Appendix A. Traffic Appendix

Dowling Associates, Inc.

Transportation Engineering • Planning • Research • Education

TRANSPORTATION PLANNING PARTNERSHIP GROUP

2007 COUNTYWIDE MODEL PROJECT

VERSION 1.0

USER GUIDE

(DRAFT)

Stanislaus County Association of Governments
www.STANCOG.org

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1. INTRODUCTION AND SUMMARY

The Transportation Planning Partnership Group (TPPG) Countywide travel forecasting model represents an multi-jurisdictional effort on the part of the California Department of Transportation (Caltrans), the Stanislaus County Council of Governments (StanCOG or COG) and the City of Modesto to integrate the two longstanding models used in the County for planning purposes: the City of Modesto General Plan Model and the StanCOG air quality model. This integrated countywide model was developed by obtaining up to date land use roadway and planning data and incorporating it into a model with improvements and functional extensions to both the City and the COG models that it is based upon.

1.1 Model Software

The TPPG model has been developed and is operable on the Cube/TP+ (Transportation Planning Plus) software platform. The model is fully compatible with the current version of Cube Software and is backwards compatible with TP+ 3.0. Cube/TP+ is a proprietary platform developed by Citilabs. Support for these packages and software upgrades are usually available on the Citilabs website at www.citilabs.com.

It is recommended for users to have access to Microsoft Excel to manipulate land use and other input files. Microsoft Excel is available from the Microsoft Corporation. Support and upgrades are available from www.microsoft.com. Microsoft Excel should be installed with Visual Basic for Applications included in the install for full functionality.

1.1.1 Model Coverage and Traffic Analysis Zones (TAZs)

The study area for the TPPG model covers all of Stanislaus County, including the incorporated areas. The county is broken up into approximately 2,500 traffic analysis zones (TAZs) including 50 gateways. The model has capacity for 3,200 zones through zone subdivision.

1.1.2 Socioeconomic Data / Land Use Inputs

The travel demand model land use inputs (socioeconomic data) by TAZ include population related data (household data, broken down by household type and auto-ownership and population estimates), and employment related data (broken down into five employment categories: retail, service, government, education, and other).

The starting point for the socioeconomic data by traffic analysis zone (TAZ) was the 2000 Census and the 2005 InfoUSA business survey (InfoUSA, 2006). Housing forecasts were adjusted to match countywide population controls from the California Department of Finance (DOF). Employment forecasts were adjusted to match countywide control totals provided by Woods and Poole, inc. and California Department of Finance projections.

Future year land use for the Modesto General Plan area were based on the 2003 General Plan MEIR land use assumptions with adjustments to the Village Residential land use to match updated City population projections. Land Use assumptions for the rest of the county were based on the 2005 update of the StanCOG model which incorporates countywide land use projections apportioned among the various jurisdictions by StanCOG staff.

1.1.3 Roadway Network Characteristics

The travel demand model roadway network includes over 10,000 nodes, and nearly 25,000 links. Links include: freeways, freeway ramps, highways (multi and two-lane), arterials, collectors, and rural roads. Important road network attributes include distances, uncongested speeds, and hourly capacities.

The model utilizes a coordinate system used for most GIS applications. The model network can be viewed together with other geographic information such as street maps, TAZ maps and census information using a GIS package such as ArcView or Viper. This improves the model estimates of link distances since the roadway network is spatially correct. The TAZ maps for the model are provided in PDF format and as GIS files supplied with the default model.

The travel demand model network link attribute assumptions were developed by analysis year based on StanCOG's Regional Transportation Plan (RTP) and the Transportation Improvement Program (TIP), local agency Capital Improvement Programs (CIP) as well as local jurisdiction general plans and circulation elements and guidance.

Separate transit networks have not been developed.

1.1.4 Forecasting Process

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

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

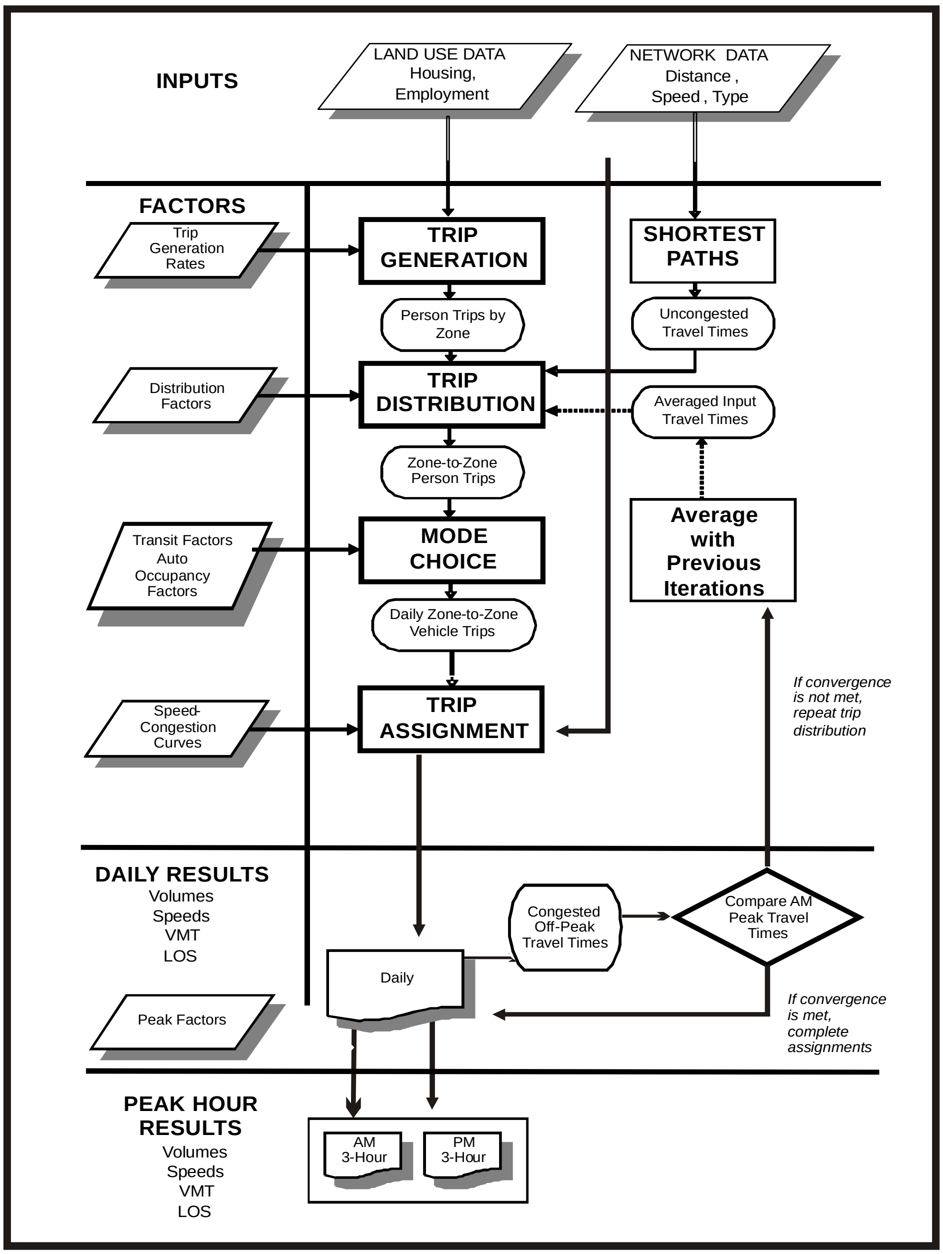
- **Trip Distribution.** The second general step estimates how many trips travel from one zone to any other zone. The distribution is based on the number of trip ends generated in each of the two zones, and on factors that relate the likelihood of travel between any two zones to the travel time between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

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

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

A flow chart of the TPPG model process is shown in Table 1.

Figure 1 - TPPG Travel Demand Model Process



1.1.5 Forecast Time Periods

The travel demand model currently estimates travel demand and traffic volumes for daily traffic, AM 1-hour peak period and PM 1-hour peak.

1.1.6 Feedback Loops

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

1.1.7 Model Validation

The TPPG model was revalidated to 2005 daily and peak hour counts

The model estimates of 2005 daily volumes are within all of the FHWA percent difference targets by facility type. All model performance measure meet the FHWA criteria. Therefore, the model is considered acceptable based on FHWA guidelines. The model validation is presented in Appendix A.

1.1.8 Statewide Survey

The TPPG model uses a variety of inputs based upon the California 2001 statewide transportation survey. The survey results were combined for Stanislaus County with Merced County to the south and San Joaquin County to the north in order to increase the sample size (to roughly 1,500 responses versus only 500 for Stansilaus County by itself). The survey results form the basis for the friction factors, trip generation rates and peaking factors.

1.2 Transportation Conformity Rule Modeling Requirements

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

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

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

reasonableness and compared to historical trends and other factors, and the results must be documented.

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

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

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

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

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

1.3 Procedures to "Run the Model"

Most of the travel demand model procedures have been programmed into the TPPG TP+ job script. Except for changing the selected year for the network build procedure; this job script should rarely have to be edited by the user. The user will usually be editing networks (to reflect the latest information about roadway facilities) and modifying land use assumptions (to reflect the latest information about development) and then simply applying the model.

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

1. Document all alternative assumptions
2. Copy master directory
3. Modify "master" network, if necessary
4. Modify the land use / trip generation, if necessary
5. Modify the TP+ job script, if necessary (e.g. change forecast year)
6. "Run" the model alternative
7. Adjust turn or link volumes as necessary
8. View and print the results

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

1.3.1 Document all Alternative Changes

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 printed out and clearly marked. Ideally, all assumptions would be filed together so that they are easily accessible in the future.

1.3.2 Copy Master Directory

The generic TPPG model is stored in a master directory that includes the "Master" network, the land use / trip generation workbook, the TP+ job script, and all of the supporting files necessary to create a new model alternative. See Figure 2 for a sample master directory. In order to save the integrity of this data set, the user should make electronic copies of the input data files by copying the master directory to a new directory (i.e. folder). This can be done using Windows Explorer or other file management software.

If a model alternative is desired that is based on an already completed model run, simply copy the input files associated with the previous model alternative to a new directory and follow the same steps outlined below.

Figure 2 - Sample Master Directory

Name	↑Ext	Size
[..]		<DIR>
Gate_2005_Unbal	dbf	7,718
tppg_2005_SpecGen	dbf	572
tppg2005_LU	dbf	844,949
transit_2005	dbf	197,341
Transit_2025	dbf	197,341
xClsPcts	dbf	342,596
ca05_SUB_XX	inp	769
ca05_XXAM	inp	713
ca05_XXPM	inp	750
ca25_SUB_XX	INP	783
ca25_XXAM	inp	717
ca25_XXPM	inp	723
KF_HW_61	inp	11,669
KF_NW_61	inp	11,669
MASTER	net	1,195,388
2005Penalties	pen	4,118
2005_TPPG_Master	s	73,580
ff_Stan	txt	7,959
TripRates	txt	5,108

1.3.3 Update Network

Use Viper to edit the master roadway network if necessary. This could include changing the number of lanes, adding freeway interchanges, and/or adding new zones with centroid connectors.

1.3.4 Update Land Use / Trip Generation

Use Excel to update the land use and trip generation workbook. Typical modifications would be: adding zones and redistributing land uses, adding project specific developments for traffic impact analyses, and creating interpolated land use scenarios for milestone-year models.

1.3.5 Update the TP+ Job script

Use Viper to modify the TP+ job script, if necessary. Typical modifications include entry of the correct forecast year (very important for network “extraction” from the “Master” network).

1.3.6 Apply the Model

Use TP+ to “run” the model alternative. The user launches the TP+ program and selects the appropriate job script for the "Input Job File", specifies the "Working Directory" and the "Project Prefix", and then clicks the "Start" button.

1.3.7 Adjust the Model Results

Although the TPPG model has been validated on screenlines and for overall fit, it is likely that the model will NOT be accurate enough in every location to reliably calculate level of service directly from raw model output. Therefore, it is recommended that adjustments be applied to model results prior to traffic operations analysis.

1.3.8 View and Report Model Results

There are a variety of ways to report the results of the TP+ traffic distribution and assignment, including Viper screen graphics, plots and printed reports.

2. MODEL STUDY AREA AND ZONE SYSTEM

The study area for the TPPG model covers all of Stanislays County, including the cities of Modesto, Turlock, Ceres, Oakdale, Riverbank, Patterson, Hughson, Waterford and Newman. The county is broken up into approximately 2,500 traffic analysis zones (TAZs) with unused zones set aside for a total of 3,200 possible zones including gateways. Figure 4 shows the travel demand model TAZs .

The TAZ polygon shapefiles are maintained in ArcView and can be viewed in Viper these are provided with the default model.

2.1 Internal Zones

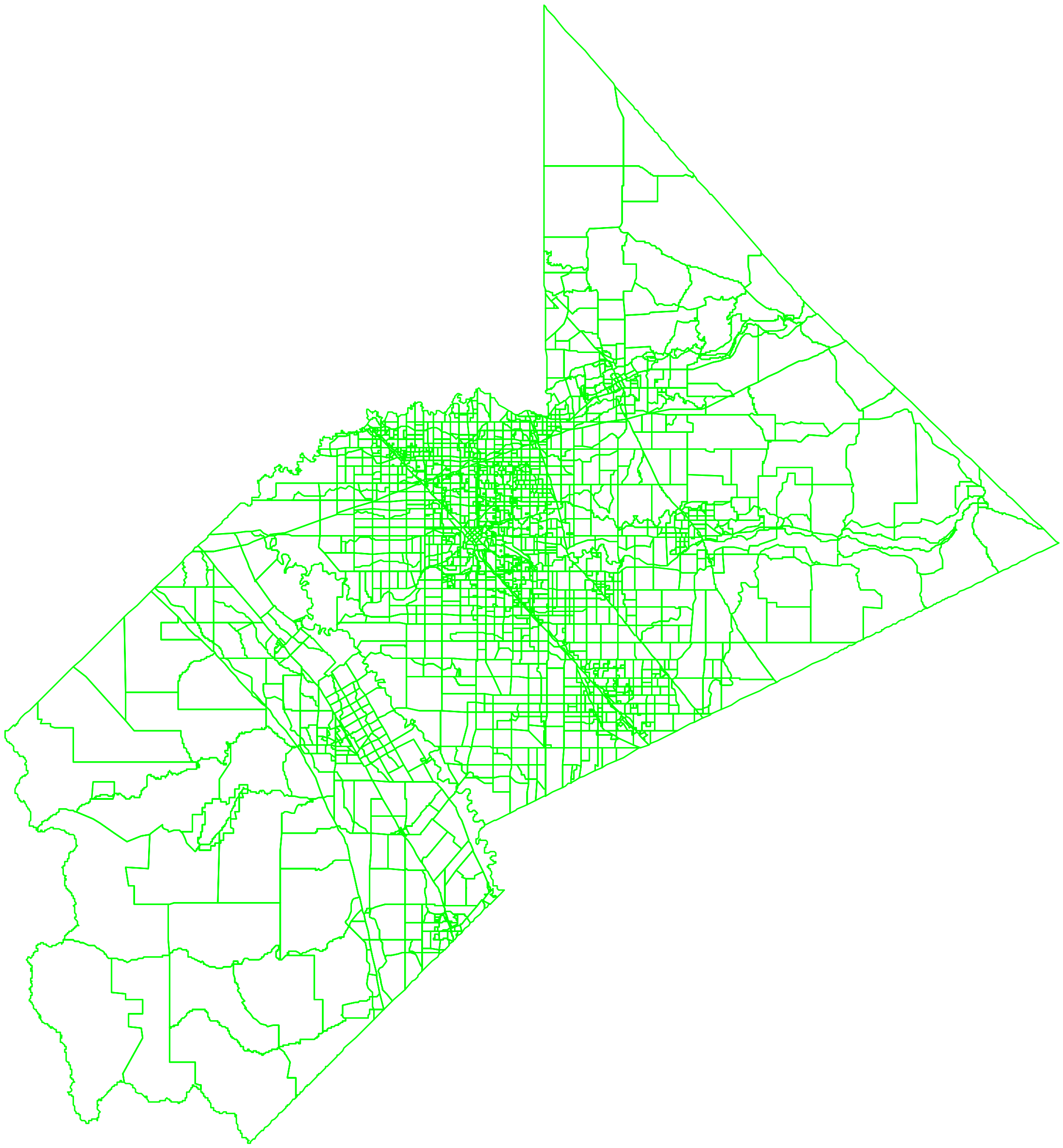
Zone numbers 1 to 3200 are used for internal Stanislaus County zones. Not all zone numbers in this range have been used, allowing for future detailing or expansion of the model. The TAZs are generally smaller in size where land use density is higher, such as in the commercial are of Modesto, while larger zones are used for the more rural portions of the county.

The TAZ allocations are summarized in below.

Table 1 TAZ Numbering Ranges

Zone Range	Intended Coverage
1-50	Gateways
51-1200	Modesto and Vicinity (including Salida)
1201-1450	Ceres and Vicinity
1451-1600	Riverbank
1601-1800	Oakdale
1801-1900	Waterford
1901-2000	Hughson and Vicinity
2001-2300	Turlock Area
2301-2400	Patterson Area
2401-2500	Newman Area
2501-3200	Unincorporated Stanislaus County

Figure 3 TPPG Travel Demand Model TAZs and Gateways



2.2 External Zones

The TPPG model has 45 external cordons (gateways) for representing travel into, out of, and through the region. Appendix B lists the external zones, their locations and their assumptions.

3. USING TP+

The purpose of this documentation is to provide a user with the general procedures to apply the TPPG model. Users should refer to the TP+ and Viper documentation provided by Citilabs for specific TP+ and Viper related questions.

TP+ is a library of program modules that employs a control language that allows the user to write the script to provide instructions for performing all types of typical planning operations. At the heart of the TP+ system is the control language referred to as a scripting language. The script is stored in a file and then read when the system is executed. The individual modules are activated according to the instructions in the script. Each module is designed to perform certain operations, but only as specified by the user. A typical application could involve a very complicated set of instructions, or could be as simple as computing and/or printing a number from a file. It is the user's responsibility to design the process that is to be run.

The binary files generated by TP+ are designed to reduce disk storage requirements and reduce the amount of time spent on input/output. They have a proprietary format that can not be used by other software, but the user can translate them to other formats.

3.1 Required Resources:

TP+ requires a Windows 95/98/NT/2000/XP environment in which to function. The system utilizes RAM as needed; most applications will not require any special RAM considerations. The exact amount of RAM required can not be determined until an application actually runs and the combination of user options is diagnosed. It is fairly safe to state that if a computer can run Windows, it has enough RAM to run TP+.

About 2 MB of disk space is required to store the system. Additional disk space is required for the various files. A typical application will require zonal data files, networks, and matrices. Zonal data files are not very large, and network sizes will depend upon the number of alternatives and variables that the user wishes to employ. The largest networks will be only a few MB. The largest storage requirements will be associated with matrices. A matrix will contain zones*zones cells of information. Each cell value can be from 0 to 9 bytes in size, but TP+ uses a proprietary data compression technique that helps to reduce the sizes. The user can control the matrix sizing.

The minimum recommended hardware (for TP+ without Cube or Viper) is:

- Pentium class PC
- 512 MB of RAM
- 1 GB hard disk
- Generic Printer
- Any reasonable monitor
- Typical Windows printer drivers are required if TP+ is requested to do plotting

TP+ is designed to run in a multitasking environment. In such an environment, there is a possibility that several simultaneous applications could try to access the same data files simultaneously. This could possibly cause problems if one application is trying to update a file while other applications are accessing it. Different operating systems may handle this conflict differently. TP+ currently does nothing specifically to deal with this.

3.2 Directories

The TP+ and Viper software are 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.

As discussed above, each model alternative should be run and stored in a separate subdirectory. This includes all associated input and output files.

Geographic files that are common to all alternatives (such as the TIGER street map and the zone boundaries) may be stored in a single directory rather than copied to each alternative.

3.3 TPPG Model Files

The different types of data or instructions used by the traffic model are stored in various computer files. The following file types are used in the TPPG Countywide model:

- TP+ script files (ending with .S) for control instructions
- Land use and external trip files (ending with .DBF)
- Road network files (ending with .NET)
- Viper project settings files (ending with .PRJ)
- Turn penalty files (ending with .PEN)
- Matrix files (e.g., trip tables) created by TP+ (ending with .MAT)
- Report files created by TP+ (ending with .PRN)
- Miscellaneous text output files (ending with .VAR, or .TXT)

The following sections describe the input and output files. In this description, "y" characters are used as placeholders for numbers (“yy”). For example, "20yy_LU.dbf" means any file name that begins with 20, followed by two other numbers, and ends with "_LU.dbf" (such as, 2025_LU.dbf)

The input files for the full model run are listed in Table 2.

Table 2 - TPPG Model Input Files

File Name	Description	Created Using
20yy_Master.s	Main TP+ script file for analysis year 20YY	Viper
TripRates.txt	Cross classified HH and employee trip generation rates	MS Excel
MASTER.net	Input master road network	Viper
20yyPenalties.pen	Turn penalties for year 20YY	Viper
ff_Stan.txt	Friction factors	MS Excel
KF_HW_61.inp	Home based work K-factors (set to 1.0 by default)	MS Excel
KF_NW_61.inp	Non work K-factors (set to 1.0 by default)	MS Excel
CAyy_SUB_XX.inp	Year 20yy Statewide Model Subarea external to external trips	MS Excel
CAyy_XXAM.inp	Year 20yy AM peak hour external to external trips	MS Excel
CAyy_XXPM.inp	Year 20yy AM peak hour external to external trips	MS Excel
XCLSPcts.dbf	cross classification seed file	MS Excel
TPPG20yy_LU.dbf	Land Use data file	MS Excel
TPPG_20yy_SpecGen.dbf	Year 20yy special generators file	MS Excel
Gate_20yy_Unbal.dbf	Unbalanced IX trip generation	MS Excel

Note, all files created with MS Excel are editable with a text editor.

3.4 Model Application

Model application (i.e., "running the model") refers to the calculations that convert the data inputs into results. In TP+, the program reads a set of instructions in a script file that tell the computer to use selected TP+ programs and operate on selected data files. The data files must already be edited and placed in the current subdirectory. In some cases, the script must also be edited so that it contains the correct instructions and titles.

3.4.1 Script Files

The standard script file, "20yy_Master.s ", has been arranged to make it easy to run a new alternative. The first part of the script lists the important input files. Use this as a checklist for preparing files. The analysis year can be changed by modifying one line of code.

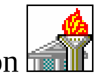
Lines beginning with a semicolon (;) are comments that are ignored by the program and are added for clarity or documentation. The user can also add additional comment lines beginning with a semicolon (;).

3.4.2 Scenario Name

Each model alternative should have a unique scenario name (also known as "project prefix"). Similar to MINUTP (the software the MOGP model used previously), the scenario name is used to identify important input and output files. It is also recommended that the subdirectory name incorporate the scenario name. The TP+ software restricts the user to four characters. The default name is TPPG.

3.4.3 Running TP+

Once all the input files have been updated and included in the model alternative directory, the user is ready to start TP+.

If TP+ has been properly installed, there should be a TP+ icon  on the desktop that can be used to launch TP+. Click on the TP+ icon and the TP+ control screen will appear. If there is no icon, TP+ can be started from the Start Menu like any other program in Windows. TP+ can also be started directly from within Viper. From the Viper menu, choose Run and then either File, Current File, Select Text, or Current Step, whichever is appropriate. If starting TP+ from Viper, be sure that any of the files that are to be used during the TP+ application are not left open in Viper while the TP+ application is executing.

Once TP+ has been activated, the TPPLUS window will open and prompt the user for the following items:

- The name of the script file that is to be run (if not shown the user can select the "Browse" button to select the correct script file in the correct subdirectory);
- The working directory where the basic application data is stored (this should default to the directory where the job script file resides when a new job script file is selected);
- A system prefix (make certain that the Project Prefix matches the scenario you have selected, such as "TPPG", and is a max of 4 characters - ALWAYS VERIFY THIS.);
- The desired height and width of a printed page (usually the default isn’t modified); and
- An ID that will be printed at the top of every printed page (descriptive text for your alternative).
- Press "Start"

When this data is completed, the Start Button is pressed, and TP+ begins execution. As it is executing, periodic messages will be written to the message box. The program window can be minimized or left open as TP+ is executing. The X button allows for pre-mature termination of the application. When the application is finished, the View Print File button can be pushed to view the printed results.

3.4.4 Errors

If there is an error, the TP+ control screen will display a message such as "Return Code 2." The only description of the error is contained in the **.PRN** file created by TP+.

Select "View Print File." Press the <F3> function key to move to the first error message.

4. Modifying the Roadway Network

The TPPG regional travel model uses coded representations of the region's existing and future roadway networks that can be edited for alternative year scenarios.

4.1 Road Network Elements

The road network is a computerized representation of the major street and highway system within the study area. The more important streets (freeways, expressways, arterials, and collectors) are fully included in the network. The model does not explicitly include all local streets. Some minor collector streets, local streets and driveways are instead represented by simplified network links ("zone centroid connectors") that represent local connections to the adjacent major roadway network.

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

4.1.1 Nodes

Nodes are established at each and every intersection between two or more links. Nodes are assigned numbers, with the first 3200 node numbers in the TPPG model representing traffic analysis zones (TAZ) as discussed above.

The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays. As part of the PROJECT, the roadway network was projected to State Plane 1983, California Zone 4 coordinates, with measurement in feet. Additionally, individual nodes were moved geographically to allow the model network to overlay in a consistent manner with other geographical information such as census maps.

Node data includes the node number, the X and Y coordinates, a City code filed, and separate numbering for TAZ and Gateway nodes (the same number as the node number).

4.1.2 Links

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

4.2 "Master" Roadway Network

Dowling Associates has developed a "Master" network to store the network related attributes for the 2005 base and Modesto General Plan version of the network including number of lanes, facility type. Capacity-increasing roadway network improvements are in the Master network with construction year (project completion) identifiers. All roadway networks used in the travel demand model are "built" from this Master network. The link attributes in the Master Network are similar to those in the

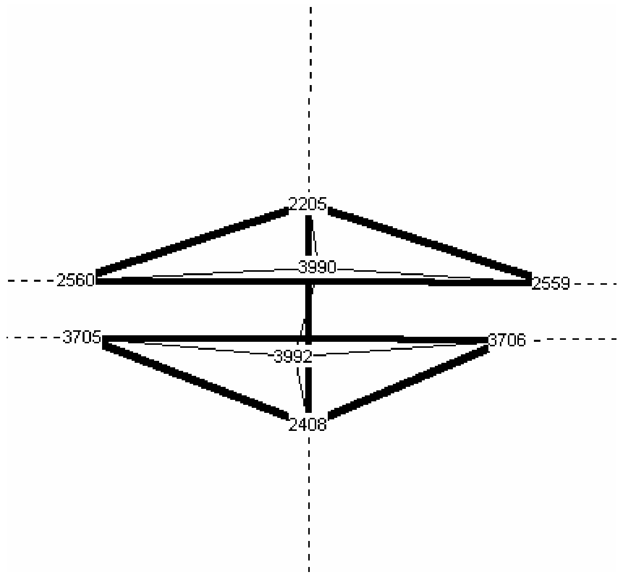
The purpose of creating a Master network was to make the task of network maintenance more efficient. In the past, if a roadway network improvement was to be included in several alternatives, the same network editing had to be performed individually for each of the network years. With a Master network, the user need only input the improvement in one place with the appropriate year of construction and then all desired network years can be built and will be consistent.

While the creation of a Master network will make the task of network maintenance more efficient, it will require the user to be very aware of how network coding is handled and to be diligent about displaying proper network data. Figure 4 shows an example of the Master network coding that illustrates the need for user diligence.

This figure shows a base year location with at-grade intersections that will become a grade-separated interchange in the future. The base year and future links are shown in different widths and two of the nodes (3990 and 3992 in this hypothetical example) are shown exaggeratedly offset for clarity. The dashed links are included in both the base year network and in the future network. The light weight solid links are included in the base year network but are excluded from the future network. The heavy weight links are included in the future network but are excluded from the base year network.

The display of these links in the master network can be confusing, because there are duplicate links for connecting the extremes of the interchange facility and the nodes are not normally offset as shown in Figure 4. One set of links is for the base year and one set is for the future year. When creating or editing such links care must be taken to add or change nodes and links so that the desired future network will be produced. The section titled *Building the Future Year Roadway Network,* below, describes how the link attributes are used to create the future network.

Figure 4 - Example of Master Network Coding



Base Year Links
2205-3990*
3990-3992*
3992-2408*
2559-3990
3990-2560
3705-3992
3992-3706

Future Year Links
2205-2408*
2559-2560
3705-3706
2559-2205
2205-2560
3705-2408
2408-3706

* = two-way link

4.2.1 Editing the Master Roadway Network

If new or revised roadway facility projects are identified in the future that are not already included in the Master network, changes will need to be made to the Master network. Such changes might include adding links that are not already in the Master network, changing the number of lanes for links that are already present or deleting links that are already present.

To add a link: First copy a link that is similar to the one you want to add. 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 location is within the search tolerance to an existing node, the end point of the new link will snap to this node; otherwise, the program prompts the user to add a new node and requests the new node number. A list of unused nodes will be displayed in the new node dialog box and the new number can then be selected from the list of unused nodes or entered manually. Then, enter or change the various link attributes to properly represent the link you are adding.

To widen a link: Click on the link to select it. The attributes for the link will be displayed in a dialog box. Change the LANES_IMP and IMP_MOGP attributes to properly represent the widening. If it is a two-way link, change the attributes for both travel directions (A-to-B and B-to-A).

To delete a link: Click on the link to select it, then press the **Delete** key.

4.2.2 Building the Future Year Roadway Network

As discussed above, links for all base year and future year improvements are included in the Master network. Future year roadway networks are created by including future links or changing the number of lanes and the speed and capacity classes on appropriate links. In some cases, it will be necessary to exclude base year links (e.g., if an at-grade intersection is being improved to a grade-separated crossing, the links that are attached to the node where the current at-grade condition exists must be excluded).

This process of including, changing, and/or excluding links is accomplished dynamically as the model is run. The information stored in each link's attributes is used to determine whether the link will be included, or changed, or excluded. The attributes that control this process are IMP_YEAR (the year when the improvement is to become effective), LANES05 (the base year number of lanes for the link), and LANES_MOGP (the improved number of lanes for the link). IT IS IMPERATIVE THAT FOR EACH RUN THE ANALYSIS YEAR IN THE SCRIPT BE PROPERLY SET.

The portion of script shown in Figure 5 uses these attributes to extract or build the correct roadway network for the defined alternative year. Figure 5 shows how these attributes are used to accomplish the three basic improvement actions (include, change, and exclude). If the analysis year in the script is later than the IMP_Year for the MOGP scenario, the number of lanes, speed and capacity class for the MOGP scenario will be included in the run.

Figure 5 - Job Script Code Lines to Build Future Year Network

```
;
;
;    USER MUST INPUT THE ANALYSYS YEAR!!!!!!!!!!!!!!!!!!!!!!!
;
NetYear=2025             ; User MUST input study year for correct
network
;
;===================================================================
=
;  NETWORK DEVELOPMENT
;===================================================================
=
RUN PGM=HWYNET

   .
   .
   .
```

```
      IF (@NetYear@<IMP_MOGP)
        SPEED=SPEED_05
        CAPCLASS=CAPC_05
        LANES=LANES_05
      ELSE
        SPEED=SPEED_mogp
        CAPCLASS=CAPC_mogp
        LANES=LANES_mogp
      ENDIF
```

```
   .
   .
   .

 IF (LANES=0) DELETE    ; Delete link if it is only a future link

ENDRUN
;===================================================================
=
```

Figure 6 - Creating Future Year Networks

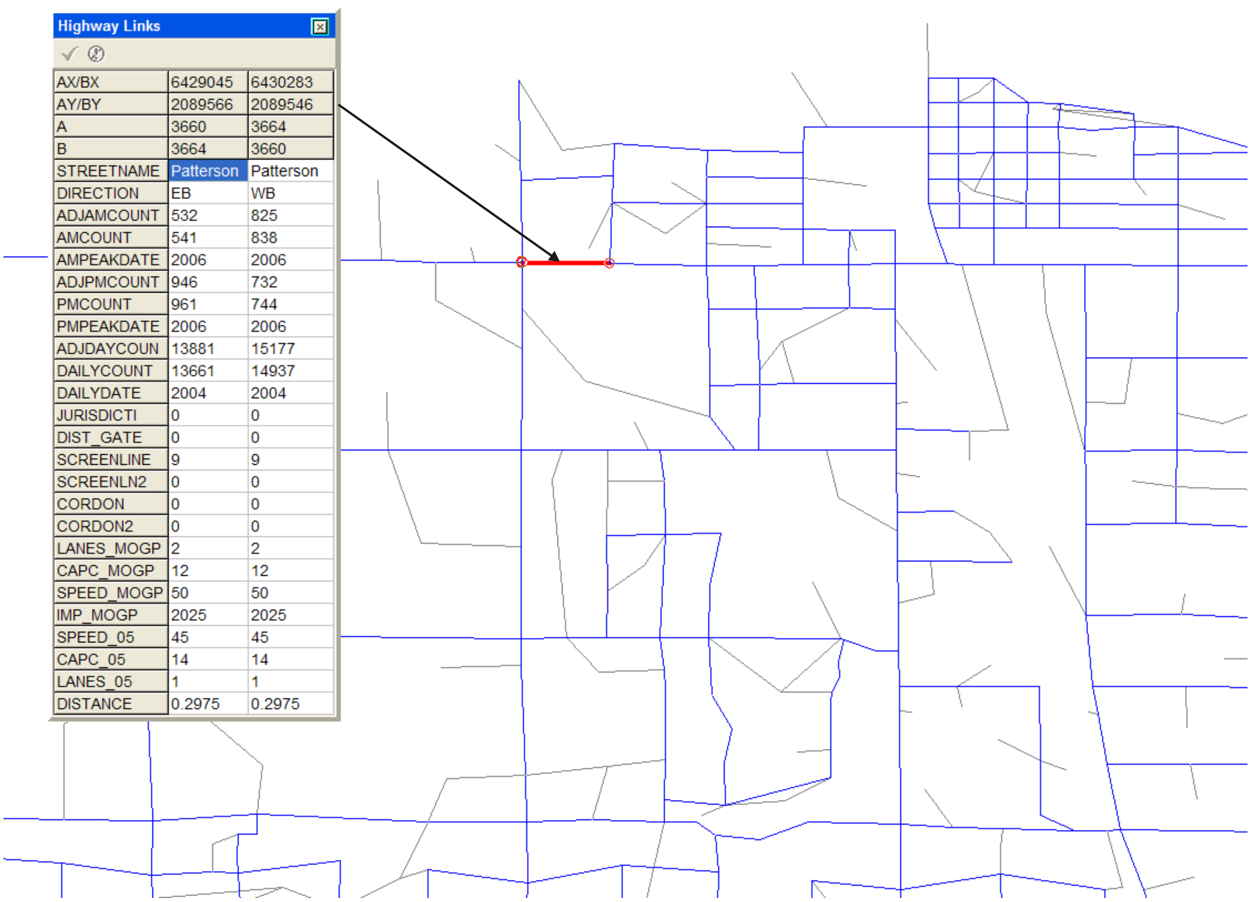
Highway Links

AX/BX	6429045	6430283
AY/BY	2089566	2089546
A	3660	3664
B	3664	3660
STREETNAME	Patterson	Patterson
DIRECTION	EB	WB
ADJAMCOUNT	532	825
AMCOUNT	541	838
AMPEAKDATE	2006	2006
ADJPMCOUNT	946	732
PMCOUNT	961	744
PMPEAKDATE	2006	2006
ADJDAYCOUN	13881	15177
DAILYCOUNT	13661	14937
DAILYDATE	2004	2004
JURISDICTI	0	0
DIST_GATE	0	0
SCREENLINE	9	9
SCREENLN2	0	0
CORDON	0	0
CORDON2	0	0
LANES_MOGP	2	2
CAPC_MOGP	12	12
SPEED_MOGP	50	50
IMP_MOGP	2018	2018
SPEED_05	45	45
CAPC_05	14	14
LANES_05	1	1
DISTANCE	0.2975	0.2975

4.2.3 Link Attributes

In the TPPG model, free-flow speeds are coded individually for each road link. As Figure 7 shows, capacities and speed-versus-congestion characteristics are assigned to groups of links based on the road type for the analysis year. The the attribute CAPC_yy contains the capacity class of the link. Table 4 shows the capacity classes and the hourly capacity that is associated with each one.

Figure 7 - Viper Display of Link Data



AX/BX	6429045	6430283
AY/BY	2089566	2089546
A	3660	3664
B	3664	3660
STREETNAME	Patterson	Patterson
DIRECTION	EB	WB
ADJAMCOUNT	532	825
AMCOUNT	541	838
AMPEAKDATE	2006	2006
ADJPMCOUNT	946	732
PMCOUNT	961	744
PMPEAKDATE	2006	2006
ADJDAYCOUN	13881	15177
DAILYCOUNT	13661	14937
DAILYDATE	2004	2004
JURISDICTI	0	0
DIST_GATE	0	0
SCREENLINE	9	9
SCREENLN2	0	0
CORDON	0	0
CORDON2	0	0
LANES_MOGP	2	2
CAPC_MOGP	12	12
SPEED_MOGP	50	50
IMP_MOGP	2025	2025
SPEED_05	45	45
CAPC_05	14	14
LANES_05	1	1
DISTANCE	0.2975	0.2975

Table 3 - Capacities and Speed-Delay Curves by Roadway Type

ROAD TYPE	CAPACITY CLASS (CAPCLASS)	DESCRIPTION	HOURLY CAPACITY (VEHICLES PER LANE)
FREEWAY	1	Freeway	1800
2-LANE HIGHWAY	2	Two-lane Rural Principal Road	1000
MULTI-LANE HIGHWAY	2 12	Multi-lane Unsignalized or Rural Principal Road Multi-lane Rural Principal Road with center turn lane	900 900
ARTERIAL	2 3 13	Unsignalized Arterial Urban Signalized Arterial Urban Signalized Arterial with center turn lane	900 750 825
COLLECTOR	4 14	Urban Collector 2-lane unsignalized road	650 925
2-LANE RURAL ROAD	5	Minor Rural Road	1000
MULTI LANE RURAL ROAD	5	Minor Rural Road	900
UNSIGNALIZED COLLECTOR	6	Unsignalized Urban Collector	
ZONE CONNECTOR	7	Gateway Connector Zone Connector	0 0
EXPRESSWAY	8 9 10	Class A Expressway Class B Expressway Class C Expressway	1500 1250 1000
SPECIAL LINK	11	Special Link (Needham Overpass, Pelandale Interchange)	1625
RAMP	19	Freeway Ramp	1000

4.2.4 Turn Penalties

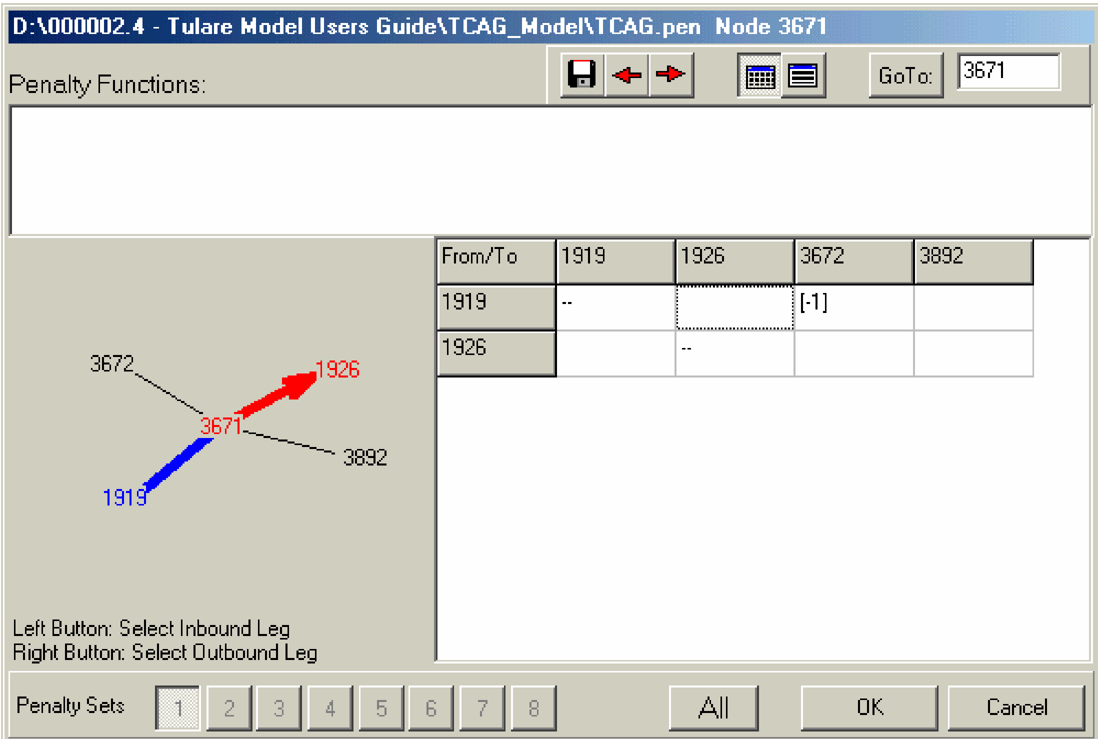
Turn penalties are coded in a separate file, and can be used to identify node-to-node movements which are prohibited (such as certain left turns) or which have additional delays. In the TPPG model, turn penalties are primarily used to represent prohibited left turns to and from ramps at freeway interchanges.

Viper can be used to view and edit turn penalty files used in TP+ using the following steps:

- Use the Turns-Read Penalty File menu command to read a penalty file. If the specified file can not be found, the program will prompt the user to create a new file.
- Select a node from the network and press F2 (or select the Turns-Edit Penalty menu item) to display the penalty edit dialog box for that node.

The turn penalty edit dialog box is divided into three parts (see Figure 8). The top panel is the penalty function list. The left panel is the intersection geometric (the current movement highlighted.). And, the right panel is a grid with the penalty codes/values.

Figure 8 - Turn Penalty Dialog Box



The grid can be displayed in two styles:

- Matrix style - The rows are for inbound nodes and the columns are for outbound nodes (shown in Figure 8)
- Table style - Penalty records are listed in a table format with an extra field for comments.

The penalty values can be edited in both grid display styles and the intersection geometric panel displays the movement in the selected cell. The Grid/Table buttons on the toolbar is used to toggle between the two styles.

Notes on geometric display:

- A blue line denotes the inbound leg, and a red line with an arrow head 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, use the right button to select the outbound leg.
- The toolbar on top has buttons for saving the penalty file, go to the previous intersection, go to the next intersection, switch grid style, and go to a particular intersection.

4.3 Final Combined Loaded Network

After being run the TPPG model outputs a loaded network with slightly different attributes than the inputs stored in the master network. The final combined loaded network combines the results stored in the three networks that result from the assignment of daily, AM and PM traffic respectively. The combined loaded network is generated and named for the analysis year so references to the year are omitted in the link attribute fields. A subset of the link input variables and validation variables are included and the model volume estimates and VC ratios are appended to these. Table 4 lists loaded network attributes.

Table 4 - TPPG Loaded Network Link Attributes

NETWORK VARIABLE	DESCRIPTION
Network Input Attributes	
ID	Link ID code
A	A Node
B	B Node
DISTANCE	Length of Link in Miles
SPEED	Free Flow Speed
CAPCLASS	Capacity Class
LANES	Directional Lanes of Travel
TIME_FF	Free Flow Travel Time on Link
Validation Attributes (Not provided uniformly)	
STREETNAME	Street Name
DIRECTION	Cardinal Direction of Travel on link
DISTANCE	Distance (calculated from coordinates)
ADJAMCOUNT	Directional AM Validation Count adjusted to 2005
AMPEAKDATE	Date of Directional AM Validation Count
ADJPMCOUNT	Directional PM Validation Count adjusted to 2005
PMPEAKDATE	Date of Directional PM Validation Count
ADJDAYCOUNT	Directional Validation Count adjusted to 2005
DAILYDATE	Date of Directional Daily Validation Count
SCREENLINE	ID of Validation Primary Validation Screenline
SCREENLN2	ID of Secondary Validation Screenline
Model Output Values	
VOL_Daily	Directional Daily Model Volume Estimate
VOL_AM	Directional AM Model Volume Estimate
VOL_PM	Directional PM Model Volume Estimate
TOTVOL_DAILY	Bi-Directional Daily Model Volume Estimate
TOTVOL_AM	Bi-Directional AM Model Volume Estimate
TOTVOL_PM	Bi-Directional PM Model Volume Estimate
VCDAY	Directional Daily Model Volume to Capacity Ratio
AM_VC	Directional AM Model Volume to Capacity Ratio
PM_VC	Directional PM Model Volume to Capacity Ratio

4.4 Transit Network

The TPPG travel model does not include a separate transit network. Based on the Caltrans *2000 Travel Survey*, transit trips (not including school buses) account for a negligible portion of trips in Stanislaus County. This proportion is not expected to increase significantly in the future with the current Regional Transportation Plan.

Future regional transportation studies may require more detailed analysis of transit infrastructure investments. If so, the TPPG travel model capabilities could be enhanced by adding separate representation of the transit systems and a mode choice analysis step. The peak period model structure is compatible with transit and mode choice procedures used for other Central Valley travel models such as San Joaquin County and Fresno County.

5. LAND USE / EXTERNAL TRIP ASSUMPTIONS

Land use and socioeconomic data at the traffic analysis zone level are used for determining trip generation. The TPPG model maintains the previous zonal variables for the land use/socioeconomic database, including housing units by single-family and multiple-family use and auto occupancy, and employment by category (retail, service, education, government, and other). A TAZ map of the zonal structure is provided in GIS and *.pdf format with the default files.

Land use and socio-economic data, as well as information on special generators and external trips are all accessible and editable in Microsoft Excel. When so accessed the formats are intended to allow the user to easily modify land use assumptions and re-export these files out as .DBF files the required files needed to run the TPPG model.

5.1 Household Cross Classification Data

Auto ownership data and Household size data were obtained from the 2000 Census and a household cross classification scheme developed for household trip generation. The percentages of 0, 1, 2, 3, and for or more auto household were indexed against households of size 1, 2, 3, 4, 5 or more for both single family and multifamily dwellings. For each TAZ containing housing an estimate is therefore available for the proportion of households falling within any one of fifty categories each having its own set of trip generation rates. This data is contained in the file xClsPct.dbf. For housing in new zones this file is used to estimate cross classification proportions by applying a regression equation against other land use variables. The user has the option of editing the xClsPct.dbf file directly to input the proportions of households with different levels of auto ownership and different numbers of persons. The totals for auto ownership and household size must add up to 1 in both cases this is not recommended for any but the most advanced users.

The 2005 employment data in the updated model is primarily based on the land use database from the previous version of the model. The land use database in the previous version of the TPPG model was based on an extensive compilation of acreages by community plan land use category in each community. Occupied acreages were converted to building area and numbers of employees using standard density factors.

The most recent available information on the numbers of Stanislaus County employees in each employment category were obtained from the 2005 California State Profile (Woods and Poole Economics, Inc. 2006). Factors were applied so that the countywide totals of each employee type would match 2005 employment totals reported by Woods and Poole.

shows the cross-classified household data for 2005 shows the same data for 2025. shows the employment data for 2005 and the Modesto General Plan year.

Table 5 2005 Countywide Cross Classified Summary

2005 Land Use			HH Size 1	2	3	4	5 or more
SF	Autos Owned	0	1,725	2,438	1,469	1,448	1,788
		1	6,666	10,395	6,185	6,037	6,866
		2	8,117	14,508	8,701	8,882	9,644
		3	2,869	5,274	3,258	3,265	3,630
		4 or more	1,069	2,008	1,227	1,244	1,426
SUBTOTAL							120,138
MF	Autos Owned	0	1,034	1,191	704	641	744
		1	3,332	4,333	2,530	2,248	2,476
		2	3,070	4,621	2,702	2,456	2,674
		3	1,011	1,590	999	859	975
		4 or more	344	551	338	293	340
SUBTOTAL							42,056
TOTAL							162,194

Future year land use for the Modesto General Plan area were based on the 2003 General Plan MEIR land use assumptions with adjustments to the Village Residential land use to match updated City population projections. Land Use assumptions for the rest of the county were based on the 2005 update of the StanCOG model which incorporates countywide land use projections apportioned among the various jurisdictions by StanCOG staff.

Table 6 2025 Future Year Land Use Summaries

2025 Land Use			HH Size 1	2	3	4	5 or more
SF	Autos Owned	0	3,140	4,438	2,675	2,635	3,254
		1	12,135	18,923	11,260	10,990	12,500
		2	14,777	26,411	15,839	16,170	17,556
		3	5,223	9,600	5,931	5,943	6,609
		4 or more	1,947	3,656	2,234	2,264	2,596
SUBTOTAL							218,707
MF	Autos Owned	0	2,250	2,592	1,531	1,394	1,619
		1	7,251	9,428	5,504	4,892	5,387
		2	6,681	10,055	5,880	5,343	5,819
		3	2,199	3,459	2,173	1,868	2,122
		4 or more	749	1,198	736	639	740
SUBTOTAL							91,509
TOTAL							310,216

Table 7 2005 and 2025 (General Plan Year) Employment Summary

EMPLOYMENT	2005	2025
Retail	16,300	104,862
Service	22,200	141,344
Education	10,000	27,778
Government	13,700	33,140
Other	49,700	224,081
TOTAL EMPLOYMENT	**111,900**	**531,240**

5.2 Modifying Land Use Assumptions

The land use data used by default in the model are contained in the TPPG2005_LU.dbf and TPPG2025_LU.dbf files these are the base year land use and the 2025 horizon year land use inputs).

The base year land use data represents the latest land use inventory as of the date of this model update, and hence represents the year 2005 land use status. These data are consistent with the validation run, and the user is expected to maintain this consistency unless errors are found and need to be corrected.

Future horizon year (2025) land uses can be redistributed based on new input from local jurisdictions, or to reflect new project specific land use proposals. If alternative scenarios to the adopted buildout land use scenario are being tested, the adopted file should be backed up and maintained in a separate directory.

To make changes in the 2025 land use input data, modify the information for the appropriate TAZ in the 2025 land use find the TAZ in the left most column and make the appropriate changes in housing and/or employment levels to represent the total levels with the land use changes that are being made. The fields in the land use file are

TAZ = Traffic Analysis Zone Number
AREA = Land Area in Acres
POP = Population
SF = Single Family households
MF = Multi Family households
RET = Retail Employees
SER = Service Employees
EDU = Educational Employees
GOV = Government Employees
OTH = Other Category Employees

Note that the **POP** column must be updated as the various household variables are changed. The default for population is 2.9 persons per SF or MF household. If the user desires to split a TAZ, then changes will have to be made to add one or more new TAZs to both the base year and the horizon year land use files. Appropriate data for the old TAZ and the new TAZ(s) will need to be entered on each worksheet. (This TAZ splitting procedure should only be undertaken by experienced users.)

Figure 9 - Portion of the 2025 (General Plan Year) Land Use Database

	A	B	C	D	E	F	G	H	I	J	K	L
1	TAZ	ACREAGE	POP	TOT_HH	SF	MF	RET_EMP	SER_EMP	EDU_EMP	GOV_EMP	OTH_EMP	TOT_EMP
113	151	15	87	34	30	4	0	0	0	0	0	0
114	152	31	597	208	206	2	0	0	0	0	0	0
115	153	49	177	66	61	5	9	8	0	0	0	16
116	154	46	2126	733	425	308	37	10	300	0	5	352
117	155	139	548	189	110	79	0	64	0	0	0	64
118	156	29	0	0	0	0	7	140	52	0	51	250
119	157	142	272	81	77	4	4	34	23	0	31	92
120	158	125	239	71	67	4	3	30	20	0	27	81
121	159	11	0	0	0	0	78	323	0	33	0	434
122	160	35	2087	683	467	216	0	20	0	0	1	21
123	161	120	231	68	65	3	3	29	19	0	26	78
124	162	77	4	1	1	0	0	0	0	0	1743	1743
125	163	80	22	11	8	2	0	0	200	0	0	200
126	164	48	49	14	11	3	1	6	0	0	4	11
127	165	80	47	16	12	4	2	9	0	0	7	18
128	166	64	672	193	191	2	2	16	10	0	14	42
129	167	58	735	216	214	2	2	25	9	0	13	49
130	168	31	0	0	0	0	137	556	0	0	0	692
131	169	3	0	0	0	0	44	34	0	0	0	78
132	170	17	484	133	97	36	0	19	0	0	2	21
133	171	28	148	48	47	1	49	31	4	0	36	120
134	172	124	63	22	15	7	3	14	0	0	11	28
135	173	48	29	11	8	3	1	7	1	0	4	14
136	174	85	163	49	46	2	2	21	14	0	18	55
137	175	90	173	51	49	3	3	22	14	0	19	58
138	176	44	1375	474	94	380	0	0	0	0	0	0
139	177	23	412	142	142	0	0	0	0	0	0	0
140	178	22	789	272	128	144	0	0	0	0	0	0
141	179	23	0	0	0	0	0	0	0	0	2	2
142	180	12	230	79	59	20	20	0	0	0	0	20
143	181	71	78	26	16	10	4	318	2	0	0	323
144	182	32	366	92	38	54	113	242	0	0	0	355
145	183	11	0	0	0	0	251	117	3	0	37	408
146	184	16	162	56	39	17	2	0	53	0	0	55
147	185	36	374	128	93	35	7	24	0	0	2	33
148	186	14	0	0	0	0	217	100	16	0	15	347
149	187	16	101	35	24	11	0	0	34	0	0	34
150	188	23	32	11	11	0	600	3	0	0	15	619

5.3 Using Special Generators

The model is capable of incorporating "special generators" within Stanislaus County. These are included in the Spec Gen worksheet (trip generation for special generators). Special generators are used to include trips from land uses that are not well represented by the standard land use categories or trip rates. In the TPPG model, special generation is input directly as person trips by trip purpose this may require the analyst to estimate the distribution of trips by purpose and will require the analyst to apply vehicle occupancy factors to convert person trips to vehicle trips.

Often the estimation of trips by purpose is obviated by the fact that special generators are input as Home Based Other trips to reflect categories that are not reflected by other purposes (such as recreational attractions). The distribution can also be estimated based on similar zones (by reference to the output file "TPPG_input_PA.dbf" generated by the model). Or can be calculated for trip attractors by multiplying the employment times the trip generation rates (see appendix). Once the distribution by trip purpose is determined vehicle trips are converted into person trips by using the vehicle occupancy factors embedded into the model and shown in the appendix.

New special generators should be appended to the file TPPG_20XX_SPECGEN.dbf. shows the special generator zones for the 2025 scenario.

Table 8 2025 Special Generators

Zone	Name
665	Costco's
770	Beckwidth Dakota CPD
721	
406	
772	
907	

5.4 External Trips

There are two types of trips at the cordons or "gateways" of the TPPG 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. External trips have one end in Stanislaus County and one end outside Stanislaus County.

Daily 2005 vehicle through trips were estimated for Stanislaus County based on actual 2005 counts at the gateways and the proportion of trips considered to be through trips in the Caltrans statewide model. The Caltrans percentages were applied at each gateway.

Base year external trips to and from Stanislaus County (I-X and X-I) were estimated from 2005 traffic counts at the cordon points. These trips are split into the five trip purposes and further divided into gateway productions (trips produced outside Stanislaus County and attracted to Stanislaus County) and attractions (trips produced inside Stanislaus County and attracted to areas outside Stanislaus County). The external vehicle trips for each trip purpose are multiplied by the appropriate average auto occupancy rate to convert them to person trips.

Future total gateway volumes are factored from the 2005 base year gateway traffic counts using annual growth factors derived from traffic projections in adjacent counties as well as historical traffic growth rates. The through trip forecast volume for each pair of gateways is based on the average of the growth factors at each end of the trip.

It is not expected that the user should need to modify the external trip assumptions, which are included in the Gateway Inputs worksheet (gateways I-X/X-I input values) and the Gateway X-X worksheet (gateway X-X input values).

Using these assumptions, resultant eternal trips (XX, I-X and X-I) are calculated for the selected year. The I-X and X-I trips are exported with the land use assumptions in xxyyLU.DBF and the X-X trips are exported in a separate file called xxyyXX.DBF.

5.5 Creating New Scenarios

The model is set up to evaluate the base year and horizon year travel demand without significant changes to the files provided as defaults. If interim years are desired the analyst must provide some alternative inputs. This is recommended for advanced users only.

1) Set Analysis Year. One line of code in the model script must be modified. The analysis year entered at the top of the set up portion of the script as the variable **'NetYear,'** must be set to the desired year.

2) Provide Interim/Outyear Land Use File. This can based on wholesale inclusion of the General Plan build out assumptions for various areas of the model where development is expected to occur (for example for a specific plan or community plan area that is expected to develop in the interim). This requires specific planning guidance and should involve direction from the appropriate jurisdictions. An alternative approach is to perform a wholesale interpolation/extrapolaitoni between the 2005 and the 2025 land use files provided for the default model. This is best accomplished in a spreadsheet where the POP,SF,MF,RET,SER,EDU,GOV, and OTH variables are calculated for the interim analysis year based on the formula:

*Value_**[Analysis Year]**= Value_2005 + [(Value_2025-Value_2005)*(AnalysisYear-2005)/20]*

The resulting worksheet must be saved with the name in the format:

TPPG***[Analysis Year]_***LU.dbf.

Where ***[Analysis Year]*** is substituted with the desired analysis year. This file must be in *.dbf format. 'TPPG' is the default prefix and may change accordingly. The special generators must be edited in Excel and the file renamed .

TPPG***_[Analysis Year]_***SPECGEN.dbf.

3) Provide Turn Penalty File. Turn penalty files are only provided for the default base year and general plan year scenarios. The user has the option of selecting the general plan year file and renaming it according to the convention:

[Analysis Year]penalties.pen

This should be suitable for most applications except that the user should verify that there are no locations where interim year restrictions are eliminated in the general plan.

4) Verify Network Improvements. The user must review the Master Network and adjust improvement years for facilities that will be improved by the by the interim analysis year. The default improvement year is 2025. The analysis must coordinate with the lead agency to make these modifications. ALSO it may be necessary to add additional attributes to the Master network to reflect instances where links are improved but not to the full general plan level. This is done in viper under the menu item LINK=>Attribute=>Add. Three attributes should be added and named:

[Analysis Year]Speed
[Analysis Year]Lanes
[Analysis Year]CAPC

The analyst should typically set the values of these attributes to the MOGP values making using the menu commands LINK=>Compute, then modify the links with interim year differences manually. This process is recommended for very advanced users only and such changes should be reported back to the TPPG members.

6. MODE CHOICE CHANGES

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

Table 9 - TPPG Vehicle Trips per Person Trip

Mode Split Factors Vehicles Trips per Person Trip	
Home Work	0.89860
Home School	0.35400
Home Shop	0.65930
Home Other	0.58980
Work Other	0.86060
Other-Other	0.60610

6.1 Transit Factors

The TPPG model contains a simplified mode split model so transit and other trip reduction scenarios can be estimated with the model. Using a simplified method eliminates the need to create and maintain a transit network along with fare and other cost information.

Basic mode split factors were developed from Caltrans' trip survey data. Additional factoring is applied for traffic zones that are planned as urban villages or to account for a higher expected level of transit usage. The Caltrans survey contains information on all trips made as well as the mode used for the trips, so person trip to vehicle trip conversion factors by purpose can be developed from the data.

The mode split process is divided into two parts:

1. The person trip tables by purpose are factored to vehicle trips using factors derived from the Caltrans' trip survey data. These factors take into account rural and urban transit usage as well as vehicle occupancy.

2. Transit assumptions are then applied to the resulting vehicle trip tables as further trip reductions. There are three transit scenarios, signifying the three levels of transit investments: low, medium, and high. No additional factoring will be done for the low transit scenario since a low level of transit usage is already assumed in step one, person to vehicle factoring. For the medium and high transit scenarios, additional reductions will be applied to the trip tables based on the level of local and regional transit service to each zone. contains the factors for transit usage.

Since existing transit usage is quite low, it is not possible to develop transit factors from existing conditions. The factors used are based on transit models in similar size counties and what reasonable reduction can be expected from transit service improvements.

Table 10 - TPPG Transit Service Factors

Local Service					
Transit Service Factor	**None**	**Minimal**	**Low**	**Medium**	**High**
None	1.000	1.000	1.000	1.000	1.000
Minimal	1.000	0.995	0.990	0.985	0.980
Low	1.000	0.990	0.985	0.980	0.975
Medium	1.000	0.985	0.980	0.975	0.970
High	1.000	0.980	0.975	0.970	0.965
Regional Service					
Transit Service Factor	**None**		**Low**	**Medium**	**High**
None	1.000		1.000	1.000	1.000
Low	1.000		0.990	0.985	0.980
Medium	1.000		0.985	0.960	0.950
High	1.000		0.980	0.950	0.940

The data file TRANSIT20yy.INP contains the coding for transit levels of service and city code each traffic zone. Transit service is divided into local and regional service, where local service is only available between traffic zones with the same city code, and regional service is only available between traffic zones with differing city codes. The service ratings are based on the traffic zones' distance from transit lines as well as the headways of the accessible transit service.

Local service has 5 levels:

- None (0)
- Minimal (1)
- Low (2)
- Medium (3)
- High (4)

Regional service has 4 levels:

- None (0)
- Low (1)
- Medium (2)
- High (3)

Both the medium and high transit scenarios are contained in the TRANSIT20yy.INP file. The TP+ script file will utilize one of the scenarios based on the column specification in the ZDAT record.

7. SPECIAL ASSIGNMENTS

In an effort to meet the needs of the TPPG, several special assignment options are explained here, including the saving of selected intersection turn volumes, select link and select zone assignments.

7.1 Intersection Turn Volumes

The TP+ command TURNS is used to request that the volumes at specific nodes are to be accumulated. If there is at least one TURNS statement, the module will accumulate turns for every assignment loading. At the end of each iteration (in the Phase=Adjust), a single total turn volume will be computed for each movement at the nodes where turns are requested. By default, the single volume is computed by adding all the individual turn volume sets together (T = TURN[1] + TURN [2] + TURN [..] ...).

If turn volumes are to be accumulated and reported, it is necessary to specify the selected nodes with an N= , , , etc statement, and also to have a FILEO TURNVOLO specified to define the file(s) to which the turn volumes will be written. N |IP| is a list of nodes at which turning volumes are to be accumulated.

A sample job script to save turn volumes is shown in . This job script loads the morning 3-hour peak period traffic onto the network saving turns at the nodes specified by:

```
TurnList=1521-1523,1525.
```

A binary file (.BIN) and a database file (.DBF) are created with the turning volume output by:

```
TURNVOLO=LDA3_SelLink.TRN, FORMAT=BIN
TURNVOLO=LDA3_SelLink.DBF, FORMAT=DBF
```

7.2 Select Link Analysis

also shows the commands to track the traffic using a selected link or set of links. The chosen links are specified by:

```
SelLinkList='1519-1520*,1521-1565*'
```

The volumes using the selected links are saved in the output file as a separate link attribute that is created by:

```
PATH=TIME,PENI=1,VOL[1]=MI.1.1,
    MW[2]=MI.1.1, SELECTLINK=(L=@SelLinkList@),
VOL[2]=mw[2]
```

Figure 10 - Sample Jobstream for Turning Volumes & Select Link Analysis

```
;================================================================================
;  PM PEAK WITH SELECT LINK Analysis
;================================================================================
;
;    USER MUST INPUT THE ANALYSYS YEAR!!!!!!!!!!!!!!!!!!!!!!!
;
 NetYear=2025         ; User MUST input study year for correct network
 NumItersEQ=30        ; Equilibrium assignment iterations (30)
 SelLinkList='1519-1520*,1521-1565*'    ; Must be in 'single quotes'
 TurnList=1521-1523,1525
      ;
      ;       Examples of Select Links
      ;
      ;  SELECTLINK=(L=1519-1520)  link 1519-1520 in A-B dir
      ;  SELECTLINK=(L=1521-1565*) link 1519-1520 in A-B or B-A dir

;======================================================================
;  PM TRAFFIC ASSIGNMENT
;======================================================================
RUN PGM=HWYLOAD
    ;----------------------------------------
    ; Load Network with Full Trip Table
    ;----------------------------------------
    NETI=?_@NetYear@_BASE.NET
    MATI=?_PM1_OD.MAT
    NETO=?_@NetYear@_PM1HR.NET

    TURNVOLO=PM_SelZone.TRN, FORMAT=BIN
    TURNVOLO=PM_SelZone.DBF, FORMAT=DBF
    TURNS N=@TurnList@

    CAPFAC= 0.1      ; EQui ON

   MAXITERS= @NumItersEQ@
    TURNPENI=@NetYear@Penalties.pen  ; Set turning penalties & prohibitors
    FUNCTION  V=VOL[1]
    PHASE=LINKREAD
      LINKCLASS=LI.CAPCLASS
      CAPACITY=LI.CAPACITY
      T0=LI.TIME_FF
   ENDPHASE

   Phase=Iloop
         PAth=time,vol[1]=MI.1.1,Peni,VOL[1]=MI.1.1,
             MW[2]=MI.1.1, SELECTLINK=(L=@SelLinkList@),
             VOL[2]=mw[2]                        ; using SelLinkList
   endphase

    PHASE=ADJUST
      TC[02]=T0*(1 +0.15*(VC/0.75)^4)+ (0.15*(VC/0.95)^12); Highway/Unsig. Art.
      TC[04]=T0*(1 + 0.15*(VC/0.9)^6)                     ; Collector
      TC[05]=T0*(1 + 0.25*(VC/0.6)^4)                     ; Rural Collector
      TC[06]=T0*(1 + 0.1*(VC / 0.85)^4)                   ; Unsig. Collector
      TC[07]=min((T0*30.0),(T0*(1 + 0.15* (VC / 0.25)^4))); Centroid Connector
    ENDPHASE
   endRun
```

7.3 Select Zone Analysis

shows the commands to track the traffic to and from selected zones, which is a technique that can be used to estimate project trip distribution for traffic impact studies. This jobstream actually tracks traffic to and from selected zones that uses selected links and keeps track of the turning movement volumes at selected nodes. The chosen nodes and links are specified as described in the previous section. The chosen zones are specified by:

```
SelZoneList=185-187,191
```

The volumes to and from the selected zones that use the selected links are saved in the output file as a separate link attribute that is created by:

```
PATH=TIME,PENI=1,VOL[1]=MI.1.1, MW[2]=MI.1.1,
     SELECTLINK=(A=@SelZoneList@ | B=@SelZoneList@),
     VOL[2]=mw[2]
```

Figure 11 - Sample Jobstream for Select Zone Analysis

```
;===============================================================================
;  PM PEAK WITH SELECT ZONE Analysis
;===============================================================================
;
;    USER MUST INPUT THE ANALYSYS YEAR!!!!!!!!!!!!!!!!!!!!!!
;
 NetYear=2025         ; User MUST input study year for correct network
 NumItersEQ=30        ; Equilibrium assignment iterations (30)
 SelZoneList=200-300  ; SELECTLINK=(A=@SelZoneList@ | B=@SelZoneList@)
                      ; to OR from SelZoneList
 TurnList=1521-1523,1525
;=====================================================================
;  PM TRAFFIC ASSIGNMENT
;==========================================================================
RUN PGM=HWYLOAD
    ;----------------------------------------
    ; Load Network with Full Trip Table
    ;----------------------------------------
    NETI=?_@NetYear@_BASE.NET
    MATI=?_PM1_OD.MAT
    NETO=?_@NetYear@_PM1HR.NET
;
    TURNVOLO=PM_SelZone.TRN, FORMAT=BIN
    TURNVOLO=PM_SelZone.DBF, FORMAT=DBF
    TURNS N=@TurnList@
;
    CAPFAC= 0.1      ; EQui ON
;
   MAXITERS= @NumItersEQ@
    TURNPENI=@NetYear@Penalties.pen  ; Set turning penalties & prohibitors
    FUNCTION  V=VOL[1]
    PHASE=LINKREAD
      LINKCLASS=LI.CAPCLASS
      CAPACITY=LI.CAPACITY
      T0=LI.TIME_FF
   ENDPHASE

   Phase=Iloop
       PAth=time,vol[1]=MI.1.1,Peni=1,VOL[1]=MI.1.1,
          MW[2]=MI.1.1, SELECTLINK=(A=@SelZoneList@ | B=@SelZoneList@),
          VOL[2]=mw[2]      ; to or from SelZoneList
   endphase

    PHASE=ADJUST
      TC[02]=T0*(1 +0.15*(VC/0.75)^4)+ (0.15*(VC/0.95)^12); Highway/Unsig. Art.
      TC[04]=T0*(1 + 0.15*(VC/0.9)^6)                     ; Collector
      TC[05]=T0*(1 + 0.25*(VC/0.6)^4)                     ; Rural Collector
      TC[06]=T0*(1 + 0.1*(VC / 0.85)^4)                   ; Unsig. Collector
      TC[07]=min((T0*30.0),(T0*(1 + 0.15* (VC / 0.25)^4))); Centroid Connector
    ENDPHASE
    endRun
```

8. ADJUSTMENT OF RESULTS

The traffic validation indicates that the TPPG model provides a good overall estimation of travel demand patterns in Stanislaus County. However, 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:

Adj. Forecast Volume = Base Year Count + (Model Forecast Volume **-** Base Year Model Volume)

An incremental adjustment is generally 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.

8.1 Turn Movements

The TPPG model has been validated to replicate overall existing traffic volumes in Stanislaus County. The model accurately represents overall traffic volumes on roads grouped by classification or across regional screenlines. In many locations, the model also accurately estimates traffic on specific road segments. It is likely that the model will not be accurate enough in every location to reliably calculate level of service directly from model output. However, a validated model will generate good estimates of changes in traffic volume in response to changes in land use or road network assumptions. Therefore, it is recommended that adjustments be applied to model results prior to traffic operations analysis.

The primary reference for traffic model volume adjustments *is National Cooperative Highway Research Program Report (NCHRP) 255: Highway Traffic Data for Urbanized Area Project Planning and Design, 1982* (now out of print). Some of the simplified procedures described in NCHRP 255 can be improved using current computer programs.

8.1.1 Link Volumes

There are two common procedures for adjusting link volumes from a model:

1. Increments (adjust traffic counts by increment from base year model to future year model)
2. Growth Factors (adjust traffic counts by ratio of future year model to base year model)

It is recommended that link volumes from the TPPG model be adjusted based on the increment method, for any link where traffic counts are available. Factors may be applied in locations where forecasts are needed and traffic counts are not available.

Discussion of Factor Method

The growth factor or ratio method calculates the ratio of future model forecast volumes to base year model volumes and applies the ratio to the base year traffic count. For example, a segment of a given street may have a 2005 traffic count of 24,000 daily vehicles. The validated 1998 base year model may estimate a 2005 volume of 19,500 (19% low) and a 2020 volume of 23,800 (lower than the 2005 count). The growth factor method would calculate an overall factor of 23,800/19,500 = 1.22. Applying the factor of 1.22 to the count of 24,000 would result in an adjusted forecast of 29,280.

The factor method can generate very odd results when either the traffic count or base year model volume is very low. The factor method also does not guarantee continuity of flow from one link to the next. Therefore, the increment method is recommended.

Procedure for Links with Traffic Counts

The following procedure is recommended for adjustment of all forecast volumes on all road types, including freeways, local streets, and intersection approach and departure volumes. A spreadsheet is useful for organizing the adjustments.

1. Balance Counts. Balance existing traffic counts between adjacent road segments or adjacent intersections where appropriate. The exiting volume from one intersection should equal the entering traffic at the next intersection if there are no streets or driveways between the intersections.
2. Compile Base Year Model Volumes. Enter the appropriate daily, A.M. peak hour or P.M. peak hour traffic volumes from the version of the TPPG model that is closest to the traffic count year. If a version of the model is not available within two years of the traffic count year, it is recommended to interpolate between two model years to estimate the appropriate base year. For example, 2005 model volumes could be estimated for comparison with 2002 traffic counts by interpolating the increment between 2002 and 2005 model volumes.
3. Compile Future Year Model Volumes. Enter the appropriate daily, A.M. peak hour or P.M. peak hour traffic volumes from the version of the TPPG model that is closest to the future study year.
4. Calculate Increment from Base Year Model to Future Year Model. Subtract the base year model volume on each link from the future year model volume.
5. Check Negative Increments. In some cases, the model volumes will decrease between the base year and the future year. Decreases in traffic could be due to legitimate reasons, such as construction of a new facility that diverts traffic off of the road. There could also be legitimate but difficult-to-explain reasons, such as future traffic avoiding a road where the model is predicting significant future congestion. Or, decreases could be due to errors or discrepancies between the base year and future year land use assumptions. The analyst must determine whether to allow traffic to decrease consistent with the model assumptions, or to reset the negative increments to zero so that no future forecasts are lower than the base year traffic counts.

6. Add Increment to Traffic Count. Add the growth increment to the base year traffic count to calculate the final adjusted forecast volume.

Procedure for Links without Traffic Counts

For road segments that exist in the base year but do not have traffic counts, a factor method is recommended for adjusting future model volume forecasts.

1. Adjust Links with Traffic Counts. Calculate adjusted forecast volumes for links with traffic counts following the above procedure in Section 2.2.

2. Select Representative Links. Select one or more similar nearby links with adjusted forecasts. For example, adjacent freeway links should be used for adjustments on freeways. Ramps that serve the same general movements (such as "northbound off-ramp from downtown") should be used to adjust ramp volumes. Parallel arterials should be used to adjust arterial segments. Calculate the adjustment factor on those nearby links as the adjusted traffic volume divided by the unadjusted future year model volume.

3. Apply Adjustment Factor. Apply the average adjustment growth factor to the unadjusted future year model volume on the link without traffic counts.

For future roads that do not exist in the base year, it would generally be appropriate to use unadjusted model traffic volume forecasts.

8.1.2 Intersection Turn Volumes

It is possible to create a travel model that estimates accurate link volumes on a majority of important road segments. However, it is very difficult to accurately estimate individual turn movements. This is primarily due to the aggregation of land uses into transportation analysis zones (TAZs), which means that the model cannot represent all of the individual paths that drivers use to reach individual parcels and driveways. Therefore an adjustment process is recommended.

Procedure for Turn Movements

The procedure for intersection turn volumes is a two-step process. First, the link volumes entering and exiting the intersection are adjusted as described above. Second, existing turn movement counts are factored to match the adjusted entering and exiting volumes.

1. Adjust Link Volumes. Adjust the peak hour link volumes in and out of each leg of the intersection (generally eight segments for a standard four-way intersection) using the incremental adjustment process described in Section 2.2.
2. Factor Turn Volumes. Factor the base year turn movement count at the intersection until the total volumes in and out of each leg closely match the adjusted link volumes. A common factoring algorithm is named after its creator, Furness. Computer applications of the Furness procedure are available ("Turns32" on the Dowling Associates website, www.dowlinginc.com, or the "LOS" program from TJKM Transportation Consultants, "Estimate Turns from

In/Out Volume" option) or simplified versions can be programmed in spreadsheets.

3. Check Increments. Some of the factored turn movements may end up lower than the base year traffic counts, due to large increases on certain exiting movements that divert traffic away from other movements. The analyst must decide if the forecast turn movements can decrease from the base year traffic counts, or if the forecast turn movements should be reset to be no lower than the base year traffic counts.

Procedure for Movements without Traffic Counts

If a new road segment is added in the future, there will be no traffic counts available for adjustment. The following procedure is recommended

1. Model Traffic Assignment. Assign future peak hour traffic using the TP+ model and save turn movements at the selected intersections.
2. Intersection with Existing Road. If the new road will intersect an existing road, estimate base year traffic counts and adjusted forecast link volumes on as many movements as possible on the existing road at the new intersection based on traffic counts at adjacent locations.
3. Substitute Model Volumes for Count. Substitute model-estimated turn movement volumes as base year traffic counts for all turn movements to and from the new road.
4. Factor Turn Movements. Continue with the procedure described in Section 3.1.

Shortcut Procedure

The factoring procedure described in Section 3.1 will give the most representative results for intersection turn movement forecasts based on growth on individual legs. However, there may be times when the analyst may not have ready access to the adjustment software and needs a quick assessment of intersection conditions. The following procedure is recommended for "shortcut" analysis only:

1. Calculate Factors. Calculate the growth factors on each leg of the intersection as the adjusted future year model volume (or unadjusted future year model volumes if adjustments are not available) divided by the base year model volume (or base year traffic count if the base year model is not available). The factor can be calculated based on total two-way or directional one-way daily or peak hour model volumes.
2. Apply Factors. Apply the growth factor on each leg to the turn movement counts entering from that leg;

   OR

   Calculate the growth factor for each turn movement as the average of the two growth factors on the entering and exiting leg.
3. Check Results.

9. REPORTING THE RESULTS

There are a variety of ways to report the results of the TP+ traffic assignment, including screen graphics, plots and printed reports.

9.1 Viewing and Plotting Model Data

9.1.1 Network Project Files

Network project files are used by Viper to store various settings from the network window, including:

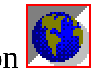
- The status and drawing order of the display layers
- For each display layer
  - File name
  - Coordinate offset
  - Coordinate scale
  - Color specifications
  - Selection criteria
- Saved views
- Saved polygons
- Page setup information
- Highway network attribute calculation information
- Left-hand drive display option

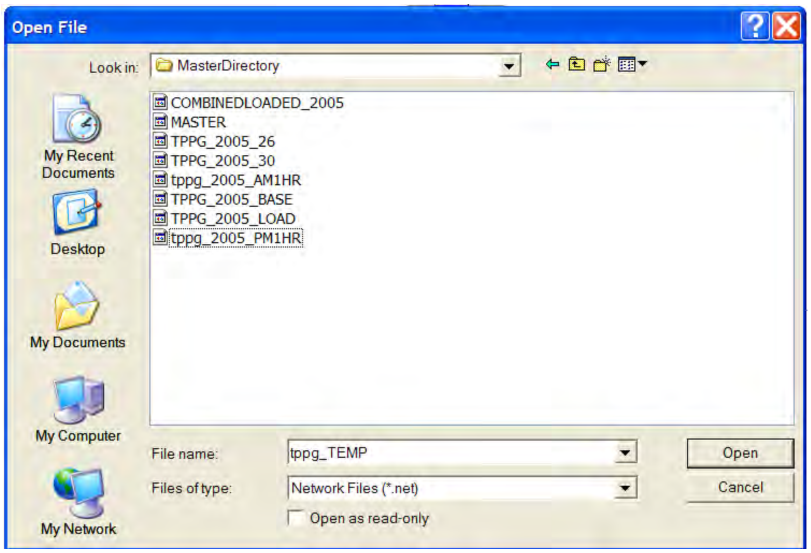
The project file is an ASCII formatted file which looks like a Windows INI (Initialization) file. This file should not be modified directly. Citilabs recommends that this file only be modified by changing the settings in Viper. The default name for the project file is the same name as the highway network file with a PRJ file extension.

Viper 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 Viper will try to search for a file named DEFAULT.PRJ in the current (project) directory and then in the Viper program directory. If a DEFAULT.PRJ file is located, Viper will utilize the settings in this file.

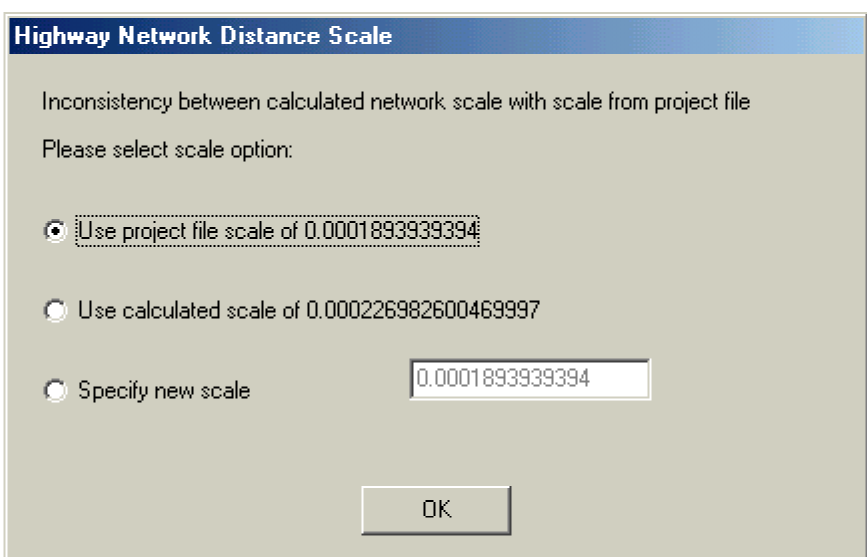
Viper "project files" (.PRJ) have been developed to allow TPPG to view and plot model link data included in each scenario's loaded network. The project file can be opened with the Open File dialog and the saved settings restored in a new highway window.

9.1.2 Opening Networks

1. Start Viper by either "double clicking" on its icon  on your desktop OR by selecting Viper from the START bar under PROGRAMS.
2. In Viper, select File Open.
3. Use the "Look in:" pull down to select the correct directory
4. Type in "*.net" in the "File name" box as shown in the figure below.

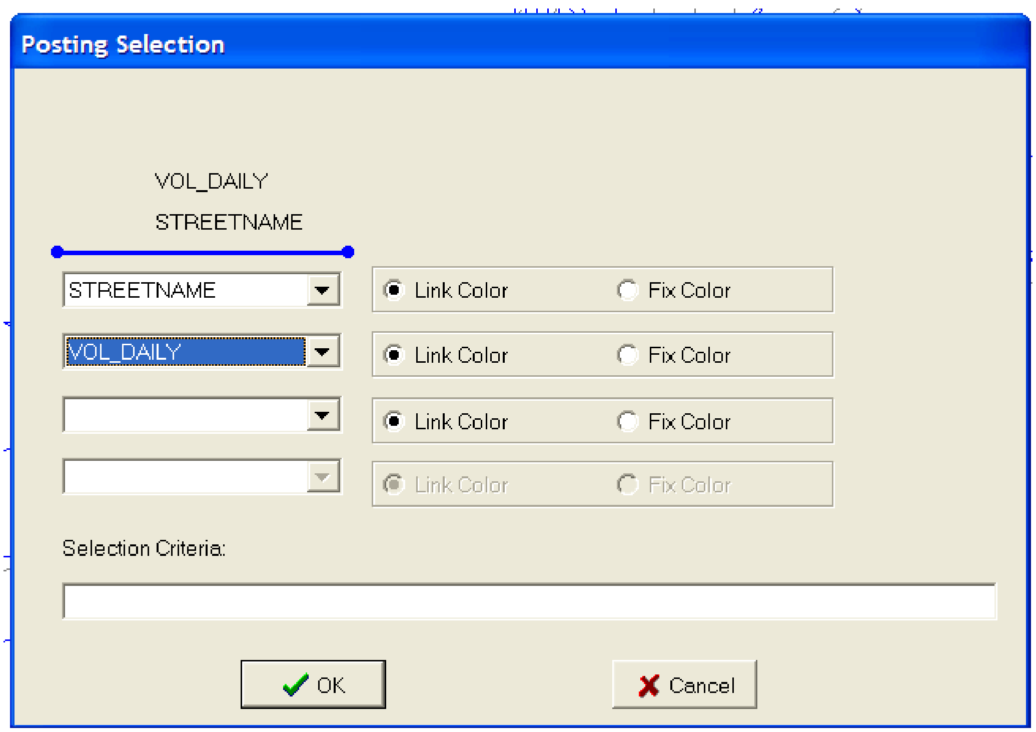


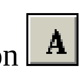
5. Select the network you want to open.
6. You may be asked to set the scale for a network. Enter "OK" to use the project scale on the Highway Network Distance Scale dialog box as shown below. This scale (0.000189…) represents a foot-to-mile scale (1/5280).



9.2 Posting Volumes on Loaded Networks

1. Once you have your loaded network open, select Post… All Links… to get the Posting Selection dialog box shown below. Select daily volumes and street names with colors as shown below. (Note: You could also post other variables like AM or PM values.) The color usually defaults to Link Color. Usually select Fix Color to black.



2. To change the font size, select the font icon  from the command bar.

3. Select File… Printer Setup… to get your printer options. I usually select Portrait for the full TPPG model area and Landscape for zoomed in views. Note: These do not be save in the Viper project files and must be reset when reopening a network.

4. Select View… Resize to Plot Page… to set your view window so WYSIWYG (what you see is what you get…).

5. Select View… Restore… to zoom in to any of the predefined window areas.

6. Select File… Print… to print to your defined printer or plotter.

10. THE FORECASTING PROCESS - 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.

10.1 Trip Stratification

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

10.1.1 Trip Purposes

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

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

Splitting the trips into purposes allows for a better understanding of the relationship between jobs and housing, by separating commute trips. It also provides more control over the trip distribution, since different types of trips involve different trip lengths. For a peak period model, it is important to identify the differences in travel characteristics over the day.

10.1.2 Productions and Attractions

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

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

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

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

10.2 Trip Generation Rates (Person Trips)

Trip generation rates (person trips) for the TPPG peak period model were derived from the 2001 Caltrans Statewide Travel Survey (the most recent available at the time of this writing), supplemented by information from previously developed models and knowledge about the accuracy of travel surveys. Separate trip generation rates were derived for each land use cross classification and employment category and for each trip purpose.

10.2.1 Household Trip Productions

A standard procedure for "cross-classification" trip generation would be to determine the average trip rate for each of the six household categories. With a small survey sample size, this procedure can result in zero or inconsistent rates for certain household categories. The TPPG model uses a "proportional smoothing" technique to determine the household rates. The proportional smoothing technique calculates the average ratio of rates for single family versus multiple family households, and the average ratios of rates for household size and auto ownership categories. The ratios are then combined to determine the rates for each of the six individual categories. These rates are substituted for zero values obtained from the survey. and show the cross-classified household trip generation rates for single family and multi family households respectively.

10.2.2 Work-Other Trip Productions

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

Table 11 Cross Classified Single Family Trip Generation Rates

Land Use Category					Household Size				
					1	2	3	4	5 +
Single Family	Production	H-W	Auto Ownership	0	0.064	0.171	0.247	0.269	2.797
				1	0.841	1.179	1.861	1.436	1.946
				2	0.737	2.220	2.248	2.709	2.670
				3	1.193	2.245	3.523	3.810	3.660
				4+	0.655	2.400	4.383	4.575	5.236
		H-SC		0	0.038	0.018	3.557	0.723	1.221
				1	0.215	0.102	1.663	4.094	8.625
				2	0.223	0.106	0.849	3.424	5.257
				3	0.061	0.029	0.698	4.080	6.612
				4+	0.198	0.094	0.833	3.014	4.539
		H-S		0	0.407	0.283	0.296	0.372	0.380
				1	1.238	1.404	2.369	0.415	4.381
				2	1.108	1.943	2.182	2.452	1.489
				3	1.649	1.573	1.333	2.254	2.255
				4+	2.182	1.426	2.008	2.503	3.524
		H-O		0	0.750	0.128	0.207	0.308	0.451
				1	1.244	2.206	7.017	11.055	10.826
				2	2.048	2.988	4.705	6.883	11.736
				3	2.863	2.712	3.983	5.779	8.228
				4+	0.443	3.634	3.655	5.979	6.944
		O-O		0	0.005	0.002	0.002	0.002	0.002
				1	0.633	0.337	1.190	0.105	0.595
				2	1.314	1.554	1.127	1.221	1.364
				3	1.209	0.964	0.915	1.436	0.935
				4+	0.819	0.766	1.605	0.852	1.962
	Attraction	W-O		0	0.081	0.014	0.022	0.033	0.049
				1	0.135	0.240	0.763	1.202	1.177
				2	0.223	0.325	0.511	0.748	1.276
				3	0.311	0.295	0.433	0.628	0.894
				4+	0.048	0.395	0.397	0.650	0.755
		O-O		0	0.005	0.002	0.002	0.002	0.002
				1	0.633	0.337	1.190	0.105	0.595
				2	1.314	1.554	1.127	1.221	1.364
				3	1.209	0.964	0.915	1.436	0.935
				4+	0.819	0.766	1.605	0.852	1.962

Table 12 Cross Classified Multi-Family Trip Generation Rates

Land Use Category					Household Size 1	2	3	4	5 +
Multi Family Multi Family	Production	H-W	Auto Ownership Auto Ownership	0	0.740	1.976	1.076	0.372	0.561
				1	0.621	1.756	1.222	1.646	2.266
				2	1.500	1.886	1.875	1.783	2.788
				3	2.321	2.321	2.733	2.511	1.660
				4+	1.312	3.330	2.621	3.001	4.526
		H-SC		0	0.004	2.233	1.134	0.971	2.333
				1	0.018	0.576	0.956	3.466	10.494
				2	0.021	0.123	1.702	3.710	5.926
				3	0.009	0.304	0.090	2.873	5.755
				4+	0.011	0.368	0.109	3.481	6.974
		H-S		0	1.556	0.191	0.541	0.529	4.513
				1	1.149	0.544	1.478	0.540	3.592
				2	0.473	1.520	0.427	0.977	8.631
				3	1.165	0.969	3.084	0.577	4.926
				4+	0.857	0.713	2.269	0.425	3.625
		H-O		0	0.664	0.909	3.083	2.185	2.347
				1	1.713	2.122	3.881	3.862	5.674
				2	0.315	2.464	3.014	5.363	5.393
				3	0.734	1.195	1.753	5.126	3.086
				4+	0.735	1.197	1.755	5.134	3.091
		O-O		0	0.011	0.020	0.006	0.009	0.012
				1	0.960	0.551	0.489	0.037	0.418
				2	0.113	0.947	0.091	0.220	0.491
				3	2.157	3.365	2.805	1.157	1.389
				4+	1.462	2.672	4.919	0.687	2.914
	Attraction Production	W-O		0	0.072	0.099	0.335	0.238	0.255
				1	0.274	0.339	0.620	0.617	0.906
				2	0.050	0.394	0.481	0.857	0.861
				3	0.117	0.191	0.280	0.819	0.493
				4+	0.117	0.191	0.280	0.820	0.494
		O-O H-W		0	0.011	0.020	0.006	0.009	0.012
				1	0.960	0.551	0.489	0.037	0.418
				2	0.113	0.947	0.091	0.220	0.491
				3	2.157	3.365	2.805	1.157	1.389
				0	0.740	1.976	1.076	0.372	0.561

Table 13 Employment Trip Generation Rates

Land-Use		Trip Purpose					
		H-W	H-SC	H-S	H-O	W-O	O-O
Retail	Productions	--	--	--	--	1.73	4.89
Service		--	--	--	--	1.15	0.29
Educ		--	--	--	--	1.15	--
Govt		--	--	--	--	1.15	2.01
Other		--	--	--	--	1.04	--
Retail	Attractions	1.32	--	5.75	2.59	1.73	4.89
Service		1.32	--	--	3.45	1.15	0.29
Educ		1.32	20.70	--	--	1.15	--
Govt		1.32	--	--	1.90	1.15	2.01
Other		1.32	--	--	1.32	1.04	--

10.2.3 Trip Attractions

Home-Work attractions can be derived from the travel survey. Each surveyed person 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.

Home-Shop attractions were estimated by assuming that all Home-Shop trips are attracted to retail employees. This is simplification, since some trips that people classify as Home-Shop may be attracted to service or other employees (for example, a trip to the bank).

Trip attractions for other purposes are difficult to derive directly from limited travel survey data. Work-Other trips and Other-Other trips are allocated based in order to fill out trip generation rates for employment types using ITE rates as a guide with the end in mind that these trips should be balanced and countywide totals by purpose should be reasonably well matched with survey results.

The initial estimates of trip generation rates provided a close match with Stanislaus County totals reported in the Caltrans Statewide Travel Survey. However, tests of the model indicated that trips were underestimated, particularly along urban arterials and collectors.

It is assumed that the most likely trips to be under-reported in the travel survey would be incidental trips, such as a trip from the grocery store to the laundry. These trips mostly fall into the Other-Other category.

The Other-Other production and attraction rates for each employment type were estimated by comparing the trip generation to standard vehicle trip generation rates in the *ITE Trip Generation Manual* (Institute of Transportation Engineers, 7th Edition, 2004). The model person trip generation rates were converted to vehicle trips using auto occupancies for each trip purpose. The vehicle trip rates were compared for each employment type. The Other-Other trip rates were increased so that the model trip generation rates would replicate the ITE vehicle trip generation rates.

10.3 Cordon or "Gateway" Trips

There are two types of trips at the cordons or "gateways" of the TPPG model, through trips (external-external or X-X) and external trips (external-internal, internal-external or I-X/X-I). Through trips are trips that pass through the model area without stopping (e.g., a trip from San Joaquin County to Merced). External trips have one end in Stanislaus County and one end outside Stanislaus County (e.g., a trip from San Joaquin County). External trip assumptions are shown in Appendix A. The external vehicle trips for each trip purpose are multiplied by the appropriate average auto occupancy rate to convert them to person trips. Initial estimates of productions and attractions at each gateway are adjusted to provide an overall balance of gateway person-trip productions and attractions with internal person-trip productions and attractions. These "gateway" trips are then distributed to the model zones along with the internal model area trips.

10.3.1 Through Trips

The largest numbers of through trips pass through the county on SR 99. Daily 2005 vehicle through trips were estimated for Stanislaus County based on actual counts at the gateways and the proportion of trips considered to be through trips in the Caltrans Statewide Model. Future through trips were factored from the 2025 scenario of the Statewide Model. Peak hour through trips were factored based on peaking factors and directional factors on freeway gateways and adjusted during calibration.

10.3.2 External Trips

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

10.4 Special Generators

Special generators are used to include trips from land uses that are not well represented by the standard trip rates. In the TPPG model, special generators are used primarily to define Home-Other trips attracted to recreational areas such as parks and golf courses. Typical vehicle trip generation values were estimated for each of these recreational areas based on previous studies. The vehicle trips are converted to person trips using average auto occupancy rates. The special generator trips are then added to the appropriate TAZs after trips are calculated using the standard household and employment trip generation rates. (shows the special generators used in the model.)

11. THE FORECASTING PROCESS - TRIP DISTRIBUTION

The trip distribution process estimates how many trips travel from one zone to another. Consistent with many regional models across the country, the TPPG 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.

11.1 Description of Gravity Model

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

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

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

P_i = total number of trips produced in zone i

A_j = attractions of zone j

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

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

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

n = number of zones

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

11.2 Zone-To-Zone Travel Times

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

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

11.2.1 Intrazonal Travel Times

Intrazonal travel times represent the average travel time for trips that stay within a particular zone. They are estimated based on 50 percent of the travel time to the nearest adjacent zone.

11.2.2 Terminal Times

Terminal times are also added to represent the average time to access one's vehicle at each end of a trip. The TPPG model assumes an average terminal time of one minute for most trips.

11.3 Friction Factors

The effects of spatial separation in the gravity model are represented empirically by "friction factors" that express the effect that travel time exerts on the propensity for making a trip to a given zone. Typically the probability for making a particular trip declines as the travel time increases. For the TPPG model, five sets of friction factors are used, with each set corresponding to one of the five 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.

11.4 Adjustment Factors

Adjustment Factors ("K factors") can be 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.

K-Factors are not used by default in the TPPG model. The inclusion of K-factors may be suitable for specific model applications but this should only be undertaken by advanced users.

12. THE FORECASTING PROCESS - TRIP ASSIGNMENT

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

12.1 Traffic Assignment

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

12.1.1 Traffic Assignment Time Periods

The TPPG model assigns traffic for daily traffic and for the AM and PM peak hours. Peak hour traffic is derived from daily traffic and assigned after feedback (see sections 7 and 8).

12.1.2 Congested Travel Speeds

The relationship of speed to congestion on a particular roadway is based on a set of curves which are included in the traffic assignment model. The curves are based on the standard British Public Roads Curve:

$$T = T(\text{free Flow}) * (1 + 0.15(VC/0.75)^4) \qquad \textit{BPR Speed Curve}$$

For example, the curves may indicate that an arterial street with no congestion will operate at 35 miles per hour so that a segment of that street takes 60 seconds to traverse, while an arterial link with a traffic volume equal to 90 percent of the capacity of the link will operate at about 27 miles per hour and take 80 seconds to traverse.

Adjustment to this basic curve are made during validation and calibration. Adjusted curves are employed for:

Rural Highways /Unsig. Arterials	= T0*(1 +0.15*(VC/0.75)^4)+ (0.15*(VC/0.95)^12)
Collectors	= T0*(1 + 0.15*(VC/0.9)^6)
Rural Collector	= T0*(1 + 0.25*(VC/0.6)^4)
Unsignalized Collector	=T0*(1 + 0.1*(VC / 0.85)^4)
Centroid Connector	=min((T0*30.0),(T0*(1 + 0.15* (VC / 0.25)^4)))
Class B Expressway	=T0*(1 +0.15*(VC/0.75)^4+ 0.05*(VC/0.98)^6)
Class C Expressway	=T0*(1 +0.15*(VC/0.75)^4+ 0.05*(VC/0.98)^6)

Identical speed curves are used by the model for the daily and peak hour assignment processes.

12.2 Pricing

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

13. THE FORECASTING PROCESS - FEEDBACK MECHANISMS

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

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

13.1 TPPG Model Feedback Loop

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

13.1.1 Congested Travel Times

The initial trip distributions for all six 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 daily traffic assignment are used as input to the trip distribution and the distribution is rerun. The feedback loop convergence criteria are based on convergence of the congested travel times.

13.1.2 Method of Successive Averages

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

13.1.3 Convergence Criteria

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

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

The TPPG model feedback loop is considered to converge when:

1. Less than 5% of the origin-destination pairs have daily congested travel times that change by more than 5% between iterations; and

2. The weighted average change in daily 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 seven feedback iterations:

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

14. THE FORECASTING PROCESS - PEAKING FACTORS

The TPPG peak period model has been set up to estimate travel demand during the AM and PM peak hour. Peak hour volumes are often required for capacity analysis and local traffic studies.

14.1 Time-of-Day Factors

The AM peak hour period trips, the PM peak hour period trips and the off-peak 18-hour period trips are calculated by factoring the daily trips after trip distribution. The daily trips are factored separately for each trip purpose as shown below in .

The time-of-day factors are based on information from the 2001 Caltrans travel survey (Appendix C). Many travel models use time-of-day factors which are based on the start times of each trip. The TPPG model uses factors which are based on the "midpoint" of each trip, looking at both the start and end times. This technique provides a more representative estimate of the number of trips in progress during each time period. During model validation, the factors were adjusted from the survey results.

These peak hour factors should be reviewed and updated when new peak hour traffic count and survey information is available.

Table 14 Time of Day Factors

Trip Purpose	Percent of Daily Trips		
	Productions to Attractions	Attractions to Productions	Total
AM PEAK			
Home-Work	10.26	0.532	10.79
Home-School	21.7	0.07	21.77
Home-Shop	0.72	0.12	0.84
Home-Other	5.52	1.38	6.90
Work-Other	1.25	9.125	10.38
Other-Other	2.88	1.62	4.50
PM PEAK			
Home-Work	0.94	13.22	14.16
Home-School	0.11	2.69	2.80
Home-Shop	2.74	6.76	9.51
Home-Other	3.02	4.82	7.84
Work-Other	11.50	0.63	12.13
Other-Other	4.12	1.76	5.88

APPENDIX A – VALIDATION

Model Validation

Model validation refers to comparing the model volumes to observed volumes. The following sections describe how traffic data was collected and organized by screenlines, the validation criteria to be met according to the scope of work, and finally the validation results.

Traffic Data

Traffic data for the year 2000 validation were obtained from a variety of sources, including traffic counts provided by the StanCOG, Stanislaus County, and the Cities of Ceres, Hughson, Modesto, Newman, Oakdale, Patterson, Riverbank, Turlock, and Waterford. Special acknowledgement is also due to a number of private consultants including KdAnderson and Associates, Omni Means Associates, Fehr and Peers and Associates, and TJKM and Associates for providing data in electronic format. Data was also obtained from sources published or maintained by the California Department of Transportation (Caltrans).

Daily counts and peak hour counts were input directly into a database. Over 2,200 peak hour 580 daily traffic counts were entered. Duplicate counts were eliminated by replacing older counts with newer counts and estimates of daily traffic were developed based on peak hour traffic and the peaking factors obtained from the statewide travel survey. This resulted in 1,305 unique counts/count estimates for each of the AM, PM and daily traffic periods. The counts utilized were included to allow the comparison of model output and observed traffic volumes based on screenlines.

Proposed Validation Criteria

It is proposed that the TPPG consolidated transportation model traffic validation be based on several criteria, including the following:

- Comparison to Vehicle Miles of Travel (VMT) from the Caltrans Highway Performance Monitoring System (HPMS)
- Comparison of model counts to observed traffic counts.
- The percentage of links falling within the FHWA validation curve. The FHWA suggested link-specific validation criteria is that 75% of freeway and principal arterials fall below the validation criteria and 100% of screenlines fall below the validation curve shown in Figure 1.
- Use the Federal Highway Administration and Caltrans recommended error limits for total error by functional classification (type of road) as a regionwide validation :

- Freeways less than 7 percent error
- Principal Arterials less than 10 percent error
- Minor Arterials less than 15 percent error
- Collectors less than 25 percent error

HPMS Traffic Validation Results

Vehicle Miles of Travel

Vehicle Miles of Travel (VMT) is calculated as the number of vehicles on a road segment multiplied by the length of the segment, summed over all road segments in a certain geographic area. The Caltrans Highway Performance Monitoring System (HPMS) estimates daily vehicle miles of travel for each county in California based on a sample of traffic counts on various road types (2005 California Public Road Data, Caltrsns, 2006). A comparison of model-estimated VMT with VMT from the HPMS can indicate if the model is generating the correct magnitude of travel, even if there are inaccuracies in the specific road segment traffic volumes.

Vehicle miles of travel are calculated from the TPPG travel demand model by multiplying link volumes by link distances and comparing with the HPMS estimates. The FHWA model validation criterion is that the VMT calculated from the model should be within 5% of the HPMS estimate. The VMT from the final validation including intrazonal VMT is just under one percent lower than the VMT from HPMS. This indicates that the model is generating an appropriate amount of traffic within Stanislaus County.

Table B1. Daily Validation by VMT

2005 HPMS	2005 Model	Percent	FHWA Standard	Meets Criteria
11,301,000	11,448,572	-1.3%	+/-5.00%	YES

FHWA Criteria

Total Volumes

The traffic counts and the model volumes are compared by facility type and by the volume range in which they are classified (Table A-1). The comparison is made in terms of total model volume compared to total traffic counts. A measure of variation is also provided, the root mean square error (RMSE).

Table A1: Daily Count/ Model Volume Comparison by Facility Type

Facility Type	CapClass	Criteria	Observed Counts	Model Volumes	No. of Links	Diff.	Delta2	Pct. Diff.	MSE	%RMSE	Meets Criteria
Freeways	1	+/- 7%	884,000	901,036	18	17,036	470,821,408	1.9%	26,156,745	10%	YES
Principal Arteria	2	+/- 10%	1,241,862	1,357,250	168	115,388	851,505,534	9.3%	5,068,485	30%	YES
Arterials	3	+/- 15%	3,721,154	4,047,345	419	326,191	3,872,614,449	8.8%	9,242,517	34%	YES
Collectors	4	+/- 25%	1,349,257	1,369,502	567	20,245	912,461,190	1.5%	1,609,279	53%	YES
All			**7,196,273**	**7,675,133**	**1,172**	**478,860**	**6,107,402,581**	**6.7%**	**5,215,544**	**37%**	

Table B2: AM 1-Hour Count/ Model Volume Comparison by Facility Type

Facility Type	CapClass	Criteria	Observed Counts	Model Volumes	No. of Links	Diff.	Delta2	Pct. Diff.	MSE	%RMSE	Meets Criteria
Freeways	1	+/- 7%	66,088	61,726	18	(4,362)	15,772,052	-6.6%	876,225	25%	YES
Principal Arteria	2	+/- 10%	102,646	111,831	168	9,185	10,483,553	8.9%	62,402	41%	YES
Arterials	3	+/- 15%	306,096	315,450	419	9,354	35,866,564	3.1%	85,600	40%	YES
Collectors	4	+/- 25%	118,999	101,323	567	(17,676)	12,437,272	-14.9%	21,935	71%	YES
All			**593,829**	**590,330**	**1,172**	**(3,499)**	**74,559,441**	**-0.6%**	**63,672**	**50%**	

Table B3: PM 1-Hour Count/ Model Volume Comparison by Facility Type

Facility Type	CapClass	Criteria	Observed Counts	Model Volumes	No. of Links	Diff.	Delta2	Pct. Diff.	MSE	%RMSE	Meets Criteria
Freeways	1	+/- 7%	75,030	70,909	18	(4,121)	12,315,479	-5.5%	684,193	20%	YES
Principal Arteria	2	+/- 10%	117,189	127,812	168	10,623	34,602,027	9.1%	205,964	65%	YES
Arterials	3	+/- 15%	347,885	371,500	419	23,615	42,049,445	6.8%	100,357	38%	YES
Collectors	4	+/- 25%	127,074	121,512	567	(5,562)	9,513,712	-4.4%	16,779	58%	YES
All			**667,178**	**691,733**	**1,172**	**24,555**	**98,480,663**	**3.7%**	**84,100**	**51%**	

Table B4: Daily Count/ Model Volume Comparison by Volume Range

Volume Range											
From	To	Criteria	Observed Counts	Model Volumes	No. of Links	Diff.	Delta2	Pct. Diff.	MSE	%RMSE	Criteria
1	5,000	+/- 60%	2,552,764	2,883,783	1,215	331,019	2,616,694,469	13.0%	2,153,658	70%	YES
5,000	10,000	+/- 55%	2,456,219	2,526,572	341	70,353	1,990,374,973	2.9%	5,836,877	34%	YES
10,000	20,000	+/- 45%	2,660,368	2,700,118	202	39,750	1,921,993,818	1.5%	9,514,821	23%	YES
20,000	30,000	+/- 40%	372,383	342,235	17	(30,148)	222,351,540	-8.1%	13,079,502	17%	YES
30,000	40,000	+/- 37%	65,612	49,324	2	(16,288)	144,960,194	-24.8%	72,480,097	26%	YES
40,000	50,000	+/- 34%	100,000	105,241	2	5,241	14,282,145	5.2%	7,141,073	5%	YES
50,000	75,000	+/- 28%	807,000	830,600	14	23,600	457,972,890	2.9%	32,712,349	10%	YES
Sum			**9,014,346**	**9,437,873**	**1,793**	**423,527**	**7,368,630,029**	**4.7%**	**4,111,959**	**40%**	

Facility Type. The Federal Highway Administration[2] and Caltrans[3] recommend error limits for total error by functional classification (type of road):

- Freeways — less than 7 percent error
- Principal Arterials — less than 10 percent error
- Minor Arterials — less than 15 percent error
- Collectors — less than 25 percent error
- Frontage Roads — less than 25 percent error

For the TPPG consolidated transportation model, the "Principal Arterial" criterion is applied to expressways and inter-urban highways, while the "Minor Arterial" criterion is applied to all local arterial streets.

The 2005 traffic validation of the TPPG model meets the criteria for all facility types, for Daily, AM and PM peak hour volumes. Key steps in achieving validation included:

- The development of new capacity class: rural collector with a capacity of 950 vehicles per hour per lane (vphpl) for one directional lane and 850 vphpl for 2 or more lanes,
- The modification of speed curves based on multiple validation runs,
- The adjustment of trip generation rates and review of land use inputs
- Peak hour validation was further facilitated through the adjustment of peaking factors across trip purposes.

Volume Range. Table B-1 lists the volume ranges which are recommended for the comparison of daily traffic counts to model volumes by volume range. The final model validation meets the FHWA criteria for all ten of the volume ranges. For those volume ranges, the total model volume is within 1 percent of observed volumes

Root Mean Square Error. The root mean square error (RMSE) is a statistical estimator that is intended to represent the average percent error between an estimated value (such as a model volume) and an observed value (such as a traffic count). The RMSE is calculated as:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(C_i - V_i)^2}{n}}$$, where

- n is the total number of links
- C_i is the observed count for road i

[2] Federal Highway Administration, *Calibration and Adjustment of System Planning Models*, 1990

[3] California Department of Transportation, *Travel Forecasting Guidelines*, 1992

- V_i is the model volume for road i
- i represents a road link

The 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 comparison of total model volumes and traffic counts. The overall target daily RMSE is 40 percent, which is met generally ranges. Generally on low volume roads RMSE will be relatively high as small differences in absolute volume represent large increases in RMSE on low volume roads. Similarly, peak hour RMSE is typically higher that daily RMSE.

Screenlines

Screenlines are imaginary lines, often along natural or man-made physical barriers (e.g., rivers, railroad tracks) that ideally have a limited number of crossings. To the extent possible screenlines should "cut" the entire study area, intercepting all travel across them, thereby eliminating issues about individual route choice. Use of a system of screenlines allows systematic comparison of total model estimated versus observed travel in different parts of the model area. However, they do not ensure that traffic is being assigned to the correct routes across each screenline. The study area includes 20 screenlines (See Figure A1.)

Screenline Validation

A comparison of model volumes to 2005 traffic counts across screenlines for the daily period is presented based for 20 screenlines. The locations of these screenlines are shown on Figure B1. The 20 screenlines are presented in Table B3. Under both the two way and one way comparisons all of the are satisfactory. Screenlines are broken down by direction of travel. Northbound and Eastbound travel across screenlines are shown together on Figure B2. Southbound and Westbound are shown on Figure B3. Figure B4 shows the maximum tolerances under the FHWA criteria

Table 1. Screenline Comparisons

Screenline	Dir.	Model Volume	2005 Count	Percent Deviation	Meets Criteria	Dir.	Model Volume	2005 Count	Percent Deviation	Meets Criteria
1. North of Stadiford Road	N	96,746	75,613	27.9%	YES	S	97,833	82,009	19.3%	YES
2. South of Kiernan Avenue	N	100,656	109,233	7.9%	YES	S	101,868	108,934	6.5%	YES
3. West of Dale Road	E	43,023	47,348	9.1%	YES	W	38,145	40,413	5.6%	YES
4. East of McHenry Avenue	E	81,558	77,723	4.9%	YES	W	83,216	79,385	4.8%	YES
5. East of Claus Road	E	19,374	17,973	7.8%	YES	W	28,375	26,827	5.8%	YES
6. Tuolumne River	E	55,109	57,282	3.8%	YES	W	55,310	58,808	5.9%	YES
7. East of Sisk Road	E	76,328	80,259	4.9%	YES	S	65,787	73,221	10.2%	NO
8. East of Oakdale Road	E	65,997	65,638	0.5%	YES	W	64,925	67,378	3.6%	YES
9. South of Pelandale Avenue	N	111,979	113,413	1.3%	YES	S	111,765	112,103	0.3%	YES
10. East of Albers Road/Geer Road	E	33,072	43,811	24.5%	YES	W	32,921	43,092	23.6%	YES
11. Toulumne Road	N	30,573	33,845	9.7%	YES	S	33,458	33,470	0.0%	YES
12. North of Briggsmore Avenue	N	47,281	44,535	6.2%	YES	S	46,949	45,362	3.5%	YES
13. West of Carpenter Road	E	25,111	27,600	9.0%	YES	W	23,731	22,452	5.7%	YES
14. South of Murphy Road	N	2,850	4,047	29.6%	YES	S	2,149	4,188	48.7%	YES
15. South of Sperry Road/Las Palmas Avenue	N	18,935	20,196	6.2%	YES	S	25,373	25,091	1.1%	YES
16. West of Coffee Road	E	88,078	85,706	2.8%	YES	W	88,789	83,538	6.3%	YES
17. South of Service Road	N	87,057	82,216	5.9%	YES	S	85,623	82,904	3.3%	YES
18. South of West Main Street	N	8,780	6,846	28.3%	YES	S	8,781	6,837	28.4%	YES
19. San Joaquin River	E	28,697	22,052	30.1%	YES	W	28,717	22,200	29.4%	YES
20. West of Faith Home	E	9,896	8,620	14.8%	YES	S	9,831	8,438	16.5%	YES

Figure 1. 2005 Screenline Locations

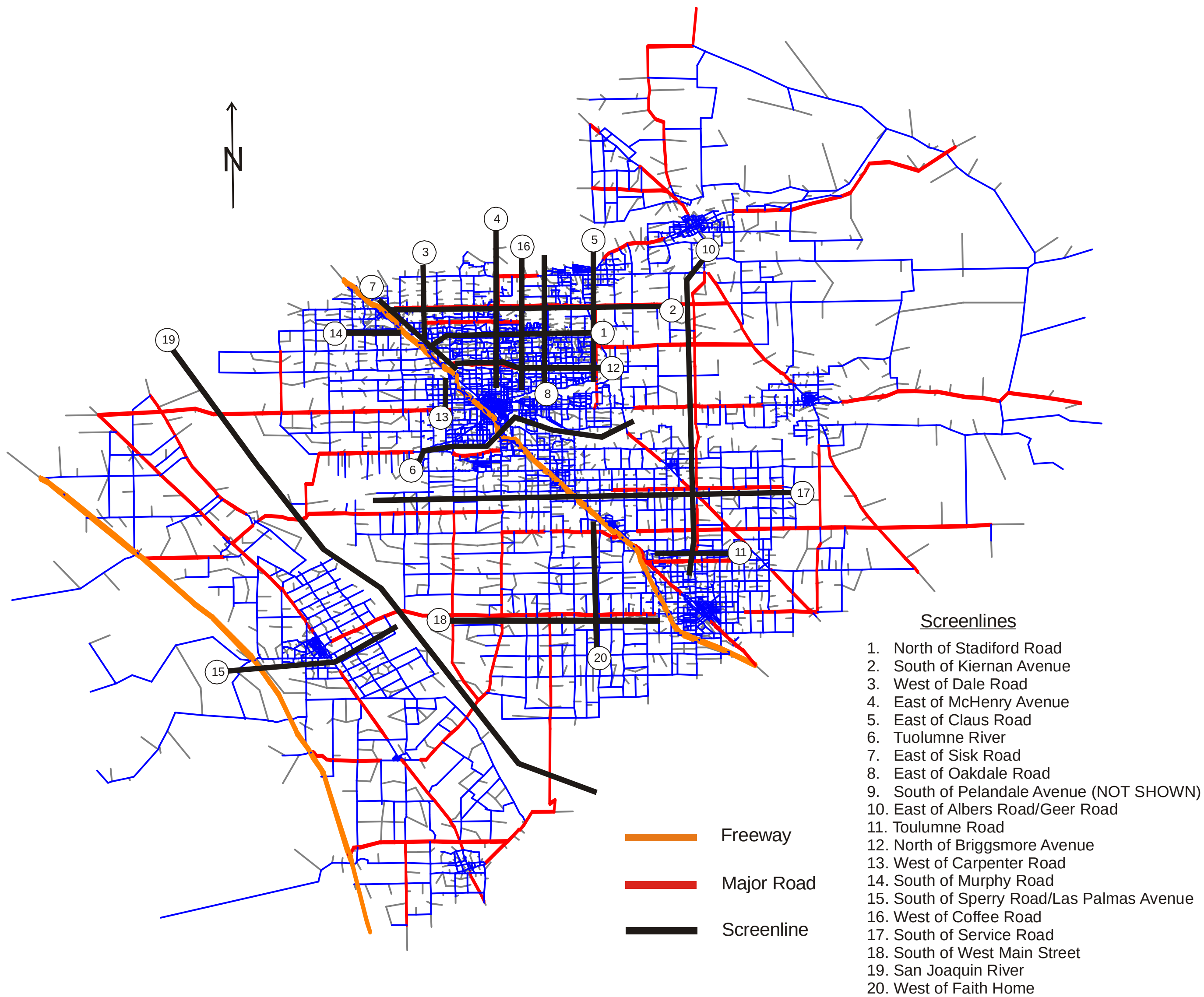


Figure B2**. Northbound/Eastbound One-Way Screenline Deviation versus Validation Criteria**

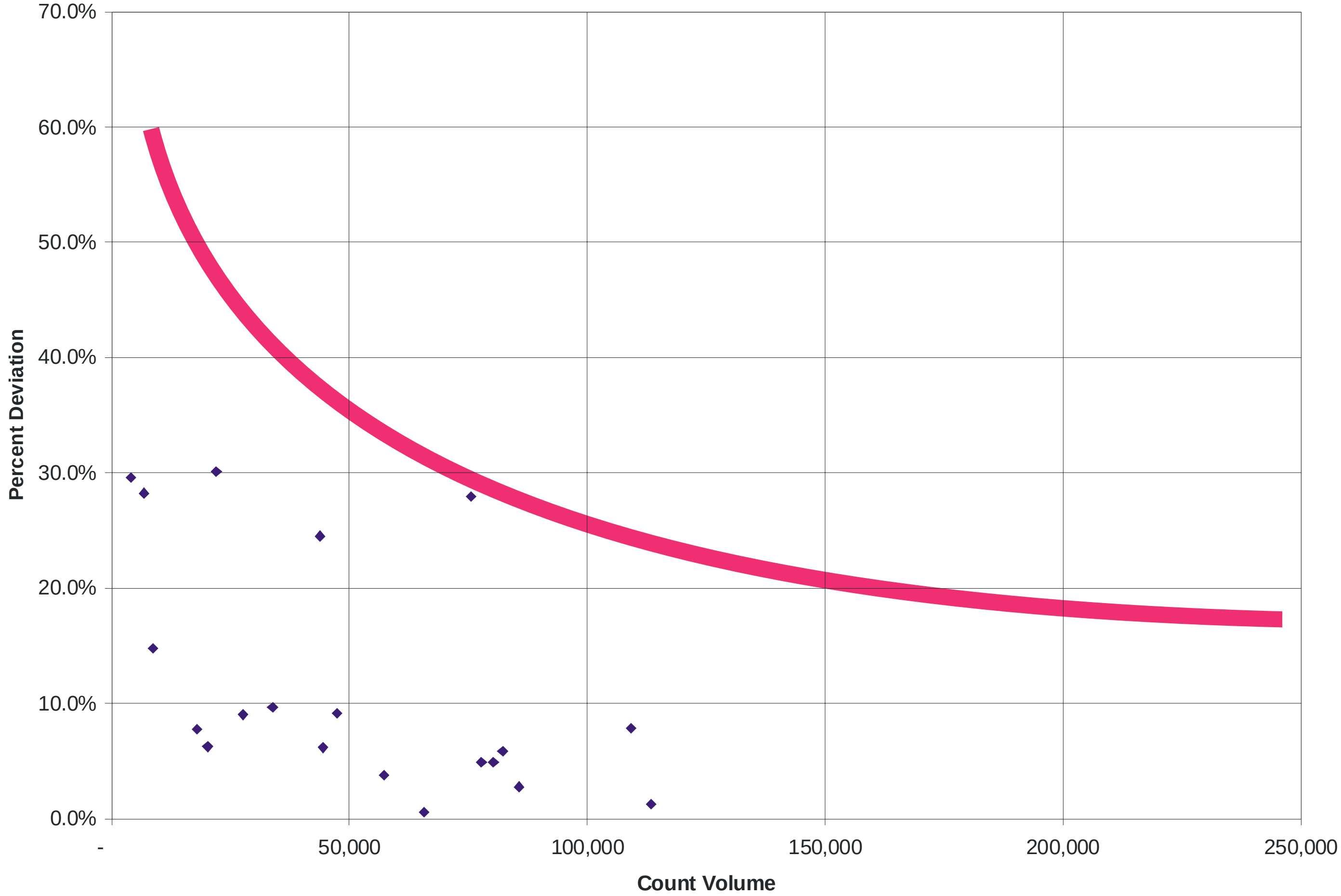


Figure B3**. Westbound/Southbound One-Way Screenline Deviation versus Validation Criteria**

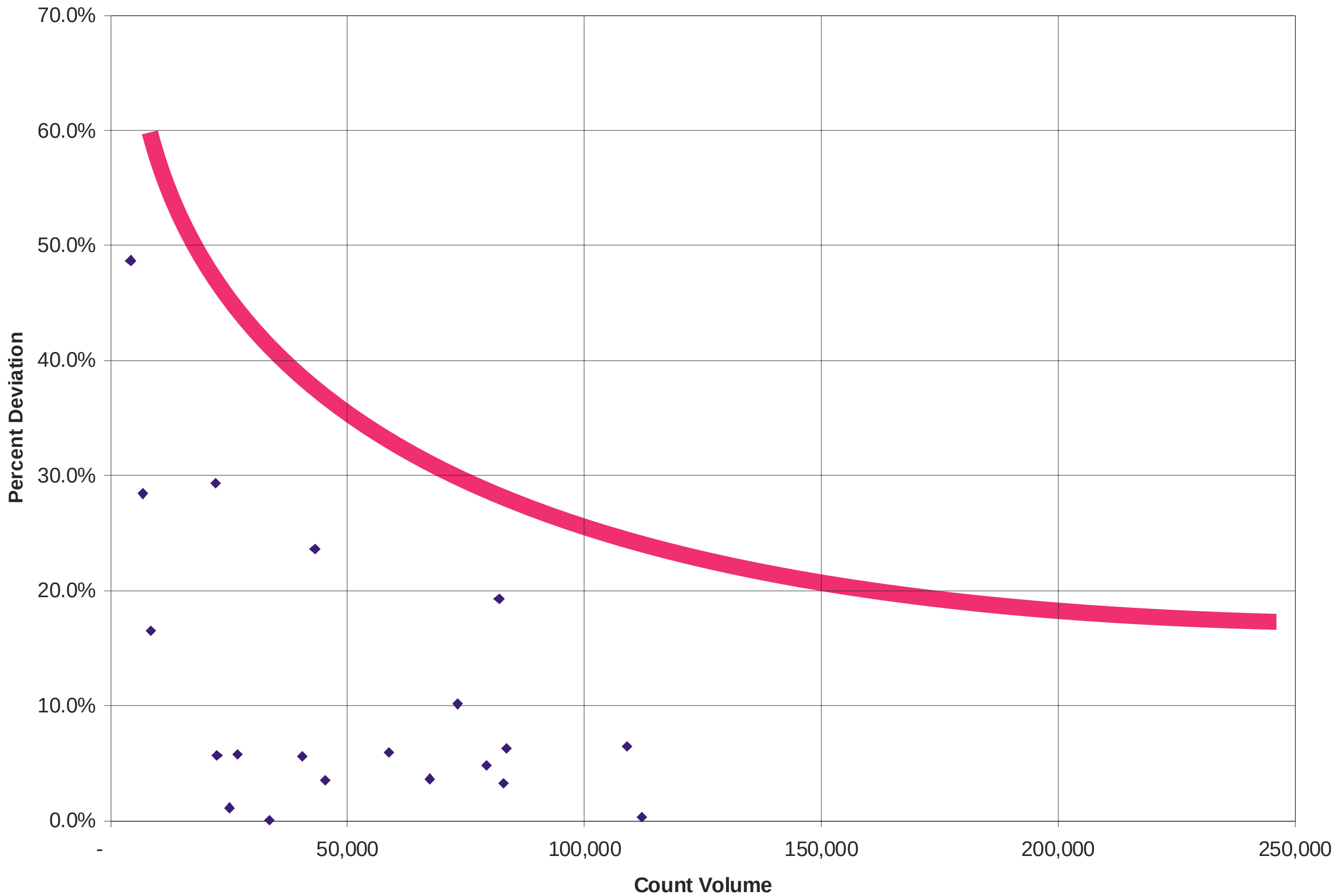
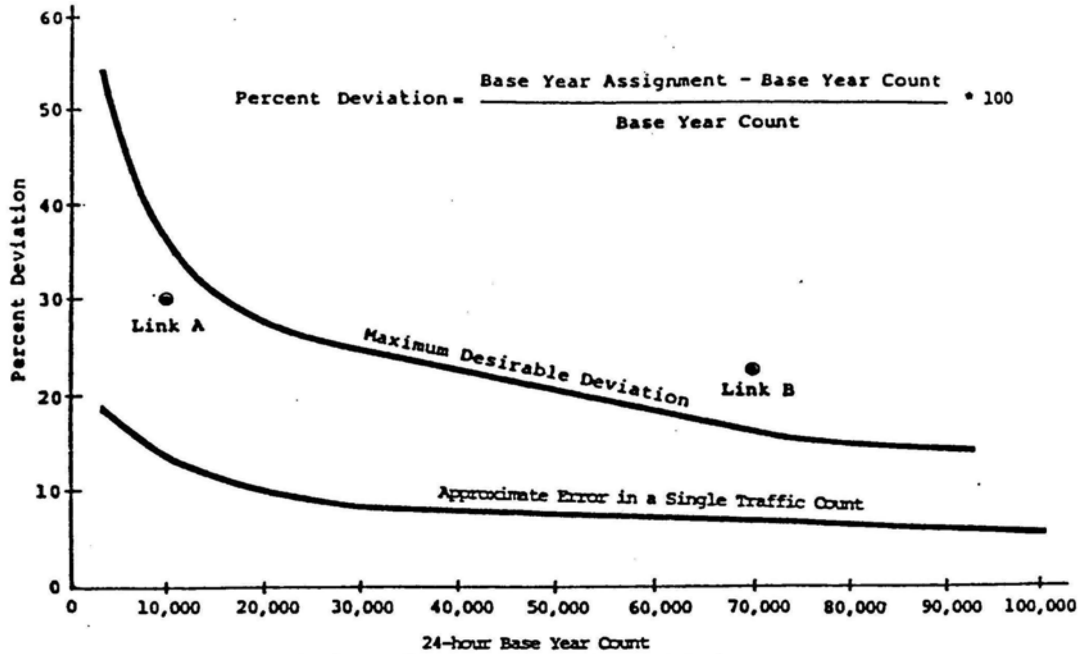
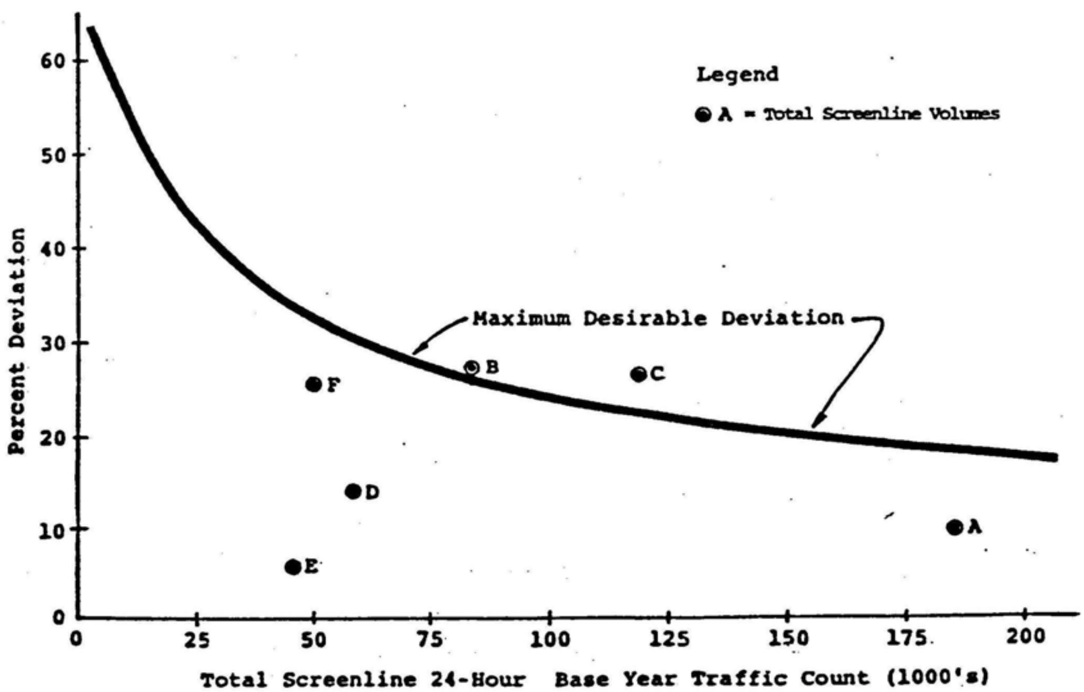


Figure B4 Maximum Desirable Error for Links and Screenlines



Maximum Desirable Error for Link Volumes



Maximum Desirable Deviation in Total Screenline Volumes

Appendix B

External and Through Trips

			2005	2005	2005	2005	Annual	2005	Estimated Trip Purpose Percentages							
Zone	Gateway	Count Location	Volume	Volume	% Thru	Thru	Growth	I-X / X-I	H-W	H-SCH	H-S	H-O	W-O	O-O	CV	Total
1	I-5	San Joaquin County Line	39,000	39,000	86%	33,540	-0.5%	5,460	43%	1%	11%	21%	10%	14%	0%	100%
2	Blewett Road	San Joaquin County Line	592	592	0%	0	3.1%	592	43%	1%	11%	21%	10%	14%	0%	100%
3	S.R. 132	San Joaquin County Line	19,800	19,800	6%	1,188	2.6%	18,612	43%	1%	11%	21%	10%	14%	0%	100%
4	Koster Road	San Joaquin County Line	3,551	3,551	0%	0	3.1%	3,551	43%	1%	11%	21%	10%	14%	0%	100%
5	S.R. 33	San Joaquin County Line	1,700	1,700	0%	0	19.5%	1,700	43%	1%	11%	21%	10%	14%	0%	100%
6	River/McCracken Road	San Joaquin County Line	2,249	2,249	0%	0	3.1%	2,249	43%	1%	11%	21%	10%	14%	0%	100%
7	S.R. 99	I-99 N	116,000	116,000	36%	41,180	1.4%	74,820	34%	1%	25%	15%	11%	14%	0%	100%
8	McHenry Avenue	San Joaquin County Line	13,513	13,513	18%	2,432	2.8%	11,080	43%	1%	11%	21%	10%	14%	0%	100%
9	Santa Fe Avenue	San Joaquin County Line	9,072	9,072	0%	0	2.4%	9,072	43%	1%	11%	21%	10%	14%	0%	100%
10	River Road	San Joaquin County Line	2,726	2,726	32%	872	2.4%	1,854	43%	1%	11%	21%	10%	14%	0%	100%
11	Valley Home Road	San Joaquin County Line	1,496	1,496	32%	479	2.4%	1,017	43%	1%	11%	21%	10%	14%	0%	100%
12	Dodds Road	San Joaquin County Line	663	663	32%	212	2.4%	451	43%	1%	11%	21%	10%	14%	0%	100%
13	S.R. 108/120	Tuolumne County Line	22,700	22,700	79%	17,933	0.5%	4,767	26%	1%	14%	28%	14%	18%	0%	100%
14	Rock River Road	Tuolumne County Line	474	474	0%	0	3.1%	474	26%	1%	14%	28%	14%	18%	0%	100%
15	La Grange Road N	Tuolumne County Line	89	89	0%	0	48.8%	89	26%	1%	14%	28%	14%	18%	0%	100%
16	S.R. 132	Mariposa County Line	2,050	2,050	41%	841	3.4%	1,210	41%	1%	11%	22%	11%	14%	0%	100%
17	Fields Road	Tuolumne County Line	3,906	3,906	0%	0	3.1%	3,906	26%	1%	14%	28%	14%	18%	0%	100%
18	La Grange Road S	Merced County Line	1,370	1,370	0%	0	-1.5%	1,370	35%	1%	13%	24%	12%	16%	0%	100%
19	Los Cerritos	Merced County Line	1,776	1,776	0%	0	3.1%	1,776	35%	1%	13%	24%	12%	16%	0%	100%
20	Keyes Road	Merced County Line	518	518	0%	0	32.0%	518	35%	1%	13%	24%	12%	16%	0%	100%
21	Looney/Bledsoe	Merced County Line	1,184	1,184	0%	0	3.1%	1,184	35%	1%	13%	24%	12%	16%	0%	100%
22	East Avenue	Merced County Line	1,631	1,631	0%	0	3.0%	1,631	35%	1%	13%	24%	12%	16%	0%	100%
23	Oakdale Road	Merced County Line	1,184	1,184	0%	0	3.1%	1,184	35%	1%	13%	24%	12%	16%	0%	100%
24	Santa Fe Drive	Merced County Line	4,364	4,364	2%	87	17.8%	4,277	35%	1%	13%	24%	12%	16%	0%	100%
25	S.R. 99	I-99 S	75,000	75,000	56%	42,000	-0.5%	33,000	34%	1%	13%	25%	12%	16%	0%	100%
26	S.R. 165	Merced County Line	19,900	19,900	32%	6,368	2.3%	13,532	35%	1%	13%	24%	12%	16%	0%	100%
27	River Road	Merced County Line	3,000	3,000	32%	960	9.0%	2,040	35%	1%	13%	24%	12%	16%	0%	100%
28	August/American/Mitchell/Fa	Merced County Line	3,000	3,000	32%	960	9.0%	2,040	35%	1%	13%	24%	12%	16%	0%	100%
29	Canal/Brazo Road	Merced County Line	5,500	5,500	50%	2,750	9.0%	2,750	35%	1%	13%	24%	12%	16%	0%	100%
30	S.R. 33	Merced County Line	7,300	7,300	51%	3,723	4.4%	3,577	35%	1%	13%	24%	12%	16%	0%	100%
31	Upper Road	Merced County Line	1,315	1,315	0%	0	3.0%	1,315	35%	1%	13%	24%	12%	16%	0%	100%
32	Draper Road	Merced County Line	302	302	0%	0	3.0%	302	35%	1%	13%	24%	12%	16%	0%	100%
33	Eastin Road	Merced County Line	338	338	0%	0	12.1%	338	35%	1%	13%	24%	12%	16%	0%	100%
34	I-5	Merced County Line	38,500	38,500	81%	31,185	-0.1%	7,315	35%	1%	13%	24%	12%	16%	0%	100%
35	Del Puerto Canyon Road	West of I-5	144	144	0%	0	1.7%	144	26%	1%	14%	28%	14%	18%	0%	100%
36	FUTURE GATEWAY		0	0	0%	0	0.0%	0	36%	1%	12%	24%	12%	15%	0%	100%
37	FUTURE GATEWAY		0	0	0%	0	0.0%	0	36%	1%	12%	24%	12%	15%	0%	100%
38	FUTURE GATEWAY		0	0	0%	0	0.0%	0	36%	1%	12%	24%	12%	15%	0%	100%
39	FUTURE GATEWAY		0	0	0%	0	0.0%	0	36%	1%	12%	24%	12%	15%	0%	100%
40	S.R. 120	San Joaquin County Line	14,800	14,800	32%	4,736	3.8%	10,064	43%	1%	11%	21%	10%	14%	0%	100%
41	Route 4	San Joaquin County Line	4,800	4,800	93%	4,464	2.7%	336	43%	1%	11%	21%	10%	14%	0%	100%
42	Route 4	Calaveras County Line	5,400	5,400	92%	4,968	2.6%	432	34%	1%	13%	25%	12%	16%	0%	100%
43	Milton Road	Calaveras County Line	1,322	1,322	0%	0	4.4%	1,322	34%	1%	13%	25%	12%	16%	0%	100%
44	Harder Road	Merced County Line	343	343	0%	0	3.0%	343	35%	1%	13%	24%	12%	16%	0%	100%
45	Golf Road	Merced County Line	3,019	3,019	0%	0	3.0%	3,019	35%	1%	13%	24%	12%	16%	0%	100%
46	Lone Tree	San Joaquin County Line	2,553	2,553	32%	817	3.3%	1,736	43%	1%	11%	21%	10%	14%	0%	100%
47	Washington/Tenger/Elaine/H	Merced County Line	1,700	1,700	0%	0	3.0%	1,700	35%	1%	13%	24%	12%	16%	0%	100%
48	Clausen/W Bradbury	Merced County Line	2,476	2,476	0%	0	3.0%	2,476	35%	1%	13%	24%	12%	16%	0%	100%
49	Linwood/Roselawn/Vincent	Merced County Line	1,200	1,200	0%	0	3.0%	1,200	35%	1%	13%	24%	12%	16%	0%	100%
50	FUTURE GATEWAY		0	0	0%	0	0.0%	0	36%	1%	12%	24%	12%	15%	0%	100%
			443,518	443,518		201,695	5.0%	241,823								

Table A-1
Roadway Segments with 2005 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

	Roadway Segment	From	To	LOS
1	7th Street	Tuolumne Boulevard	Crows Landing Road	F
2	9th Street	Woodland Avenue	Needham Avenue	E
3	9th Street	Morton Boulevard	River Road	F
4	Bangs Avenue	Dale Road	McHenry Avenue	E/F
5	Bodem Street	Morris Avenue	Scenic Drive	F
6	Briggsmore Avenue	SR 99	Carver Road	F
7	Briggsmore Avenue	Coffee Road	Rose Avenue	E
8	Briggsmore Avenue	Oakdale Road	Lakewood Avenue	F
9	Broadway Avenue	SR 99	Finney Road	E/F
10	Carpenter Road	SR 99	Blue Gum Avenue	F
11	Carpenter Road	Maze Boulevard	Beverly Drive	E/F
12	Carpenter Road	Paradise Road	Whitmore Avenue	F
13	Carver Road	Rumble Road	Briggsmore Avenue	E/F
14	Carver Road	Orangeburg Avenue	9th Street	E/F
15	Celeste Drive	Vera Cruz Drive	Rose Avenue	F
16	Claribel Road	McHenry Avenue	Coffee Road	E
17	Coffee Road	Celeste Drive	Brighton Avenue	E/F
18	Coldwell Avenue	9th Street	Kearney Avenue	F
19	Conant Avenue	Standiford Avenue	Rumble Road	F
20	Crows Landing Road	7th Street	Butte Avenue	E/F
21	Dale Road	Venemen Avenue	Standiford Avenue	F
22	El Vista Avenue	Scenic Drive	Edgebrook Drive	F
23	Finch Road	Mitchell Road	McClure Road	E/F
24	Floyd Avenue	Oakdale Road	Lincoln Oak Drive	
25	Kansas Avenue	Carpenter Road	SR 99	F
26	Kiernan Avenue	SR 99	Stoddard Road	E/F
27	La Loma Avenue	Morton Boulevard	Buena Vista Drive	E
28	Maze Boulevard	Martin Luther King Drive	Washington Street	E/F
29	McHenry Avenue	Bangs Avenue	Claratina Avenue	F
30	McHenry Avenue	Briggsmore Avenue	Needham Avenue	E/F
31	Merle Avenue	Oakdale Road	Walnut Tree Drive	F
32	Mitchell Road	Finch Road	Hatch Road	F
33	Morris Avenue	Bodem Street	Coffee Road	E/F
34	Norwegian Avenue	McHenry Avenue	Coffee Road	E
35	Oakdale Road	Mable Avenue	Syvlan Avenue	E/F
36	Oakdale Road	Lancey Drive	Surrey Avenue	E/F
37	Orangeburg Avenue	Lakewood Drive	Lillian Drive	E
38	Orangeburg Avenue	Coffee Road	Sonoma Avenue	F
39	Paradise Road	Pine Tree Lane	Martin Luther King Drive	F
40	Pelandale Avenue	Chapman Road	Dale Road	E
41	Pelandale Avenue	Prescott Road	Carver Road	F
42	Pelandale Avenue / Claratina Avenue	Tully Road	Dragoo Park Drive	E
43	Prescott Road	Plaza Parkway	Briggsmore Avenue	F
44	Roselle Avenue	Floyd Avenue	Millbrooke Avenue	E
45	Rumble Road	Conant Avenue	Prescott Road	E
46	Rumble Road	Napier Drive	Sherwood Avenue	E
47	Scenic Drive	Downey Avenue	Oakdale Road	E/F
48	Scenic Drive	Sonoma Avenue	Lillian Drive	E/F
49	Sisk Road	Conant Avenue	Briggsmore Avenue	E
50	Sisk Road	Pirrone Road	Kiernan Avenue	F
51	Standiford Avenue	Sisk Road	Conant Avenue	E/F
52	Standiford Avenue	Longbridge Drive	Colonial Drive	E
53	Standiford Avenue	Sherwood Avenue	McHenry Avenue	E

Table A-1
Roadway Segments with 2005 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

	Roadway Segment	From	To	LOS
54	Sunrise Avenue	Briggsmore Avenue	Granger Avenue	F
55	Sylvan Avenue	Bridgeford Lane	Claremont Avenue	E
56	Sylvan Avenue	Coffee Road	Palmwood Drive	E
57	Tully Road	Claratina Avenue	Snyder Avenue	E
58	Vintage Drive	Sisk Road	Gagos Drive	F
59	Whitmore Avenue	Crows Landing Road	Morgan Road	F
60	Woodland Avenue	Carpenter Road	9th Street	E/F
61	Yosemite Boulevard	Morton Boulevard	Santa Cruz Avenue	E/F
62	Yosemite Boulevard	Capistrano Drive	Mariposa Road	E/F
63	Yosemite Boulevard	Norseman Drive	Root Road	F
64	SR 99 Southbound	Hammett Road	Broadway Avenue	E
65	SR 99 Southbound	Beckwith Road	Carpenter Road	F
66	SR 99 Southbound	Kansas Avenue	H Street	E
67	SR 99 Southbound	H Street	Crows Landing Road	F
68	SR 99 Southbound	Crows Landing Road	9th Street	E

Source: Transportation Planning Partnership Group (TPPG) Countywide Travel Demand Model, 2007.

Table A-2
Roadway Segments with 2025 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

	Roadway Segment	From	To	LOS
1	7th Street	Tuolumne Boulevard	Crows Landing Road	F
2	9th Street	SR 99	Needham Avenue	E/F
3	Bangs Avenue	Dale Road	McHenry Avenue	F
4	Beckwith Road	Finney Road	SR 99	E/F
5	Bodem Street	Morris Avenue	Scenic Drive	F
6	Briggs Avenue	Seybold Avenue	Martin Luther King Drive	E
7	Briggsmore Avenue	SR 99	Carver Road	F
8	Briggsmore Avenue	College Avenue	Sherwood Avenue	E
9	Briggsmore Avenue	Sunrise Avenue	Lakewood Avenue	E/F
10	Briggsmore Avenue	Claus Road	Held Drive	E
11	Brighton Avenue	Coffee Road	Wylie Drive	E/F
12	Brink Avenue	Beckwith Road	Morse Road	F
13	Brink Avenue	Shoemake Avenue	Carpenter Road	F
14	Buena Vista Drive	La Loma Avenue	Encina Avenue	F
15	California Avenue	Panama Drive	Spencer Avenue	E
16	Carpenter Road	SR 99	Paradise Road	F
17	Carpenter Road	Robertson Road	Whitmore Avenue	F
18	Carver Road	Kiernan	9th Street	F
19	Celeste Drive	Coffee Road	Oakdale Road	E/F
20	Chicago Avenue	Harris Avenue	Paradise Road	F
21	Church Street	Garst Road	Yosemite Boulevard	F
22	Claremont Avenue	Dragoo Park Drive	Rumble Road	F
23	Claus Road	Sylvan Avenue	Yosemite Boulevard	E/F
24	Coffee Road	Claratina Avenue	Mable Avenue	E
25	Coffee Road	Sylvan Avenue	Morris Avenue	E/F
26	Coldwell Avenue	9th Street	Tully Road	F
27	College Avenue	Rumble Road	Bowen Avenue	F
28	College Avenue	Stoddard Avenue	Needham Avenue	F
29	College Avenue	Briggsmore Avenue	Roseburg Avenue	E/F
30	Conant Avenue	Standiford Avenue	Sisk Road	F
31	Crows Landing Road	7th Street	Butte Avenue	E/F
32	Dakota Avenue	Beckwith Road	North Avenue	E
33	Dale Road	Ladd Road	New Roadway north of	E

Table A-2
Roadway Segments with 2025 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

	Roadway Segment	From	To	LOS
			Kiernan Avenue	
34	Dale Road	Pelandale Avenue	Standiford Avenue	E/F
35	Dallas Street	Hatch Road	Butte Avenue	E
36	Edgebrook Drive	El Vista Avenue	Riverside Drive	F
37	El Pasado Drive	Riverside Drive	Capistrano Drive	E
38	El Vecino Avenue	Orangeburg Avenue	Fairmont Avenue	E
39	El Vista Avenue	Scenic Drive	Encina Avenue	E/F
40	Emerald Avenue	Lone Palm Avenue	California Avenue	E/F
41	Encina Avenue	Buena Vista Drive	Conejo Avenue	E/F
42	Ensenada Drive	Vera Cruz Drive	Rose Avenue	F
43	Enslen Avenue	Orangeburg Avenue	Coldwell Avenue	F
44	Evergreen Avenue	Sisk Road	Carver Road	E
45	Fairmont Avenue	Sunrise Avenue	Coffee Road	F
46	Finney Road / Broadway Avenue	SR 99	Murphy Road	E/F
47	Floyd Avenue	McHenry Avenue	Vera Cruz Avenue	F
48	Floyd Avenue	Keller Street	Orchard Park Way	E/F
49	Floyd Avenue	Claus Road	Held Drive	F
50	Garner Road	Finch Road	Hatch Road	F
51	Garst Road	Claus Road	Norseman Drive	E
52	Granger Avenue	Enslen Avenue	Sherwood Avenue	E
53	Granger Avenue	Florida Avenue	Sunrise Avenue	F
54	Graphics Drive	Woodland Avenue	Kansas Avenue	F
55	Grecian Avenue	Dragoo Park Drive	Drakeshire Drive	F
56	Hahn Drive	Venemen Avenue	Standiford Avenue	F
57	Hammett Road	SR 99	Pirrone Road	F
58	Hatch Road	Dallas Street	Crows Landing Road	F
59	Held Drive	Floyd Avenue	Briggsmore Avenue	F
60	Houser Lane	Carpenter Road	Seybold Avenue	E
61	I Street	Washington Street	SR 99	F
62	Kansas Avenue	Carpenter Road	SR 99	F
63	Kearney Avenue	Orangeburg Avenue	Coldwell Avenue	F
64	Kiernan Avenue	SR 99	Stoddard Road	F
65	Kiernan Avenue / Claribel Road	Chapman Road	Santa Fe Avenue	E/F
66	La Force Drive	Oakdale Road	Hillglen Avenue	E
67	La Loma Avenue	Morton Boulevard	Yosemite Boulevard	E
68	Lancey Drive	Rose Avenue	Oakdale Road	E/F
69	Locke Road	Coffee Road	Rose Avenue	F
70	Lucern Avenue	McHenry Avenue	Brighton Avenue	F
71	Mable Avenue	Palmwood Drive	Oakdale Road	E
72	Manor Oak Drive	Orchard Park Way	Lincoln Oak Drive	F
73	Martin Luther King Drive	California Avenue	Paradise Road	F
74	Maze Boulevard	Carpenter Road	Washington Street	E/F
75	McHenry Avenue	Kiernan Avenue	Needham Avenue	E/F
76	Merle Avenue	Oakdale Road	Walnut Tree Drive	F
77	Miller Avenue	Covena Avenue	El Vista Avenue	F
78	Mitchell Road	Yosemite Boulevard	Tanaya Drive	E
79	Mitchell Road	Riverside Drive	Hatch Road	F
80	Monticello Lane	Hatch Road	Salazar Circle	F
81	Morgan Road	Hatch Road	Nelson Way	E
82	Morris Avenue	McHenry Avenue	Coffee Road	F
83	North Avenue	Dakota Avenue	Morse Road	E
84	Norwegian Avenue	McHenry Avenue	Coffee Road	F
85	Oakdale Road	Claratina Avenue	Scenic Drive	E/F
86	Orangeburg Avenue	Briggsmore Avenue	Carver Road	F
87	Orangeburg Avenue	Enslen Avenue	Florida Avenue	E

Table A-2
Roadway Segments with 2025 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

	Roadway Segment	From	To	LOS
88	Orangeburg Avenue	McHenry Avenue	Eastridge Drive	F
89	Orangeburg Avenue	Lakewood Drive	Lillian Avenue	F
90	Orangeburg Avenue	Glenbrook Way	Claus Road	F
91	Oregon Drive	Santa Rosa Avenue	Santa Cruz Avenue	E
92	Paradise Road / H Street	Pine Tree Lane	3rd Street	F
93	Pecos Avenue	Crows Landing Road	Boulder Avenue	E
94	Pelandale Avenue	Sisk Road	Dale Road	F
95	Pelandale Avenue / Claratina Avenue	Prescott Road	Santa Fe Avenue	E/F
96	Peppermint Drive	Oakdale Road	McGuire Drive	E
97	Pine Tree Lane	Paradise Road	Robertson Road	E
98	Poust Road	McDonald Avenue	Chapparal Place	F
99	Prescott Road	Pelandale Avenue	Cheyenne Way	E/F
100	Prescott Road	Mount Vernon Drive	Briggsmore Avenue	F
101	Riverside Drive	Encina Avenue	Miller Avenue	F
102	Riverside Drive	Yosemite Boulevard	Mitchell Road	F
103	Robertson Road	Carpenter Road	Pine Tree Lane	F
104	Rose Avenue	Floyd Avenue	Scenic Drive	E/F
105	Roselle Avenue / Lakewood Avenue	Floyd Avenue	Scenic Drive	E/F
106	Rosemore Avenue	Chapparal Place	Kansas Avenue	E/F
107	Rumble Road	Sisk Road	Hahn Drive	E
108	Rumble Road	Conant Avenue	Tully Road	E/F
109	Rumble Road	Napier Drive	Hashem Drive	E/F
110	Salida Boulevard	Pelandale Avenue	Dakota Avenue	F
111	Santa Rosa Avenue	Yosemite Boulevard	Oregon Drive	F
112	Scenic Drive	Downey Avenue	Lakewood Avenue	E/F
113	Seybold Avenue	Houser Lane	Briggs Avenue	E
114	Sherwood Avenue	Standiford Avenue	Leveland Avenue	E/F
115	Sherwood Avenue	Granger Avenue	Orangeburg Avenue	F
116	Sisk Road	Vintage Drive	Briggsmore Avenue	E/F
117	Sisk Road	Pirrone Road	Kiernan Avenue	F
118	Snyder Avenue	Dale Road	Viader Drive	E
119	Standiford Avenue	SR 99	Prescott Road	E/F
120	Standiford Avenue	Shawnee Drive	Carver Road	E
121	Standiford Avenue	Longbridge Drive	Colonial Drive	E
122	Standiford Avenue	Sherwood Avenue	McHenry Avenue	E
123	Stoddard Avenue	Tully Road	Sycamore Avenue	E/F
124	Stoddard Road	Ladd Road	Kiernan Avenue	F
125	Sunrise Avenue	Floyd Avenue	Lucern Avenue	E/F
126	Sycamore Avenue	Orangeburg Avenue	Needham Avenue	E/F
127	Sylvan Avenue	Bridgeford Lane	Oakdale Road	E/F
128	Sylvan Meadows Drive	Coffee Road	Forest Glenn Drive	F
129	Tenaya Drive	Conejo Avenue	Mitchell Road	F
130	Tokay Avenue	McHenry Avenue	Sunrise Avenue	E
131	Tully Road	Bangs Avenue	Orangeburg Avenue	E/F
132	Tuolumne Boulevard	Colorado Avenue	Roselawn Avenue	E
133	Tuolumne Boulevard	Neece Drive	SR 99	E
134	Ustick Road	Hatch Road	Boise Avenue	E
135	Veneman Avenue	Dale Road	Hahn Drive	F
136	Vintage Drive	Sisk Road	Dale Road	E/F
137	Washington Street	Maze Boulevard	I Street / Vine Street	F
138	Woodland Avenue	Poust Road	9th Street	E/F
139	Woodrow Avenue	Colonial Drive	Sherwood Avenue	E
140	Wylie Drive	Brighton Avenue	Oakdale Road	F

Table A-2
Roadway Segments with 2025 PM Peak Hour Level of Service E or F
(On Arterial Streets and Above)

Roadway Segment		From	To	LOS
141	Yosemite Boulevard	D Street	El Vista Avenue	E/F
142	Yosemite Boulevard	Riverside Drive	Santa Fe Avenue	E/F
143	New Roadway north of Kiernan Avenue	Dale Road	Prescott Road	E
144	New Roadway north of Kiernan Avenue	Carver Road	McHenry Avenue	E
145	SR 99 Northbound	Hammett Road	Kiernan Avenue	F
146	SR 99 Northbound	Kiernan Avenue	Pelandale Avenue	E
147	SR 99 Northbound	Beckwith Road	Tuolumne Boulevard	E
148	SR 99 Southbound	Hammett Road	Broadway Avenue	E
149	SR 99 Southbound	Standiford Avenue	Crows Landing Road	F
150	SR 99 Southbound	Crows Landing Road	Hatch Road	E
151	SR 99 Southbound	Hatch Road	Whitmore Avenue	F

Source: Transportation Planning Partnership Group (TPPG) Countywide Travel Demand Model, 2007.