Final Report

for the

SCAG Subregional Model in TransCAD 5.0

June, 2009

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Executive Summary

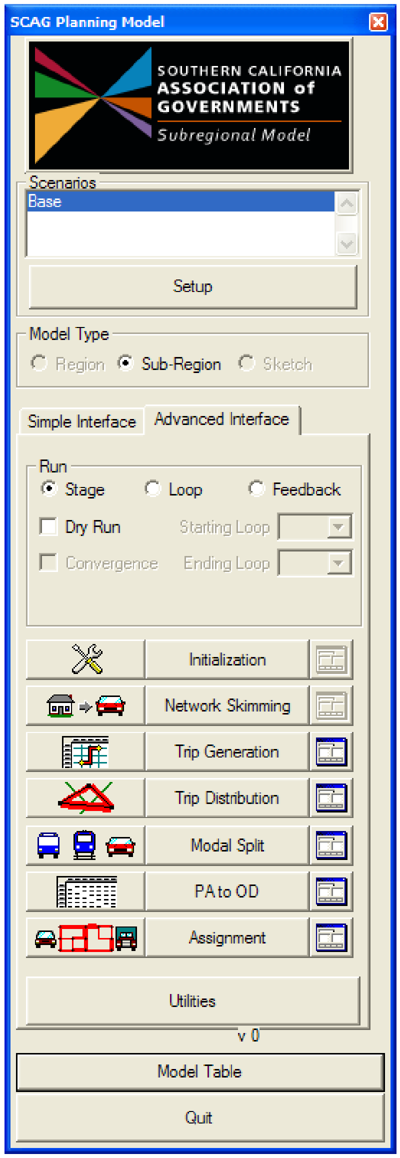
The SCAG Subregional model is special variant of the SCAG Regional model. The Subregional Model allows the user to develop and run a focused model for a subregion within the SCAG regional area.

A focused subregional model was developed using San Bernardino County datasets as a test case in order to verify the model approach and mechanisms. A custom zonal structure provided by San Bernardino County was used for the model, and all other input datasets were obtained from the Regional Model. The San Bernardino Subregional model was verified to produce model results that are consistent with the Regional Model.

The Subregional model uses all of the models and datasets of the Regional model. Since this focused model also includes zonal aggregations outside of the subregion, models needed to be developed to counteract trip loss due to zonal aggregations. Many of the models developed for the Sketch Plan Model, developed by Caliper Corporation in 2008, were used for the Subregional Model.

The final Subregional Model for San Bernardino County contains 3108 zones and has a model run time of about 18 hours on a fast computer. By comparison, the Regional Model contains 4192 zones and has a model run time of about 24 hours. These times are machine dependent and will improve in the future.

The Subregional Model includes a model interface that is both easy to use and easy to understand. A snapshot of the interface is shown below:



The Subregional model also contains a several utilities that aid in developing appropriate subregional datasets:

- A utility that automatically creates a merged TAZ GIS database from an input Regional TAZ GIS layer and an input Subregion TAZ layer with disaggregated zones
- A utility that automatically converts Regional model input datasets into data that is consistent for the Subregional Model and it's focused data structure
- A option that lets the user substitute custom Subregional input socio-economic data in place of the SCAG regional estimates

The Subregional model was verified to 2003 Base Year Regional model results. The following model steps were verified:

- The household auto availability model was verified to the survey

- Trips generated were compared and verified to the Regional model results
- Trip distribution average trip lengths and trip length frequency curves were verified to the 2000 survey.
- Mode shares were verified to Regional model mode share targets
- The following trip assignment results were compared and verified to the Regional model:
    - VMT by County and Air Basin
    - VMT, VHT, Delay and average speed by time period
    - Total screenline volumes
    - Transit boardings by mode

Trips generated in the Subregion Model matched within 1% of the Regional model. Trip distribution average trip lengths were consistent with the suvey, but were bit longer in order to match resulting VMT to the Regional Model. Mode shares in the Subregion model in general matched quite well with Regional model results. VMT, VHT and delay results from the Subregional model also matched well with Regional results.

Sensitivity tests were conducted comparing Subregional and Regional results for the 2008 and 2035 plan. Various other “what if” scenarios (e.g. increasing all freeways by one lane) were also created and run in order to determine model sensitivity. In each of these cases, the Subregional results compared favorably with the Regional results, and showed reasonable sensitivities.

Introduction

This report presents the results of the Subregional Model development project. The goal of this project was to develop a focused Subregional Model based upon the Regional Model, and to apply the Subregional Model to a test case for San Bernardino County. The second goal of this project was to develop utilities that make it easy to convert Regional Model data inputs into focused Subregional Model datasets.

In a focused model, the TAZ zones within a specified subregion are usually much more detailed than the regional zones. Outside of the subregion, TAZs are aggregated to a larger level in order to improve model performance.

For the areas in the focused model that are simplified, the aggregations cause many trips to be lost, and cause model results to diverge from the Regional model results. To counteract these lost trips, and to ensure model result consistency with the Regional model, additional ancillary models were transferred from the SCAG Sketch Plan Model:

- A zone allocation model for determining highway and transit skims
- A Super-intrazonal traffic assignment model
- A Super centroid connector traffic assignment model

For the areas in the focused model that are disaggregated or are similar to the regional zones, the Subregional Model uses the same models and approaches as the Regional model.

The rest of this document describes in detail all of the models developed or utilized in the subregional model. The document also describes the processing conducted to prepare the subregional data inputs for the San Bernardino test case. Lastly, this document describes all of the model verification performed to ensure consistency with the Regional Model.

Subregional Dataset Development

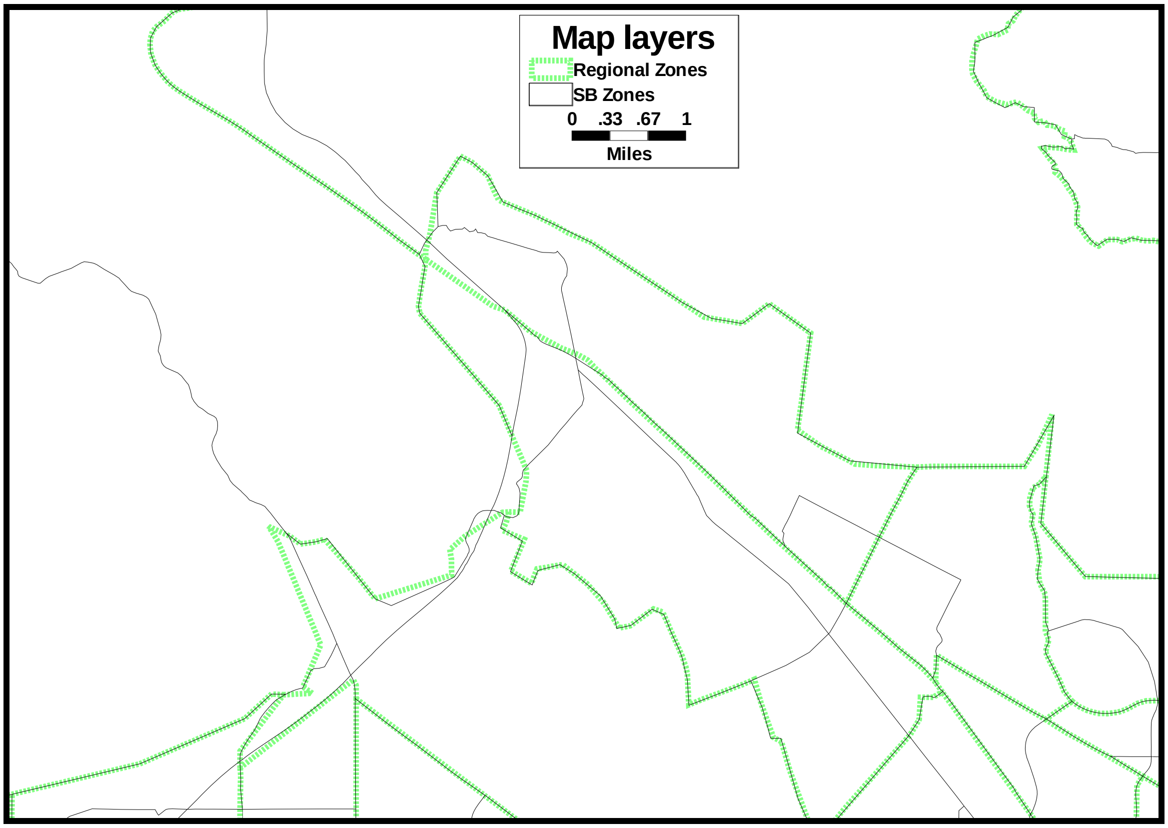
This section describes the zonal and network datasets that were developed for the subregional model. For the most part, the datasets were consistent with the Regional Model, but use a focused approach for the subregion.

In a focused model, the TAZs within a specified subregion are usually much more detailed than the regional zones. Typically, these zones are disaggregations of the regional TAZ's. Immediately outside of the subregion, zone sizes are equivalent to region TAZs, and further outside of the subregion, TAZs are aggregated to a larger level, such as Community Service Areas (CSA's). The focused approach allows much more detailed model specification and analysis in the subregion, while giving less attention to areas outside the subregion. The main reason for aggregating outside of the subarea is to improve model performance. In addition, the modeler is not burdened with estimating socioeconomic and network inputs outside the subarea in a detailed manner.

Zone System Development

The Subregional model is patterned on the regional model, but has more detailed zones in the subregion of interest, and less detail in areas outside of the subregion. The testbed subregion used to develop and verify the model is San Bernardino County. The Regional model contains 4192 transportation analysis zones, of which 402 zones are in San Bernardino County. San Bernardino County provided a GIS layer of detailed TAZs for the county in the form of a Shape file. The input disaggregated zone system contained about 2208 zones, or about 4 times the detail of the existing SCAG Regional zones.

One of the early goals of the project was to merge the SB TAZ layer with the SCAG Regional zone layer. The merging process was problematic since the San Bernardino zone layer was non topological, and contained numerous TAZ boundaries that did not line up with each other and/or did not line up properly with the Regional zone system. In addition, there were several situations where the SB zones did not perfect nest inside the Regional zones properly, and there were other instances where the SB zone boundaries were offset from the Regional zone boundaries. An example of this discrepancy is shown in the following diagram:



The difficulty involved in integrating these two zone layers required a manual process for merging and integration that involved overlays, disaggregations, and other GIS manipulations. An automated process could not be developed for this particular dataset due to the issues noted above. The result of this manual process is an integrated TAZ layer with San Bernardino County disaggregated zones within SB county, and SCAG TAZ zones outside of SB County. This provides the main TAZ geographic input for the Subregional model.

Outside of the San Bernardino subregion, the Regional zones were used directly or were aggregated into Community Statistical Areas (CSAs). Immediately within 10 miles of San Bernardino County, the zones were preserved from the Regional Model. Outside of the 10 mile radius, zones were aggregated to CSAs. The original 83 external, air and port zones were preserved. In all, there are 3108 total zones in the Subregional model for San Bernardino County.

As part of the project, an automated utility has been developed to create an integrated TAZ geographic input file from a subregional TAZ layer. The utility requires the subregion TAZ layer to be topological, overlay with the regional zone layer, and to split the regional zones without any overlaps. The utility also lets the user specify a distance parameter around the subregion that determines boundary Regional zones to be preserved versus the zones outside of the boundary to be aggregated. A full description of this utility and its use is available in the Subregional Model User's Guide.

This GIS area zone layer includes the regional TAZ for areas outside of the subregion, and the disaggregated TAZs for the area inside the subregion. Each zone contains information on the original Regional TAZ it is associated with, the Subregion TAZ number it is assigned to, the "aggregation type" of the TAZ, and the percentage split of the TAZ of the original Regional TAZ if it is inside the subregion. The following table and graphic describe required fields in the zone layer:

Fieldname	**Description**
ID	GIS ID of layer (autocalculated)
Area	GIS Area (autocalculated)
RegionTAZ	Original regional TAZ number of zone
SubregionTAZ	Assigned Subregion TAZ number
AGGType	Aggregation type of zone. Values are: A: Regional TAZ zone is to be aggregated into SubregionTAZ. Typically used for zones outside the subregion. U: Zone is to be left preserved and assigned a Subregion TAZ number. Typically used for zones bordering the subregion, for external and port zones, and for zones inside the subregion that are not split. D: Regional TAZ is to be disaggregated and assigned a Subregion TAZ number. Typically used for zones inside the subregion that are split.
SplitPercent	For AGGType "D", the percentage of the Subregion TAZ that is in the regional TAZ, for all other AGGTypes, the SplitPercent is 1.0
CNTY	County that TAZ is in
RSA	RSA that TAZ is in
CSA	CSA that TAZ is in
AIR_BASIN	Air basin that TAZ is in
SUB_AIR_BASIN	Sub air basin that TAZ is in

Dataview1 - Districts

ID	Area	RegionTAZ	SubregionTAZ	SplitPercent	AGGType	CNTY	RSA	AIRDB	CSA	AIR_BASIN	SUB_AIR_BASIN
2	39.53	2	220	1.00	A	222	6	1	294	1	11
3	20.64	3	220	1.00	A	222	6	1	294	1	11
5	1.58	5	220	1.00	A	222	6	1	294	1	11
4	1.43	4	222	1.00	A	224	6	1	296	1	11
6	0.83	6	222	1.00	A	224	6	1	296	1	11
7	0.55	7	222	1.00	A	224	6	1	296	1	11
20	1.35	20	229	1.00	U	224	6	1	296	1	11
3287	0.51	3287	730	1.00	U	712	4	4	242	2	23
3288	0.63	3288	731	1.00	U	713	4	4	242	2	23
3289	0.35	3289	732	1.00	U	714	4	4	242	2	23
3724	0.93	3600	845	1.83	D	829	5	3	267	2	24
3725	0.19	3600	846	0.17	D	830	5	3	267	2	24
3729	1.39	3603	849	0.62	D	833	5	3	267	2	24
3730	0.56	3603	850	0.25	D	834	5	3	267	2	24
3731	0.28	3603	851	0.13	D	835	5	3	267	2	24
3738	0.24	3614	900	0.10	D	885	5	3	267	2	24
3739	0.23	3614	901	0.10	D	886	5	3	267	2	24
3740	1.83	3614	902	0.80	D	887	5	3	267	2	24
5931	3.13	4110	3026	1.00	U	3009	--	--	--	--	--
5932	3.13	4111	3027	1.00	U	3010	--	--	--	--	--
5933	3.13	4112	3028	1.00	U	3011	--	--	--	--	--
5934	3.13	4113	3029	1.00	U	3012	--	--	--	--	--
5935	3.13	4114	3030	1.00	U	3013	--	--	--	--	--
5936	3.13	4115	3031	1.00	U	3014	--	--	--	--	--
5937	3.13	4116	3032	1.00	U	3015	--	--	--	--	--
5938	3.13	4117	3033	1.00	U	3016	--	--	--	--	--

The SplitPercents were calculated based upon the percent of the subregion disaggregated zone that is within the SCAG TAZ. The percentage was based upon the area percentage of the disaggregated zone within the regional zone. The split percents can be overridden by percent estimates of population and or employment, however.

Model Demographics

The Subregional model uses the Regional estimates of TAZ-based socio-economic data as inputs. For subregion zones that are disaggregated, the socioeconomic data are disaggregated as well, based on area split percentages in the merged TAZ layer described above. The subregion model contains an optional method available that lets the user specify custom socioeconomic TAZ data for the subregion TAZs, or for any set of TAZs. A description of this method and the input datasets required is available in the Subregional Model User's Guide. The Subregional model requires the exact same demographic and employment inputs as the Regional Model, which is described below:

Input Demographics (SED\model_sed.bin)

Field	Description
SEQ #	TAZ Number
CNTY	County
TAZ_ID	Alternate TAZ Number
DISTRICT	District Number
DISTRICT2	District 2 Number
POP	Population
RES	Resident Population
HH	Households
GN	Group Quarters Population
HHSIZE_1	1 Person Households
HHSIZE_2	2 Person Households
HHSIZE_3	3 Person Households
HHSIZE_4PLUS	4+ Person Households
HHSIZE_4E	Alternate calculation of 4+ person households

Field	Description
AGE5_17	Population Ages 5-17
AGE18_24	Population Ages 18-24
AGE16_64	Population Ages 16-64
AGE65_OVER	Population Ages 65 and over
HO18_24	Head of Household Age 18-24
HO25_44	Head of Household Age 25-44
HO45_64	Head of Household Age 45-64
HO65_OVER	Head of Household Age 65 and over
HH_W0	Households with 0 workers
HH_W1	Households with 1 worker
HH_W2	Households with 2 workers
HH_W3	Households with 3+ workers
K12	Kindergarden – 12th grade enrollment
COLLEGE	College enrollment
MEDIAN	Median Income
HO<$25K	Households with < $25,000 annual income
MEDIAN25K	Median Income in < $25,000 income group
$25K<HO<$50K	Households with income $25,000 - $50,000
MEDIAN25_50	Median Income in $25,000-$50,000 income group
$50K<HO<$100K	Households with income $50,000 - $100,000
MEDIAN50_100	Median Income in $50,000-$100,000 income group
HO>$100K	Households with income > $100,000
MEDIAN_100	Median Income in > $100,000 group
LINC_WRK	Low Income Workers
MINC_WRK	Medium Income Workers
HINC_WRK	High Income Workers
TOT_EMP	Total employment
TOTLOW_EMP	Total low income employment
TOTMED_EMP	Total medium income employment
TOTHIG_EMP	Total high income employment
AG_EMP	Agricultural employment
CONST_EMP	Construction employment
MANU_EMP	Manufacturing employment
WHOLE_EMP	Wholesale employment
RET_EMP	Retail employment
TRANS_EMP	Transportation employment
INFOR_EMP	Information services employment
FIRE_EMP	Financial-Real Estate employment
PROF_EMP	Professional employment
EDUC_EMP	Educational employment
ARTENT_EMP	Arts/Entertainment employment
OTHSER_EMP	Other Services employment
PUBADM_EMP	Public Administration employment
DAILYPARK	Daily parking cost
HOURLYPARK	Hourly parking cost
CBD	Central Business District flag
RSA	RSA Number

An automated procedure is used to convert all regional model inputs into subregion equivalents. This procedure is also applied to the demographic and employment data described above. Therefore, the data source for socioeconomics can come from SCAG and need not be independently provided.

Subregional Model Network

The Subregional Model utilizes the same highway and transit networks as the Regional Model, with similar centroid connectors. The similarity of networks occurs for both the geographic links and routes, and for all attribute information. Thus, even if TAZ zones were aggregated outside of the subregion, the networks remain the same and are not be simplified.

The decision to use similar highway and transit networks, instead of developing simplified networks, was made for the following reasons:

1. A main goal of the Subregional Model was to generate results that are consistent with the Regional Model. Using similar highway and transit networks improves the likelihood for generating similar results.
2. In the Regional Model, the long run times were mainly due to the large number of TAZ zones. The network size plays a very small role in processing times. Thus, any simplification of the network would provide only minimal performance enhancements.
3. The transit routes are heavily dependent upon the network links. Simplification of the highway network would most likely require manual realignment of some transit routes.

The Subregional model was designed such that it would be easy to convert Regional Model inputs into the Subregion framework. Any manual simplification of the highway or transit networks would greatly complicate the conversion process.

The centroids and centroids connectors for the Subregion network were processed differently based on how the subregion TAZs were defined. The TAZs are defined in three distinct categories:

1. Zones, especially within the subregion, that are disaggregated from the original SCAG TAZ zones. In the input TAZ layer, these are defined as AGGTYPE = "D" zones.
2. Zones that were defined to be the same as the TAZ zones, labeled as AGGTYPE = "U" zones in the input TAZ layer.
3. Zones, especially outside of the subregion, that are aggregated from SCAG TAZ zones, and are defined as AGGTYPE = "A" zones in the input TAZ layer.

The processing method for each is described below:

Network Processing for Disaggregated (AGGTYPE = "D") Zones

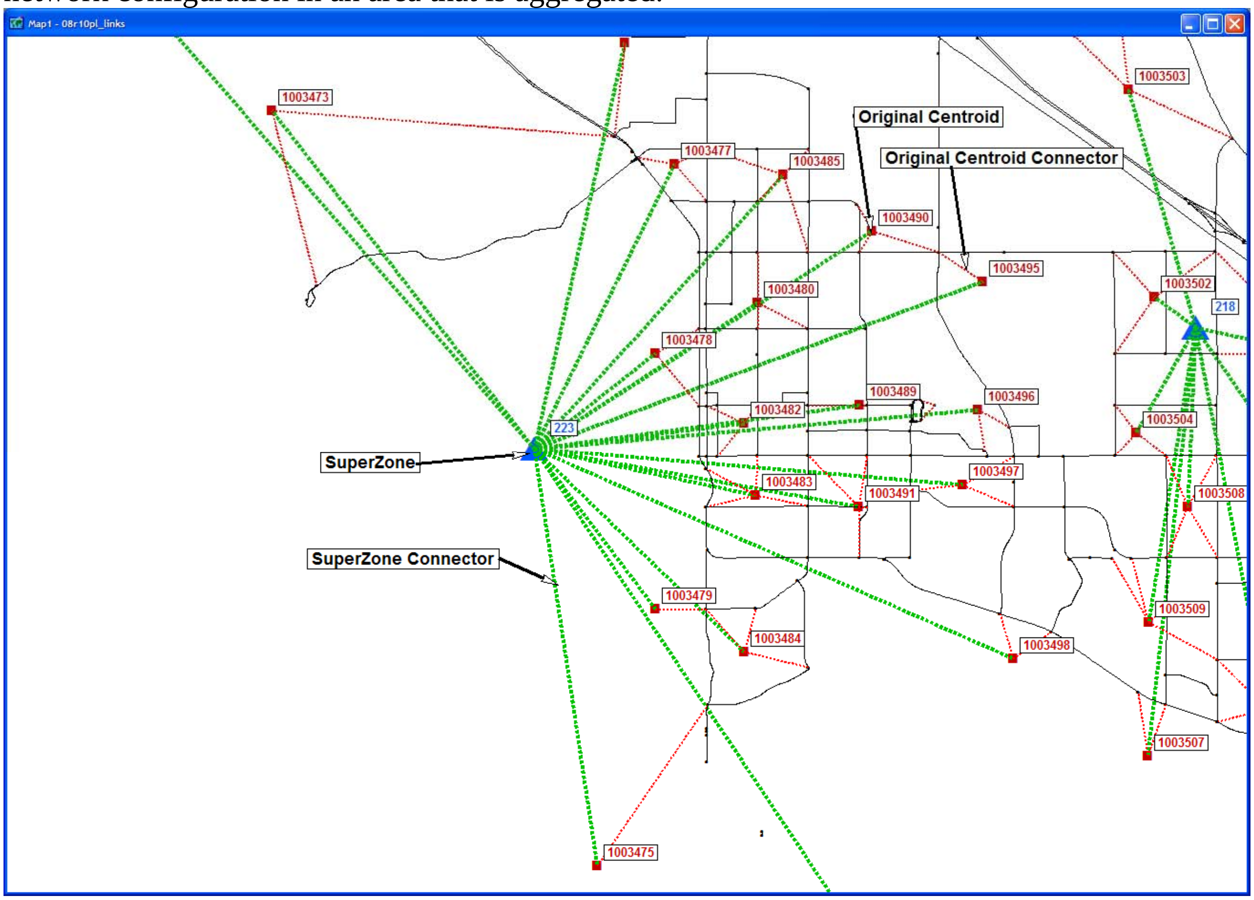
For zones that are disaggregated (AGGTYPE = "D"), a new set of centroid connectors are created using the same methodologies as TransCAD's centroid connector tool. This utility creates a node at the disaggregated TAZ's centroid location, and creates up to 4 connector links from the centroid location to the mid-point of nearby links. The utility then deletes the original centroid connectors from the regional TAZs.

Network Processing for Unchanged (AGGTYPE = "U") Zones

For zones and centroids that are of AGGTYPE = "U", no transformations are performed. The original centroid node and centroid connector links from the Regional network are used. The centroid node is renumbered to the Subregion zone's assigned subregion TAZ number.

Network Processing for Aggregated (AGGTYPE = “A”) Zones

For the network in aggregated (or superzone) areas, first a superzone centroid location was determined, which was generally the center of the CSA. Then, additional centroid connectors were added to the highway networks that connect the superzone centroid to the rest of the network. These connector links are generated from the superzone centroid to the original SCAG TAZ zone locations. The following figure illustrates a typical network configuration in an area that is aggregated:



In the above diagram, there is one superzone connector link between the superzone node and each TAZ node within the superzone. The superzone nodes are numbered according to the Subregion TAZ number assigned in the correspondence table. As the illustration also shows, the original regional network centroid nodes have been renumbered so that they reflect the original centroid node TAZ number plus 1,000,000. This was enacted to avoid node ID conflicts between superzone nodes and original TAZ nodes. This methodology for aggregated zones was borrowed from the Sketch Plan Model.

Adding Network Detail

Typically within a subregion, links would be added in order to add more detail, and to make the network detail consistent with the greater zonal detail. For this project, due to the lack of available data, no extra network links were added to the subregion. The addition of network detail in the subregional is a recommendation for further work. The option to add network detail is available within the conversion utility.

The entire process described above of taking the Regional Network, and converting it to a Subregional network is automated within a conversion utility. The conversion utility also allows the user to specify additional links to add to the network within the subregion, although this feature is currently not used in the SB County test case. A full description of this conversion utility can be found in the Subregional Model User's Guide.

Other Model Inputs

Aside from the network and TAZ inputs, all other subregional model inputs were derived directly from the Regional Model inputs. An automated utility was created that converts all Regional Model inputs into Subregional compatible inputs. For the most part, this utility converts the 4192-zone based zone, matrix and network inputs into Subregion sized inputs using the zonal correspondences that exist in the merged TAZ layer described above. For the test case in San Bernardino, all model inputs were converted from the 4192 Region base to the 3108 zones in the focused model.

Conversion Utility

The development of network, socio-economic, and other subregional model inputs has been automated in a couple of conversion utilities. The first utility creates the merged Region TAZ from a Subregion TAZ GIS file and the SCAG Regional TAZ model. The second utility automatically converts zonal, network, matrix, and other regional data inputs into datasets that can be directly used for the subregional focused model. Documentation on these utilities is presented in the Subregional Model Users Guide.

Modeling Procedures

This section describes all the modeling procedures used in the Subregional model. For the most part, the modeling procedures are consistent with the Regional model. Certain new models have been added specifically for the Subregional project. Many of these models, especially the ones that handle zonal aggregation, are borrowed from the SCAG Sketch Plan Model. For the most part, the zonal aggregation models are applied to the regions of the network and zones that are aggregated.

Network Skimming

For network skimming, skimming generally occurs from subregion TAZ to subregion TAZ. For unchanged and disaggregated zones, the skimming is performed from their centroid locations. For aggregated zones, a special technique is used to account for the potential of generating aggregation bias in skim results. Thus, in aggregated zones, the technique similar to that utilized in the SCAG Sketch Plan Model was adopted. In this method, a representative production and attraction zone is chosen for each superzone, and both the highway and transit skims are performed between these representative zones. The representative zones are chosen through a zone allocation model that is described in detail later in this section. Only zones and centroid nodes that are of AGGTYPE = "A" are transformed into this superzone and connector configuration. The skimming procedure for both highway and transit then proceeds in a similar fashion as the regional model. For more information on the Regional network generation and skimming models, see the document "SCAG TransCAD Regional Model Users Guide.pdf". The zonal allocation model is described below.

Zone Allocation Model

For the zones that are aggregated (AGGTYPE = "A" zones), the Subregional model contains a zone choice model in order to handle the aggregation bias that occurs when TAZs are aggregated to the superzone CSA level. For each superzone pair, a single representative origin TAZ and a single representative destination TAZ are selected, and both the highway and transit level of service variables (LOS) from that detailed TAZ pair are used to represent the superzone pair.

In the zone allocation model, a "weighted" superzone centroid "production" and "attraction" coordinate is calculated for each superzone. The production centroid is weighted based on the original TAZ households, and the attraction centroid is weighted based on the original TAZ employment. The weighted production coordinate is based on the following formula for each superzone:

$$Longitude = \sum_{allTAZ} Longitude_i * Household_i \,/ \sum_{allTAZ} Household_i$$

$$Latitude = \sum_{allTAZ} Latitude_i * Household_i / \sum_{allTAZ} Household_i$$

The weighted attraction coordinate is based on the following formula for each superzone:

$$Longitude = \sum_{allTAZ} Longitude_i * Employment_i / \sum_{allTAZ} Employment_i$$
$$Latitude = \sum_{allTAZ} Latitude_i * Employment_i / \sum_{allTAZ} Employment_i$$

The production zone chosen is then the closest zone to the weighted production coordinate. The attraction zone chosen is the closest zone to the weighted attraction coordinate. Both the production and attraction zones chosen also must be within the superzone.

All highway and transit skims are then performed from the allocated production TAZ to attraction TAZ instead of the aggregated CSA.

Trip Generation Models

The Subregional vehicle availability and trip generation models are similar to those in the Regional Model. Like the Regional Model, the inputs to the trip generation model are zonal demographic and employment data. The exact same input demographics table is used for both models. Thus, the Subregional model utilizes the full 4109 zone table as input. During the trip generation model process, this demographics table is aggregated and disaggregated into the Subregional structure. The GIS layer's RegionTAZ-to-SubregionTAZ correspondence table is used to perform the aggregation and disaggregation.

Certain input fields, such as the median income fields, are averaged instead of aggregated. This leads to small but generally acceptable inaccuracies in the estimation of aggregated and disaggregated median variables. To calculate accurate median variables, it is necessary to have the disaggregated income household information, which is not possible for future forecast years. All vehicle availability and trip generation models are subsequently run using the modified data. For more information on the Regional trip generation models, see the document "SCAG TransCAD Regional Model Users Guide.pdf".

Trip Distribution Model

The Subregional model utilizes the exact same trip distribution models as the Regional Model. This was done to ensure consistency between the models. The only difference is that the Subregional model estimates distributions between it's zonal system, while the Regional model estimates distributions between the original 4109 zones. For the zones that are aggregated, there are several effects on the model:

1. The model will produce much more intrazonal trips. For example, while the Regional model estimated that for the Home-Based Work purpose, about 3%

of all trips were intrazonal, the Subregional model estimates as much as 18% of all trips are intra-superzonal for the aggregated zones.

2. During calibration, average trip lengths will be modified. In the Regional Model, survey average trip lengths were calculated from TAZ to TAZ. In the Subregional model, these trip lengths were re-estimated from the Subregional zone system.

Due to these effects, it is necessary to re-estimate the friction factor curve functions for each trip purpose and time period. The re-estimation ensures that the both the model average trip lengths and model trip length frequency curves matched survey results.

For more information on the Regional trip distribution models, see the document “SCAG TransCAD Regional Model Users Guide.pdf”.

Mode Choice Model

The Subregional mode choice model utilizes the same models and methodology as the Regional Model. The modified zone system of the Subregional model and zonal aggregation requires the recalibration of mode choice constants to ensure that Subregional mode shares are consistent with the Regional model. For more information on the Regional mode choice models, see the document “SCAG TransCAD Regional Model Users Guide.pdf”.

Intra-Superzone Assignment Model

When TAZs are aggregated from the Regional Model and assignments are performed, this assignment will produce many more intrazonal trips. For example, in the regional network, trips would be made from two separate TAZs that belong to the same superzone, and these trips would be assigned to the regional network. Once these TAZs are aggregated to a superzone, these are considered intrazonal trips and are thus not assigned to the network. Potentially, this leads to an under-assignment of trips in an aggregated network. These kinds of trips are called Intra-Superzonal trips: trips that are interzonal in the regional network and are thus assigned in the Regional Model, but are considered intrazonal in the aggregated portions of the Subregional Model and not assigned.

To account for these trips, the Subregional Model takes these intra-superzone trips and disaggregates them into full TAZ-based OD trips. The model then assigns these trips to the network using the TAZ-based centroid connectors, ensuring that these trips are not lost as intrazonal trips. This model is invoked between the mode split and trip assignment models.

A key challenge is to convert intra-superzone trips into TAZ-based OD trips. The steps are as follows:

1. Base Year Intra-Superzone OD matrices are estimated from the output of the Base Year Regional Model.

2. The Subregional model estimates scenario year superzone OD trip matrices.
3. TAZ land use household and employment data are used to estimate superzone-to-TAZ disaggregation factors.
4. The intra-superzone trips from Step 2 are disaggregated into full TAZ trips using the Base Year matrices from Step 1 and the disaggregation factors from Step 3.
5. The TAZ trip matrices from Step 4 are loaded onto the highway network.

The first step in this process involves the estimation of Base Year TAZ Intra-Superzone OD trip matrices. A utility in the Regional Model performs this function. The utility takes the OD matrices from the base year model output, and breaks down the trips into inter-superzone vs. intra-superzone trips using a Superzone-TAZ correspondence table.

The procedure takes the AM, PM, MD and NT regional base year origin-destination matrices from the model as input. Each OD matrix contains 8 modes: Drive Alone, Shared Ride 2 HOV and non-HOV, Shared Ride 3+ HOV and non-HOV, Light Truck, Medium Truck, and Heavy Truck. The procedure then breaks down each mode's OD matrix into inter-superzonal vs. intra-superzone trips using the correspondence table. As an example, consider the same correspondence table and the following OD matrix:

Datav...

ID	CSA
3804	261
3809	261
3813	261
3817	261
3819	261

Matrix6 - AM Trip OD (DA)

	3817	3818	3819	3820
3817	263.73	14.75	78.77	11.12
3818	3.25	5.58	1.94	6.86
3819	63.22	8.04	79.99	6.87
3820	7.52	18.67	4.87	162.91
3821	3.55	6.43	2.35	25.51
3822	7.63	12.17	5.45	29.69

The procedure breaks down the OD matrix into the two following matrices:

Matrix7 - AM Trip OD CSA (DA CSA)

	3817	3818	3819	3820
3817	263.73	0.00	78.77	0.00
3818	0.00	5.58	0.00	0.00
3819	63.22	0.00	79.99	0.00
3820	0.00	0.00	0.00	162.91
3821	0.00	6.43	0.00	0.00
3822	0.00	0.00	0.00	0.00

Matrix7 - AM Trip OD CSA (DA Rest)

	3817	3818	3819	3820
3817	0.00	14.75	0.00	11.12
3818	3.25	0.00	1.94	6.86
3819	0.00	8.04	0.00	6.87
3820	7.52	18.67	4.87	0.00
3821	3.55	0.00	2.35	25.51
3822	7.63	12.17	5.45	29.69

The "DA CSA" matrix represents all trips that both begin and end in the same CSA (region) (e.g. 3819-3817). These are considered intra-superzonal trips. The "DA Rest" matrix represents all trips that begin in one CSA and end outside of the CSA (e.g. 3817-3818). These are considered inter-superzonal trips. The intra-superzonal trip matrices are extracted and used in the next step.

The second step is automatically estimated by the Subregion model through its trip generation, distribution, mode split, and time-of-day processes, which are similar to the Regional model. The end results are time period (AM, PM, MD, NT) OD trip matrices. The diagonals of these matrices are considered to be intra-superzonal trips, and the non-diagonals are considered to be inter-superzonal trips. This is the case only for zones that are aggregated. For the Subregion zones that were not aggregated, this transformation does not occur.

For Step 3, TAZ households and employment inputs are used to estimate TAZ origin and disaggregation factors. In this simple model, households and employment are added together, and then factored by time period time-of-day and departure and return percentages to produce full superzone-to-TAZ disaggregation factors. These factors tell the model the relative importance of each TAZ in a superzone to OD tripmaking, compared to other TAZs in the superzone. Thus, a TAZ that has more household and employment would be allocated a higher factor. All TAZ factors within a superzone would be normalized to 1.0. The time of day and departure and return percentages were estimated by the survey, and lump together all trip purposes.

In Step 4, intra-superzone OD trips are disaggregated into their full TAZ-to-TAZ components through an IPF Fratar procedure. First, the superzone trip row and column marginals are disaggregated into TAZ marginals using the disaggregation factors from step 3. As an example, say there are 1000 superzone trips from superzone 1 to superzone 1. The table below would illustrate the calculated TAZ marginals disaggregated from the 1000 trips given an input set of disaggregation factors:

Superzone	TAZ	Origin Disaggregation Factor	Destination Disaggregation Factor	Origin Marginal	Destination Marginal
1	21	0.2	0.3	200	300
1	22	0.3	0.3	300	300
1	23	0.4	0.3	400	300
1	24	0.1	0.1	100	100

An IPF Fratar procedure is then used to grow the Base Year intra-superzone trip matrix into the estimated scenario Intra-Superzone TAZ trip matrix using the origin and destination marginals.

In the final step, the intra-Superzone TAZ trip matrix is assigned to the network. This assignment step is detailed in the next section.

Highway Assignment

For consistency, the Subregional highway assignment models use the same assignment method (User Equilibrium) and volume delay curves and link parameters as the Regional Model. It was necessary, however, to add assignment models in order to account for trips lost when assigning intra-superzonal trips, and trips lost on superzone centroid connectors. The Subregional Model performs three kinds of highway assignments:

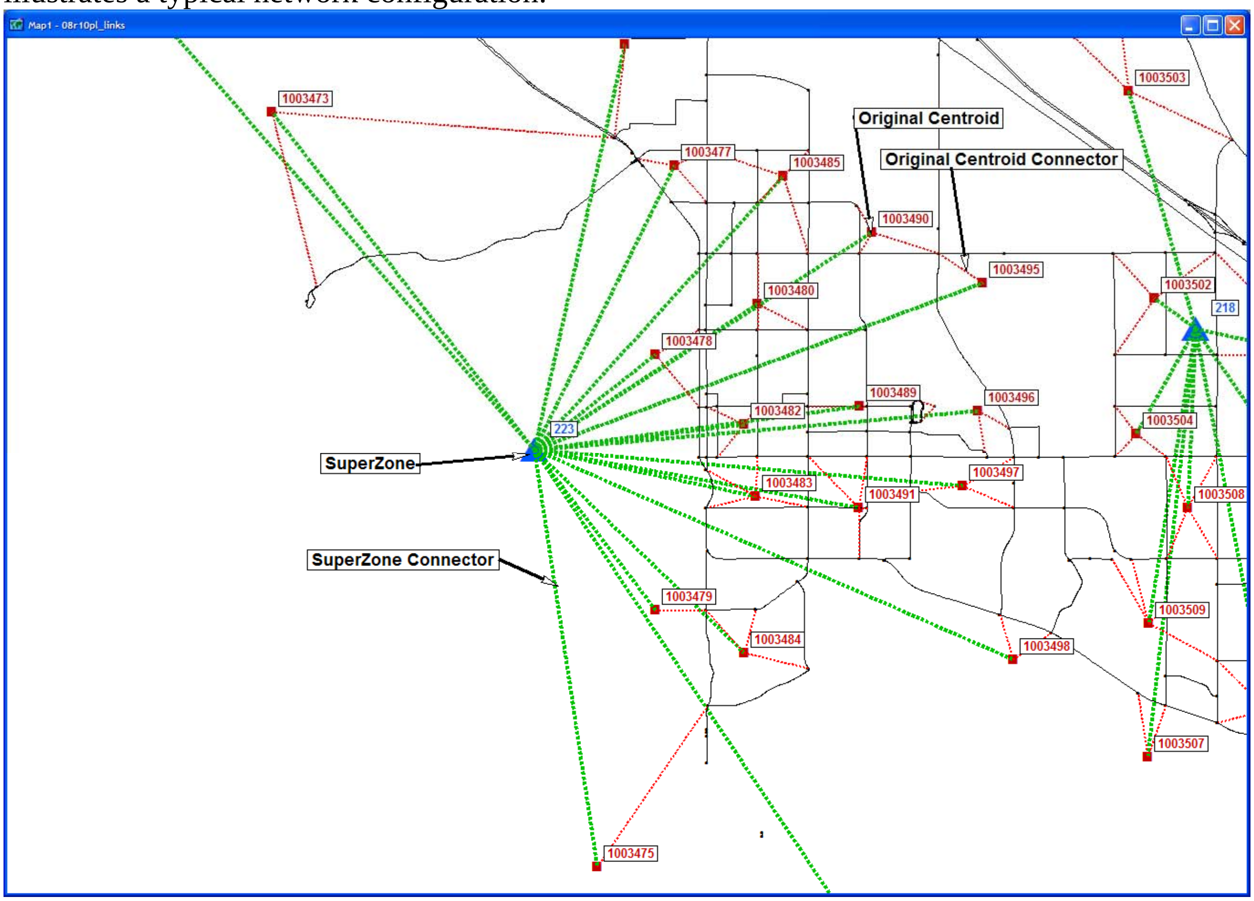
1. An Intra-superzone assignment is performed to assign intra-superzone trips to the network.
2. An Inter-superzone assignment is performed to assign non-intra-superzone trips to the network.

3. A superzone connector assignment is performed to re-assign trips on the superzone connector back to the rest of the network.

The OD matrices generated for these assignments are designed to be compatible with the sketch plan network design, which is described in the next section.

Organization of Centroid Connectors

For the regions of the model that are aggregated to CSAs, the Subregional network has been processed such that it contains two sets of centroid connectors. One set of connectors are preserved from the original regional network. The second set of connectors are created during the Subregion conversion process, and adds links between the aggregate zone centroid and the original TAZ centroid. The following figure illustrates a typical network configuration:



In the above diagram, there is one superzone connector link between the superzone node and each TAZ node within the superzone. The superzone nodes are numbered between 1 and the highest superzone number. As the illustration also shows, the original regional network centroid nodes have been renumbered so that they reflect the original centroid node TAZ number plus 1,000,000. Again, the superzones, connectors, and renumbering of original zones only occur in the areas that are aggregated.

For zones and centroids that are of AGGTYPE = “U”, no transformations are performed. The original centroid node and centroid connector links are used. The centroid node is renumbered to the Subregion zone’s TAZ number.

For zones and centroids that are disaggregated (AGGTYPE = “D”), a new set of centroid connectors are created using TransCAD’s centroid connector tool. This utility creates a node at the disaggregated TAZ’s centroid location, and creates up to 4 connector links from the centroid location to the mid-point of nearby links. The utility then deletes the original centroid connectors from the regional TAZs.

Assigning Intra-Superzone Trips

The outputs of the Intra-Superzone Trips model are time period origin-destination matrices of intra-superzone trips. The origin and destination node IDs of the trips reflect the original regional TAZs, plus 1,000,000, for compatibility with the Regional network. This OD matrix is then assigned to the Subregion network. In this network, the superzone connectors are turned off. In addition, assignment volume flows from previous feedback assignments are used as a preload. This simulates appropriate levels of congestion so that the intrazonal trips take reasonable congested paths. The output flows are considered to be intra-superzone flow.

Assigning Inter-Superzone Trips

After the intra-superzone flow is assigned, inter-superzone trips are assigned. These are the non-diagonal cells in the time period superzone OD trips matrices that are estimated from the trip generation, distribution, mode split, and time of day models. These are also the OD pairs that are outside of the aggregated regions. In this assignment, the superzone connectors are turned on. To properly reflect the congestion levels, the intra-superzone flows calculated from the previous assignment are used as a preload to this assignment.

Assigning Superzone Connector Trips

Inter-superzone trips use superzone connectors at the beginning and end of their trips in the Subregional assignment. In the Regional Model, these trips would have begun and ended at TAZs within the superzone, and would have taken local network links instead of the superzone connectors. This underestimates local network volume flow to some degree. To account for this, superzone connector trips are re-assigned to the network. First a superzone connector OD matrix is created using the following procedure:

1. Each superzone connector goes from the superzone node to the original centroid node. For each superzone connector:
    a. The TAZ zone closest to the midpoint of the superzone connector is identified and is chosen as the starting node of the trip (ANODE).
    b. The ending node of the trip is the original centroid node (BNODE of the connector).
2. All superzone connector trips are aggregated into an OD matrix from original centroid node to original centroid node

Note that like the Intra-superzone assignment, the superzone connector assignment only occurs in the regions where zones are aggregated.

Volume flows calculated from the previous assignments are used as preloads in order to estimate proper congestion levels. After these local volume flows are estimated, the volumes from the superzone connectors are deleted in order to avoid any double counting.

The total vehicle volumes are thus the sum of the intra-superzone volumes, inter-superzone volumes, and the re-assigned superzone connector volumes.

Calibration and Validation

We now describe the model verification performed on the Subregional model to ensure model consistency with comparable Regional model and survey results. A full submodel model calibration and validation was not conducted due to the lack of validation data specific to the San Bernardino subregion. In addition, the full subregion network was not yet available for the San Bernardino subregion at the time of this report.

Once specific San Bernardino networks are available, and once more detailed validation data such as counts and trips for San Bernardino is available, the intent is to incorporate these datasets into the Subregional model and to perform full-scale calibration and validation. Due to the very short time scale of this project, however, the incorporation of these datasets, and full scale calibration and validation were beyond the scope of this project. The goal of verification thus is to ensure that model results for the base year are consistent with the Regional model. An additional goal is to ensure that model sensitivity to various network, demographic, and policy changes are consistent with the Regional Model, and are reasonable.

Model Verification Dataset

The Subregional model was verified using the Base Year 2003 Regional Model. The Base Year 2003 regional model is the official adopted version of the SCAG model with highly reliable and reproducible model outputs. All of the input networks, demographics, and other datasets used for the Year 2003 model has been checked, verified, and thoroughly tested as part of the RTP and TIP process. In addition, Year 2003 model results can also be checked against both Census 2000 datasets and year 2000 travel survey data. Base Year 2008 input data were also produced for the Subregional model and checked for reasonableness, but the bulk of the verifications were performed using Year 2003 data.

Model verification was performed using solely SCAG-generated Regional socio-economic estimates. For the subregion, the socio-economic data were disaggregated based upon area proportions. Specific socio-economic data for the subregion was available from San Bernardino county, but was not used for the verification test. The goal of verification is to test the model results and sensitivities to the Regional model, and the clearest approach is to use similar demographic inputs. The use of alternate socioeconomic inputs would cause a deviation from this test. The subregional model does, however, allow the user to substitute custom demographics inputs for the subregion. A test was conducted using the alternate socioeconomic inputs from San Bernardino, and the results are presented later in this report.

Both the Regional and Subregional models were developed under TransCAD Version 5.0 R2. This version of the model is named Version 5.0 and it offers many features and improvements over the officially adopted Version 4 Regional Model running under TransCAD Version 4.8. Both the Regional and Subregional models share similar models and also share the exact same underlying model code. The Version 5 model results are slightly different than Version 4 due to many added and updated models, and a few model fixes. The overall model results and sensitivities of Version 4 and Version 5 are similar, however. Due to these small differences, and to obtain a similar base for comparisons, the Subregional model results were compared and verified to the Version 5 Regional model.

Model Verification Steps

The Subregion model was verified to both 2000 survey and Year 2003 Regional model results. The following model steps were verified:

- The household auto availability model was verified to the survey
- Trip generation was compared and verified to the Regional model results
- Trip distribution average trip lengths and trip length frequency curves were verified to the 2000 survey
- Mode shares were verified to Regional model mode share targets
- The following trip assignment results were compared and verified to the Regional model:
    - VMT by County and Air Basin
    - VMT, VHT, Delay and average speed by time period
    - Total screenline volumes
    - Transit boardings by mode

Household Auto Availability Verification

In the household auto availability model, the total percent of 0, 1, 2, and 3+ auto households by county generated by the Regional model was compared with survey results. Constants in the logit models were adjusted until the percentages matched the survey. The following table compares the Regional vs. survey results. In all cases, the Regional results were within half a percent of the survey.

Census vs. Model Auto Availability

Census Auto Availability

	% No Autos	% 1 Auto	% 2 Autos	% 3 Autos	% 4+ Autos
Imperial	11.09%	34.02%	36.33%	13.44%	5.12%
Los Angeles	12.55%	36.95%	34.46%	11.28%	4.76%
Orange	5.82%	31.12%	42.60%	14.29%	6.18%
Riverside	7.08%	34.66%	39.28%	13.47%	5.51%
San Bernardino	7.97%	32.37%	38.75%	14.75%	6.16%
Ventura	5.02%	28.03%	43.26%	16.40%	7.29%
Total	10.07%	34.85%	37.16%	12.59%	5.33%

Model Auto Availability

	% No Autos	% 1 Auto	% 2 Autos	% 3 Autos	% 4+ Autos
Imperial	11.04%	33.94%	36.39%	13.48%	5.15%
Los Angeles	12.49%	36.89%	34.53%	11.31%	4.78%
Orange	5.81%	31.10%	42.62%	14.29%	6.18%
Riverside	7.07%	34.64%	39.30%	13.47%	5.52%
San Bernardino	7.92%	32.28%	38.82%	14.80%	6.18%
Ventura	5.02%	28.02%	43.26%	16.40%	7.30%
Total	9.97%	34.77%	37.26%	12.65%	5.35%

Model/Census Ratio

Imperial	0.996	0.998	1.002	1.003	1.005
Los Angeles	0.995	0.998	1.002	1.003	1.003
Orange	0.998	0.999	1.000	1.001	1.001
Riverside	0.999	0.999	1.000	1.001	1.001
San Bernardino	0.994	0.997	1.002	1.003	1.004
Ventura	0.999	1.000	1.000	1.000	1.000
Total	0.991	0.998	1.003	1.004	1.004

Trip Generation

For the trip generation results, total Regional productions and attractions by trip purpose and time period were compared with Regional model results. All trip generation models in both the Regional and Subregional model are identical. The table below illustrates the comparison trip results between the Region and Subregion.

Trip Generation Trips

Purpose	Regional Model	Subregion Model	Difference
HBWD1	4,076,826	4,087,515	0.26%
HBWD2	2,510,387	2,505,117	-0.21%
HBWD3	1,953,863	1,946,548	-0.37%
HBWS1	1,275,675	1,274,736	-0.07%
HBWS2	780,135	778,512	-0.21%
HBWS3	606,323	601,062	-0.87%
HBSC	4,925,815	4,925,785	0.00%
HBCU	677,820	677,800	0.00%
HBSH	4,941,584	4,936,304	-0.11%
HBSR	4,334,171	4,313,113	-0.49%
HBO	7,528,673	7,541,228	0.17%
HBSP	7,337,999	7,387,178	0.67%
WBO	3,609,872	3,619,321	0.26%
OBO	13,503,273	13,497,706	-0.04%

As can be seen, the Subregional trips are very similar to the Regional model trips. This is not surprising, since the same input demographic tables are used, and since the same models are implemented. A very limited amount of variation occurs due to the aggregation of the demographics in areas where TAZs were aggregated to CSAs. The trip generation trips for San Bernardino County were also compared and are listed below:

Trip Generation Trips - San Bernardino

Purpose	Regional Model	Subregion Model	Difference
HBWD1	400,763	400,766	0.00%
HBWD2	259,217	259,223	0.00%
HBWD3	155,477	155,465	-0.01%
HBWS1	128,753	128,880	0.10%
HBWS2	83,303	83,355	0.06%
HBWS3	50,195	50,187	-0.02%
HBSC	584,277	584,265	0.00%
HBCU	66,881	73,955	10.58%
HBSH	515,146	513,940	-0.23%
HBSR	461,104	458,395	-0.59%
HBO	787,860	787,888	0.00%
HBSP	811,701	814,438	0.34%
WBO	291,591	292,391	0.27%
OBO	1,247,352	1,246,825	-0.04%

For the most part, the Subregional trips are similar to the Regional trips with the exception of HBCU trips. Since HBCU trips overall are similar, this discrepancy might be due some HBCU trips being allocated in one county versus another.

Trip Distribution

For trip distribution, several comparisons between the Regional and the Subregional model were made. First, average trip distances and travel times were compared between the Subregional Model and the survey. The average trip lengths and the trip distribution curves were adjusted by adjusting the B, C1 and C2 gamma parameters by trip purpose and period in the Friction Factors Parameters table. The following table illustrates the comparison in average trip lengths for the entire SCAG area and for San Bernardino County.

Trip Distribution-Average Trip Lengths

	Survey		Subregion		Percent Difference	
TRIP_PURPOSE	**Time**	**Distance**	**Time**	**Distance**	**Time**	**Distance**
HBWD1 PK	21.0	11.3	21.8	11.5	3.5%	2.1%
HBWD2 PK	24.5	13.2	25.3	13.3	3.1%	1.0%
HBWD3 PK	26.4	14.2	26.8	14.2	1.4%	0.3%
HBWS1 PK	21.0	11.0	22.0	11.7	4.8%	6.4%
HBWS2 PK	24.4	13.1	26.0	13.9	6.8%	6.8%
HBWS3 PK	28.7	15.4	29.0	15.6	1.0%	1.3%
HBSP PK	12.2	6.7	12.6	6.8	3.8%	1.5%
HBSC PK	8.0	4.2	9.4	5.0	18.4%	19.9%
HBCU PK	17.9	9.4	17.5	9.3	-2.3%	-0.8%
HBSH PK	14.3	8.2	15.1	8.3	5.0%	1.8%
HBSR PK	19.4	11.1	20.1	11.2	3.5%	1.0%
HBO PK	17.5	10.1	18.6	10.5	6.3%	3.6%
OBO PK	13.8	7.6	14.2	7.6	3.0%	0.8%
WBO PK	19.7	10.9	19.6	10.7	-0.7%	-2.6%
HBWD1 OP	18.5	11.2	19.2	11.6	4.1%	3.1%
HBWD2 OP	23.7	15.0	24.3	15.1	2.8%	1.2%
HBWD3 OP	24.6	15.4	25.1	15.7	2.0%	1.8%
HBWS1 OP	20.7	12.9	21.8	13.5	5.1%	4.7%
HBWS2 OP	21.9	13.6	22.7	14.1	3.6%	4.3%
HBWS3 OP	26.4	16.7	27.3	17.3	3.4%	3.5%
HBSP OP	12.0	7.4	12.5	7.6	4.7%	2.6%
HBSC OP	6.9	3.9	8.2	4.7	19.0%	23.0%
HBCU OP	14.9	8.8	14.8	8.8	-0.7%	-0.5%
HBSH OP	12.3	7.4	12.6	7.5	2.1%	2.0%
HBSR OP	19.3	12.1	19.8	12.5	2.7%	2.8%
HBO OP	15.2	9.4	15.9	9.8	4.8%	4.8%
OBO OP	13.2	8.0	13.7	8.1	3.5%	1.3%
WBO OP	15.3	9.3	15.4	9.3	0.3%	0.1%

Average travel times for the Subregion Model were fairly close to the regional model. Average travel distances were also fairly close to the regional model, but are slightly longer. Trip lengths and times were purposefully made slightly longer in order to match up the Regional versus Subregion model VMT later in the model.

The trip length frequency curves for both the Regional and survey were then compared. Coincidence ratios comparing the subregion and regional curves were calculated by trip purpose and time period, and are presented in the following table. The objective was to obtain a correlation coefficient of 0.8 or above. As can be seen, in most cases the objective was reached. For some purposes, such as HBCU, it was extremely difficult to verify to that level due to the limited number of zones that had college and university facilities, and the above-average incidence of intrazonal tripmaking for this purpose.

Trip Length Frequency Coincidence Ratios

Purpose	PK	OP	Total
HBCU	0.67	0.69	0.76
HBO	0.81	0.82	0.85
HBSC	0.80	0.78	0.81
HBSH	0.80	0.82	0.84
HBSP	0.79	0.77	0.80
HBSR	0.78	0.78	0.80
HBWD1	0.81	0.80	0.83
HBWD2	0.83	0.79	0.86
HBWD3	0.83	0.76	0.85
HBWS1	0.75	0.79	0.81
HBWS2	0.76	0.78	0.81
HBWS3	0.76	0.72	0.80
OBO	0.81	0.80	0.82
WBO	0.79	0.82	0.85

Total county to county trips were compared to the Regional model, and can be seen in the following table.

Trip Distribution - County to County Trip Comparison

Regional Model

COUNTY	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	TOTAL
Imperial	444,156	214	123	5,791	465	5	450,754
Los Angeles	1,074	30,920,287	1,271,925	139,930	425,285	288,701	33,047,201
Orange	854	1,186,545	9,084,887	124,636	112,714	8,213	10,517,849
Riverside	13,737	259,046	256,068	4,561,573	435,738	3,248	5,529,411
San Bernardino	2,360	602,244	197,985	409,883	4,624,416	6,733	5,843,621
Ventura	60	360,759	10,964	2,381	5,084	2,294,324	2,673,572
TOTAL	462,241	33,329,095	10,821,951	5,244,195	5,603,702	2,601,224	58,062,408

Subregion Model

COUNTY	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	TOTAL
Imperial	431,474	4,526	1,974	9,215	3,165	344	450,698
Los Angeles	4,780	31,058,935	1,162,988	135,798	414,556	277,925	33,054,982
Orange	1,793	1,084,762	9,211,253	104,098	107,827	11,120	10,520,852
Riverside	15,104	263,086	228,468	4,613,076	410,407	7,101	5,537,242
San Bernardino	2,916	586,796	195,162	384,088	4,671,689	9,323	5,849,974
Ventura	411	351,640	15,861	4,577	8,811	2,296,874	2,678,173
TOTAL	456,478	33,349,744	10,815,707	5,250,852	5,616,455	2,602,687	58,091,922

Percent Difference

COUNTY	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura	TOTAL
Imperial	-2.86%	2012.14%	1509.59%	59.13%	580.57%	6567.44%	-0.01%
Los Angeles	345.18%	0.45%	-8.56%	-2.95%	-2.52%	-3.73%	0.02%
Orange	109.80%	-8.58%	1.39%	-16.48%	-4.34%	35.39%	0.03%
Riverside	9.95%	1.56%	-10.78%	1.13%	-5.81%	118.61%	0.14%
San Bernardino	23.56%	-2.57%	-1.43%	-6.29%	1.02%	38.47%	0.11%
Ventura	586.42%	-2.53%	44.67%	92.19%	73.29%	0.11%	0.17%
TOTAL	-1.25%	0.06%	-0.06%	0.13%	0.23%	0.06%	0.05%

In most cases, the total trip interchanges compared fairly well, although slightly more intra-county trips are observed in the SubRegional model. These extra intra-county trips are offset by slightly fewer inter-county trips. This result is most likely caused by the aggregation of zones to CSAs. In the Regional model, there were trip interchanges between TAZs in adjacent counties. In the Subregion Model, these trips are more likely to stay inside a CSA, which will stay within a county. These trip interchanges between counties are accounted for, however, in the Intra-Superzone assignment model and in the Superzone centroid connector assignment model. The results of these assignments are not reflected in the above trip distribution reporting results. Of particular interest are the trips within, and into and out of San Bernardino County. As seen above, these trips match up fairly well with the Regional model with a few exceptions.

The table below compares intrazonal trips from the regional model to the Subregion Model. Not surprisingly, the Regional model contains many more intrazonal trips, due to the aggregation of zones.

Regional Model Intrazonal Trips			
Peak			
Purpose	Total	Intra	PercentIntra
HBWD1	689,878	27,248	3.9
HBWD2	1,385,445	43,849	3.2
HBWD3	3,574,887	92,419	2.6
HBWS1	203,152	6,904	3.4
HBWS2	406,826	11,305	2.8
HBWS3	1,046,953	22,816	2.2
HBSP	4,767,498	1,032,936	21.7
HBSC	3,640,185	682,269	18.7
HBCU	371,625	11,898	3.2
HBSH	1,997,383	200,910	10.1
HBSR	1,555,106	121,144	7.8
HBO	3,352,158	305,736	9.1
OBO	5,872,900	519,910	8.9
WBO	1,932,274	114,344	5.9
HBOALL	4,907,264	426,880	8.7
Off Peak			
Purpose	Total	Intra	PercentIntra
HBWD1	352,997	16,902	4.8
HBWD2	708,868	27,223	3.8
HBWD3	1,829,001	57,979	3.2
HBWS1	123,231	4,583	3.7
HBWS2	246,801	7,643	3.1
HBWS3	635,170	15,092	2.4
HBSP	2,570,501	517,589	20.1
HBSC	1,285,630	319,511	24.9
HBCU	306,195	11,997	3.9
HBSH	2,944,201	411,599	14.0
HBSR	2,779,064	200,457	7.2
HBO	4,176,515	515,033	12.3
OBO	7,630,373	732,043	9.6
WBO	1,677,598	154,316	9.2
HBOALL	6,955,580	715,490	10.3

SubRegional Model Intrazonal Trips			
Peak			
Purpose	Total	Intrazonal	% Intrazonal
HBWD1	700,240	92,857	13.3
HBWD2	1,378,446	188,503	13.7
HBWD3	3,570,170	482,348	13.5
HBWS1	205,555	31,848	15.5
HBWS2	404,093	59,318	14.7
HBWS3	1,042,378	143,199	13.7
HBSP	4,799,450	2,129,200	44.4
HBSC	3,640,159	1,893,470	52.0
HBCU	371,614	74,375	20.0
HBSH	1,995,246	742,967	37.2
HBSR	1,547,750	444,397	28.7
HBO	3,357,745	1,039,117	30.9
OBO	5,870,516	2,104,979	35.9
WBO	1,937,333	470,952	24.3
HBOALL	4,905,495	1,483,514	30.2
Off Peak			
Purpose	Total	Intrazonal	% Intrazonal
HBWD1	358,277	54,058	15.1
HBWD2	705,268	105,669	15.0
HBWD3	1,826,780	268,300	14.7
HBWS1	124,640	19,806	15.9
HBWS2	245,043	37,189	15.2
HBWS3	632,601	85,883	13.6
HBSP	2,587,728	1,047,591	40.5
HBSC	1,285,626	758,483	59.0
HBCU	306,186	71,004	23.2
HBSH	2,941,058	1,082,111	36.8
HBSR	2,765,363	630,163	22.8
HBO	4,183,483	1,255,091	30.0
OBO	7,627,190	2,555,801	33.5
WBO	1,681,988	642,378	38.2
HBOALL	6,948,846	1,885,254	27.1

Mode Split

For mode split verification, the Subregional model results were compared with the Regional model results. The final mode shares from the Regional model were turned into mode share targets, and an automated mode split utility was invoked that adjusted the logit equation constants by mode and trip purpose, until mode share results matched target values. Some manual adjustment was also necessary. The goal in most cases was to match auto and transit shares. The following table shows final mode share comparisons between the Regional and Subregional model.

Mode Choice Results

Regional Model				Trip Purpose				
Mode	HBW	HBSH	HBSC	HBCU	HBO	WBO	OBO	TOTAL
Auto	91.48%	87.99%	51.81%	81.12%	87.58%	90.27%	89.75%	85.72%
DA	72.94%	38.89%	2.09%	58.44%	34.23%	72.81%	36.32%	41.48%
SR2	12.70%	25.10%	18.69%	14.44%	25.66%	10.67%	26.93%	22.19%
SR3	5.84%	24.01%	31.03%	8.24%	27.69%	6.80%	26.50%	22.05%
Transit	4.03%	0.76%	1.91%	6.65%	1.43%	0.44%	0.78%	1.58%
Non-Motorized	4.49%	11.25%	34.55%	12.23%	10.98%	9.28%	9.47%	11.70%
School Bus	0.00%	0.00%	11.73%	0.00%	0.00%	0.00%	0.00%	0.99%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Subregion Model				Trip Purpose				
Mode	HBW	HBSH	HBSC	HBCU	HBO	WBO	OBO	TOTAL
Auto	91.30%	87.96%	52.14%	80.97%	87.52%	90.19%	89.58%	85.65%
DA	74.15%	39.06%	2.65%	58.56%	34.32%	73.13%	36.38%	41.82%
SR2	11.81%	25.07%	18.61%	14.31%	25.69%	10.49%	26.93%	22.00%
SR3	5.33%	23.84%	30.89%	8.09%	27.52%	6.56%	26.27%	21.82%
Transit	4.14%	0.75%	1.87%	6.76%	1.42%	0.46%	0.82%	1.61%
Non-Motorized	4.56%	11.29%	34.31%	12.27%	11.05%	9.36%	9.61%	11.75%
School Bus	0.00%	0.00%	11.67%	0.00%	0.00%	0.00%	0.00%	0.99%
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Difference				Trip Purpose				
Mode	HBW	HBSH	HBSC	HBCU	HBO	WBO	OBO	TOTAL
Auto	0.19%	0.03%	-0.65%	0.18%	0.07%	0.10%	0.20%	0.08%
DA	-1.67%	-0.44%	-26.79%	-0.21%	-0.26%	-0.44%	-0.16%	-0.81%
SR2	6.95%	0.13%	0.44%	0.89%	-0.10%	1.68%	0.01%	0.83%
SR3	8.74%	0.71%	0.45%	1.77%	0.63%	3.40%	0.88%	1.02%
Transit	-2.73%	1.37%	2.08%	-1.69%	0.69%	-3.22%	-5.35%	-1.58%
Non-Motorized	-1.39%	-0.36%	0.69%	-0.30%	-0.65%	-0.80%	-1.42%	-0.43%
School Bus			0.51%					

In most cases, auto and transit shares match fairly well.

Trip Assignment

For trip assignment verification, several model results were compared. First, VMT by county and air basin was compared, and is presented in the following table:

VMT By County and Air Basin

Regional Model			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial	0	0	0	5,004,015	5,004,015
Los Angeles	0	195,698,268	6,694,679	0	202,392,946
Orange	0	68,032,252	0	0	68,032,252
Riverside	0	37,702,906	2,128,038	9,388,156	49,219,099
San Bernardino	0	30,140,341	23,562,684	0	53,703,025
Ventura	16,943,033	0	0	0	16,943,033
TOTAL	16,943,033	331,573,766	32,385,401	14,392,171	395,294,370

Subregion Model			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial	0	0	0	7,712,342	7,712,342
Los Angeles	0	186,253,636	7,731,598	0	193,985,235
Orange	0	66,292,638	0	0	66,292,638
Riverside	0	36,892,984	2,557,425	11,717,005	51,167,413
San Bernardino	0	29,813,112	24,214,141	0	54,027,253
Ventura	18,013,025	0	0	0	18,013,025
TOTAL	18,013,025	319,252,371	34,503,164	19,429,347	391,197,906

Difference			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial				54.12%	54.12%
Los Angeles		-4.83%	15.49%		-4.15%
Orange		-2.56%			-2.56%
Riverside		-2.15%	20.18%	24.81%	3.96%
San Bernardino		-1.09%	2.76%		0.60%
Ventura	6.32%				6.32%
TOTAL	6.32%	-3.72%	6.54%	35.00%	-1.04%

The VMT overall is fairly close to the Regional Model. For San Bernardino, the VMT in the Subregion model is also fairly close to the Regional Model.

Second, VMT, VHT, Delay, and average speeds by time period were compared, and are presented in the following table:

Assignment Speed, VMT, VHT, Delay

	Time Period				
Regional Model	**AM PEAK**	**PM PEAK**	**MIDDAY**	**NIGHT**	**TOTAL**
Average Speed (mph), ALL	30.9	26.9	35.8	43.8	32.1
Vehicle Miles Traveled ('000), ALL	79,792	133,369	117,306	64,827	395,294
Vehicle Hours Traveled ('000), ALL	2,583	4,956	3,279	1,481	12,298
Vehicle Hours Delay ('000), ALL	755	1,823	610	86	3,273

	Time Period				
Subregion Model	**AM PEAK**	**PM PEAK**	**MIDDAY**	**NIGHT**	**TOTAL**
Average Speed (mph), ALL	30.4	27.4	33.7	41.7	31.7
Vehicle Miles Traveled ('000), ALL	78,453	127,763	117,554	69,276	393,046
Vehicle Hours Traveled ('000), ALL	2,580	4,667	3,492	1,662	12,402
Vehicle Hours Delay ('000), ALL	704	1,526	690	115	3,035

	Time Period				
Difference	**AM PEAK**	**PM PEAK**	**MIDDAY**	**NIGHT**	**TOTAL**
Average Speed (mph), ALL	-2%	2%	-6%	-5%	-1%
Vehicle Miles Traveled ('000), ALL	-2%	-4%	0%	7%	-1%
Vehicle Hours Traveled ('000), ALL	0%	-6%	6%	12%	1%
Vehicle Hours Delay ('000), ALL	-7%	-16%	13%	34%	-7%

The VHT and Delay are comparable with the Regional model, but are a bit lower, and, as illustrated before, the VMT is a bit lower.

For emissions factoring, the emissions factors that adjust volumes by sub-air-basin for cars and trucks were re-calculated. The following two tables compare VMT by county and air basin, after emissions factoring.

VMT After Emissions Factoring

Regional Model			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial	0	0	0	4,880,765	4,880,765
Los Angeles	0	205,565,829	7,679,227	0	213,245,056
Orange	0	69,370,769	0	0	69,370,769
Riverside	0	30,616,289	1,957,814	10,650,814	43,224,916
San Bernardino	0	33,704,777	20,395,528	0	54,100,305
Ventura	18,388,255	0	0	0	18,388,255
TOTAL	18,388,255	339,257,663	30,032,569	15,531,579	403,210,066

Subregion Model			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial	0	0	0	4,884,728	4,884,728
Los Angeles	0	205,621,390	7,671,058	0	213,292,448
Orange	0	69,351,464	0	0	69,351,464
Riverside	0	30,616,269	1,962,292	10,651,935	43,230,496
San Bernardino	0	33,711,257	20,398,484	0	54,109,741
Ventura	18,391,254	0	0	0	18,391,254
TOTAL	18,391,254	339,300,380	30,031,834	15,536,663	403,260,131

Difference			Air Basin		
County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
Imperial				0.08%	0.08%
Los Angeles		0.03%	-0.11%		0.02%
Orange		-0.03%			-0.03%
Riverside		0.00%	0.23%	0.01%	0.01%
San Bernardino		0.02%	0.01%		0.02%
Ventura	0.02%				0.02%
TOTAL	0.02%	0.01%	0.00%	0.03%	0.01%

As can be seen, the Subregional model matches the Regional model quite well after emissions factors are adjusted. For San Bernardino County, the VMT results match quite well as well.

Total screenlines between the Regional and Regional model were also compared, and are presented in the following table:

Screenline Flows

Screenline Number	Count	Region Flow	Region Difference	Subregion Flow	Subregion Difference
1	1,454,360	1,434,322	-1.38	1,120,473	-22.96
2	1,601,031	1,597,539	-0.22	1,437,459	-10.22
3	1,389,112	1,232,766	-11.26	1,057,470	-23.87
4	1,241,117	1,304,071	5.07	1,140,892	-8.08
5	1,097,428	1,246,414	13.58	1,106,565	0.83
6	976,208	926,797	-5.06	949,512	-2.73
7	801,874	716,778	-10.61	670,020	-16.44
8	1,164,055	1,139,938	-2.07	1,115,083	-4.21
9	485,326	441,842	-8.96	425,181	-12.39
10	182,226	225,601	23.8	211,077	15.83
11	237,399	251,385	5.89	231,979	-2.28
12	182,116	174,901	-3.96	188,175	3.33
13	174,994	198,091	13.2	215,234	23
14	250,100	265,586	6.19	245,780	-1.73
15	277,637	345,000	24.26	340,127	22.51
16	1,263,948	1,408,658	11.45	1,182,543	-6.44
17	2,102,947	2,006,654	-4.58	1,706,546	-18.85
18	411,832	360,368	-12.5	268,322	-34.85
20	82,340	90,057	9.37	101,049	22.72
21	161,106	142,237	-11.71	150,821	-6.38
22	19,696	20,900	6.11	26,551	34.81
23	41,029	42,276	3.04	69,296	68.89
Total	**15,597,880**	**15,572,181**	**-0.16**	**13,960,156**	**-10.5**

Overall, the Regional screenline volumes are slightly lower than the Regional model screen volumes. In addition, certain screenlines have less accurate volumes compared with the Regional model. The aggregation probably caused certain trips to be re-routed to alternate centroid connectors compared to the Regional model, which adversely affects some screenline results. Screenlines 6, 7, 8, 9, 13 and 20 were also looked at in greater detail since they are either directly in or near San Bernardino County. These screenline volumes are a little bit worse than the Regional model, but mostly they are within reasonable bounds. It is expected that when extra network detail is added in San Bernardino, extra count data is entered in and compared, and when centroid connectors are adjusted, that the screenline flows will match better with the counts.

Transit trips were also verified. The table below illustrates transit boardings by mode for the Regional vs. the Subregional model:

Transit Boardings by Mode

	Total Boardings		
MODE	**Region Model**	**SubRegion**	**Difference**
Commuter Rail	36,250	44,921	23.92%
MTA Local Bus	961,976	1,015,885	5.60%
MTA Express Bus	113,297	99,072	-12.56%
Metro Rail	228,755	223,384	-2.35%
14	93,708	92,500	-1.29%
15	67,017	78,227	16.73%
16	227,851	215,359	-5.48%
17	40,885	45,457	11.18%
18	655	210	-68.03%
19	361,991	398,819	10.17%
20	8,448	8,500	0.61%
Rapid Bus	55,509	79,328	42.91%
TOTAL	2,196,343	2,301,662	4.80%

MetroRail boardings match well with the Regional model. Commuter Rail and MTA Local bus boardings are slightly high. There are increasing differences in the other modes.

Future Year Comparisons

The SubRegional model results were compared with the Regional results for Year 2035 Plan and 2008. VMT and transit ridership were compared. The following tables lists VMT by air basin and county comparisons after emissions factors are applied for the two model years.

VMT By County by Air Basin - 2035 Plan

Region

County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
			Air Basin		
Imperial	0	0	0	15,290,907	15,290,907
Los Angeles	30,440	238,738,742	23,458,599	0	262,227,781
Orange	0	86,593,955	0	0	86,593,955
Riverside	0	59,819,489	4,589,378	27,190,707	91,599,573
San Bernardino	0	55,391,633	42,710,926	0	98,102,558
Ventura	23,626,311	89,954	0	0	23,716,265
TOTAL	23,656,751	440,633,772	70,758,902	42,481,614	577,531,039

Subregion

County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
			Air Basin		
Imperial	0	0	0	10,101,907	10,101,907
Los Angeles	61,887	238,714,197	18,830,844	0	257,606,928
Orange	0	87,112,638	0	0	87,112,638
Riverside	0	58,840,043	3,478,815	24,348,582	86,667,440
San Bernardino	0	56,378,449	42,444,628	0	98,823,078
Ventura	23,202,226	68,710	0	0	23,270,936
TOTAL	23,264,113	441,114,037	64,754,288	34,450,488	563,582,926

VMT By County by Air Basin - 2008

Region

County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
			Air Basin		
Imperial	0	0	0	7,326,551	7,326,551
Los Angeles	0	197,483,636	7,036,695	0	204,520,331
Orange	0	70,764,210	0	0	70,764,210
Riverside	0	42,506,426	2,593,037	11,252,826	56,352,289
San Bernardino	0	33,870,220	26,481,163	0	60,351,383
Ventura	16,984,497	0	0	0	16,984,497
TOTAL	16,984,497	344,624,492	36,110,895	18,579,377	416,299,261

Subregion

County	VC SCCAB	SCAB	MDAB	SSAB	TOTAL
			Air Basin		
Imperial	0	0	0	10,593,415	10,593,415
Los Angeles	0	191,976,225	8,605,716	0	200,581,941
Orange	0	70,273,297	0	0	70,273,297
Riverside	0	42,953,567	3,170,837	14,755,207	60,879,610
San Bernardino	0	35,313,242	28,429,807	0	63,743,049
Ventura	18,357,421	0	0	0	18,357,421
TOTAL	18,357,421	340,516,330	40,206,360	25,348,621	424,428,732

Generally, the SubRegional model produces similar results to the Regional model, with small differences.

Transit boarding results and comparisons with the Regional Model are presented in the following tables:

Transit Boardings by Mode-2035 Plan

	Total Boardings		
MODE	**Region Model**	**Subregion**	**Difference**
Commuter Rail	135,427	86,793	-35.91%
MTA Local Bus	1,076,652	1,100,270	2.19%
MTA Express Bus	94,705	71,032	-25.00%
Metro Rail	461,508	424,256	-8.07%
14	116,023	88,065	-24.10%
15	134,094	130,081	-2.99%
16	275,371	236,517	-14.11%
17	46,833	40,744	-13.00%
18	936	208	-77.81%
19	490,293	498,322	1.64%
20	61,284	61,550	0.43%
21	79,669	125,219	57.17%
22	281,079	288,463	2.63%
TOTAL	3,253,874	3,151,521	-3.15%

Transit Boardings by Mode-2008

	Total Boardings		
MODE	**Regional**	**Subregional**	**Difference**
Commuter Rail	43,361	50,470	16.39%
MTA Local Bus	993,795	1,080,815	8.76%
MTA Express Bus	96,221	81,835	-14.95%
Metro Rail	262,041	266,074	1.54%
LA Express	79,790	76,605	-3.99%
Local Foothill	91,212	94,114	3.18%
Local LA1	241,060	216,169	-10.33%
Local LA2	38,611	26,730	-30.77%
Local Inglewood	792	217	-72.59%
Local Non-LA	423,432	383,210	-9.50%
Other Express	13,065	16,366	25.26%
Rapid Bus	168,292	213,418	26.81%
TOTAL	2,451,672	2,506,022	2.22%

Subregional Transit Boardings by Mode-2008 vs. 2003

	Total Boardings		
MODE	**2003**	**2008**	**Difference**
Commuter Rail	44,921	50,470	12.35%
MTA Local Bus	1,015,885	1,080,815	6.39%
MTA Express Bus	99,072	81,835	-17.40%
Metro Rail	223,384	266,074	19.11%
LA Express	92,500	76,605	-17.18%
Local Foothill	78,227	94,114	20.31%
Local LA1	215,359	216,169	0.38%
Local LA2	45,457	26,730	-41.20%
Local Inglewood	210	217	3.58%
Local Non-LA	398,819	383,210	-3.91%
Other Express	8,500	16,366	92.53%
Rapid Bus	79,328	213,418	169.03%
TOTAL	2,301,662	2,506,022	8.88%

Overall, the Subregional model shows similar sensitivities to the Regional model, which is not surprising since similar models and networks are used. For some of the modes, the Regional model produces similar results, while other modes produce somewhat different results. For Subregional purposes, it is important to note that the model produces results within the same range as the Regional model and with similar sensitivities.

Other Sensitivity/Verification Tests

The following additional sensitivity/verification tests were conducted that involved broad scale changes to the highway or transit networks, or changes to the demographics:

- 1 lane was added to all freeways
- Free flow speeds were increased on all freeways by 15%
- All commuter rail route headways were set to 10 minutes
- Households are doubled in the region
- Auto operating costs increased to 30 cents/mile from 13.76 cents/mile due to substantially high gas prices

VMT, VHT, delay, and transit trip statistics are reported out from these runs:

VMT, VHT and Delay Scenario Comparisons

	VMT	VHT	Delay
Base Scenario	393,046	12,402	3,035
10 min CR Headways	389,881	12,222	2,929
1 Extra Lane on all Freeways	403,079	12,245	2,791
15% Higher Freeway Speeds	399,037	12,082	3,061
Doubling Households and Employment	659,835	29,110	12,181
High Auto Operating Cost	337,881	10,228	2,146

In the model runs, the commuter rail scenario caused a slight decrease in VMT, VHT and delays. The freeway scenarios caused a small increase in VMT, and decreases in VHT and delay. The doubling of households caused vast increases in VMT, VHT and delays. The high AOC (gas prices) scenario causes a substantial decrease in VMT, VHT and delays, as trips become shorter, and trips switched over to non-auto modes.

The following tables list the transit boarding comparisons between the scenarios:

Transit Boardings by Mode-Sensitivity Comparisons

	Total Boardings					
Mode	**Base**	**10 min Commuter**	**1 Lane Freeway**	**Freeway 15%**	**Double Housing**	**High AOC**
Commuter Rail	44,921	69,502	44,987	42,842	100,001	47,574
MTA Local Bus	1,015,885	1,012,491	1,021,913	1,009,477	2,000,325	1,473,927
MTA Express Bus	99,072	95,926	98,345	92,923	221,000	164,460
Metro Rail	223,384	222,846	219,896	215,253	582,891	298,618
LA Express	92,500	82,923	93,599	83,376	217,564	188,923
Local Foothill	78,227	77,068	78,975	77,391	156,548	127,372
Local LA1	215,359	213,542	217,568	212,730	422,267	318,889
Local LA2	45,457	45,456	45,030	44,986	102,052	59,243
Local Inglewood	210	204	218	207	397	302
Local Non-LA	398,819	389,393	403,141	388,148	773,031	713,334
Other Express	8,500	7,771	9,162	8,210	11,391	21,020
Rapid Bus	79,328	78,796	78,595	77,459	159,558	115,946
Total	2,301,662	2,295,918	2,311,428	2,253,002	4,747,027	3,529,607

In the full run scenario, the 10 minute commuter rail change caused 50% increase in commuter rail ridership, with the other modes relatively unaffected. The freeway scenarios had little effect on transit boardings. The doubling of housing systemwide resulted in over a doubling of transit boardings. The high gas price (AOC) scenario causes a substantial increase in transit trips across all modes.

To further evaluate the freeway scenarios, screenline flows by facility groups are compared between the base and the two freeway scenarios:

Screenline Flow Comparisons by Facility Group - Freeway Scenarios

	Base Flow	**Extra Lane Flow**	**Extra Lane Diff**	**Extra 15% Flow**	**Extra 15% Diff**
Freeways	9,577,402	10,007,111	4.49%	9,742,090	1.72%
HOV	386,620	274,812	-28.92%	243,750	-36.95%
Expressways	32,010	47,611	48.74%	48,256	50.75%
Principal Arterial	3,915,590	3,321,335	-15.18%	3,318,915	-15.24%
Minor Arterial	1,996,969	1,447,034	-27.54%	1,455,983	-27.09%
Collector	217,536	116,078	-46.64%	124,085	-42.96%
Total	**15,597,880**	**14,553,391**	**-6.70%**	**14,310,989**	**-8.25%**

The comparison shows increases of between 2 and 5% on freeway flow due to the freeway changes and subsequent decreases on the HOV flows. Flows on alternative arterial and minor links are also reduced.

Recommendations for Future Enhancements

The Subregional model is an innovative tool that lets users define and run a focused subregional version of the SCAG Regional Model. There are various enhancements that can be made to the model, however. One set of enhancements can improve the accuracy of the model. A second set of enhancements adds to the features of the model. A third set of enhancements describes data collection enhancement. This section will detail those recommended enhancements. Some of these enhancements were considered but were rejected due to time constraints and lack of available data.

Accuracy Enhancements

There are several recommended enhancements that can improve the Subregional model's accuracy and sensitivity:

Zonal Allocation

In the current implementation of the model, a weighted production and attraction zone is calculated for each aggregated zone. A random allocation model was rejected due to the somewhat random nature of results. This does not suggest, however, that a random allocation model is neither feasible nor undesirable. However, a higher sampling rate would probably be required

A superior methodology would sample multiple production and attraction TAZ zones, and then average their skim costs, in order to more accurately reflect aggregate highway and transit skim costs. There are two tradeoffs for this methodology. First, it would complicate the model coding. Second, it would make the model run more slowly, since multiple skims from multiple TAZs would need to be calculated. If the model coding can be efficiently achieve and if performance can be optimized for this process, however, then this enhancement may be well worth performing.

Superzone Connector Assignment

In the current model, trips on the superzone centroid connector are reassigned to the network by choosing the closest TAZ to the midpoint of the connector as the starting node of the trip, instead of using the superzone. A more accurate methodology would proportionally allocate trips among several TAZs instead of just one, and would take into account the direction of the trip in the allocation process. Such a process, however, would definitely increase overall VMT and VHT results, which would necessitate a re-calibration of the model.

Demographics Aggregation

In the tool that converts Regional Model inputs to Subregional inputs through aggregation, some of the demographic inputs, such as median income, are simply averaged. This simple aggregation and can lead to some errors in trip generation. Enhanced forecasting methods should be developed to better estimate medians and averages of demographic data when aggregating to higher level zonal structures.

Additional Model Features

During the step that converts regional model inputs into subregional inputs, it is required that the zones in the subregion nest inside the regional TAZ's. The effective disaggregation of zone and matrix-based inputs is problematic if the zones do not perfectly nest. An additional model feature would relax that constraint.

Additionally, the TAZ conversion routine automatically calculates the split percent of disaggregated zones within the regional zones as an area percent. An additional model feature would calculate the split percentages more accurately by utilizing population or employment-based block or block group data.

The Subregional model requires that TAZ zone numbers be consecutively numbered between 1 and the highest TAZ. It also requires that the ID values of the network nodes that are centroids be numbered in a similar function. This follows the requirements of the Regional model. An advance would allow a more flexible numbering system for zones, and would allow the designation of node TAZs to be in an attribute fields rather than on the IDs.

Additional Data Collection

The subregion model for San Bernardino County was verified to the Regional model using the same highway network as the Regional model, and using similar socioeconomic input data. Additional model validation was not performed due to lack of available data, such as:

- Additional link detail in the subregion
- Additional period and daily traffic count data in the subregion
- Additional travel survey data in the subregion
- Additional transit boarding count or ridership data in the subregion.

In addition, all of the available validation data is from the Base Year 2003. If the above data can be collected for Base Year 2008, a more thorough calibration and validation of the model could be performed.