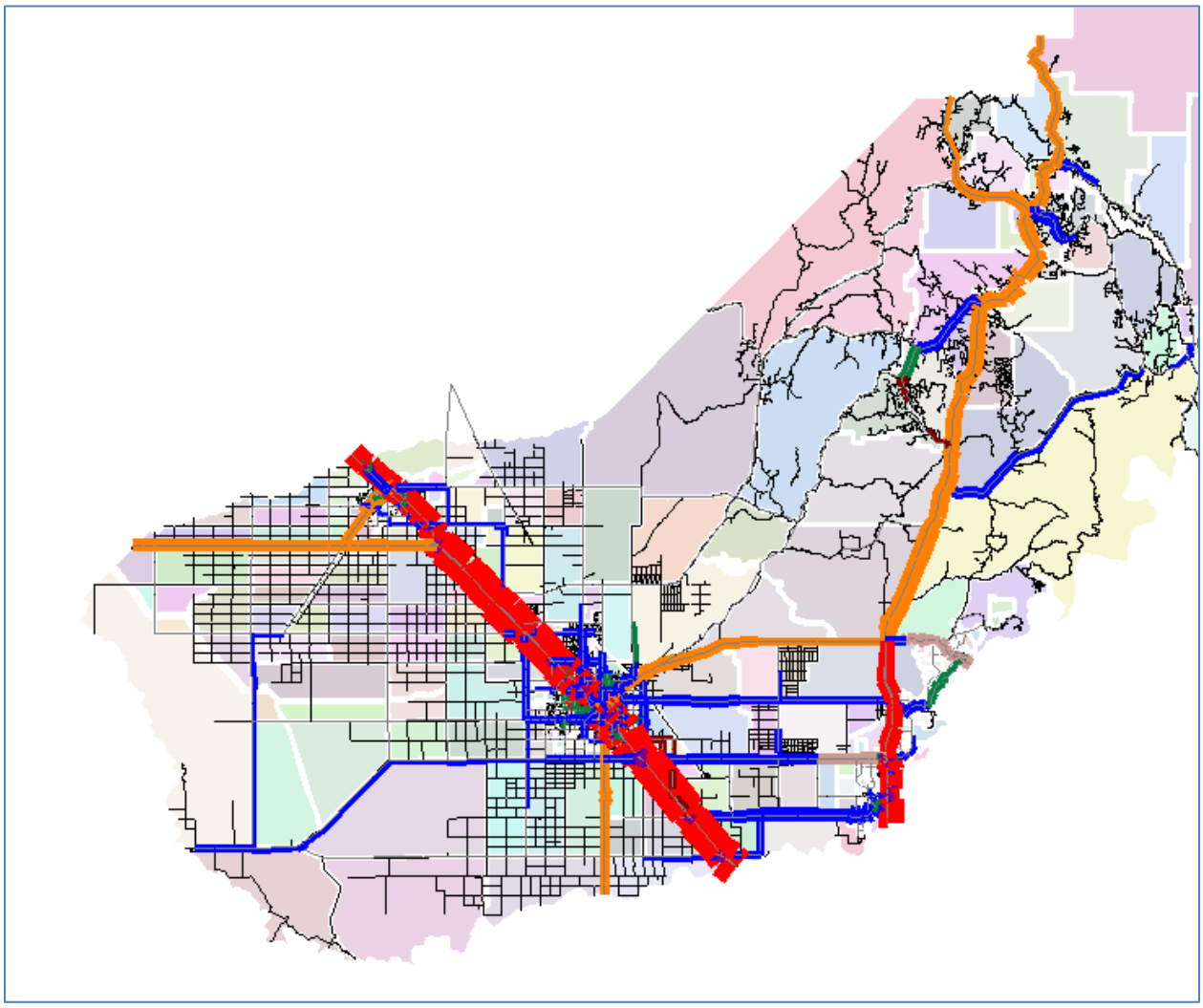
The results of the travel forecasts can include the following:

- Traffic volumes on each link, stratified by different categories
- Congested speeds and travel times on each link
- Comparison of volume to capacity on each link
- Summary measures of effectiveness (MOE) for the entire county such as vehicle-miles of travel, person-hours of delay or average speed by road type

Road Network Results

The forecast information on each road segment can be displayed graphically or numerically. An example of a graphic display of traffic volumes is shown in Figure 15.

Figure 15: Example Forecast Volume Graphic



The information available on each link of the road network is listed in Table 24. The output information includes traffic volumes by time period, by type of vehicle, by vehicle occupancy and by household vehicle availability. An estimate of level of service is provided for each time period based on the volume/capacity ratio.

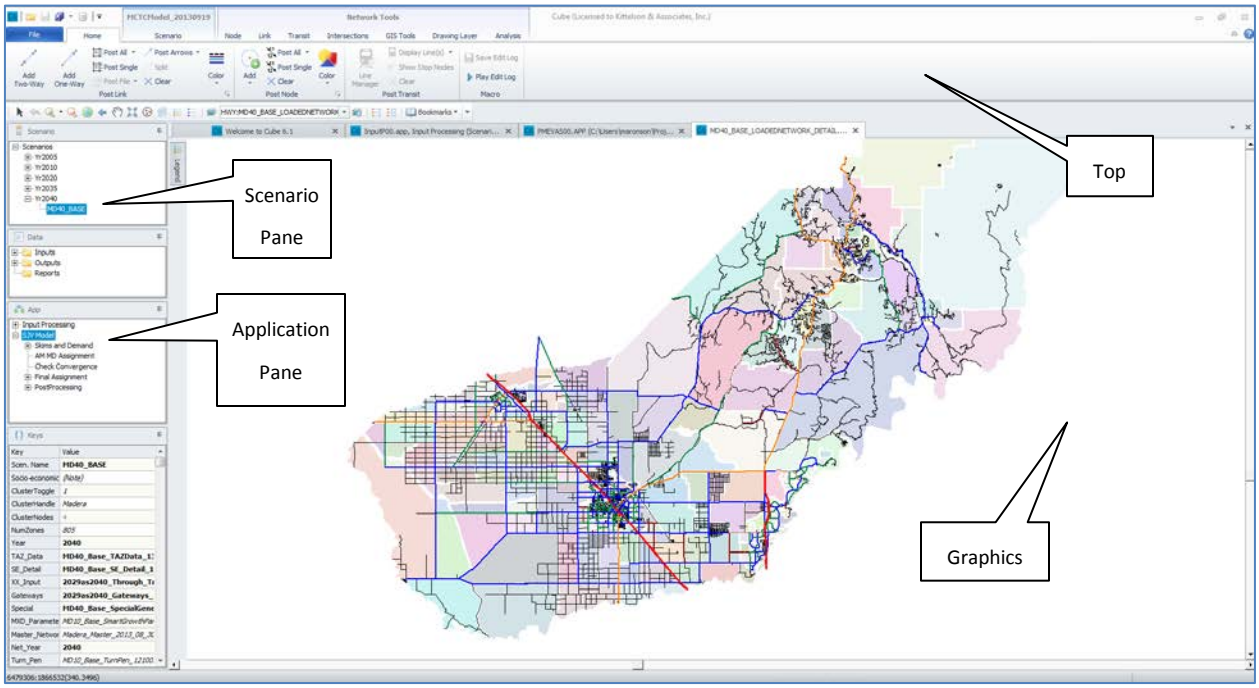
Table 24: Output Network Link Variables

Link Value	Field Name	Stratifications
Total One-Way Volume	A01_VOL, A03_VOL, etc…	Time Periods:
Total Two-Way Volume	TOT_A01_VOL, etc…	A01 = AM Peak Hour
Automobile Volume	A01_PAS_VOL, etc…	A03 = AM Peak 3-Hour Period
Small Truck Volume	A01_TS_VOL, etc…	M07 = Midday 7 hours
Medium Truck Volume	A01_MED_VOL, etc…	P01 = PM Peak Hour
Heavy Truck Volume	A01_HVY_VOL, etc…	P03 = PM Peak 3-Hour Period
Total Truck Volume	A01_TRK_VOL, etc…	E11 = Night 11 hours
		D24 = Daily 24-hour total
Congested Speed	A01_ASG_SPD, etc…	All 7 Time Periods
Level of Service based on volume/capacity ratio	LOS_AM (AM 3-hour), LOS_PM (PM 3-hour), LOS_MD (Midday 7 hours), LOS_EV (Night 11 hours), LOS_AM1HR, LOS_PM1HR, LOS_DAILY	All 7 Time Periods
Volume by Vehicle Occupancy and Household Vehicle Availability	A03_DA_1V, etc…	Vehicle Occupancy: DA = Drive Alone S2 = Shared Ride 2 S3 = Shared Ride 3+ XX = Through Trips
		Vehicle Availability 0V = 0 Vehicles Available 1V = 1 Vehicle Available 2V = 2+ Vehicles Available
		All 7 Time Periods
Daily Link Capacity Estimate	DAILY_CAP	
Daily Volume/Capacity Ratio	VC_DAILY	

Measures of Effectiveness

The Madera County model calculates a number of transportation system performance measures. These include performance measures derived from the trip calculations and performance measures calculated from the traffic assignment results on the road network. Measures from the trip calculations include numbers of trips by trip purpose, average trip lengths by trip purpose, and trips by each mode. Measures from the road network include vehicle-miles of travel (VMT) by speed category or by facility type.

13. USING CUBE



This section and the reminder of the User Guide provide general procedures to apply the Madera County travel model using the Cube software by Citilabs. Users should refer to the Cube documentation provided by Citilabs for specific Cube and Voyager related questions.

SUMMARY OF MODEL APPLICATION STEPS

The general procedure to apply (or run) a travel model includes:

1. Document all changes and assumptions for this scenario
2. Copy the appropriate input files, or use "Save As" to save files to new names after editing
3. Modify roadway (and transit) networks, as necessary
4. Modify the land use and socioeconomic inputs, if necessary
5. "Run" the model alternative and post-process the model results (e.g., compare road volumes, select link analysis)
6. View and print the results

These steps are summarized here and discussed in more detail in this Users Guide.

1. Document all Alternative Changes and Assumptions

All assumptions for the alternative to be run should be adequately documented so that, after some time has gone by, a user can still identify the land use and network input sources.

- Network modifications should be noted on maps or network plots.
- Land use changes should be clearly marked in electronic files or printed out.

Ideally, all assumptions would be filed together so that they are easily accessible in the future.

2. Copy Appropriate Files

There are two file management steps which are important to maintain the integrity of the model files.

Maintain Original Files

A version of the original model files should always be kept in a separate place from the working copy of the model files. If files were received on a CD or DVD, the original CD or DVD should be kept for reference. If files were received electronically, the original version should be kept separate from the working version. This could include updated model files (such as a new land use workbook) as well as the original model release.

Work on Copies or Save With New Names

All work done on the model should use copies of the original model files. If you are modifying a network or land use input, you should either:

- Make a copy of the file first before editing; or
- Edit the input file and save with a new name (such as adding the current date to the file name)

These bookkeeping steps are very important for tracing model assumptions.

3. Update Roadway and Transit Networks

Use Cube to edit the master road (and transit) networks if necessary. This could include changing the number of lanes, adding new facilities, adding new bus lines, and/or adding new zones with centroid connectors.

4. Update Land Use

Use Excel to update the Parameters workbook. Save the workbook with a new name. Use the macro buttons in the workbook to save the files that are input to the travel model.

5. Update the Job Script (Generally Not Necessary)

Use Cube (or Word or a text editor) to modify the Cube/TP+ job script, if necessary. The Madera County model should not require any modifications to job scripts unless new functions are required.

6. Apply and Post Process the Model

Use Cube to "run" the model alternative. Select the "Input Processing" and "SJV Model" applications and the required input files.

7. View and Report Model Results

- Use Cube to view road or transit volumes on specific segments, or to review detailed trip matrices.
- Use Excel workbooks to compile systemwide measures of effectiveness.
- Use Cube for simple graphics of TAZ data or a GIS software such as ArcMap for more complex graphics of TAZ data.

CUBE COMPONENTS

The Cube software includes the user interface (Cube Base) and the programs which run the model calculations (Voyager).

Cube Base

Cube Base includes the Graphics Window, the Application Manager and Scenario Manager.

Graphics Window

The Graphics Window is in the main part of the screen and displays various types of data. The Graphics Window can display model networks, GIS layers, text files, Excel workbooks or databases.

Application Manager

The Application Manager also appears in the main part of the screen and displays a flow chart for model applications. Input and output files are shown in the context of the model and can be immediately viewed or edited by double-clicking on the appropriate box in the flow chart.

Scenario Manager

The Scenario Manager is on the left side of the screen and highlights key model parameters and data for creation and testing of scenarios.

Voyager

The Cube Voyager software runs the calculations that perform trip distribution, traffic assignment and trip calculations. The software is controlled by scripts which are essentially a programming language similar to Basic or FORTRAN.

Cube Catalog

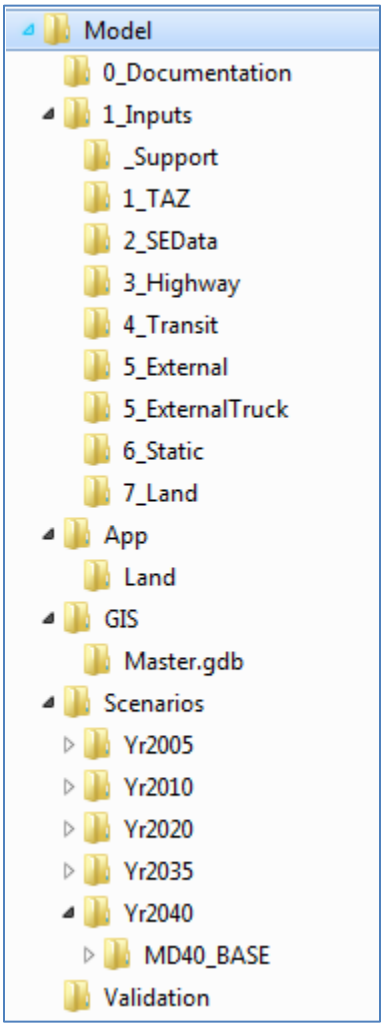
A catalog file stores links to and between the various model scenarios and applications. For this model the Cube catalog is "MCTCModel_[date].CAT" and the applications contain Voyager modules. It is located in the "Model" directory.

CUBE ON YOUR COMPUTER

The Cube software is typically installed in the C:\Program Files\Citilabs directory and subdirectories. These files do not need to be modified or accessed unless the user is updating the software from the web site or using a CD distributed by Citilabs.

The directory structure for the Madera County travel model is shown in Figure 16. "Model" is the root directory and should be copied to a preferred location (i.e. if you want the model to reside on your C Drive under Documents, copy the folder "Model" from the CD to c:\Documents\Model).

Figure 16: Madera Model Directory Structure



The "App" directory contains the scripts and printed output from model runs. Files which are specific to each scenario are stored under "Scenarios" in subdirectories with the scenario name.

CUBE MODEL APPLICATION

Model application begins by opening a Cube Catalog.

Opening a Catalog

The following steps are used to open a Cube Catalog.

- Start Cube by either "double clicking" on its icon 

on your desktop

  OR

  Select Cube from the START bar under PROGRAMS.

- Select "Open your Last Catalog" if you are using the same version of the Madera County model as your last time in Cube

- Select "Open an Existing Catalog" if the "Open your Last Catalog" option does not provide the correct file

  - In Cube, select "File Open"
  - Browse to the directory "Model"
  - Select "MCTCModel_[date].CAT" and click "Open."

The Scenario Manager will be on the left side of the screen. The Graphics Window will initially be blank.

If you just want to look at a specific file, such as a network result, you can select Cancel and then use File Open to open the specific file without entering the Madera Model Cube catalog. This option can be useful for examining files from other models.

Catalog Components

The catalog consists of four panes.

Scenarios Pane

The Scenarios Pane provides a way to manage, add and run alternatives. Each scenario has its own set of input files, listed below as "keys." The "base" scenario "Scenarios" represents the standard situation. From any scenario, you can create scenarios that will appear as "children" of the scenario. A child may be considered as a variation on its parent.

A "child" scenario will inherit key values from its parent. If a new scenario "AltA" was created as a child of the "Yr2040" scenario, the keys for the new "Alt A" scenario initially would have the same values as

the "Yr2040" scenario. The keys should be modified to reflect the correct inputs for the new model run. These steps are described in a later section.

Applications Pane

The Application pane shows the applications that have been added to the catalog. Double clicking on any application will open it.

Data Pane

The Data Pane provides an alternative interface to edit and view data. To edit/view a data file, double click on the file name. The version of that file for the current scenario (as selected in the Scenario tree) will be displayed. Right clicking on the data file name and selecting Edit/Current Scenario produces the same result.

Keys

Catalog Keys define items that vary each time an Application in a Catalog is run. They are assigned values by Scenario.

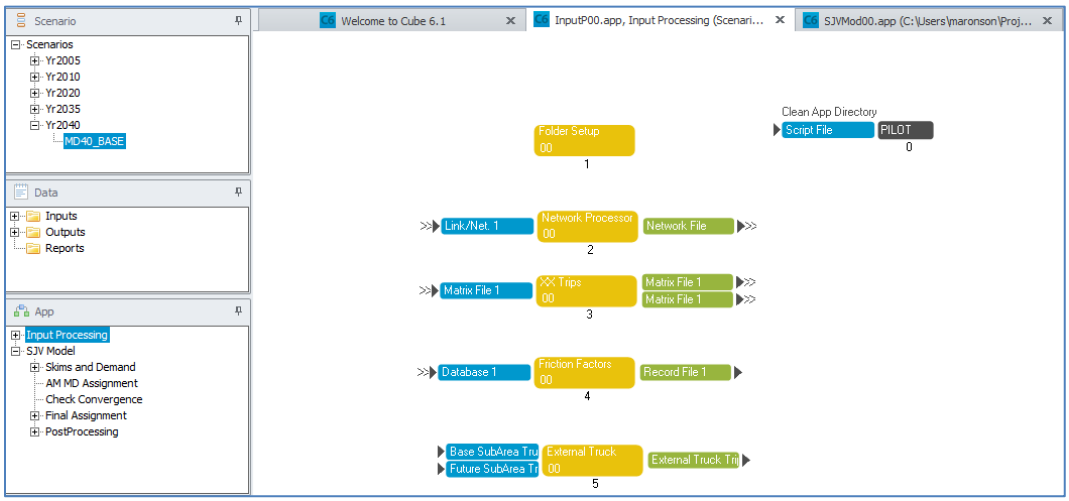
Opening Applications

There are two applications used for the Madera County Model

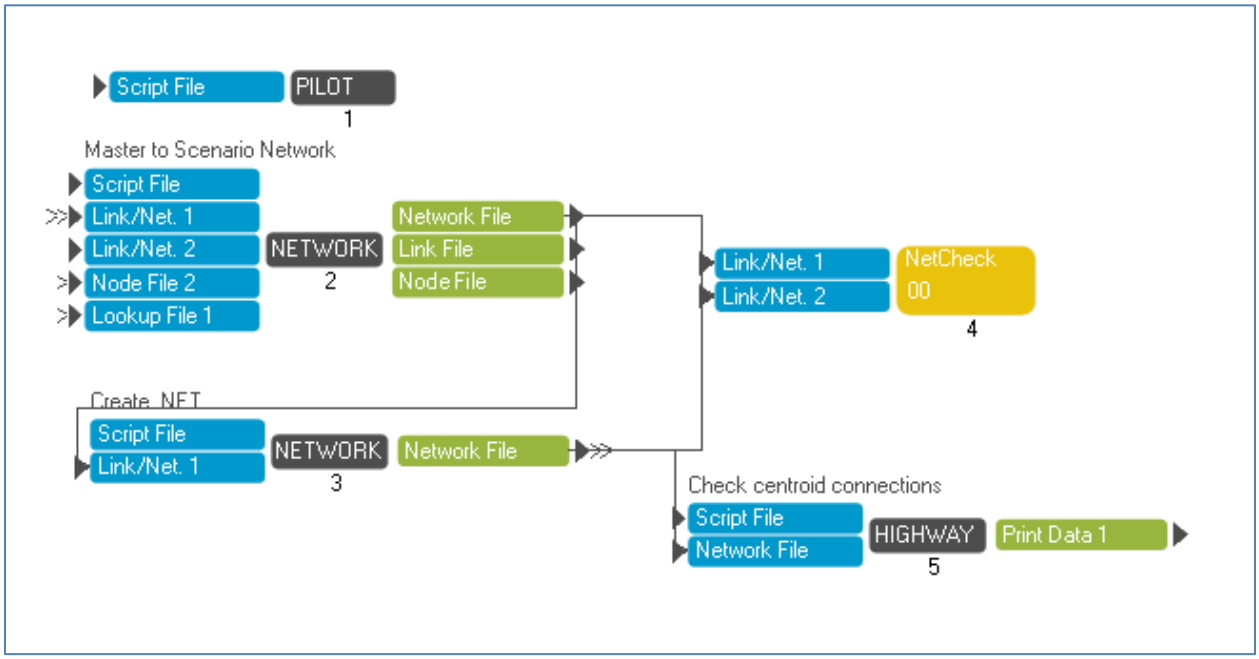
- Input Processing – Creates files required to run the model and checks key inputs.
- SJV Model – Runs the full model

Double clicking on any application box will show the applications or programs under it (Figure 17).

Figure 17: Input Processing Application



Clicking on any of the individual component boxes, for example “Network Processor” will take you to the next level of detail and display the files and processes for that individual step. The application now shows the Voyager program “NETWORK” which performs the network update task. The blue boxes denote input files and green boxes denote output files. To go back to the previous screens, right click and select “Go to Parent”.



Adding a Scenario

The Cube environment makes it easy to add and run a new scenario. As an example let us go step by step and create a street widening alternative along Avenue 26 for 2040.

- Open Catalog "MCTCModel-[date].CAT
- Click on the "Yr2040" alternative in the Scenarios Pane.
- Right Click and choose "Add Child"
- Give the Alternative an appropriate name. Let's call it "AltB".
- A Properties screen may appear.
    - If the Properties screen does not appear, right-click on the new scenario and select Properties
    - Type in a code for the scenario (such as "ALTB"). Keep the scenario code at 2 to 4 characters. The scenario code will be appended to the names of all of the files that are created during the run. Write a description for the alternative.
- A Run screen may appear. Click "OK" for now until you have set up the inputs for the model run.
- Find the network you wish to modify (for example, Madera_Master_2013_08_30.NET) in the Model\1_Inputs\3_Highway directory
- Use Cube to edit the network and create the new 2040 network file with the street widening. Save it in the 1_Inputs\3_Highway folder with a new name (for example, "Madera_Master_ALTB.NET").
- In the Applications pane, select "Input Processing"
- In the Scenarios pane, double click on "ALTB." The run screen will appear.
- Use "Browse" to select the new input road network from the 1_Inputs\3_Highway folder.
- Click Run.

If a new scenario is completely independent of one of the existing scenarios, add the "Child" scenario to the Scenarios scenario.

14. VIEWING AND PRINTING NETWORKS

Cube Base is used to view networks, edit networks to represent changes in road or transit inputs, and to display results such as traffic volumes or level of service. The networks can also be displayed with GIS layers (generally created using other software).

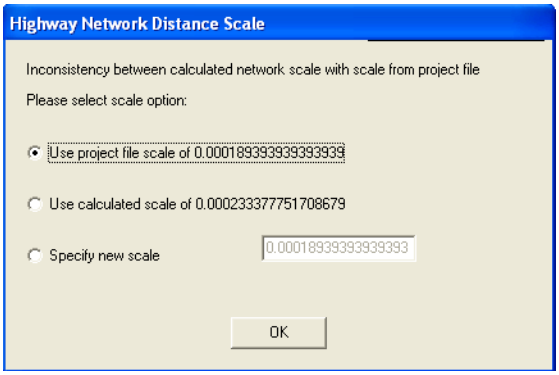
OPEN A NETWORK

A network can be opened for viewing in several ways.

- Double-click on a network box in the Application Pane, such as "Link/Net 1" at the beginning of Input Processing or "Network File" at the end of the Final Assignment section of SJV Model
- Use File/Open and browse to the network

Distance Scale

You may get a message box about the Distance Scale. Click "OK" to "Use project file scale of 0.00018939…" which equals 1/5280 and indicates that one foot in the model network coordinate system equals one mile.



If you do not get the message box, or if you are concerned about the accuracy of edits you are making, use File/Options, NET/GIS Tab, Network Window button to check the Distance Calculation. It should always state that 5280 layer coordinate units equals 1.0 distance units.

Cube can open multiple networks at once, so results from two or more scenarios can be opened and compared.

CHANGING THE VIEW

There are several tools to move around the network and get the view you want.

 Zoom In: Start in one corner of the desired view, hold down the left mouse button and drag a box around the desired view. When it looks right, release the mouse button.

 Zoom Out: This command is not as intuitive. As with Zoom In, you draw a box with the mouse. The view will then shift to show more area, in proportion to the box you drew relative to the screen size. If you draw a box half as big as the screen, the new view will show twice as much network centered on the box you drew.

 View Move: Hold the left mouse button and drag the view to the place you want. You can use this command to "drive" down a particular road.

The scroll bars on the right side and bottom of the screen can also be used to pan the view.

 Previous View: Returns to the previous view screen. This command can be used repeatedly to go back several views.

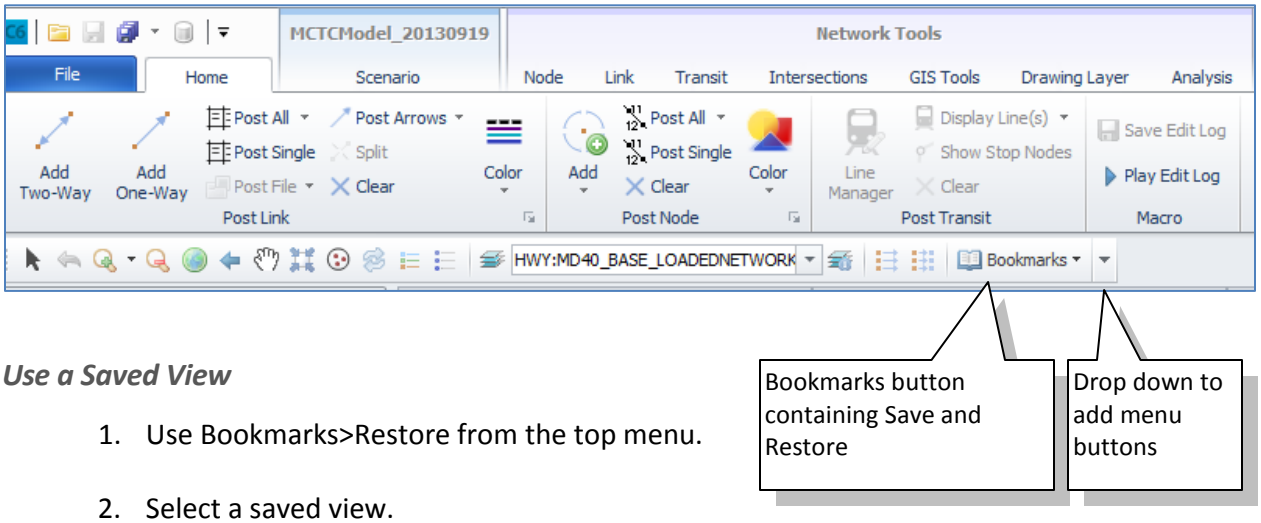
 Zoom All: Display the entire extent of all layers. If you bring in a GIS layer for the entire state of California, this command will show the entire state rather than just the Sonoma County road network.

 View Center on Nodes: This command is useful if you know you want to look at a specific TAZ or node. Type in a node number, and then a Zoom Level in feet. For example, if you want a quarter-mile square view, type in 1,320.

Saved Views

Certain screen views can be saved. These are most useful for printing the exact same view as a previous print. Views can be set up to focus on each city or specific portions of the county.

You may need to add the Bookmarks button to the top menu bar.



Use a Saved View

1. Use Bookmarks>Restore from the top menu.
2. Select a saved view.

Create a New View

1. Zoom to the view that you want to save.
2. Use Bookmarks>Save from the top menu.
3. Select an unused number or letter
4. Enter a name for the view.

Use a Common View for Two or More Networks

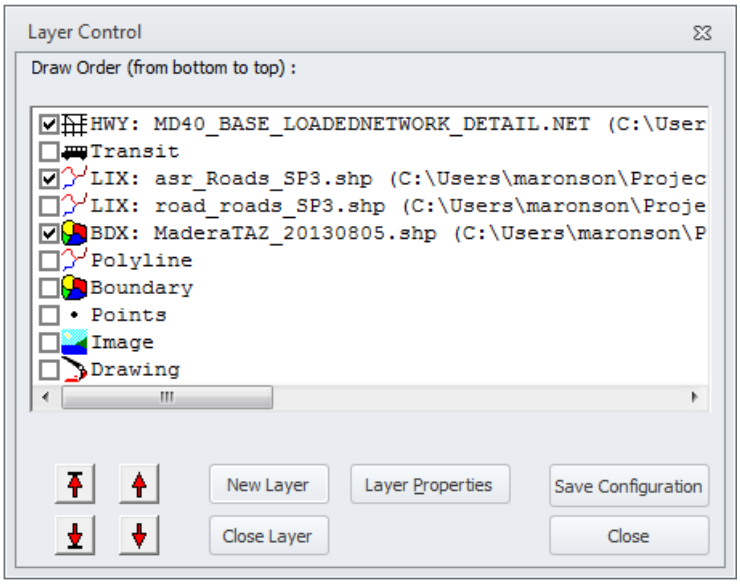
Sometimes you may want to view a specific area in one network, and then look at the exact same area in another network.

1. Open the two (or more) networks for viewing.
2. Zoom to the desired view in the first network.
3. Use Bookmarks>Save from the top menu and select Common View
4. Use the tabs from the top menu to switch to another network
5. Use Bookmarks>Restore from the top menu and select Common View

NETWORK WINDOW LAYERS

Cube can show the model road network along with many other layers of information such as street maps or TAZ boundaries. Click on the layer control icon  or use View/Layer Control… from the menu.

The Layer Control lists the layers which are being displayed. It also allows you to browse to select different or additional layers.



The standard Madera County Model settings display the Highway Network on top, along with two GIS layers:

1. All roads
2. TAZ boundaries

To view characteristics of any of these layers, click on the file name and then click **Layer Properties** below. The **Layer Properties** is also used to find the correct location for a missing layer file, using the **Browse** button.

Use the check boxes to turn layers on and off.

If you want to add a new layer to the display, such as a City boundary, click on the correct layer type (in this example, click on Boundary layers) and then click **New Layer** below. Browse to the directory with the file you would like to add to the display.

It is recommended that the GIS layers first be converted to be the same coordinate system as the Cube network (NAD 83 California State Plane Zone 3). Unlike ArcGIS by ESRI, the Cube Base window is not able to convert coordinate systems automatically.

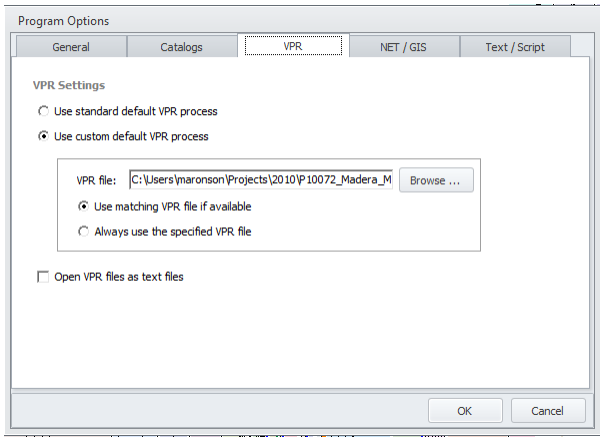
View Settings in Cube Project Files

Cube "Project Files" store various settings, including:

- The status and drawing order of the layers
- Color settings for links and nodes
- Saved views
- Saved polygons
- Printer setups
- Highway network attribute calculation information

Recommended Settings: Custom Process

The settings for the Madera County model are contained in the project file DEFAULT.VPR located in the Model directory. To use these standard settings, use File>Options, VPR Tab. The setting should be Use Custom Default VPR Process.

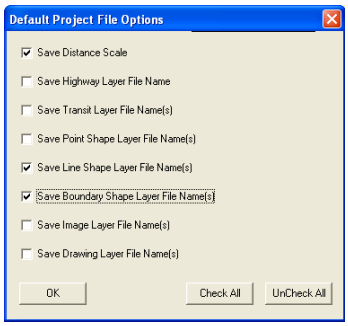


Other Option: Standard Process

With the Standard Default VPR Process, Cube will automatically search for a project file when a highway network file is opened. If a project file with the same name is found, the program will utilize the settings found in the project file. If such a file is not found, then Cube will try to search for a file named DEFAULT.VPR in the current (project) directory and then in the Cube program directory. If a DEFAULT.VPR file is located, Cube will utilize the settings in this file.

Saving New Settings

If you come up with a specific set of colors and/or print settings for a specific application, you can either add them to the DEFAULT.VPR settings or create a new Project File just for your network views.



Add to General Settings (DEFAULT.VPR)

1. File/Save Project As
2. Browse to the Model directory
3. Select DEFAULT.VPR
4. Yes to Overwrite
5. Save Distance Scale, Line and Boundary files

Create New Settings for a Particular Network

Use this option if you have created very specific displays, for example graphics of trips to and from specific TAZs.

1. File/Save Project As
2. Browse to the directory where the network is (most likely under Model\Scenarios in the scenario directory)
3. Cube will suggest a name which is the same as the network, with .VPR in place of .NET (for example, MD10_BASE_LOADEDNETWORK_DETAIL.VPR for viewing MD10_BASE_LOADEDNETWORK_DETAIL.NET). Use this name.

The next time you open that particular network, Cube will use your specific settings rather than the general settings in DEFAULT.VPR.

Cube Project File Description

The project file is an ASCII text file which looks like a Windows INI (Initialization) file. Citilabs recommends that this file only be modified by changing the settings in Cube. However, it can be viewed in a text editor (or Word). If you choose to edit the file directly, make certain that there is a backup of the original file.

Color Settings

The settings for the Madera Model include several color settings which are generally useful for viewing networks. Users can modify these settings or create their own. The settings are organized as follows:

- Settings 1-3 are most useful for Master networks
- Settings 6-7 are for final networks with traffic volumes
- Settings 8-9 are for viewing the 2010 base year validation

Users do not have to follow this numbering system. Link color settings can be assigned to any available numbers.

Link Colors

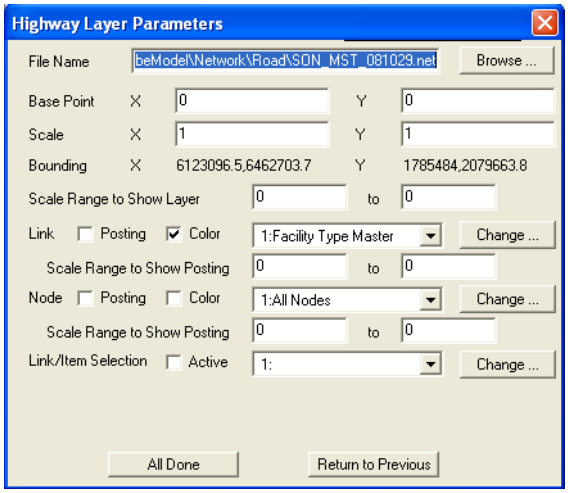
Current Link Color Settings

You can view the current link color settings by clicking on the icon with the horizontal bars  . The color settings are based on various link attributes.

Select Link Color Settings

There are two ways to select different link color settings:

1. Click the arrow next to the horizontal bar icon. The available settings will drop down.
2. Click the Layer Control icon  . Select the HWY layer and click the Layer Properties button at the bottom. The horizontal box to the right of "Link" has a drop-down arrow which will list the available settings (see example)

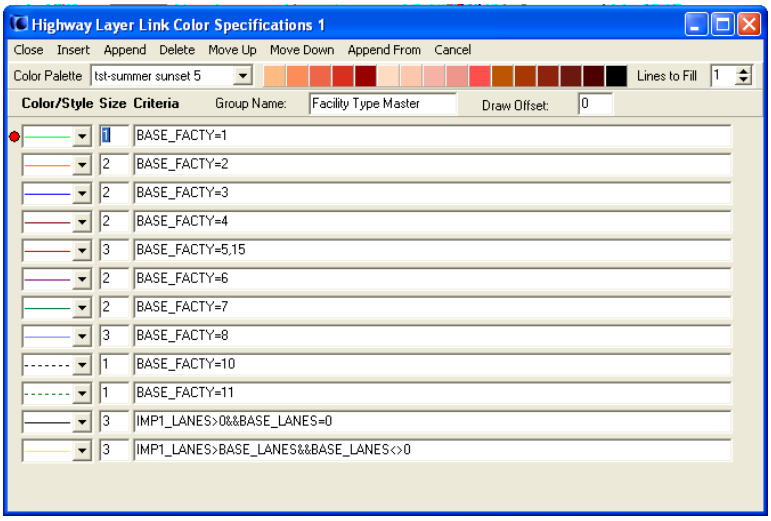


Change Link Color Settings

1. Choose a link color setting OR choose a blank setting number if you want to create a new setting.

2. View the current link color settings 

3. To change an assigned color, click on the horizontal line. Select the line type (usually the first one, a straight unbroken line), You will then get a color menu to choose from.



4. To change the line width, type a number in the Size column. Dashed lines only show up well with a Size of 1.

5. To add another setting, click in the last setting line. Then choose Append from the menu across the top. Click in the line box to choose a line type and color, then type in a Size. Now type a criterion based on a link attribute (for example, LANES=2 to highlight all roads with 2 lanes in each direction).

6. You can make the criteria more complex by using && (AND) to indicate a link has to meet both of two (or more) criteria, or || (OR) to indicate that a link can meet either of two criteria.

7. A lower criterion supercedes all earlier criteria. In the example above , all links are first given a color based on BASE_FACTY. Then, all links with IMP1_LANES greater than zero and BASE_LANES equal to zero (indicating a new road) are changed to a thicker black line.

Node Colors

Current Node Color Settings

You can view the current node color settings by clicking on the icon with the shapes  . Set 8 is provided to highlight TAZ nodes and places a black dot for every other node in the network.

Change Node Color Settings

Node color settings are selected in the same ways as link color settings. The quickest way is generally to click the arrow next to the shape icon.

Node colors can also be modified using the same procedure as modifying link colors. For nodes, instead of line types, you will select shapes such as circles or squares to represent different node characteristics.

Posting Labels

There are three ways to post information alongside nodes or links:

1. Click the Post Node  or Post Link  icon

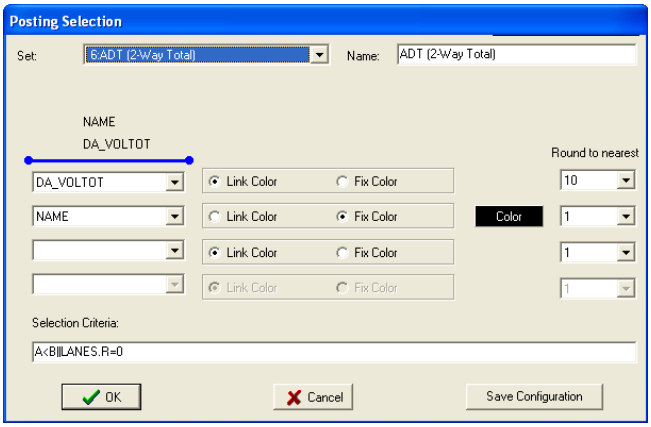
   OR

2. Select Post/All Nodes… or Post/All Links… from the top menu

   OR

3. Use the Layer Control  and click the appropriate check boxes

Any of these methods will bring up a Posting Selection box.



- You can post up to 4 attributes at once on a node or link.
- The color of the label defaults to be the same color as the node or link (black nodes will have black labels, blue links will have blue labels, etc…). You can also Fix Color to black or other colors.
- You can round numbers. Volume labels are sometimes easier to read rounded to the nearest 10 or 100. Volume/capacity ratios should be rounded to the nearest 0.01.
- You can set Selection Criteria so that not all nodes or links are labeled. For example, you may want to post information only on links with volumes greater than 100.
- To change the font size, select File>Options, General Tab, Font button.

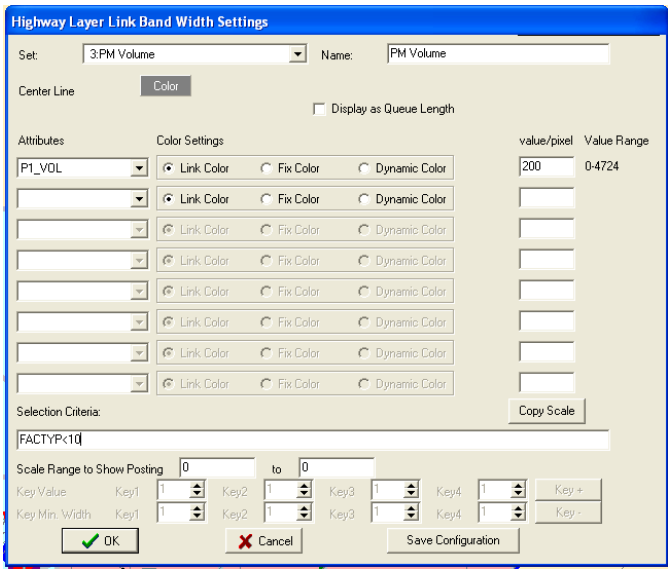
BANDWIDTHS

Bandwidths can be used to illustrate results by varying the line width in proportion to an attribute such as volume.

Modify or Create a Bandwidth Setting

1. From the top menu, select Analysis>Multi-Bandwidth  .

2. The Band Width Settings box will appear.



3. Select a Set you want to modify, or select an unused number to create a new set.

4. Under Attributes, select the network characteristic which will be used to set the line widths. Multiple attributes can be listed; for example, you may want to have three different colors of bands for drive alone, shared ride 2 and shared ride 3+ vehicles.

5. Set the band color to be either the Link Color set in the link color settings, or a specific fixed color.

6. In the value/pixel column, Cube will suggest a value. Try this value and see if you like the widths (after you click "OK"). If you want wider lines, go back and type in a smaller value/pixel. If you want narrower lines, type a larger number.

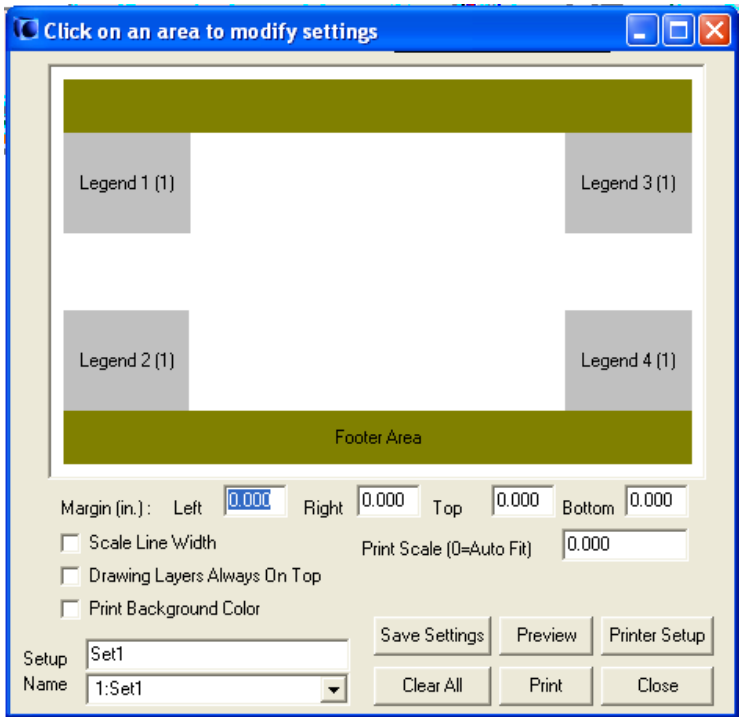
7. The selection criteria will only show widths for certain links. For example, FACTYP<10 will only show line widths for links which are not zone connectors.

8. Select **OK** when you like the settings. It generally takes several tries to get a good bandwidth display.

PRINTING VIEWS

Printing a view of a model network is often called plotting. You can print to 8.5x11 paper in a standard printer, a large-scale plotter, or create Adobe PDF files (which in turn can be converted to JPG or PNG format for insertion in other documents).

1. Select File/Page Setup… to bring up the Page Setup box.
2. Select **Printer Setup** and select the printer (can be Adobe PDF), paper size and orientation (Portrait or Landscape).
3. Select **Close**
4. Select View/Resize to Plot Page to set your view window so WYSIWYG (what you see is what you get). The window should adjust to the orientation you selected (Portrait or Landscape).



5. Zoom to the view you wish to print or use View/Restore to retrieve a standard print view.
6. Select File/Page Setup… to bring up the Page Setup box again
7. Select a previously saved setup number

   OR select an unused Setup number to create your own.
8. Select **Preview** to see how the print will look.
9. Click in any of the header, footer or Legend areas to change the text in those areas. The printer Setups can automatically include the Scenario Name in the header and the date and file name in the footer.
10. Make certain that Scale Line Width is checked if you want Bandwidths to show correctly.
11. It often takes several adjustments and Print Previews to get the print to look the way you want. When it does, select **Print**.

15. ROAD NETWORK CHANGES

The Madera County travel model uses coded representations of the region's existing and future roadway networks. 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 starting with 2010.

EDITING THE NETWORK

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 freeway interchange to the 2010 and all future networks beyond 2010), the same network editing had to be performed individually for each of the network years. With a master network, the user need only input the improvement in one place with the appropriate year of construction and then all desired network years can be built and will be consistent.

Types of Master Network Links

The master network must be edited differently from a single year road network. There are five basic types of links:

1. Same in Base and Future Years

A link that stays the same in the base and future years does not need any data in the IMP1 or IMP2 fields for facility type, lanes and speed.

2. Improved in Future Year

A link that is improved in the future year requires an improvement year in the IMP1_PRJYR field, and the attributes of the improved link should be entered in the IMP1 fields. If there will be a second phase of improvements (for example, a first phase widening and a second phase grade separation), the year for the second phase is entered in the IMP2_PRJYR field, and the attributes of the improved link after the second phase should be entered in the IMP2 fields.

3. Exists in Base Year and Not in Future Year

A link may exist in 2010 but not in the future. An example would be the links that make up an at-grade intersection that will be replaced by a freeway interchange. These links require attributes in the BASE fields, a non-zero value in the IMP1_PRJYR field and a zero (0) in the IMP1_LANES field. The IMP1_PRJYR determines the year that the link is deleted.

4. Exists in Future Year and Not in Base Year

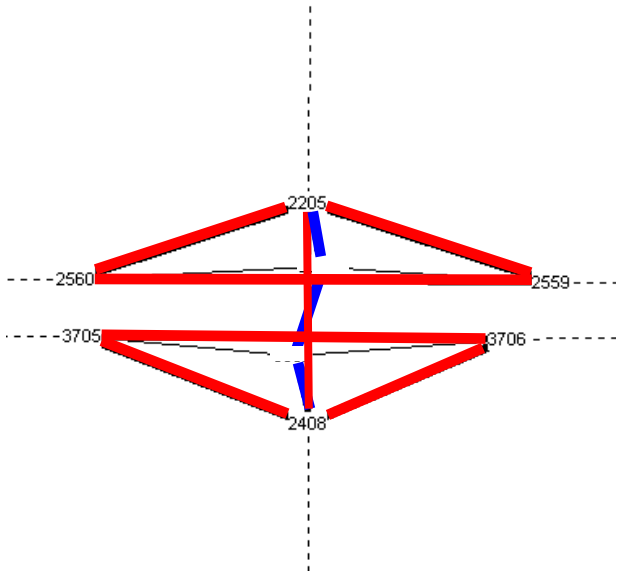
A link may be added in a future year. These links require attributes in the IMP1 fields but not in the BASE fields. The IMP1_PRJYR determines the year that the link is added.

A link could be added in one future year and then improved in a later year. An example would be a two-lane road that is extended in 2015, and is further widened in 2020. This link would have no attributes in the BASE fields, but would have attributes in the IMP1 fields. A second set of fields for IMP2 would be used for the second phase of improvements.

5. Exists Only in Years Between the Base and Future Years

Some links are associated with phased improvement projects, and exist only for a period of time between the base year and future year. An example would be a new connection to a highway in the year 2015 which is later replaced by an interchange in 2025 (Figure 18).

Figure 18: Example Phased Improvement Coding



Base Year Links

2559-3990

3990-2560

3705-3992

3992-3706

IMP1 Links (2015)

2205-3990*

3990-3992*

The link representing the first improvement (in the example, the at-grade connection) would have no BASE attributes. The IMP1_PRJYR determines the year that the link is added and the IMP2_PRJYR determines the year that the link is replaced.

Separate links for the second improvement (in the example, any link which is part of the new interchange) would have no BASE attributes. The IMP1_PRJYR would be the same as the IMP2_PRJYR indicating the link deletions for the first improvement.

It may be necessary to code parallel links to represent phased projects. The ultimate link should be coded as a single link, but the interim phased link would need to be coded as two links to keep it separate from the ultimate link.

In the example, the at-grade highway is coded as two links in each direction. These links would have BASE attributes and would have an IMP1_PRJYR with IMP1_LANES=0 for the year in which the interchange is constructed (2025). The initial new at-grade road connection (for example, 2205-2990) would be coded as three links with IMP1_PRJYR=2015, IMP1_LANES=1, IMP2_PRJYR=2025 and IMP2_LANES=0. The interchange links would have no BASE attributes, IMP1_YEAR=2025 and the IMP1 attributes would represent the final interchange.

Network Edits

Changes to a network might include adding links that are not already in the network, changing the number of lanes for links that are already present or deleting links that are already present.

Undo

Perhaps the most important command, Cube will undo changes using the Undo on the top command bar.  The Undo will not work once you have saved the revised network to disk.

Save Your Work

About every fifteen minutes, you should save the network to the disk to save the changes you have made so far. Use File/Save As…to save the network. It is recommended to use a series of temporary names (such as ALTB_Edit1.NET, ALTB_Edit2.NET, etc…) so that you can return to earlier versions of there is an error.

Move a Node

1. Click on the pointer icon 
2. Click on the node and drag the node to the new location

Cube will automatically change the distances of the links attached to the node when you move a node, based on the distance scale (shown under File>Options)

Add a Separate Node

1. Use Node>Add from the top menu

2. A node numbering box will appear. You can type in a node number or select from the list of unused nodes. Numbers 9999 and below are reserved for TAZs. In general, it is best to choose a number close to the numbers of neighboring nodes.

Add a Zone Node

1. Click on the pointer icon 

2. Select a zone node with similar characteristics. If you are dividing an existing TAZ, choose that TAZ.

3. Right click and select Copy.

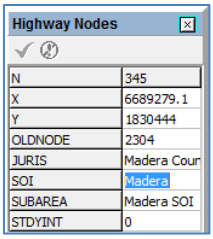
4. Pasting in Cube is different than most Windows programs. You do not move to the location you want to paste first. Instead, you right click and select Paste before selecting the location.

5. The cursor is now a cross shape. Click on the location of the new TAZ node.

6. Select a number of 9999 or lower, preferably close to the numbers of the neighboring TAZs.

7. Click on the pointer icon  and select the new node. Edit characteristics such as jurisdiction (JURIS) as needed.

8. The green check mark at the top saves edits. The red circle provides an Undo.



Change a Link

1. Click on the pointer icon 

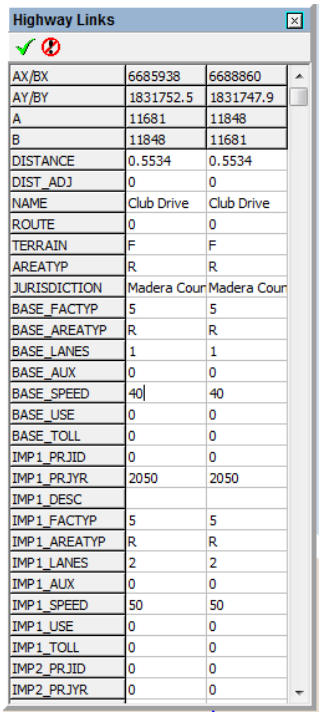
2. Select the link to change. The Highway Links window will appear. The window shows attributes for both directions of two-way links.

3. Click in any field and type in a new value. Be certain to make the changes in both directions if applicable.

4. The green check mark at the top saves edits. The red circle provides an Undo.

5. Notes on specific improvements can be input in the IMP1_DESC field.

6. You can copy text (such as street names) by double-clicking the text and then using the standard Windows <CTRL> C to copy and <CTRL> V to paste.



Move a Link

1. Click on the pointer icon 

2. Select the link to move. The Highway Links window will appear. Drag it out of the way if needed.

3. The selected link will flash and the end nodes will have red circles. Click on one of the end nodes and drag the end node to the new end node.

Add a Link

Generally, the best way to add a link is to copy an existing link that is similar to the one you want to add.

1. Click on the pointer icon 

2. Select the link to copy. The Highway Links window will appear.

3. Click the right mouse button and select Copy.

4. Pasting in Cube is different than most Windows programs. You do not move to the location you want to paste first. Instead, you right click and select Paste.

5. Next, click and hold the left mouse button down when the cursor is on the A-node location, then drag the mouse cursor to the B-node location and release the mouse button. If the selected locations are near existing nodes, the end points of the new link will snap to these nodes.

6. If Cube does not find a node near your starting and/or end point, it will ask you to add a new node. If this is not what you wanted to do, select No or Cancel.

7. If you select Yes, a list of unused nodes will be displayed in the new node dialog box. Cube will generally suggest a new node number at the end of the current node numbering. The

new node number can be selected from the list of unused nodes by double-clicking or entered manually. It is recommended to select a node number close to the nearby nodes.

8. Click on the new link and change the various link attributes to properly represent the link you are adding. Remember to change the street name in both directions!

Delete a Link

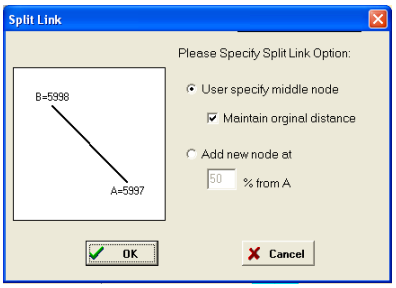
If the link is to be deleted from all study years, click on the link to select it, then press the **Delete** key.

If the link will exist and be deleted within the model time period, input the correct IMP1_PRJYR and IMP1_LANES=0.

Add a New Node on a Link (Split a Link)

If you want to add a new connection to an existing road segment, you cannot just add a new node and link in the desired location. You must split the existing segment into two segments with a new node.

1. Click on the pointer icon 
2. Select the link to split. The Highway Links window will appear. Drag it out of the way if needed.
3. Select Home>Post Links>Split from the top menu, or click the right mouse button and select Split.
4. In most cases, accept the default option of User specify middle node.
5. The cursor will switch to a cross. Click on the location of the new middle node. It does not have to be directly on the link.



6. Answer “Yes” to Add New Middle Node.
7. Select a node number from the Unused Nodes.
8. There will be two links in place of the one original link. The distances will be automatically recalculated. You may wish to click on each link and make sure that the attributes are correct.

CHECK YOUR WORK

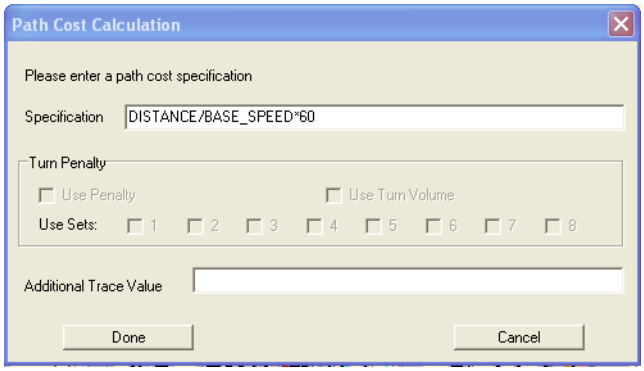
Post labels such as lanes or speeds whenever you finish a short series of changes. Post in both directions. This will allow you to quickly check your work and ensure that link data has been edited in both directions if necessary.

Another useful check is to add a link color setting with a very bright wide line for unrealistic values, such as speeds of 0 or greater than 70.

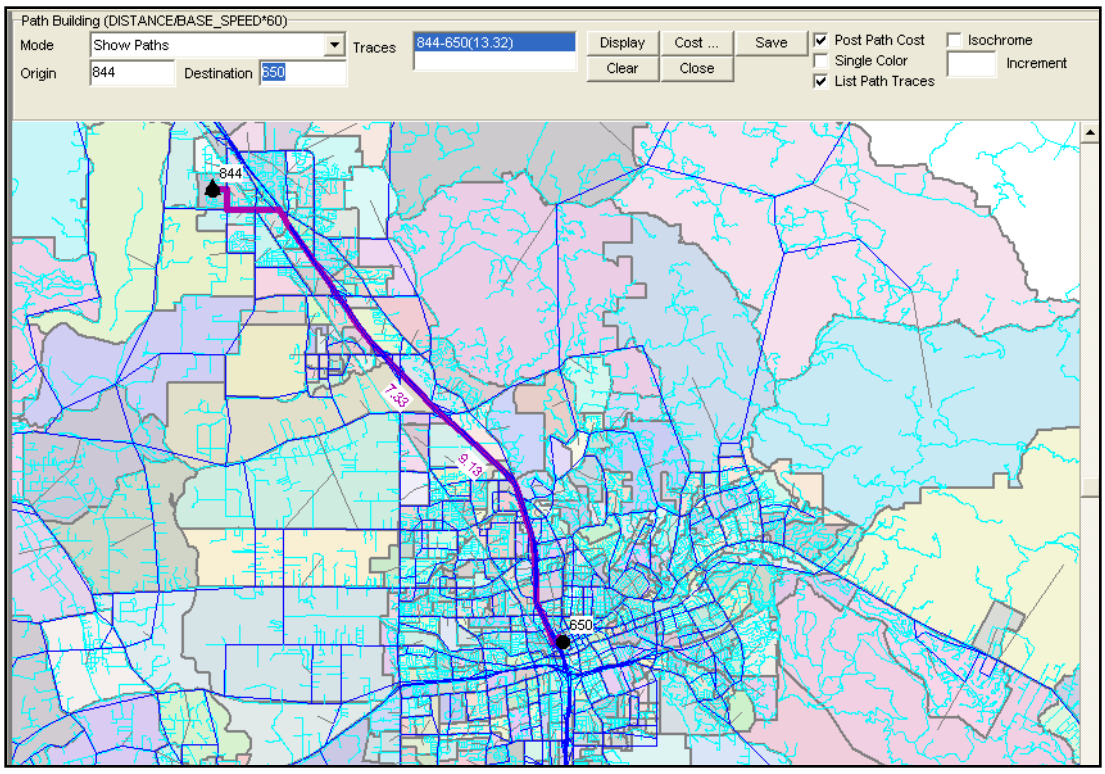
Paths

A useful way to check network revisions is to test zone-to-zone paths.

1. Select Path/Build from the top menu.
2. In the Specification window, click the right mouse button. A long list of network attributes will appear (including repeated attributes with a .R at the end which represent reverse direction attributes). Select DISTANCE.



3. Type " /" to indicate division
4. Select BASE_SPEED or SPEED.
5. Type "*60" to convert to minutes.
6. Click **Done** There may be compute errors which can be ignored (click "OK").
7. The Path Building menu will appear at the top of the Network Window. You can interactively enter Origin nodes and Destination nodes (either type numbers, or click in the window and then click a node). Click **Display** to see the selected path and determine if it is logical.



8. You can zoom in on the path and see the accumulated minutes. This information could help to spot an illogical speed or distance in the network.

Save Network Files

When editing is completed on the master road network, it is recommended that you save the master road network (File/Save As…) with a file name that includes the update date.

TURN PENALTIES

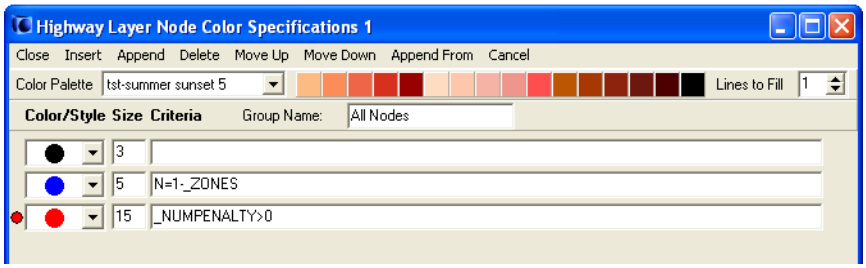
Turn penalties are coded in a separate file, and can be used to identify node-to-node movements which are prohibited (such as certain left turns) or which have additional delays. Turn penalties are primarily used to represent prohibited left turns to and from ramps at freeway interchanges.

Cube can be used to view and edit turn penalty files using the following steps:

1. Use the Intersections>Intersection Files>Turn Penalty File menu command to read a penalty file from the Model\1_Inputs\3_Highway directory. The original base year penalty file is MD10_Base_TurnPen_121005.CSV. You may need to change the file specification to All Files to see the turn penalty files, which are in CSV format.

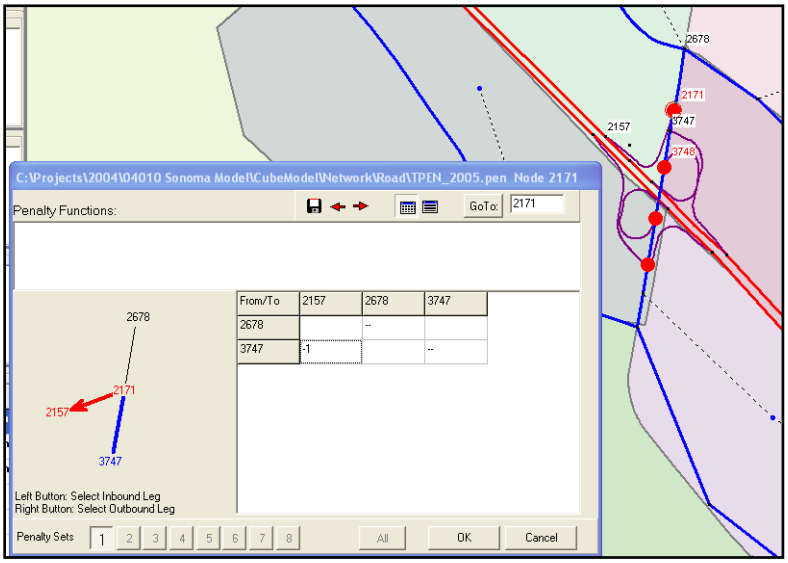
2. In order to see which nodes have turn penalties, you will have to modify the node color settings. View the current node color settings by clicking on the icon with the shapes.

Select Append to add another setting. Choose a large bright shape, such as a red circle with a size of 15. For the criterion, select _NUMPENALTY>0 (type manually or use the right mouse button within the Criteria window) to identify nodes with penalties. Click "Close" on the top menu of the Node Color box. The nodes with turn penalties should show as large red circles.



3. Select a node from the network and Select Intersections>/Edit Intersections>Turn Penalties to display the penalty edit dialog box for that node (Figure 19).

Figure 19: Turn Penalty Example



1. The toolbar on top has buttons to save the penalty file, go to the previous intersection, go to the next intersection, switch grid style, and go to a particular intersection.

2. In the diagram, a blue line denotes the inbound leg, and a red line with an arrowhead denotes the outbound leg. The mouse can be used to select a particular movement on the intersection display. Use the left mouse button to select the inbound leg, and use the right button to select the outbound leg.

3. In the table, a -1 indicates a prohibited movement. You can also enter a time penalty in minutes in place of the prohibition.

16. CHANGING LAND USE

Land use assumptions are changed in the Excel Parameters workbook.

PARAMETERS WORKBOOK CONTENTS

The workbook is used to generate land use and trip generation for one scenario at a time. The workbook includes the following information on various sheets:

- Land use inputs by TAZ for the selected scenario
- TAZ inputs such as transit frequency
- Special generator inputs
- External gateway inputs and adjustments

There are also sheets containing model inputs which are NOT generally changed between scenarios:

- Trip generation rates
- Friction factors
- Auto ownership model parameters
- Mode choice model parameters
- Diurnal (time of day) factors
- Traffic assignment parameters (capacities and speed/flow curves)
- Traffic counts

CREATE LAND USE INPUTS FOR A SCENARIO

1. Open the Excel file "xxxx_Parameters_{Date}.XLS" from the Model\1_Inputs_Support directory for the appropriate study year, if available.

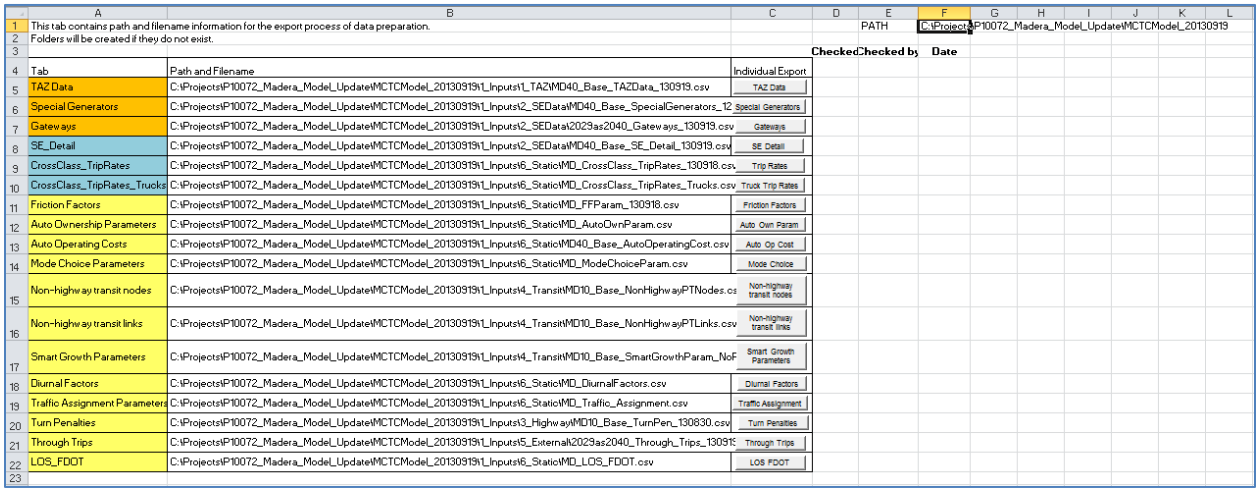
2. Go the LandUse_Inputs sheet and edit the values for each TAZ and land use category.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	TAZ	RU1	RU2	RU3	RU4	RU5	RU6	RU7	RU8	RU9	RU10	AGRICULTUR	MINING	UTILITIES	CONSTRUCTN	MANUFACTUR
87	86															
88	87															
89	88															
90	89															
91	90															
92	91															
93	92															
94	93															
95	94															
96	95															
97	96															
98	97															
99	98															
100	99															
101	100															
102	101	238	6	7	3	0	0	0	0	36	0	2	0	0	1	0
103	102	159	0	17	36	37	0	6	0	3	0	0	0	0	0	0
104	103	135	0	11	22	23	0	4	0	2	0	0	0	0	4	0
105	104	217	0	20	41	42	0	7	0	4	0	1	0	0	3	0
106	105	256	3	0	0	0	0	0	0	0	0	0	0	0	36	6
107	106	173	11	11	0	0	0	0	0	0	0	0	0	0	0	0
108	107	74	0	8	17	17	0	3	0	2	0	1	0	0	3	0
109	108	222	36	10	21	22	8	4	0	2	0	0	0	0	3	1
110	109	138	11	10	18	28	0	0	0	0	0	0	0	0	0	0
111	110	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0

3. The workbook multiplies the LandUse_Inputs by the detailed stratifications in the CrossClass_Rates sheet to create the land use in the form used by the model stored in the SE_Detail sheet.

4. Save the Excel workbook. If you want a record of this specific scenario, Save As a different name. *Make certain that the Excel file is saved in the _Support directory and NOT in "My Documents*."

5. Go to the Data Export sheet. In cell <F1>, you can enter a path name to the Model directory which will be used for the output files.



6. The important output for a land use change is SE_Detail. Edit the filename for the current scenario in Cell B8.

7. Press the **SE Detail** button which runs a "macro." The workbook automatically saves the SE_Detail file with the revised land use.

8. If appropriate, update the TAZ_Inputs sheet to reflect changes in developable acreage, transit coverage or anticipated real median household incomes.

9. Use the File_Export sheet and the **TAZ Data** button to save the TAZ data.

In general, you will not need to export any other data files from the Parameters workbook if your scenario is from an available study year. If you are creating a scenario for a new year (for example, 2033), you will need to also update the Gateways and Through Trips.

SPECIAL GENERATORS

The Madera County model does not currently use any special generators. Special generators can be input on the SpecialGenerator_Inputs sheet. The user needs to estimate the number of person (not vehicle) trips by purpose and enter these trips directly.

17. RUNNING THE MODEL

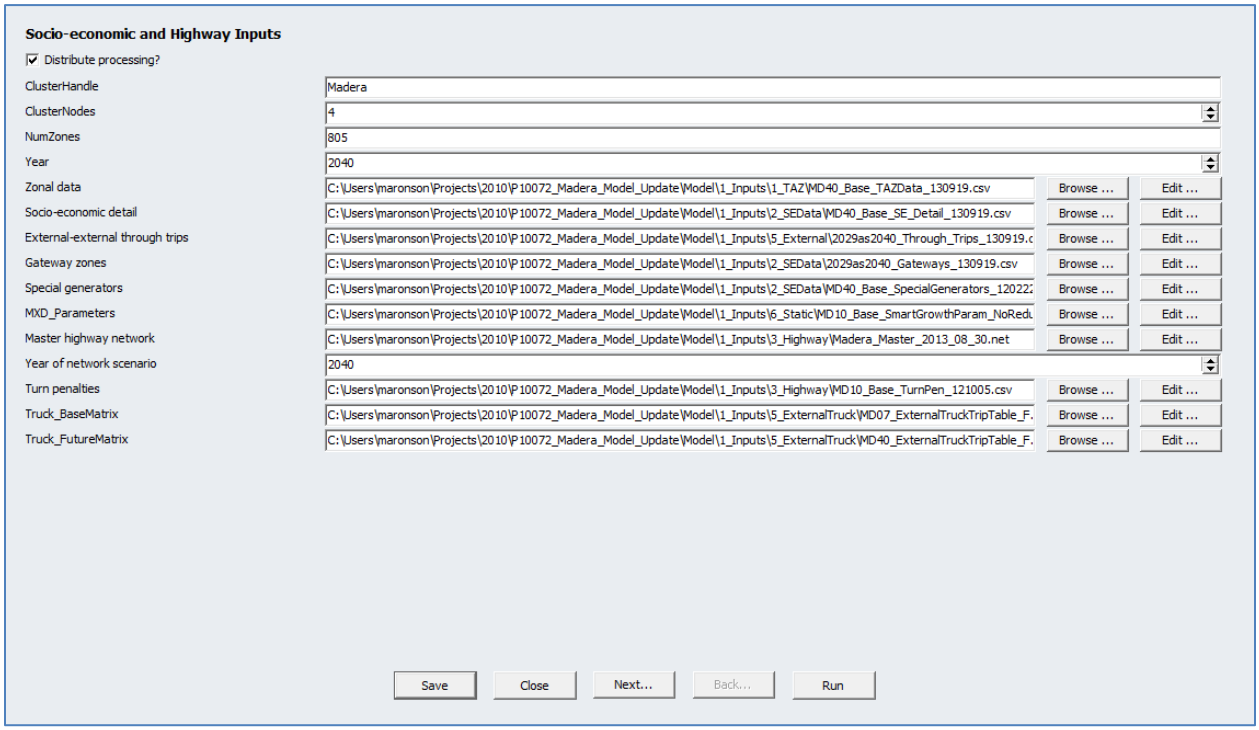
When you make changes to the network and land use inputs, you do not instantly get the revised results. You must "run" the model using the new inputs. Up to now, you have been using Cube Base only. The model run applies the Voyager software.

START A MODEL RUN

1. In the Application Pane, double-click on the Application "Input Processing." The application flow chart should appear in the Graphics Window.

2. Select a scenario by clicking its name in the Scenario Pane, and it will be highlighted.

3. Double click on the Scenario and a Run Screen will appear.

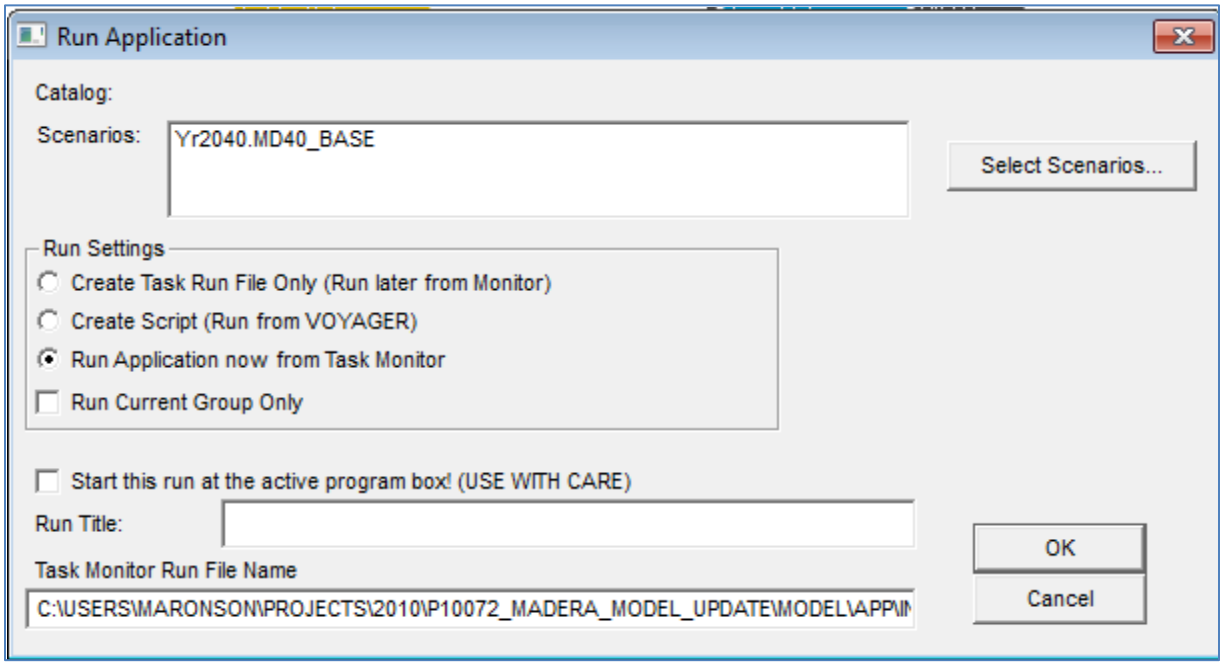


4. Choose the correct input files using the **Browse** buttons. If necessary, use the **Next** button to check the input files on the following screens. However, the most important input files to check, which might change between scenarios, are all on the first page, Socio-economic and Highway Inputs

    - Year
    - Zonal Data
    - Socio-economic detail
    - External-external through trips
    - Gateway zones
    - Special generators
    - Master highway network
    - Year of network scenario
    - Turn penalties

5. Click **Save** to save this set of file inputs for this scenario (this information is ultimately saved in the .CAT Cube catalog file).

6. Use the Home>Run Application button on the top menu to start the model. 

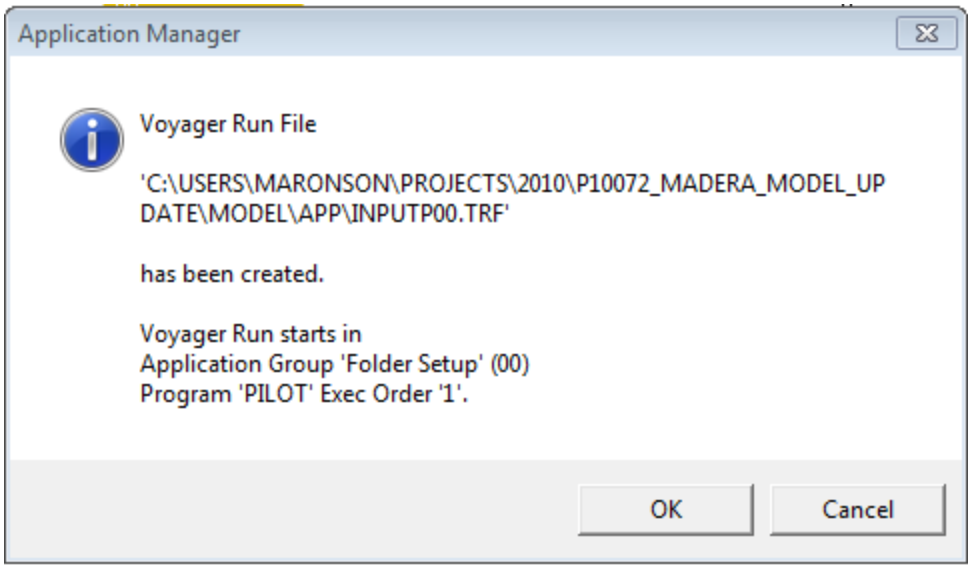


7. Make certain that correct scenario is showing in the Scenarios window, If not, use Select Scenarios to select the correct scenario and delete scenarios that have already been run.

8. If you want to run just a subset of the application (for example, just to check a road network), click Run Current Group Only.

9. Click **OK** to start the model run.

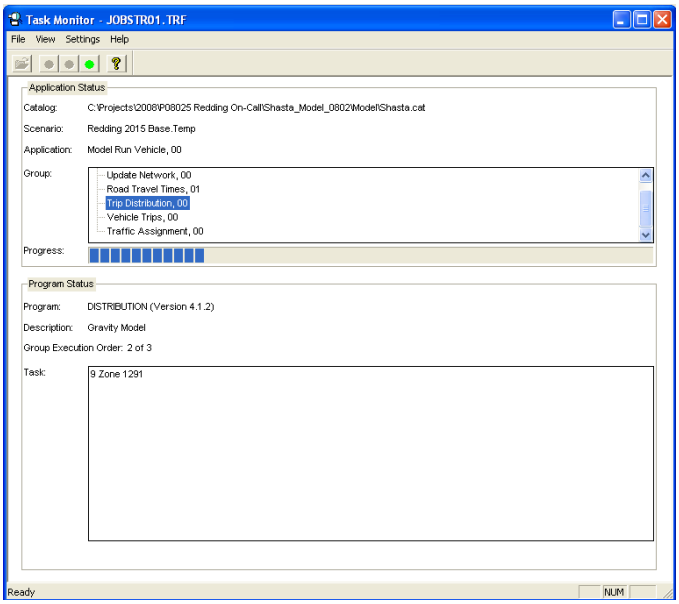
10. Cube will display a screen to tell you that it has created a script to run all of the selected steps in the application. Click **OK** to start.



Task Monitor

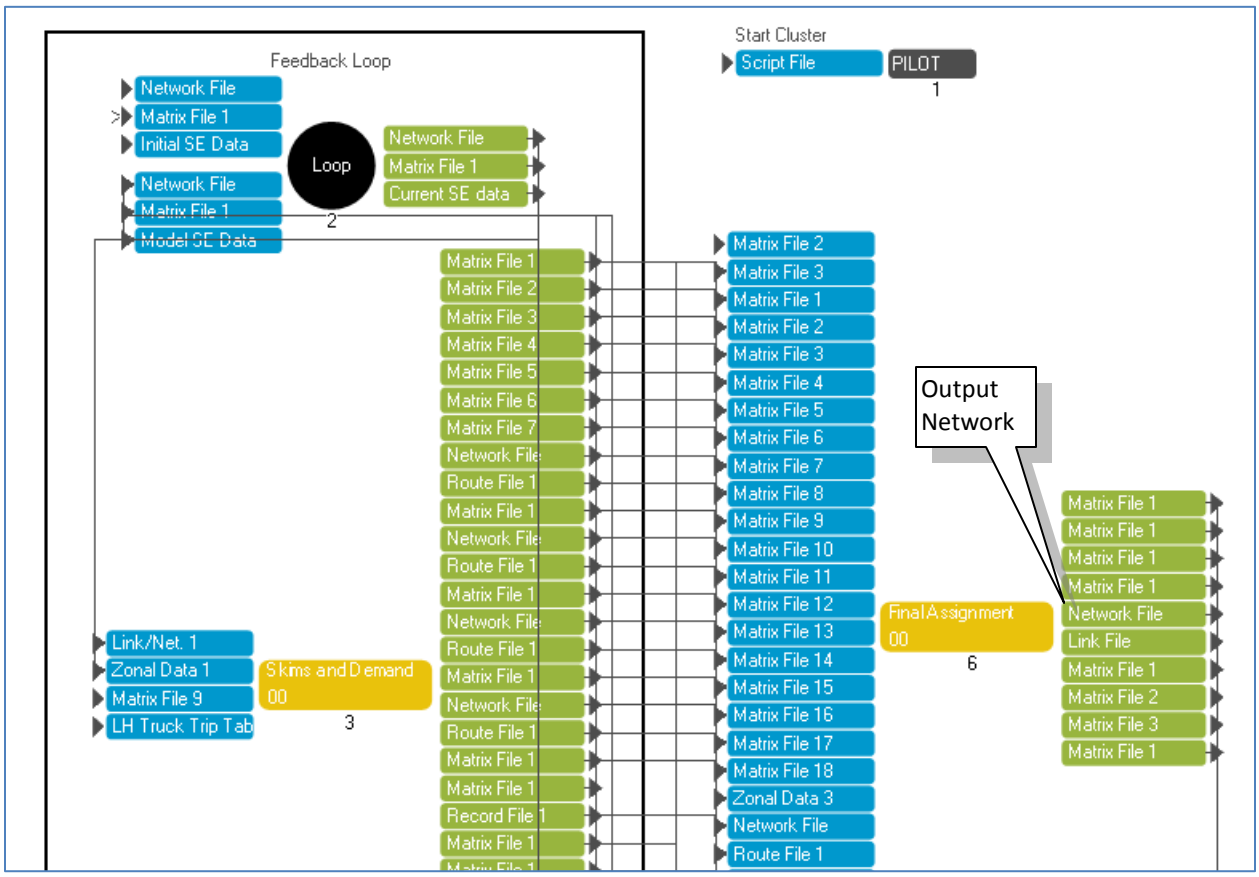
When an application is running, the Task Monitor screen appears. It shows the progress of the steps in the application.

It will also show a warning if there is an error in the model run. Errors are documented in the print output file as described below.



MODEL OUTPUTS

The primary model outputs are the "loaded networks" which are the network files with the assigned traffic volumes. The combined result network can be found at the end of the SJV Model Application flow charts and can be viewed by double-clicking the box.



Other outputs include:

- Interim trip matrix files from the trip distribution and mode choice steps.
- Printed output documenting the entire model run.
- Lists of TAZ data such as trips by purpose and trip lengths.

Printed Output

A large text file is created by each model run. The file is placed in the \Model\App directory along with the the script files (*.S). The print file has the name {Application}_{Scenario}.PRN, such as "SJV Model_MD40.PRN."

You generally do not need to get information from the print file. It does document the date and time of all input files and model steps, and includes information on average trip lengths by trip purpose. If you know where to look (at the end of each Voyager function, using the comments in the script to locate

specific matrix numbers), you can find various subtotals of person or vehicle trips by purpose and mode.

Errors

If there is an error, a screen will display a message such as "Program NETWORK failed." The only description of the error is contained in the .PRN file created by Cube.

Select "View Run Report File." Errors are identified by the symbol F(nnn). The most common errors involve selecting the incorrect directory for an input file, or forgetting to change the input file location for a new scenario.

The symbol W(nnn) indicates a warning. These may be something that should be fixed (such as turn penalties listed for nodes that do not exist in the network), but are not serious enough by themselves to stop a run. However, a long list of warnings may terminate a model run.

18. MODEL RESULTS

This section describes model results which can be obtained after the model is run. There are a variety of ways to review results, including Cube as well as date read into Excel workbooks.

PERFORMANCE MEASURES

Most of the performance measures generated by the Madera County model are in the form of CSV or DBF files which can be read into Excel for processing. The key files are in the 10_Reporting subdirectory of each scenario, and can also be accessed by double clicking on the appropriate output box in the PostProcessing section of the SJV Model application.

Some of the more useful outputs are:

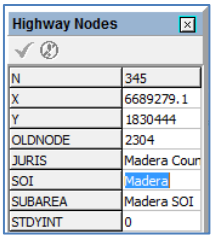
- TAZSUMMARY.DBF: Listing of TAZs with land use quantities, vehicle availability, vehicle trips by purpose and vehicle occupancy, VMT by trip purpose, average trip length by trip purpose (distance and time).
- {Scenario}_VMT_Conformity.CSV: Summary of VMT by speed category and by facility type.
- {Scenario}_VMT_Conformity_Intrazonal.CSV: Summary of intrazonal VMT (estimate of trips within TAZs) by speed category.
- {Scenario}_VMT_SB375.CSV: Summary of VMT by speed category by trip source (internal versus external).
- MODE_CHOICE_SUMMARY.DBF: Listing of TAZs with person trips by purpose and travel mode.
- DISTRIBUTION_SUMMARY.DBF: Listing of TAZs with vehicle trips by purpose and vehicle category.

INTERSECTION TURN MOVEMENTS

Each traffic assignment in the Madera County model can report intersection turn movements at specified nodes.

Designate Intersections

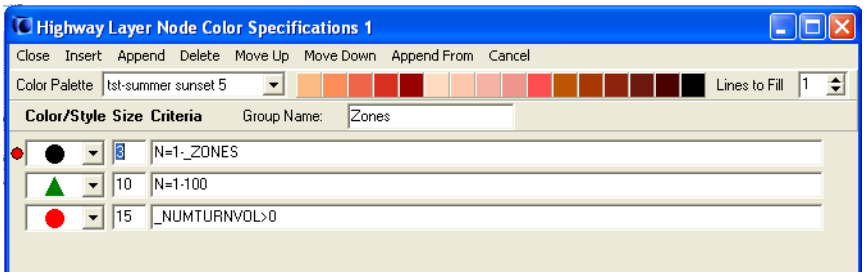
1. Prior to running the model, edit the input Master Network.
2. Click on a node where turn movements are to be saved, and edit the STDYINT value to be a number greater than zero (0).
3. Save the network file with the updated intersection information.



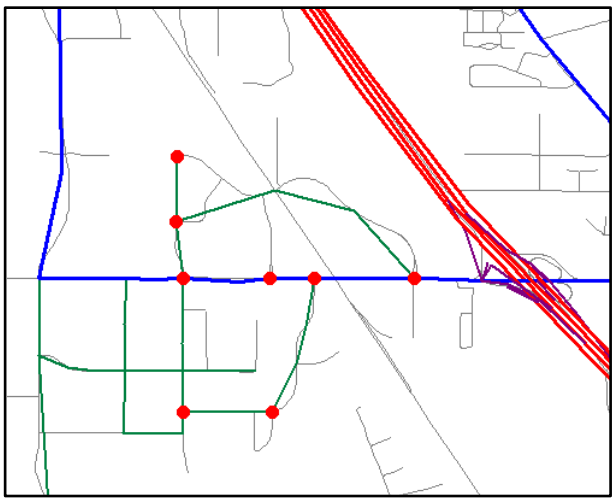
When the Input Processing application runs, it will create a file "Turns.txt" in the 09_Assignment subdirectory for the scenario. This file will contain a list of nodes where turn movements are to be saved. This list can be further edited prior to the SJV Model application run.

View Intersection Results

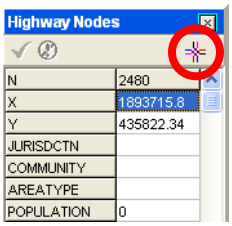
1. Open a result network with traffic volumes ("loaded" network).
2. Use the Intersections>Intersections File>Output File menu command to read a TRN file from the scenario 09_Assignment directory (for example, PMHOUR_TRN.TRN).
3. In order to see which nodes have turns, you will have to modify the node color settings. View the current node color settings by clicking on the icon with the shapes  .



4. Select Append to add another setting. Choose a large bright shape, such as a red circle with a size of 15. For the criterion, select _NUMTURNVOL>0 (type manually or use the right mouse button within the Criteria window) to identify nodes with penalties. Click "Close" on the top menu of the Node Color box. The nodes with turn movements should show as large red circles.



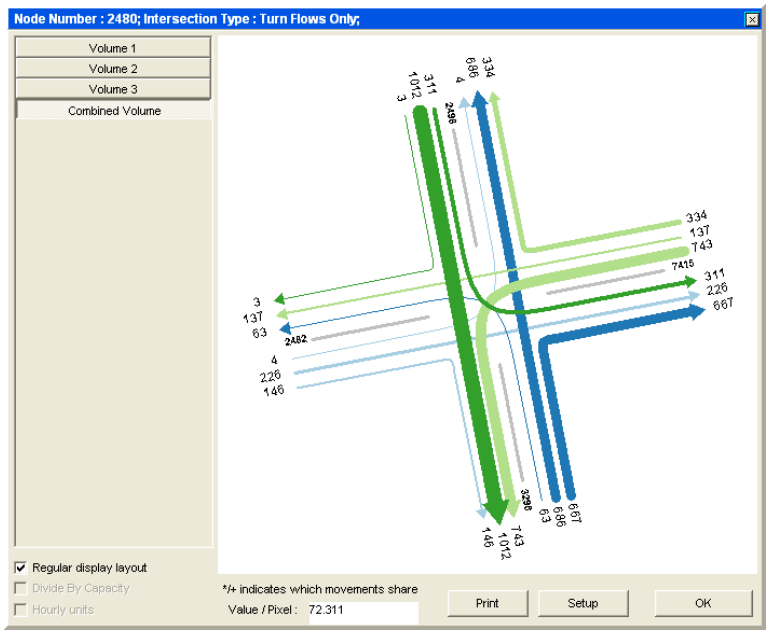
5. Use the pointer to select a node. To view the turn movements, you have three choices:



- Click the red and blue arrow icon at the top of the Highway Nodes box.
- From the top menu, select Intersection Files>Display Volumes
- Click <F3>

The <F3> key by itself will bring up an older TP+ style of turn movement diagram which resembles the turn penalty input screen.

6. A turn movement diagram will appear in the same orientation as the intersection on the network. A number of settings are available to change colors and other display features if you don't like the defaults.



The default display will show the "Combined Volume." This is a combination of the 12 volume types that are tracked separately in the traffic assignment:

1. Drive Alone, 1 Vehicle households
2. Drive Alone, 2+ Vehicle households
3. Shared Ride 2, 0 Vehicle households
4. Shared Ride 2, 1 Vehicle households
5. Shared Ride 2, 2+ Vehicle households
6. Shared Ride 3+, 0 Vehicle households
7. Shared Ride 3+, 1 Vehicle households
8. Shared Ride 3+, 2+ Vehicle households
9. Through (XX) trips
10. Small Trucks
11. Medium Trucks
12. Heavy Trucks

Turn Movement Database

The intersection turn movements are also output as a database file (such as PMHOUR_TRN.DBF). This file can be viewed in Cube, or it can be opened in Excel or any other program which can read DBF format. This is the turn movement output in DBF format.

A	B	C	T	T1	T2	T3
7415	2478	7411	130.15	99.61	23.43	7.11
7415	2478	7412	42.61	32.44	7.87	2.3
2482	2480	2498	4.16	3.15	0.77	0.24
2482	2480	3296	145.81	109.59	27.94	8.29
2482	2480	7415	225.79	170.99	42.71	12.09
2498	2480	2482	2.67	2.02	0.5	0.14
2498	2480	3296	1012.35	810.6	155.95	45.81
2498	2480	7415	310.63	244.11	52.11	14.41
3296	2480	2482	63.14	48.5	11.24	3.4
3296	2480	2498	685.95	537.41	114.9	33.64
3296	2480	7415	666.94	521.88	111.55	33.51
7415	2480	2482	136.81	105.31	24.24	7.26
7415	2480	2498	333.53	266.15	52.53	14.85
7415	2480	3296	742.53	569.37	131.9	41.26
2514	2520	3754	1328.56	1047.56	219.56	61.45
2514	2520	5019	173.63	126.73	35.95	10.95

The individual turn movements are listed in rows.

- The B node is the intersection
- The A node is the node where traffic is coming from
- The C node is the node where traffic is going after the intersection
- T is the total turn movement volume
- T1, T2…etc…are the separate volume sets as listed above.

Cube Land Summary

Cube Land is a socio-economic land use allocation forecasting model for Cube. It allocates regional control totals of households and jobs to transportation analysis zones based upon network accessibility and other relevant factors. Cube Land was designed for easy integration with Cube Voyager and ArcGIS.

Inputs:

- Control totals of households and jobs by type
- Transportation accessibility measures by zone
- Any other relevant data and/or policies by zone

Outputs:

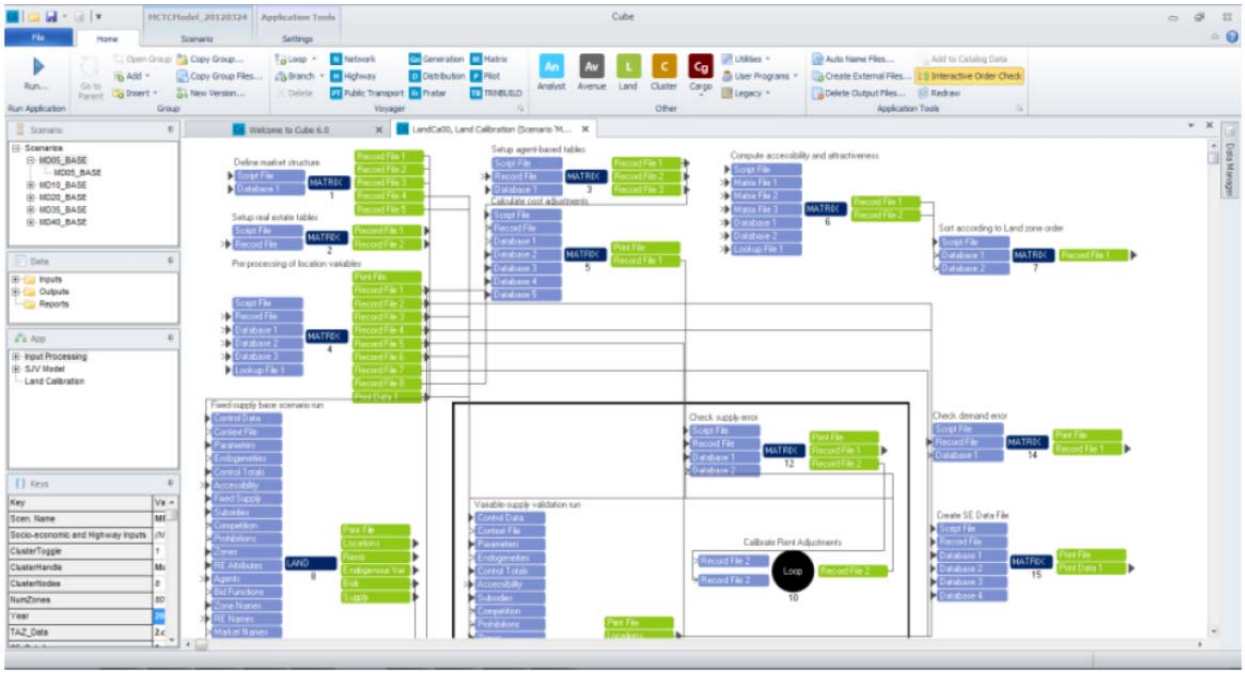
- Households and jobs by type in each zone
- Land uses by category in each zone
- Relative rental values of land uses by zone

Practical Motivations:

- Models with feedback to land use can provide more accurate and realistic numbers
- Forecasted project traffic/ridership will be different if land uses change

Policy Motivations:

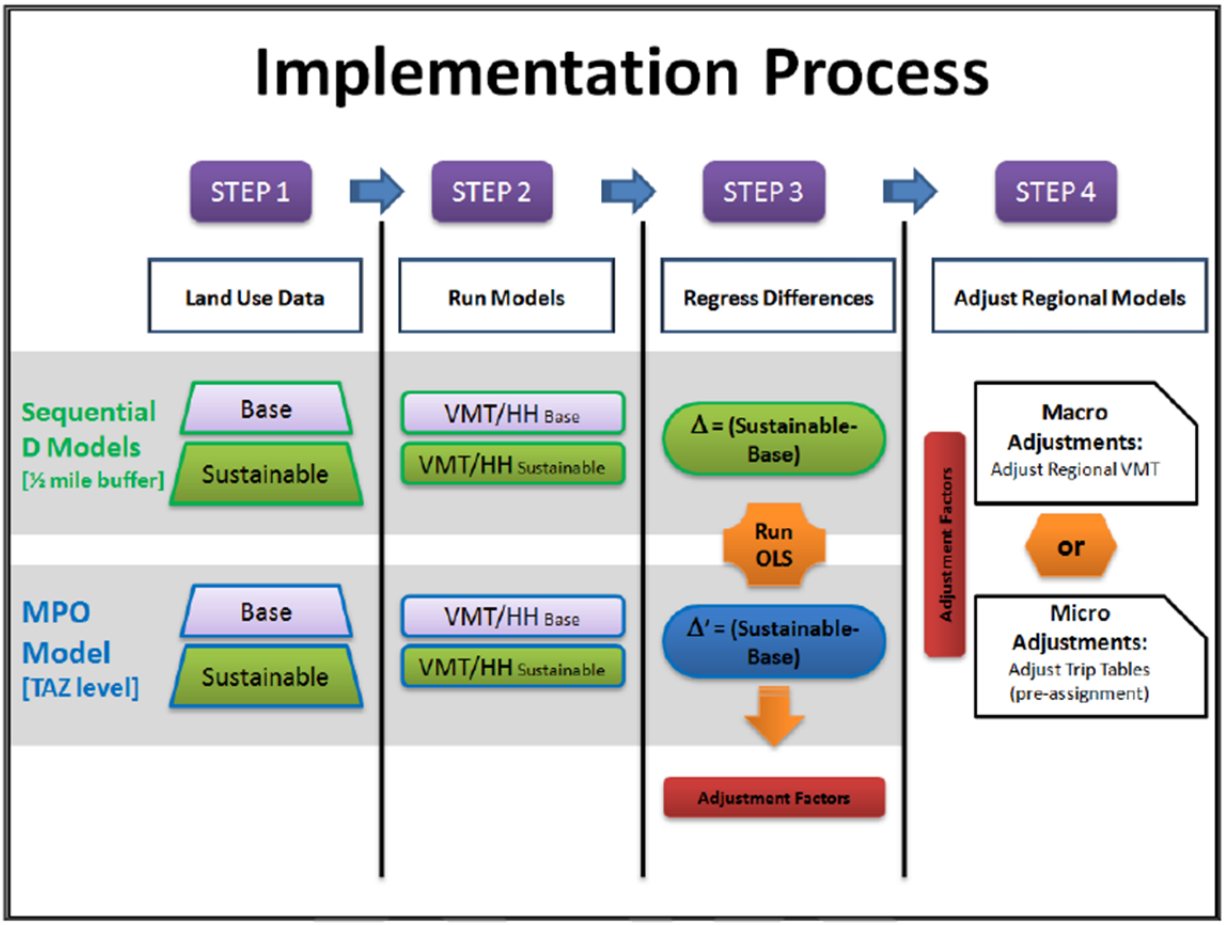
- NEPA CEQ regulations require that project sponsors consider indirect effects, such as induced growth and land use changes, as well as cumulative effects of projects
- In California, AB 32 and SB 375 require MPOs to develop SCS (or APS) to meet GHG reduction targets via integrated land use and transportation planning efforts
- Travel models with feedback to land use are not necessarily required but are better



TxD Model Post-Processor Summary

"TxD" refers to a travel model post processor developed by Fehr & Peers under contract to the California Department of Transportation (Caltrans). This post-processor has been endorsed for use in SCS and RTP scenario analysis by Caltrans and other agencies.

The TXD process adjusts the vehicle trip and vmt results from a travel model (such and MCTC's Cube Model). The adjustments are based on statistical analysis of the difference in sensitivity of the MCTC model to small-scale land use changes compared to the sensitivity of set of parcel-based regression models (referred to as "Sequential D Models" in the flow-chart below).



Step 1:

- Develop Sustainable/Swap Scenarios
  - Inputs: CrossClass Rates, Land Use Inputs, TAZ Inputs
  - Outputs: TAZ Data, Socio-Economic Data
- Buffer TAZs
  - Inputs: Base and Sustainable/Swap Scenario Socio-Economic Data, Land Use Data, Densities
  - Output: Base Buffers, Sustainable/Swap Buffers

Step 2:

- Run Models
    - Inputs: Base and Sustainable/Swap Scenario Buffered Data, Vehicle Ownership or Vehicle Availability Model Data/Output
    - Process: Calculate TDF input variables for Ds Modules, Calculate average VMT/HH or home-based VMT and TAZ VMT with 2-Step Module, Calculate the differences on % differences
    - Output: TAZ-level data for statistical analysis

Step 3:

- Regress Differences
    - Inputs: TAZ-level data for statistical analysis
    - Process: Regress D variables against Home-Base Difference of Differences
    - Output: Adjustment equation

Step 4:

- Adjust Regional Models
    - Inputs: Base and Scenario Socio-Economic Data, Vehicle Data, Land Use Data, VMT Data
    - Process: Calculate TDF input variables for Ds Modules, Prepare Base and Scenario data inputs for TxD Factors and Calculations, Calculate the differences on the % differences, apply TxD factors to VMT by trip purpose
    - Outputs: Adjusted regional VMT or trip tables

It should be noted that Steps 1, 2 and 3 have been completed by Fehr & Peers. Only Step 4, the application of the TxD adjustments, requires inputs from MCTC staff.

For the MCTC SCS/RTP EIR face to face meeting on December 17, a PowerPoint and other materials providing more information on the TxD post processor will be available:
W:\Walnut Creek N Drive\PROJECTS_WC09\WC09-2684_SACOG Statewide_Tools\Communication\June 26 2012 MPO Training\June 26 2012 MPO Training Final.pptx

FEHR PEERS

MEMORANDUM

Date: May 5, 2015

To: Dylan Stone, MCTC

From: Mackenzie Watten and Mike Wallace, Fehr & Peers

Subject: MCTC Model – Base Year Scenarios Update (On-Call Task Order #1)

WC14-3162

This memorandum documents the updates to base year scenarios 2005 and 2010 of the MCTC Model. The inputs and outputs for these scenarios were reviewed against the most recently available data. Calibration of model parameters was then performed based on that review. Based on the outputs, updated validation statistics were prepared and compared to the required thresholds set by Caltrans.

Once the base year was calibrated and validated, future year scenarios (up to 2035) were updated to include the updated model parameters. Detailed review of the inputs and outputs of the future year scenarios is recommended as future tasks.

As a result of these updates, the base year scenarios are consistent with each other and the validation statistics meet more of the guidelines necessary for an MPO such as MCTC than previously.

These tasks comprise Task Order #1 under the MCTC Technical Planning-Modeling On-Call Services Contract.

Structure of Model Files and Supporting Documents

This section describes the structure of the model files and location of supporting documents. For this example, the MCTC Model catalog file is located at 'C:\Models\MCTC'. All folder references below assume that folder as the starting point. All files updated as part of this task order have been noted with a "_20150505" suffix to represent a May 5, 2015 model transmittal.

Parameter workbooks

The parameter workbooks represent a centralized location for all the model inputs and parameters corresponding to each model scenario. From the parameter workbooks you can edit the inputs and parameters and export them to model ready files.

The parameter workbooks can be found in the folder located at 'C:\Models\MCTC\1_Inputs_Support\Parameter Workbooks'. This transmittal includes updated parameter workbooks for scenario years 2005, 2010, 2020, and 2035.

Validation spreadsheets and documentation (this document)

The validation spreadsheets contain the criteria and thresholds set for validation checks by Caltrans. There are two separate validation spreadsheets: one for highway validation (focused on roadway vehicle counts), and another on non-highway validation (focused on model behavior other than roadway vehicle counts).

The validation spreadsheets can be found in the folder located at 'C:\Models\MCTC\1_Inputs_Support\Validation'. This transmittal includes validation of the 2010 scenario.

Non-highway statistics spreadsheets

The non-highway statistics spreadsheet used in the validation step described above is a useful cross-section of travel behavior. Provided for informational purposes, this transmittal includes non-highway statistic spreadsheets for all other scenarios: 2005, 2020, and 2035.

The non-highway statistics spreadsheets can be found in the folder located at 'C:\Models\MCTC\1_Inputs_Support\Non-Highway Statistics'.

Task 1 – 2010 MCTC Model: Review Inputs, Run Model, Prepare Validation

MCTC staff provided Fehr & Peers with updated socioeconomic data for the 2010 scenario. The previous iteration of the 2010 scenario was dated August 30, 2013.

Review Inputs

Fehr & Peers reviewed the updated socioeconomic data against available data as well as previous model inputs to make sure they were still consistent.

Socioeconomic Data

The totals for updated 2010 scenario socioeconomic data did not greatly differ from the previous iteration. The majority of the changes were allocations between TAZs, mostly with an eye towards consistency with the 2005 scenario (further discussion in the 2005 scenario section below). Additionally the updated data still agrees with the observed data from Census 2010. **Table 1** presents a socioeconomic data comparison for Madera County between the data sources.

TABLE 1
MCTC – SOCIOECONOMIC DATA COMPARISON – MADERA COUNTY

Data Source	Total Households	Total Employment
August 30, 2013 Iteration	43,304	42,855
March 3, 2015 Iteration	43,303	43,547
Census 2010	43,308	42,700

Source: Fehr & Peers, 2015.

Gateway and Through Trips

With the change in allocations of land use throughout the model, Fehr & Peers reviewed the production-attraction balancing and internal-external trip distribution to ensure that it still met reasonableness checks. Based on that review, the gateway and through trip inputs were slightly updated to better reflect the refined 2010 socioeconomic data.

Master Network

Fehr & Peers reviewed the master network to ensure that all trips from the newly allocated land use were being assigned to the network. A couple of TAZs were found to be unconnected to the network and attached appropriately. Additionally, a few of the gateway links to outside Madera County were found to be incorrectly coded as one-way and updated to be two-way. Based on these updates all the trips expected to be assigned to the roadway network were now being appropriate assigned.

Updated District/"Airbasin" Definitions

Through discussion with MCTC staff, the addition of capability to report performance by geographic area/district would help support MCTC planning for individual regions of Madera County.

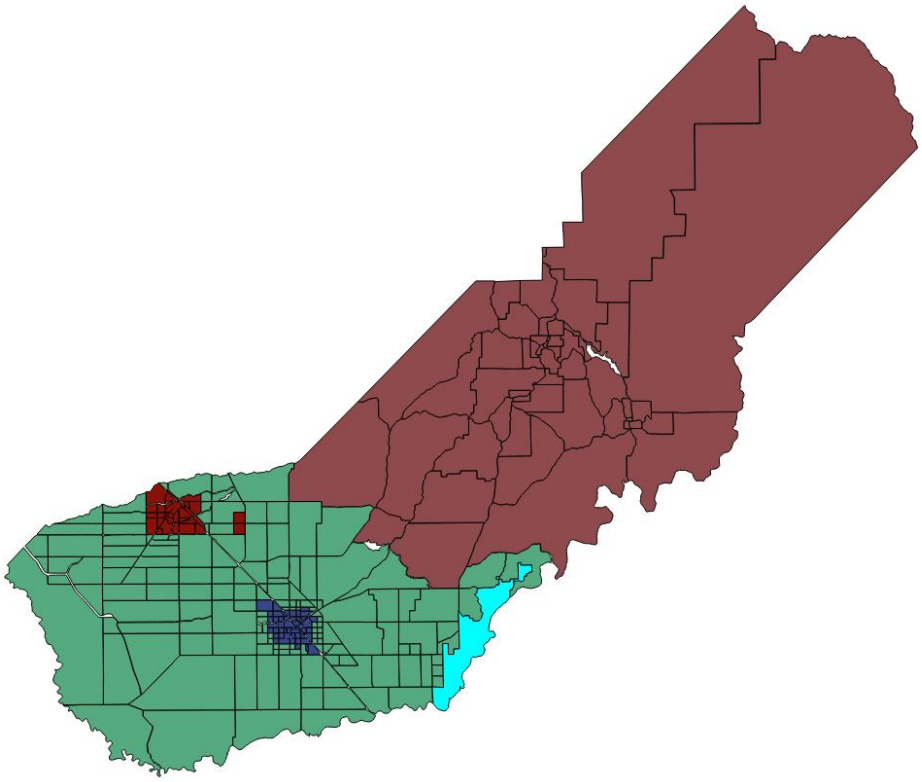
Through the use of the AIRBASIN variable in the TAZData file, districts were added to the MCTC model. Multiple model steps (such as VMT conformity) automatically report based on this variable. **Table 2** lists the name of the district and the associated TAZs.

TABLE 2
MCTC MODEL – DISTRICT ZONE RANGES

District Number	District Name	TAZ Range
1	Unincorporated Valley	301-399, 542-750, 752-754, 767
2	Chowchilla	101-200
3	Madera	201-300
4	Rio Vista	400-541
5	Mountain	751, 755-766, 768-805

Source: Fehr & Peers, 2015.

Figure 1 below visually shows the district breakdowns.



Review Model Parameters

With the changes to the model inputs described above, Fehr & Peers reviewed the model parameters to ensure

Trip Rates

The trip rates were compared relative to the other San Joaquin Valley models prepared as part of the VMIP. Based on the inputs updated above, the trip rates were slightly adjusted accordingly to improve model validation. More detail can be found in the non-highway validation section below.

Traffic Assignment

The previous iteration of the MCTC model incorporated a volume adjustment factor based on facility type. It appears that this was used for calibration purposes. This factor was removed from the model as it is not appropriate for model applications.

Friction Factors

The friction factors were compared relative to the other San Joaquin Valley models prepared as part of the VMIP. Based on the inputs updated above, the friction factors were slightly adjusted accordingly to improve model validation. More detail can be found in the non-highway validation section below.

Validation Statistics

After the input updates and calibration of model parameters as described above, Fehr & Peers ran the 2010 scenario in the MCTC model. Validation statistics were then prepared and compared to evaluation thresholds. The full validation statistics and spreadsheets can be found in the folder noted at the beginning of this document. This section will present a highlight of the validation statistics.

Highway Validation

Because MCTC is a Group B SJV MPO, most of their highway validation requirements are only for the daily time period. **Table 3** presents the daily highway validation statistics for the updated 2010 MCTC model scenario.

TABLE 3
MCTC MODEL – HIGHWAY VALIDATION STATISTICS
DAILY TIME PERIOD

Metric	Value	Threshold
Model/Count Ratio	1.02	0.90 – 1.10
Percent within Caltrans Max Deviation	79%	> 75%
Percent Root Mean Square Error	36%	< 30%
Correlation Coefficient	89%	> 89%

Source: Fehr & Peers, 2015.

As shown, the updated model meets the defined thresholds. This represents a large improvement from the previous iteration of the model.

Non-Highway Validation

The non-highway validation includes a wide range of travel behavior to summarize: production-attraction balance, person trips per household, vehicle availability, mode split by purpose, VMT, travel time, transit assignment, and trip distribution. All of these metrics can be found in the non-highway validation spreadsheet. These metrics are summarized from the model and are compared to observed data to sources including the California Household Travel Survey (CHTS), Caltrans/HPMS Data, and Census/American Community Survey (ACS).

This section will focus on the most pertinent metrics: person trips per household, VMT, trip distribution, and mode share.

Table 4 presents person trips per household as compared to CHTS data. The model closely matches the observed data.

TABLE 4
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
WEEKDAY PERSON TRIPS PER HOUSEHOLD

Metric	CHTS	Model
Person Trips per Household	7.86	7.87

Source: 2000-2001 CHTS (internal-to-internal trips only). Fehr & Peers, 2015.

Table 5 presents the model VMT as compared to HPMS data. The model slightly underpredicts VMT but is within the allowable 5% threshold.

TABLE 5
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
VMT

Metric	HPMS	Model
VMT	4,785,470	4,619,278

Source: Highway Performance Management System – 2010 California Public Road Data, Table 10. Fehr & Peers, 2015.

Table 6 presents the model trip distribution as compared to CHTS data. This metric was greatly improved from the previous iteration. The gateway trips input greatly influences this metric – the updated of that metric with the new land use improved the performance of this metric in the model. The gateway inputs are largely dependent on data quality and coordination with other models (such as the California Statewide Model).

TABLE 6
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
TRIP DISTRIBUTION

Trip Type	CHTS	Model
Internal-Internal	78%	73%
Internal-External	13%	13%
External-Internal	9%	14%

Source: 2000-2001 CHTS. Fehr & Peers, 2015.

Table 7 presents mode share as compared to CHTS data for all trip purposes. The model closely matches the observed data.

TABLE 7
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
MODE SHARE

Mode	CHTS	Model
Drive Alone	40.4%	40.6%
Shared Ride 2	33.2%	32.9%
Shared Ride 3+	25.2%	24.7%
Transit	0.1%	0.2%
Walk	1.2%	1.4%
Bike	0.0%	0.2%

Source: 2000-2001 CHTS. Fehr & Peers, 2015.

Task 2 – 2005 MCTC Model: Review Inputs, Run Model

MCTC staff provided Fehr & Peers with updated socioeconomic data for the 2005 scenario. The previous iteration of the 2005 scenario was dated September 19, 2013. The previous iteration of the 2005 and 2010 scenarios were not consistent and resulted in odd results when compared. The focus of this task was to ensure consistency between the 2005 and 2010 scenarios.

Review Inputs

Similar to Task 1 for the 2010 scenario, the inputs for the 2005 scenario were reviewed to ensure that they were consistent with the updated socioeconomic data. Where possible the review completed as part of the 2010 scenario was leveraged for use with the 2005 scenario.

As result of this review, the gateway trips, through trips, and master network inputs were updated for the 2005 scenario. The model parameters files updated as part of the 2010 scenario review were also integrated into the 2005 scenario.

Non-Highway Statistics

As a point of comparison to ensure that the updated 2005 results were consistent with the updated 2010 results, non-highway statistics were calculated for the 2005 scenario. As mentioned previously, the full list of metrics are available within the non-highway validation spreadsheet.

This section will focus on a comparison of the 2005 and 2010 scenarios for the most pertinent metrics: VMT, trip distribution, and mode share. The tables below show reasonable metrics compared between the two scenarios without a large change in travel behavior: to be expected given that they are only five years apart.

Table 8 presents the model VMT between the two scenarios. The 2010 scenario estimates more VMT than 2005, which makes sense given that 2010 contains more land use than 2005.

TABLE 8
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
VMT COMPARISON 2005 VS. 2010

Metric	2005 Scenario	2010 Scenario
VMT	4,493,422	4,619,278

Source: Fehr & Peers, 2015.

Table 9 presents the model trip distribution between the two scenarios. The results are fairly similar which makes sense given the five year time period between the two.

TABLE 9
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
TRIP DISTRIBUTION COMPARISON 2005 VS. 2010

Trip Type	2005 Scenario	2010 Scenario
Internal-Internal	73%	73%
Internal-External	14%	13%
External-Internal	13%	14%

Source: Fehr & Peers, 2015.

Table 10 presents the model mode share between the two scenarios. The results are fairly similar which makes sense given the five year time period between the two scenarios.

TABLE 10
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
MODE SHARE COMPARISON 2005 VS. 2010

Mode	2005 Scenario	2010 Scenario
Drive Alone	41.1%	40.6%
Shared Ride 2	32.8%	32.9%
Shared Ride 3+	24.3%	24.7%
Transit	0.2%	0.2%
Walk	1.4%	1.4%
Bike	0.1%	0.2%

Source: Fehr & Peers, 2015.

Task 3 – Update All Scenarios for Consistency with Base Year Updates

The Task Order focused on updating the base year scenarios (2005 and 2010). In the interest of the model being used for planning applications, the inputs and model parameters for the future scenarios (2020 and 2035) were updated to be consistent with the base year updates.

Task 4 – High Level Non-Highway Statistics for All Scenarios

As a point of high-level comparison to ensure that the updated base year results were consistent with the future scenario results, non-highway statistics were calculated for all scenarios. As mentioned previously, the full list of metrics are available within the non-highway validation spreadsheets.

This section will focus on a comparison of the all scenarios for the most pertinent metrics: VMT, trip distribution, and mode share. The tables below that overall most results seem reasonable. Of particular interest for future review may be the gateway trips inputs. The trip distribution table

below shows a significant change in trip distribution for the 2020 and 2035 scenarios as compared to the base years.

Table 11 presents the model VMT between all the scenarios. VMT goes up for each scenario year, which makes sense given the land use growth assumed in the model.

TABLE 11
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
VMT COMPARISON – ALL SCENARIOS

Metric	Scenario			
	2005	2010	2020	2035
VMT	4,493,422	4,619,278	5,519,196	6,347,002

Source: Fehr & Peers, 2015.

Table 12 presents the model trip distribution between all the scenarios. As noted above, the 2020 and 2035 scenarios show a significant change in trip distribution. Further review of the gateway inputs for those scenarios may be warranted.

TABLE 12
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
TRIP DISTRIBUTION COMPARISON – ALL SCENARIOS

Metric	Scenario			
	2005	2010	2020	2035
Internal-Internal	73%	73%	80%	86%
Internal-External	14%	13%	10%	7%
External-Internal	13%	14%	10%	7%

Source: Fehr & Peers, 2015.

Table 13 presents the model mode share between all the scenarios. The results show a very minor shift from drive alone to other modes

TABLE 13
MCTC MODEL – NON-HIGHWAY VALIDATION STATISTICS
MODE SHARE COMPARISON – ALL SCENARIOS

Metric	Scenario			
	2005	2010	2020	2035
Drive Alone	41.1%	40.6%	40.7%	40.7%
Shared Ride 2	32.8%	32.9%	33.0%	33.0%
Shared Ride 3+	24.3%	24.7%	24.4%	24.3%
Transit	0.2%	0.2%	0.3%	0.2%
Walk	1.4%	1.4%	1.5%	1.6%
Bike	0.1%	0.2%	0.2%	0.2%

Source: Fehr & Peers, 2015.

Please contact Mackenzie Watten at 925-930-7100 if you have any questions.