Association of Monterey Bay Area Governments (AMBAG) Travel Model Peer Review Report

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TMIP

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Disclaimer

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Acknowledgements

The FHWA wishes to acknowledge and thank the peer review panel members for volunteering their time to participate in the peer review of the Association of Monterey Bay Area Governments (AMBAG) travel demand model and for sharing their valuable experience.

The Peer Review Panel Members were:

- Gordon Garry (SACOG)
- David Kurth (CS)
- Maren Outwater (RSG)
- Dave Robinson (Fehr & Peers)
- Erik Sabina (DRCOG)
- Elizabeth Sall (SFCTA)

Brief biographies for each of the peer review panel members are presented in Appendix C.

Report Organization

This report is organized into the following sections:

- Overview of the purpose of this report, including an introduction to the peer review process and the objectives of the AMBAG peer review
- Planning responsibilities of AMBAG
- Introduction to the regional characteristics (demographics, land use and transportation) of the AMBAG region
- A brief history of travel demand modeling at AMBAG
- Discussion of how the AMBAG travel demand model is used, concerns about the model identified by AMBAG and users of the AMBAG model, and a review of model inputs and components (this section includes the majority of the discussion that took place during the peer review), and
- Peer review panel recommendations, including prioritized next steps.

In addition to the main body of the report, there are four appendices. Appendix A is a list of peer review participants, Appendix B is the peer review meeting agenda, Appendix C contains brief biographies for each of the peer review panel members and Appendix D includes a summary of responses to questions posed by AMBAG and other regional and local agency staff for discussion during the peer review.

Report Purpose

This report summarizes the results of a peer review of the AMBAG travel demand model. The peer review was supported by the Travel Model Improvement Program (TMIP), which is sponsored by FHWA. The peer review of a travel model can serve multiple purposes, including identification of model deficiencies, recommendations for model enhancements, and guidance on model applications. Given the increasing complexities of travel demand forecasting practices

and the growing demands by decision-makers for information about policy alternatives, it is essential that travel demand forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

AMBAG's motivation for seeking a TMIP peer review was to ensure that AMBAG staff, its policy board, regional transportation planning agencies (RTPA) and local jurisdictions have a state-of-the-practice tool to support their land use and transportation planning needs. In this context, AMBAG was seeking input on the following:

1) Receive external guidance on current model's functionalities

2) Identify possible model deficiencies

3) Receive recommendations for AMBAG's Model Improvement Plan (MIP)

4) Receive experienced advice on model development and applications

5) Receive expert opinion for agency resource needs, such as surveys/other data requirements, technical assistance, funding recommendations and time frame for model improvements

1.0 AMBAG Responsibilities

AMBAG is the federally designated MPO for Monterey, San Benito and Santa Cruz Counties to carry out metropolitan transportation planning activities, California law SB 375 implementation, and the development of the Sustainable Community Strategies (SCS). In addition to working with all local jurisdictions (18 cities and 3 counties), AMBAG works closely with the following public agencies within the MPO region who have an interest in or are users of the AMBAG travel demand model:

Regional Transportation Planning Agencies (RTPA) or Council of Governments (COG)

- Santa Cruz County Regional Transportation Commission (SCCRTC)
- Transportation Agency for Monterey County (TAMC)
- Council of San Benito County Governments (SBtCOG)

Transit Agencies

- Monterey-Salinas Transit (MST),
- Santa Cruz Metropolitan Transit District (SCMTD or SCMETRO)

Air Quality Agency

- Monterey Bay Unified Air Pollution Control District (MBUAPCD)

State Department of Transportation

- California Department of Transportation (Caltrans)

Except for several cities that have developed local-scale models, the AMBAG model serves as the primary forecasting tool for the jurisdictions in the Monterey Bay Region.

2.0 Regional Characteristics

The AMBAG planning area is situated between Silicon Valley (San Francisco Bay Area) to the north and San Luis Obispo County to the south in California's North Central Coast area. Monterey and Santa Cruz counties are situated along the coast and contain most of the area's population and employment. Monterey County also supports a significant agricultural industry that is generally located in the Salinas River Valley. San Benito County is located to the east of Monterey County and is mostly rural. Monterey and Santa Cruz Counties tend to include more higher-income households.

In 2005 the population of the AMBAG region was just over 740,000 with an average of 3.1 persons per household. Most of the population (nearly half a million) is concentrated into the 18 cities covering approximately 65,000 acres. In 2035 the population is expected to exceed 920,000, representing a 24% increase from 2005 an average of 3.0 persons per household and a population density of 179 people per square mile. Employment in the region is expected to increase from over 326,000 in 2005 to approximately 405,000 in 2035 representing a 24% increase.

Households with incomes less than or equal to $75,000 had an average travel time to work of 17 to 20 minutes, whereas households with incomes greater than $75,000 were observed to have an average travel time of just over 34 minutes. Travel times for all other trip purposes averaged between 10 and 13 minutes.

In addition, the AMBAG region has the following characteristics that affect travel behavior:

- Heavy commuter trips and interregional travel to SF Bay area and a high number of people telecommuting
- Tourist activities occurring on weekends and during different seasons and special events
- Agriculture activities from farm workers who make seasonal transient (field-to-field) trips
- Goods movements (freight / truck)
- Rural-urban characteristics with longer trip lengths resulting in higher VMT and peak spreading
- Aging population

Four main arterials connect the region. Hwy 1 and Hwy 101 link north/south travel. Hwy 68 and Hwy 152 serve as east/west connectors. Hwy 101 is expected to see more congestion as population moves to more rural areas. Hwy 101 is also constrained by law from widening in the rural areas.

3.0 History of Travel Demand Modeling at AMBAG

The first generation of the AMBAG regional travel demand model was developed in the 1990's using MinUTP. The model did not have a detailed transportation network and lacked a sophisticated mode choice model. The model base year was 1990 and forecast year was 2020.

A fully integrated 4-step trip-based model was developed during the period from 2002-2004. This model was built using the TransCAD software platform and included detailed transportation and transit networks and a nested logit mode choice mode. The model was calibrated using 2000 California households travel survey results, screenline traffic count data and Highway Performance Monitoring System (HPMS) VMT data. Transit functionality was not developed due to lack of transit boarding data and other constraints. The model area was also expanded to include Santa Clara County. This model had a 2000 base year and a 2030 forecast horizon and

was used for the development of AMBAG's 2005 Metropolitan Transportation Plan (MTP) among other local and DOT projects.

The most current version of the AMBAG regional travel demand model (updated in 2009-2010) was implemented in the TransCAD 5.0 software platform and moved to a 2005 base year and 2035 forecast horizon and included updates to the trip generation and trip distribution components.

The model update also included an updated mode choice model, added a transit assignment process and incorporated an Excel based '5D' post-processing tool to evaluate the impact of various smart growth, mixed land use strategies on vehicle trip and VMT reduction ('5Ds' stand for Density, Diversity, Design, Destination and Distance from Transit). This version of the model was used to develop AMBAG's 2010 MTP and was the subject of this peer review.

4.0 Current AMBAG Model

Overall, the AMBAG travel demand model meets current state-of-the practice travel modeling standards and has some special features that go beyond standard practice. The model contains detailed socioeconomic data and has a geographically based TAZ, link and node structure. Trips are modeled by purpose and the model uses common trip types. The model uses standard 4-step modeling practices including a gravity-based distribution model, a nested-logit mode choice model, a transit assignment model, and an equilibrium-based highway assignment model. The AMBAG travel demand model also contains a congestion feedback loop between distribution, mode choice and highway assignment to account for congested travel times in trip distribution.

The AMBAG travel demand model contains many additional features to be more relevant to answering questions specific to the region:

- The modeling approach contains a '5D' post processing method for measuring sensitivity to urban design
- The model also includes a visitor trip purpose, a key market of interest in the area
- Santa Clara County was folded into the model coverage area to better account for the strong connections for work and other trips between Monterey, Santa Cruz, and Santa Clara counties
- Use of additional data for capacity analysis, including shoulder width, lane width, access points per mile, divided highways, and area type

The AMBAG travel model uses a 2005 base year and was estimated, calibrated and validated using local survey and count data.

4.1 Model Applications

The AMBAG model is designed primarily for use in transportation planning at a regional scale. As such, the AMBAG regional travel model has been designed primarily for the following purposes:

- Development of the AMBAG Metropolitan Transportation Plan (MTP)
- Regional land use, economic and planning efforts, such as the blueprint planning effort
- Regional air quality emissions analyses

Because the model is designed and calibrated for macro-level regional planning activities, uses of the model at a more detailed level may require localized model validation and updates to

serve project-level applications. The AMBAG regional travel model has also been used for the following detailed planning efforts:

- Caltrans' evaluation of capital project, assessment of large development impacts and evaluation of long range planning activities, including system-level planning, scenario planning, markets-truck goods movements, cost benefit analyses, congestion management plans and evaluating concept reports
- RTPA-level regional transportation plans, developer fee updates and special studies (e.g. SCCRTC's Hwy 1 HOV Lane Project)
- Major transportation investment studies
- Traffic impact studies
- City and county general plans
- Fixed-guideway transit planning studies

4.2 Concerns Identified by AMBAG and Member Agencies

The following sections identify issues and concerns highlighted by AMBAG and their partner agencies during the TMIP peer review. In addition, AMBAG provided a list of specific questions for the peer review panel prior to the peer review meeting, which is included in Appendix D of this report.

4.2.1 California Law SB 375 Implementation

Senate Bill 375 was passed into California law requiring the need for a process for reducing greenhouse gas (GHG) emissions through more sustainable land use and transportation planning. The legislation aligns regional land use, transportation, housing, and GHG reduction planning efforts. AMBAG as an MPO is required to develop and adopt the Metropolitan Transportation Plan (MTP) and Sustainable Communities Strategies (SCS) pursuant to SB 375 beginning with the adoption of AMBAG's 2013 plan with final compliance required by the adoption of their 2017 plan.

Implementation of SB 375 will require regional coordination in addition to modeling various complex policies and having extensive public participation. Public participation also entails further developing visualization and interactive modeling tools.

4.2.2 Household Travel Survey

California commissioned a statewide household travel survey (CHTS) in 2001-2002. This survey was supplemented by two add-on surveys totaling 1,564 surveys in the AMBAG region representing 0.69% of the households (total households from 2000 Census). Another CHTS is expected to be conducted in 2011-2012 with an expected sample size in the AMBAG region of 1,316 households. This represents 0.56% of the households (households from 2005 ACS).

AMBAG is concerned that the sample size of the data being collected for the three county AMBAG region is too small for full use in the travel demand model. They are considering adding onto the 2011-2012 survey to increase the sample size to achieve a sample rate of at least 1% of households in the MPO region. AMBAG would like to know if this is a good use of funds and if just increasing the sample size is sufficient or if oversampling special markets or under represented demographic groups would be better.

4.2.3 Agency Resource Constraints

AMBAG expressed concerns about the balance between the uses and demands of the travel demand model and the amount of resources allocated to running, maintaining and developing the model. AMBAG has the equivalent of 0.75 full time staff who can work on the travel model on a regular basis. In addition, few funding streams have been identified for model development and data acquisition and processing. AMBAG would like advice from the peer review panel on ways to achieve better balance in this arena and still maintain a realistic schedule of model improvements that meet the needs of model users and to implement SB 375 requirements.

4.2.4 Member Agency Requests of the AMBAG Model

The three RTPAs and Caltrans are the most frequent users of the AMBAG travel demand model. TAMC would like to use the AMBAG model for a light rail study that would be seeking FTA New Starts funding and for a bus rapid transit study. They question whether the current version of the AMBAG model would be able to pass FTA's rigorous standards. The RTPAs also expressed an interest to study alternative modes (including bicycle), shifting agriculture goods movement from truck to rail and to test land use policy using the '5D' tool. Caltrans expressed concerns that the current AMBAG travel model is not calibrated to peak period conditions, which is a key aspect of some of their planning work. They would also like to see thought given to development of a meso-scopic model and a dynamic traffic assignment.

In addition, the two transit districts in the AMBAG region would like to be able to use the travel model to better understand transit markets and where to invest transit services. Information they wish to see out of the model include an origin and destination of transit riders, where to provide service, choice vs. captive riders, and assessing demand responsive service and select patronage service (college campuses, military bases or tourists).

To be more useful to their planning purposes, these entities expressed a desire for a better mode choice component of the model. There was also a general concern of how peak period congestion was (or was not) being addressed in the travel model. There was a desire expressed for better representation of peak periods due to long commuting patterns as some locations are experiencing extended AM & PM peak periods or nontraditional peaks from students and service workers.

4.3 AMBAG Model Improvement Plan

AMBAG has developed a draft model improvement plan (MIP) to address concerns with the model and to provide continuing support to maintain a travel model that is representative of current state-of-the-practice. This plan emphasizes the development of integrated land use and transportation models with various customized modeling and visualization tools to analyze the impact of specific development (residential, commercial, industrial and mixed-use developments) and their impacts on VMT and resultant GHG emissions. The proposed AMBAG MIP is also designed to enhance the modeling capabilities to accomplish SB 375 requirements as well as provide support in developing and planning for Sustainable Communities Strategies (SCS) throughout the Monterey Bay region. The following are the main priorities in the proposed AMBAG MIP:

Short Term Improvements for 2013 MTP

- Enhancements to the 2005 base year model as per TMIP peer review recommendations
- Add 2020 interim model year

Medium Term Improvements for 2017 MTP

- 2010 base year integrated land use / transportation model (parcel level)
- Update '5D' post processing tool using 2011-2012 CHST/CTPP/ACS data
- Add bicycle model component (currently funded through grant)
- Dynamic traffic assignment
- Peak hours and peak period assignment calibration/validation
- HOV/congestion pricing, gas price and other sensitivity testing

Long Term Improvements for future MTPs

- Converting travel model from trip based to activity or tour based model

4.4 Discussion of AMBAG Model Inputs and Model Components

The following sections summarize the information provided by AMBAG staff as well as comments from peer review participants. AMBAG provided the peer review panel with model documentation describing all of the model components, input data and model validation results.

4.4.1 Household Travel Survey and Transit On-Board Survey Data

The AMBAG regional travel demand model used data from the 2001-2002 California Household Travel Survey (CHTS) to calibrate trip generation cross-classification rates and mode choice constants and to validate the distribution model's friction factors and trip length frequencies. However as discussed in the concerns section of this report, the MPO expressed the need to add to the sample size for their area beyond what is being considered in the 2011-2012 CHTS. The MPO stated that an add-on to the survey was to be a set amount if no specialty target groups were identified, but the cost would be more if these groups were to be identified.

The transit agencies servicing the AMBAG region collect on-board surveys on a regular basis. However, these surveys are being collected for the transit agencies' purposes and not for travel model estimation and development. There is no uniform transit on-board survey across the transit districts.

Panel Discussion

The panel recommended that the MPO add to the 2011-2012 CHTS sample size for future model improvements. So much of the model's components and parameters depend on household survey data that making this data set more robust would be valuable. The MPO would also see an economy of scale by piggy-backing onto the CHTS. The panel commented that oversampling specialty groups such as low-income-migratory or high-income-retiree populations would be valuable.

Oversampling will not necessarily achieve the data for the transit model parameters. The panel suggested AMBAG use a transit on-board survey for model validation and recommended working with transit providers to conduct a comprehensive on-board survey.

4.4.2 Highway and Transit Networks

The AMBAG regional travel model uses a road network based on county street centerline GIS data. The 2005 base year and 2035 forecast horizon networks were both prepared based on the 2000 base year network. The road network for Santa Cruz and Monterey counties includes all public roadways. For San Benito and Santa Clara counties, only the more important streets (major collector and above) are represented. The 2035 network was built from the 2005 network

and includes the projects in the AMBAG MTP. However, improvements to the local system identified in general plans are not included in the 2035 network. The highway network has a single centroid connector to each TAZ in most cases.

Free flow speeds and capacities are coded onto the network links. Free flow speeds were developed from empirical data collected summer of 2002 and 2003 and included a broad sampling of all freeways and arterials and a select sampling of collector and local roads. Free flow speeds are cross classified by functional type and area type. Capacities are estimated based on Highway Capacity Manual 2000 procedures and link-based geometric and operational characteristics. Link capacities are calculated as hourly service flows then factored by 2.7 for the 3-hour peak period capacity and 12.0 to represent daily capacity. The model then uses volume to delay functions to calculate congested speed based on volume/capacity ratios. The volume to delay functions were based on research conducted by MTC and represent modified versions of the standard BPR curves.

The transit network consists of a description of bus lines that are superimposed on the road network. Transit line characteristics include the locations of stops, walk access links, the peak and midday headways, and the average travel speeds of buses to the average speed of all vehicles on each type of road. Transit lines are coded in the model for the following services:

- Santa Cruz Metro Transit bus service
- Monterey-Salinas Transit bus service
- San Benito County Transit bus service
- Selected Santa Clara Valley Transportation Authority (VTA) bus routes
- All VTA light rail lines
- Caltrain rail service
- Altamont Commuter Express rail service

Panel Discussion

The panel expressed concern that the model is using average daily speeds from the travel time speed runs. Average daily speeds will cloud congestion. Also the panel questioned if the average daily speeds are representing the free flow speeds in the volume delay functions. If congested speeds are being used then the speeds representing the start of the functions are too low and would affect travel time calculations in the model's path skimming.

The panel also discussed the high level of network detail, specifically the inclusion of all local roads in Santa Cruz and Monterey counties. Most panel members agreed that the AMBAG model is small enough where the extra detail would not cause an extraordinary burden and in fact, the added detail was useful for modeling accuracy. Some panel members felt that this level of detail was unnecessary and only served to increase model run time and time to code the network. It was suggested that the detail could be left in as an input and toggled off during the model run if performance became an issue. The panel also wondered if the local roadway detail was acting as pseudo centroid connectors for these two counties as the documentation indicated there tended to be only one centroid connector per TAZ and recommended adding more centroid connectors.

4.4.3 Traffic Analysis Zone Structure and Socioeconomic Data

The traffic analysis zone (TAZ) structure in the AMBAG model is based on Census 2000 block geography. Zones range in size from 0.03 sq. mi. to 394 sq. mi., but the typical TAZ in an urban area is approximately 0.15 sq. mi. TAZ boundaries were drawn with a desire to add as much detail as possible such that non-motorized and walk access to transit trips could be modeled

properly. TAZs for the AMBAG model cover the three AMBAG counties of Santa Cruz, Monterey and San Benito as well as all of Santa Clara County. Santa Clara County TAZs were derived from the Santa Clara Valley Transportation Authority (VTA) model and the AMBAG TAZ structure nests within the VTA TAZ structure. The Santa Clara TAZs are at a more aggregate scale except for the southern part of the county along the Hwy 101 corridor. The AMBAG model has 1,884 internal TAZ and 10 external TAZ.

Land use and socioeconomic data are coded at the TAZ level. The AMBAG model uses households stratified by four age categories, four income categories and four auto ownership categories. These disaggregate values were taken directly from the 2000 Census. A household stratification model is not used. Socioeconomic data also includes average household size. In forecast years, each TAZ's income and auto ownership stratification assumptions are held constant whereas in future scenarios the number of households in each age group changes. Employment data is represented by six employment categories based on SIC classifications. Employment allocation used a detailed employer sample from Info USA and expanded by employment category based Department of Finance county control totals (earlier versions of the model used Woods and Poole Economics to obtain employment expansion factors). Farm employment was allocated into five farm product types using parcel data and a consultation with regional Farm Bureau representatives. Socioeconomic data for Santa Clara County was taken from the VTA travel model.

The TAZ data also contain the following information to support two school trip purposes and a visitor trip purpose in the AMBAG model:

- Number of Hotel rooms
- Number of Visitor trips
- K-12 enrollment
- University enrollment

Panel Discussion

The panel liked that there were variables in the input data, such as hotel rooms, to capture visitor trips. The panel asked how enrollment data was forecast. The MPO responded that K-12 enrollment used what was reported by each school district. If the district projected new schools or school closures, this was reflected in the data. University enrollment used 20-year estimates from the universities. The panel also suggested looking at providing detail on special markets, such as military personnel and full and part-time residents (migrant workers and retirees are main part-time populations but are at different ends of income spectrum). Details to consider could include location as well as season when the part-time population is present.

4.4.4 Socioeconomic Forecasts

AMBAG develops population, housing and employment forecasts for Monterey, Santa Cruz and San Benito counties. Population forecasts used a cohort-component model and included details such as age, gender, birth/death rates and in/out migration. Housing unit forecasts pivot on projected population, group quarters, average household size and vacancy rates. Employment forecasts use an input-output economic model. These methods determine county level control totals that are then compared with California State county-level estimates. After negotiations, a singular set of county-level control totals is agreed upon. County level totals are then disaggregated to local jurisdictions based on trend forecasting and planning assessment of accessibility to services, amenities and jobs as well as input from a committee of local jurisdictions. The final socioeconomic forecast is then adopted by the AMBAG board.

Panel Discussion

AMBAG would like to update their current socioeconomic forecasting process for a parcel-based, integrated land use / transportation model and asked the panel to comment. The panel offered that there is a wide spectrum of land use models, ranging from more simple models like UPLAN to more complex models like UrbanSim and PECAS. It was suggested that several mid-range land use models, such as DELTA and Cube Land, require considerably less investment to build and maintain (approximately a fifth the cost) than the more complex land use models. These mid-range models can be designed to be TAZ-based but have a parcel data option and are less data hungry than the more complex models. The panel recommended investing in the more mid-range complexity land use model, especially in light of the resource constraints of the MPO. The panel also recommended that a new land use model could be built to recognize seasonal residents and workers and that it did not necessarily need to be fully integrated or automated with the travel model to include a transportation element.

The panel also commented on the experience of several areas that are implementing land use models. Puget Sound Regional Council has successfully implemented an UrbanSim model and is happy with it at the regional level. They are just starting to use it at the county or local level. The Denver Regional Council of Governments has also tested UrbanSim and concluded that it worked well in some areas and not so well in others, particularly the development model side which tended to be more idiosyncratic. The panel suggested that this issue also existed in PECAS model applications. Two of the MPOs in the San Joaquin Valley are implementing Cube Land as part of their model improvement program.

The panel inquired to understand better the reasons behind the need for a new land use model. Among other needs, the MPO stated that SB 375 required the use of a parcel-based GIS process to be used in forecasting. The panel stated that the MPO did not need a fully integrated land use / transportation model to fill the GIS-parcel requirement. However, AMBAG would like to have an end game in mind so when data sets are developed, such as in the blueprint planning process, they are developed using the correct framework. They would also like an automated process of linking parcel data with the travel model, which is currently a manual process.

AMBAG stated that they have much parcel level data collected and commented that some county data are not yet in electronic format. Assessor data are available but there is a cost and time lag associated with these data. The panel recommended that AMBAG define a process for developing parcel data through a regional data consortium. Local communities could feel a benefit from sharing data and working together by receiving information for smart growth concepts such as the '5Ds' analyses to minimize carbon footprint and VMT. This data sharing could enrich the quality of the databases and provide a cost sharing benefit.

4.4.5 Trip Generation

Trip generation rates are organized by seven basic trip purposes:

- *Home-Based Work* trips are commute trips between residences and places of employment, including both trips from home to work and from work to home
- *Home-Maintenance* trips are trips between residences and places of commercial employment
- *Home-Discretionary* trips account for all other trips which begin or end at home, and include social trips and recreational trips
- *Work-Based* trips account for trips which do not have and end at home, such as driving to a restaurant during a lunch break or driving a delivery truck away from the main office

- *Other* trips account for all other types of trips not covered by the other purposes
- *Home-Based School* trips account for trips between residences and elementary, high schools or universities
- *Visitor* trips from private residences or hotel rooms to visitor attractions and to adjacent retail areas

Home-based Work trip production rates are stratified by the four household age classifications and four income groups, resulting in 16 rates. Home-Maintenance, Home-Discretionary and Other trip production rates are stratified by four age classifications and four auto ownership groups. The Other trip purpose also includes an additional generation based on employment by type of employment. Home-based School trip production rates are based on four age classifications. Trip attraction rates are calculated based on various combinations of employment categories, K-12 and university enrollment data, age classification and auto ownership classification. Visitor trips are based on attraction locations and are considered the only special generators in the AMBAG model. Trip generation rates were derived from the 2001-2002 CHTS, which included Monterey, San Benito and Santa Cruz counties and the 2002 TAMC/SBCOG survey, which was conducted using the same survey methodology as the 2001-2002 CHTS.

The current AMBAG model has a freight purpose and is viewed as a placeholder which adds significant value over the alternative of accounting for commercial vehicle travel under the Other trip purposes. The truck model was developed using Quick Response Freight Manual (QRFM) version 1 trip rates to generate regional truck trips. An initial distribution was estimated using a traditional urban model type gravity approach (QRFM friction factors) which was then modified with an automated matrix estimating routine (ODME) to create a base year Truck OD matrix. The process produced truck assignments that are consistent with base year truck counts. Future truck amounts were estimated using the same method then were used to factor the base year ODME matrix to produce a future truck matrix.

Panel Discussion

The panel made several comments regarding the trip generation model. The panel noticed that the trip rates for K-12 seemed low. They recommended reporting unadjusted and adjusted production to attraction balances, which would clarify this and other issues related to the production and attraction equations. The panel also recommended smoothing trip rates. The panel also asked why income was used in trip generation. The MPO did not know as this was inherited from previous work. The panel commented that the there seemed to be a casual relation between age and trip rates and suggested that household size would show a more direct relationship and recommended using household size, autos or income and workers as variables and estimating trip rates for entire households, not per person in the household. The age of head of householder variable will be more useful at the household level than at the person level.

The panel also questioned whether the trip generation model at the TAZ level cross classifications would be sensitive enough to capture the ‘5Ds’ in post processing or it needed to be done at the parcel level.

The panel also asked about the military presence in the region. They wondered how people living on the military base were being handled in the model and the nature of their trip making along with other activities associated with the military institutions. It was suggested the MPO consider making the military base a special generator in the AMBAG model.

The panel discussed the current method of using ODME to develop freight trip tables and suggested that this method was not helpful for future planning, since it is insensitive to future investments or economic indicators. The panel suggested that other methods be considered for local truck travel and the new statewide freight model be considered for external truck travel.

4.4.6 External Travel and Linkage to the California Statewide Model

The model is using a methodology where external-internal (EI-IE) trips are incorporated into the internal trip distribution process. EI-IE trips are expressed in terms of productions and attractions for each trip purpose by model gateway using the following process:

- The total trips are determined based on traffic counts, generally ADT from Caltrans
- The traffic counts are split into trip purposes using percentages from the AMBAG household survey and/or the 1994 AMBAG cordon survey
- The vehicle trips by purpose are converted to person trips using average vehicle occupancies for each trip purpose from the survey information
- The person trips are split into initial productions and attractions using information from CTPP (for work trips), survey information and general knowledge of work and non-work trip patterns in the region
- The production and attraction totals for trips internal to the four-county model area are compared without and with the estimated gateway productions and attractions
- Productions and attractions are balanced by holding internal four-county trips constant and adjusting the initial split between productions and attractions at the gateways until overall productions balance with attractions for each trip purpose
- The gateway person trips are input to the standard trip distribution process along with the internal person trips
- Gateway person trips are converted back to vehicle trips using factors rather than going through the mode choice analysis
- Total gateway trips are projected using historical growth or population and employment growth factors for counties on each side of the gateway or a combination of the two

Panel Discussion

The peer review panel discussed the use of the California statewide model in determining external trip flows. The California statewide model is currently being developed. A base year is finished and future years are under development. The statewide model could provide interregional and through trips for regular trip purposes as well as recreational trips and goods movements. The panel asked if the AMBAG model and the statewide model had consistent TAZ and network data. The MPO responded that they provided these inputs to Caltrans and that the statewide model was used in the derivation of external trips in the AMBAG model. However, the actual use of the statewide model was unclear in the documentation. Because the statewide model is focused on long distance travel, the panel recommended that AMBAG use the statewide model for external trips and to begin discussion with other planning entities.

4.4.7 Trip Distribution

The trip distribution model uses a gravity model to estimate trip interactions between zones. Average daily congested travel times are used for impedance values and friction factors are set using a gamma function. The gamma function parameters for each trip purpose were calibrated using the trip length frequencies obtained from the estimated congested zone-to-zone travel times of the survey trips and the calibration tools included with the TransCAD software. The productions and attractions are doubly constrained for all but the School, University and Visitor

trip purposes that are constrained to attractions. The current version of the AMBAG model does not use K-factors.

The distribution model used self-reported trip times by trip type from the linked trip household survey data set for validation. Work trip distribution was compared to the detailed CTPP data for year 2000. Because of the differing analysis years, the commute patterns were expressed in terms of percent of originating trips and percent of workplace trips.

Panel Discussion

The panel stated that trip distribution will be hard to capture in the AMBAG region with a gravity model. For example, the validation histograms for Home-based Work trips show modeled trips as smooth curves that taper off as travel times increase but the observed data has distinct bumps at longer travel times representing commuting trips between communities. The model results should also be bumpy to reflect the commuting patterns of isolated cities. The gravity model alone will not fix this. The panel discussed ways to address this issue. The panel suggested that in the short term AMBAG reinvestigate the strategic use of a limited number of K-factors.

The panel also recommended looking into a destination choice model to address the distribution issue. This could be in conjunction with a scaled implementation of an activity based model.

In addition, the panel suggested investigating how the model is handling short vs. long distance trips. The panel asked what happened to the distribution results when Santa Clara County was added. They recommend reporting screen line validation at the Santa Clara County boarders to check. The panel also recommended sub-dividing trip length frequency reporting by county to better assess the validation of the trip distribution model.

The panel commented on the use of stated travel times from the household survey in validation. Typically travel time as reported in a household survey is inaccurate due to an incorrect perception on how long a trip actually takes or because people tend to round their times. A better approach is to assign the observed origin and destination from the survey to the model network to get a better sense of actual travel times. The panel recommended fixing the observed travel times before validating the trip distribution model. This should also be completed after the recommendations about the highway assignment and networks are completed.

4.4.8 Mode Choice

The AMBAG model uses a nested logit choice model for determining the mode of each person trip. The choices are grouped so that choices in the same level have similar sensitivities to travel characteristics. The logit model has the following nests:

Level 1 Motorized vs. Non-Motorized

Level 2 *Motorized*: Automobile vs. Transit

Level 3 *Automobile:* Drive Alone vs. Shared Ride

Level 3 *Transit:* Walk Access vs. Drive Access

Level 4 *Shared Ride:* 2-Person vs. 3+ Persons

Level 4 *Walk Access:* Premium Transit Service vs. Local Transit Service

Level 4 *Drive Access:* Park and Ride vs. Kiss and Ride

The most current version of the model was updated to reflect FTA guidance for New and Small Starts forecasting. The previous calibration to the 2001-2002 CHTS was done prior to the issuance of the guidance and thus contained coefficients that were out of accepted ranges and had county specific variables that are no longer allowed. Only coefficients outside the FTA parameters were adjusted (to be the mid-point of the range of acceptable values) and modal constants were also modified to more closely match the observed targets. Previously developed mode targets by percent share originally derived from the 2001-2002 CHTS were utilized for this process.

Panel Discussion

The panel asked whether the MPO was considering congestion pricing as this is not a choice in the current mode choice model. The MPO responded that congestion pricing was not critical in their current planning but that HOV was important because it is being considered in Santa Cruz County.

The panel also commented on several facets of the mode choice documentation. The documentation did not report at which level nesting coefficients are applied. The documentation also reported just the mode choice constants. Good practice is to report these constants in terms of equivalent minutes of in-vehicle time. The panel also commented that the source for the driving and parking costs used in the transit skimming process were not included in the documentation. They recommended that all these items be added to the documentation. The model documentation also suggested that improvements have been made to bring the logit model's parameters into line with FTA's standards. However, certain panel members disagreed and felt that the mode choice bias constants were still too high for use in any new starts analysis.

The panel noted that the mode choice parameters were inconsistent with the transit skim weights. Inconsistencies between the two can cause problematic results. The panel recommended providing consistency between the mode choice coefficients and transit skims.

The panel recommended recalibrating the mode choice model in light of the short term trip generation, distribution and mode choice fixes. They also recommended a long term improvement of estimating new mode choice models with socioeconomic and demographics variables that are sensitive to urban design and level of service variables for use in the '5D' analyses.

4.4.9 Highway and Transit Assignment

The AMBAG regional travel model uses a multiclass, origin based user equilibrium assignment. The origin based user equilibrium assignment method was used because it allows a very high degree of convergence. The four vehicle classes being assigned are:

- Single occupant autos
- High occupant autos with 2 passengers
- High occupant autos with 3+ passengers
- Trucks

Transit trips are assigned to the AMBAG transit network separately based on each of the four types of transit service and access:

- Walk access, premium transit service
- Walk access, local transit service
- Drive access, park and ride

- Drive access, kiss and ride

The transit assignment assumes that all persons within each of these four categories will use the shortest available time path. No capacity constraints or multiple assignment iterations are used for the transit trips. The total ridership on each transit line is calculated by adding the results of the four individual transit assignments.

The AMBAG model is currently set up to run highway and transit assignments for five separate time periods:

- A.M. peak hour
- P.M. peak hour
- A.M. 3 hour peak period
- P.M. 3 hour peak period
- Daily 24 hours

Trips by period were tabulated using the 2001-2002 CHTS.

Highway assignment was validated against 2005 vehicle count data from 527 locations. This data was assembled from the various AMBAG jurisdictions and Caltrans District 5. The on-going traffic monitoring programs of the three RTPA's are the primary count database sources. All counts were 24 hour counts. Peak period data were not available and there has been no validation against hourly or peak period count data. Transit boarding data was obtained from two of the three transit agencies providing fixed route bus service in the three county AMBAG region. No detailed boarding data was available for San Benito County. Transit data for Santa Clara County were not used in the validation process. Transit assignment was validated using 2005 boarding data.

The 2005 base year highway assignment validated well when compared to 527 count locations around the region. The model validation against counts shows an overall 29.1% RMSE and -1.9% count VMT error. The system-wide modeled 2005 base year VMT estimate is consistent with the 2005 HPMS estimate (within -5%). The model also closely replicated total ridership by each transit system, but individual route results vary widely. The overall transit validation had a 40.75% RMSE and an aggregate loading ratio of 0.98. The overall AMBAG model validation results fall within FHWA/FTA acceptable ranges (RMSE 40% or less and HPMS VMT +/- 5%).

Panel Discussion

The panel discussed the convergence of the assignment network and noted that the documentation does not indicate what convergence threshold is used. The panel recommended checking and reporting the assignment convergence and suggested the tolerance should be 10E-6.

The panel confirmed that the model is being validated to actual counts for volume and to HPMS for VMT. Caltrans noted that they are in the process of installing more ATR's in the AMBAG region as part of their traffic monitoring program. AMBAG also commented on the AMBAG use of many screenlines to validate the model. The panel suggested that perhaps the MPO does not need to use as many screenlines in their validation process.

The panel commented on the type of assignment method used and the use in regards to select link analyses. Though the origin based user assignment converges more quickly than other methods, select link analyses require an assignment method that maintains proportionality. The 'check proportionality' option should be used in TransCAD if origin-based assignment is used, or another assignment process that guarantees proportionality (such as Frank-Wolfe) should be used for select link analyses.

The panel also cautioned against running 24-hour assignment and suggested assigning each period separately then adding to a daily total. They also recommended using five time periods (AM, midday, PM, evening and night) to better account for certain trips that are of interest to the MPO, such as hospitality service trips. These periods could be recalculated from the CHTS survey data. The panel also noted that the documentation needs to report how trip purposes were combined for estimating time of day factors.

In the discussion, concern was raised by a member agency that 2005 boarding data used to calibrate the base year transit contained anomalies that affected ridership, including a strike. The panel recommended that instead of using a single validation year in which the data may be experiencing volatility, a multi-year trend based validation would be more appropriate and defensible. In the case of transit ridership, boardings from 2004 and 2006 could also be used to determine an appropriate validation target. The peer review panel also noted that since the household survey was conducted in 2001-2002, system performance data from that time period should be used to match the observed survey data. The MPO stated that 2002 was used to estimate mode share data but the transit assignment was developed later and used 2005 data. The model base year is 2005 and all data sets (socioeconomic, traffic counts, transportation networks, etc.) represent 2005 conditions.

4.4.10 Congested Travel Time Feedback Loop

The AMBAG regional travel model uses a distribution, mode choice, assignment feedback loop. In the loop congested travel times from assignment are brought back as inputs to trip distribution and mode choice. The loop is executed two times. For the first pass, congested travel speeds are estimated based on factors applied to the coded free flow speeds on each link. These estimated congested speeds are used as input to the first pass trip distribution and mode choice steps. The second pass calculates congested speeds on each link based on the traffic assignment completed during the first pass. The feedback loop is intended to ensure that the final congested travel speeds used for air quality analysis are consistent with the travel speeds used throughout the model system.

Panel Discussion

The panel recommended that the MPO consider using more than two iterations to obtain congested travel times. Reporting the convergence results can help determine the preferred number of feedback iterations.

4.4.11 Air Quality

AMBAG used the regional travel model for air quality determination. AMBAG is currently in attainment for all air quality pollutants.

Panel Discussion

The panel asked if AMBAG expected to become non-attainment for any air quality pollutants in the future. The MPO responded that a small pocket of San Benito County will become non-attainment for $PM_{2.5}$ when the standard is released. The greater concern for the MPO is providing modeling to support greenhouse gas emission requirements. The panel commented that modeling for air quality conformity can drive various aspects of the model and model validation.

4.4.12 Agency Resource Needs

The panel had a lengthy discussion on the staff and financial resources available to the MPO to run and maintain the travel modeling program. As identified in the "Concerns Identified by AMBAG and Member Agencies" section of this report, AMBAG has the equivalent of 0.75 full time staff committed to running the travel model program.

The panel expressed concern with the level of staffing and the MPO's ability to accomplish the model improvements needed to support the 2013 MTP requirements. The panel stressed that uses of the model should drive how the model should be built and the complexity of the data. As many demands are being placed on the AMBAG model, the panel recommended that AMBAG push for additional resources to accomplish modeling goals. The panel recommended the MPO leverage partnerships in the region, such as with other planning agencies or with the universities. Data sharing could help reduce cost and provide some of the needed resources. In addition, the panel recommended leveraging existing grants for improving modeling process and exploring other grant sources. The panel also recognized the need to increase funding for model improvements. Because there is a need by many for good travel forecasts, the broad customer base should recognize they have a stake in the development of the model as well as a need to pitch in with funding or staff.

The panel felt that with some improvements the AMBAG travel model would be able to support the 2013 MTP and begin to meet the requirements of SB 375, though it may not incorporate all of the SB 375 requirements in this timeframe. During the model development process, the AMBAG regional model can continue to be used for planning applications with the understanding that model deficiencies are being worked on and the model user needs to assess the reasonableness of the model for a particular application.

4.4.13 Release of the AMBAG Regional Travel Demand Model

AMBAG expressed concern about releasing the full model and having the model results misrepresented. AMBAG felt this could place them in the situation of having to defend outside uses of the regional travel demand model.

The panel recommended AMBAG be transparent in its operations. Having an open process puts the MPO on the 'good guy list' and gives the MPO less liability because users can't claim they didn't know. The panel suggested that the responsibility to defend should be on the model user or applier and not the MPO. The panel recommended AMBAG use a user agreement similar to that in other urban areas. The model user would be responsible for changes made to the model, its application and results. Changes and official version releases can be handled or tracked with versioning software.

4.4.14 Activity-based Travel Models

There was a lot of discussion on activity based models. The panel discussed the value of using an activity-based model in this area but recognized that full development of an activity-based model would be difficult due to cost and resource constraints. The panel talked about the value of transferring an activity-based model, such as from Lake Tahoe, Fresno, San Joaquin, Seattle or the California statewide model. Some panel members thought that transferring from a smaller activity based model could be accomplished in about a year for about a third the cost of a full independent development. Other panel members expressed concern with transferring models from other areas due to the fact that a thorough process is often not followed and cited research from Chandra Bhat. All agreed that the second generation activity-based models will come with a reduced cost as the first generation models had a steeper learning curve and have

established a knowledge and user base from which to build. If AMBAG switched to an activity-based model, they would be in the second generation. It was also suggested that AMBAG could do a phased approach to activity-based model implantation, similar to the Puget Sound Regional Council. A hybrid activity trip based model could use daily activity patterns and primary destination choice and auto ownership models and could leverage the statewide model population synthesizer. The panel also expressed concern that the MPO might not have resources to run or maintain an activity based model.

5.0 Peer Review Panel Recommendations

Following the discussion of model enhancements, the peer review panel convened separately to discuss specific model development goals. Following this panel caucus, the panel presented a summary of their recommendations to AMBAG staff and other attendees at the peer review.

5.1 General Recommendations

The panel listed the many agencies who are current or potential users of the AMBAG regional travel demand model as well as model data (the MPO, 3 RTPAs, 2 transit districts, air quality district, 18 cities, 3 counties and Caltrans). The panel also listed the universities as another possible partner. AMBAG needs to leverage these partnerships realizing that all good information and analysis comes at a price. AMBAG already has budding relationships in place through the blueprint planning process and other planning efforts. The panel recommended that AMBAG continue to foster these relationships. The panel also suggested that the MPO could leverage existing grants, such as the grant to develop a bike model, to improve facets of the model. The panel emphasized continuing to explore additional grant funding sources. Even with these leveraged opportunities, the panel recommended that AMBAG needs to increase funding for model improvements in order to meet the aforementioned legislative and technical requirements for modeling in the region.

As part of building partnerships, the panel recommended developing a more open process for releasing the AMBAG regional travel model. To the extent that the full model goes out of office, user agreements documenting rules of governance of the use of the model can protect the agency and shift the liability to the user. Version control software could also be put in place to track official versions and to review and merge any improvements back to the main model development stream. The panel stated that an open process gives transparency and makes users accountable for their own work.

5.2 Short-Term Improvements

The panel recommended the following short-term improvements to the AMBAG regional travel model. Short-term was defined as items to be accomplished in preparation for the 2013 MTP. The panel acknowledged that this infers immediate action and that improvements would need to be done over the next year to be done in time for use in the plan. The panel also acknowledged that though the list looks long many of these items are small and would not require significant effort.

The short-term recommendations are ranked according to importance and are not in sequential order. Once AMBAG determines which improvements will be made, then they should proceed to implement the improvements in a logical sequential order.

1) Supplement 2011-2012 CHTS and oversample special populations and get a good demographic description of these households; do not be overly concerned of getting a

1% household sample, rather sample should be based on obtaining enough observations in a particular cross-classification of how the data will ultimately be used; have a focus to improve future mode choice and destination choice models realizing that mode choice will also need to be supported by a transit on-board survey; if possible try to use resources to get bike surveys or choice surveys

2) Fix free flow speeds on the highway network to ensure they represent true free flow conditions and not congested conditions (may also want to investigate using Highway Capacity Manual methods to calculate free flow speed)
3) Change to five time periods, recalculate time of day factors from survey and use period assignments to construct daily measures (do not use daily assignment)
4) Report production/attraction balance
5) Fix observed travel times by assigning survey origins/destinations to the network; use weighted average skim for trip distribution
6) Report screenline validation, in particular for Santa Clara County
7) Trip length frequency distribution needs to be revisited; report trip length frequency by county and don't prohibit K-factors
8) Check and report traffic assignment and increase convergence to 10E-6
9) For select link analysis use an assignment method that maintains proportionality
10) Test and report system convergence of distribution, mode choice, assignment feedback loop as it may take more than two iterations to reach convergence
11) Consider overall or multi-year trends when using validation data and do not be tied to a specific anomalous year
12) Report how trip purposes were combined for estimating time of day factors
13) Report at which level coefficients are applied in the mode choice nesting structure; report constants in terms of equivalent in vehicle travel time
14) Make the mode choice coefficients and transit skims weighting consistent
15) Recalibrate mode choice
16) Report and analyze screenline data
17) Smooth trip generation rates to provide a smoother transition between classes (optional)

5.3 Mid-Term Improvements

The panel recommended the following medium-term improvements to the AMBAG regional travel model. Medium-term was defined as items to be accomplished in preparation for the 2017 MTP. The improvements would cover approximately the next four years. As with the short-term recommendations, the mid-term recommendations are ranked according to importance and are not in sequential order. It is left to the MPO to determine which improvements will be made and then to put them in a sequential order.

1) Consider using statewide model for EE, IE, and EI travel; continue to maintain consistent inputs between the statewide and AMBAG regional models
2) Reduce bias constants in mode choice prior to use in new starts
3) Implement a hybrid activity/trip based model to better represent unique issues with full/part time workers and long distance travel (intra-community travel); could be implemented at a TAZ or parcel level:
    a. Use daily activity model instead of trip generation model

   b. Use primary destination choice model instead of trip distribution model
   c. implement an auto ownership model
   d. Leverage statewide model population synthesizer
   e. This will partially replace '5D' tool
4) If transferring models from another area make sure biases based on regional modeling techniques are not introduced
5) Replace current truck model with goods movement model
6) Develop mid-level land use forecasting model that recognizes seasonal residents and workers and that can take advantage of parcel data; give adequate time for testing before put results into production
7) Develop parcel data set through establishment of regional data consortium
8) Incorporate bike model
9) Work with transit providers to conduct on-board transit survey
10) Collect boarding data at same time
11) Transit agency collect data and AMBAG support process
12) Data collected with travel model in mind
13) Seek grant funding from FHWA, FTA, regional partner agencies or Caltrans
14) Continue to get regular updates of visitor data from tourist industry
15) Incorporate land use planning visualization tools to support continuing blue print planning efforts and SB 375
16) Estimate new mode choice model with new socioeconomic and demographics and that incorporates urban design and level of service characteristics (broaden explanatory variables to make more robust) for use in the '5D' analyses

5.4 Long-Term Improvements

The panel recommended the following long-term improvements to the AMBAG regional travel model. Long-term was defined as items to be accomplished after the 2017 MTP, or as resources became available. These were seen as lower priorities to the other improvements recommended.

1) Implement full activity based model.
2) Implement region wide dynamic traffic assignment (DTA)

Appendix A List of Peer Review Panel Participants

Peer Review Panel Members:

Gordon Garry (chair)	Sacramento Area Council of Governments (SACOG)
David Kurth	Cambridge Systematics, Inc. (CS)
Maren Outwater	Resource Systems Group, Inc. (RSG)
Dave Robinson (co-chair)	Fehr & Peers
Erik Sabina	Denver Regional Council of Governments (DRCOG)
Elizabeth Sall	San Francisco County Transportation Authority (SFCTA)

Local Agency, DOT and FHWA Division Staff:

John Doughty	AMBAG
Bhupendra Patel	AMBAG
Randy Deshazo	AMBAG
Linda Meckel	AMBAG
Sasha Tepedelenava	AMBAG
Steph Nelson	AMBAG
Aileen Loe	Caltrans
Claudia Espino	Caltrans
Judy Lang	Caltrans
Ginger Dykaar	Santa Cruz County Regional Transportation Commission
George Dondero	Santa Cruz County Regional Transportation Commission
Mike Zeller	Transportation Agency for Monterey County
Angela Aitken	Santa Cruz Metropolitan Transit District
Carl Sedoryk	Monterey-Salinas Transit
Richard Stedman	Monterey Bay Unified Air Pollution Control District

Supporting Staff to Peer Review Panel Members:

Chad Worthen (Peer Documenter)	Resource Systems Group, Inc.

Appendix B Peer Review Panel Meeting Agenda

Peer Review Panel Meeting Agenda

AMBAG Model Peer Review Meeting
UC MBEST Center, 3180 Imjin Road
Marina, CA 93933

March 28-29, 2011

First Day: Monday, March 28, 2011

09:30 - 09:45	Welcome, Introductions and Purpose of the meeting
09:45 - 10:30	Background and Overview of the Monterey Bay Area MPO Region, Technical Overview of the Current AMBAG Regional Travel Demand Model (RTDM)
10:30 - 10:45	Break
10:45—12:00	Executive Directors briefing (AMBAG, Regional Transportation Planning Agencies (RTPAs), Transit agencies, Caltrans and Monterey Bay Unified Air Pollution Control District)
12:00—1:30	Lunch
01:30 – 3:00	Presentation and discussion on the AMBAG Model Improvement Plan (MIP)
03:00—3:15	Break
03:15—5: 00	Panel Caucus: Review/Critique and Comment on Practices (Peer Review Panelists meet to discuss information): Part I

Second Day: Tuesday, March 29, 2011

09:00 - 10:00	Panel Caucus: Review/Critique and Comment on Practices (Peer Review Panelists meet to discuss information): Part II
10:00 - 10:15	Break
10:15 - 12:00	Panel Report and Discussion (Peer Review Panelists present to MPO and others)
12:00 – 12:15	Conclusion/Adjourn

Appendix C Peer Review Panel Biographies

Peer Review Panel Biographies

Gordon Garry, Director of Research & Analysis, Sacramento Area Council of Governments (SACOG)

Gordon Garry has been with the Sacramento Area Council of Governments since 1990, developing and managing an increasing array of data and forecasting programs to support the agency's transportation, air quality, land use planning, and more recently, climate change efforts. He is responsible for modeling projections and analyses in these areas that meet local, state, and federal planning requirements. In addition to his work at SACOG, Mr. Garry currently serves as a Research Associate for the Urban Land Use and Transportation Center at the University of California, Davis. Prior to joining SACOG he worked for the city of Santa Rosa, California; SRF Consulting in Minneapolis, Minnesota; and the South Dakota Department of Transportation. Mr. Garry received his B.S. in Economics at South Dakota State University and his Masters in City and Regional Planning from the Harvard Kennedy School of Government.

David Kurth, P.E., Principal, Cambridge Systematics, Inc. (CS)

David Kurth is a Principal of Cambridge Systematics with more than 30 years of experience in travel demand model development, model application, and project management. Mr. Kurth's experience includes the development of full, four-step models for metropolitan areas; travel model validation; statewide travel modeling; development of specialized models in support of traffic and transit ridership forecasts; and application of travel demand models for the Federal Transit Administration (FTA) New Starts process, major investment studies (MIS), alternatives analyses (AA), and preliminary engineering/environmental impact statements (EIS). He also has developed and managed various types of travel surveys, including regional household, transit on-board, commercial vehicle, and vehicle intercept surveys. Mr. Kurth serves on the Transportation Research Board (TRB) Committee on Transportation Planning Applications (ADB50) and the TRB Special Committee for Travel Forecasting Resources (ADB45). He has served on peer review panels for the review of travel forecasting procedures and results for the Rocky Mountain Rail Authority (Colorado) High Speed Rail Feasibility Study, 2025 travel forecasts for the Southern California Region, and the demonstration of TRANSIMS in Portland, Oregon.

Maren Outwater, P.E., Director, Resource Systems Group, Inc. (RSG)

With 26 years of progressive experience in managing complex model development efforts, Maren Outwater has developed and enhanced models to provide practical solutions for today's transportation, growth, environmental and economic development challenges. She is skilled at translating complex technical methods into useful and practical information for decision-makers. Prior to RSG, she was the Director of Data Systems and Analysis at the Puget Sound Regional Council (PSRC) in Seattle, Washington. She managed the development of land use, travel and air quality forecasting models in 25 states and applied these models for projects such as major investment studies (MISs), regional transportation plans (RTPs), benefit analyses, growth management plans, environmental impact studies (EISs), economic development studies and feasibility studies. Ms. Outwater participated on a Travel Model Improvement Program (TMIP) Panel to provide oversight on the peer review panel program. She participated in a series of peer review panels in recent years, for the Southern California Association of Governments, the

Sacramento Council of Governments, the Columbia River Crossing (chair), the San Diego Association of Governments and the Metropolitan Transportation Commission in San Francisco. In addition, she has presented work to peer review panels for the SR-520 Tolling Implementation Committee, the Southern California Association of Governments and the PSRC.

Dave Robinson, Senior Associate, Fehr & Peers

Dave Robinson has over 17 years of transportation planning experience with areas of expertise in travel demand modeling, transportation planning and operations analysis. Mr. Robinson is involved with ongoing evaluation of modeling practices and development through the firms travel forecasting Discipline Group. Mr. Robinson also teaches a course for the Institute of Transportation Studies Technology Transfer program at U.C. Berkeley entitled, "Successful Collaboration: Methods and Best Practices."

Erik Sabina, Regional Modeling Manager, Denver Regional Council of Governments (DRCOG)

Erik Sabina is a graduate of the University of Colorado and the Massachusetts Institute of Technology, and has more than 25 years engineering and modeling experience in both the public and private sectors. Major projects Mr. Sabina has led include: the design and successful development of DRCOG's FOCUS model, one of the early implementations of activity-based models in the United States; and the Front Range Travel Counts survey project, the first multi-jurisdiction travel survey in Colorado history, covering four MPO areas and a total of nine funding partners. Mr. Sabina has published extensively on activity-based travel model development and has been a frequent peer review panelist and invited speaker throughout the country. He is a current member of the TRB's Travel Demand Forecasting committee (ADB40.)

Elizabeth Sall, Principal Planner, San Francisco County Transportation Authority (SFCTA)

Elizabeth Sall is on the team who develops and uses the SF-CHAMP regional travel demand model at San Francisco County Transportation Authority. Previously, Elizabeth was a consultant with Cambridge Systematics in both the DC Metro Area and in the Bay Area. She holds a BS and MS in civil engineering from North Carolina State University and University of Texas at Austin, respectively.

Appendix D Summary of Responses to AMBAG Questions

Summary of Responses to AMBAG Questions

The following questions were posed by AMBAG and other regional/local agency staff for discussion during the peer review. Most of the issues raised by the questions were covered during the discussion and recommendations phases of the peer review. Brief summaries of those discussions and recommendations, and selected additional responses are provided in this Appendix.

1) Does current AMBAG model need additional improvements to meet the FHWA/FTA as well as State standards?

   The current AMBAG model meets current FHWA standards, but additional improvements, as recommended by the panel, are needed to meet FTA and new State standards.

2) Are additional improvements needed to the current feedback loop procedures?

   The panel recommended the MPO test and report system convergence of the distribution, mode choice, assignment feedback loop. The panel also recommended the MPO consider using more than two iterations to obtain congested travel times.

3) Are there better techniques for handling trip generation and trip distribution for the size and diversity of our region?

   As a mid-term solution, a daily activity model could be used instead of trip generation model and a primary destination choice model could be used instead of trip distribution model to address questions related to the '5D' process and issues related to trip length frequencies. A full activity-based model is recommended as a longer term solution. In the short term, the panel suggested reinvestigating the strategic use of limited K-factors to improve trip distribution and revising trip generation rates for households rather than persons.

4) Are there checks/balances that we are not performing that should be performed? Is the current trip distribution model (gamma function) is acceptable or use the friction factors tables?

   It was suggested that the MPO check: 1) trip generation production and attraction values by purpose before and after adjustments, 2) distribution feedback loop convergence, 3) trip length distributions by county, 4) mode choice constants in terms of equivalent in vehicle travel time, 5) traffic assignment convergence, and 6) screenline validation in particular for Santa Clara County.

   The use of gamma functions for trip distribution is acceptable when applying a gravity model, but the panel recommended moving to a destination choice model due to the distribution of households and employment in the region.

5) Considering the region's diversity, how can our mode choice model be improved?

   Consideration should be given to supplement 2011-2012 CHTS and oversample special populations and get a good demographic description of these households. The focus of this should be to improve the future mode choice and destination choice models

realizing that mode choice will also need to be supported by a transit on-board survey. The MPO should work with transit agencies to conduct a comprehensive transit on-board survey geared toward travel demand modeling. Consideration should also be given to broaden the explanatory variables in the mode choice model. Estimating a new mode choice model with socioeconomic and demographics that incorporate urban design and level of service characteristics will also provide support for '5D' analyses.

6) How can our model keep up with time-of-day requirements since the region has strong influence of SF Bay/San Jose area as well as longer commute distance/time?

   The panel recommended moving to five time periods: AM, midday, PM, evening and night. The model should also be calibrated by period using congested speeds and diurnal distribution data for each time period. Diurnal data could be derived from CHTS survey.

7) How can we better reflect the commute pattern between SF Bay Area and AMBAG region?

   Implementing an activity-based model or a hybrid activity-based/destination-choice model will help to capture longer commuting patterns, such as for the highest income group (>$75,000). The California statewide is a good resource to help identify this external trip movement. In the short term, validating the trip distribution patterns by county should also help.

8) Assessment of the reasonableness of HOV/toll traffic forecasting capabilities.

   According to the model documentation, the AMBAG travel demand model has HOV forecasting capabilities; however the reasonableness of the model's HOV forecasting was not discussed separately from the context of the overall mode choice model capabilities.The panel did recommend some improvements to the mode choice model, which will apply to HOV modes. Tolling capabilities do not currently exist in the AMBAG travel demand model. The panel asked if tolling was a top question for AMBAG or its partnering agencies. Tolling options are not considered a priority in the current planning, therefore it was recommended that resources be directed from developing tolling capabilities into the model now toward more pressing needs.

9) What are ways that the AMBAG's regional model can be improved to better answer questions related to Smart Growth /mixed land use development and resultant Greenhouse Gases (GHG) reduction?

   More detailed land use variables and model improvements such as those in questions 3 and 5 that make the travel demand model more sensitive to changes to land use will help in answering these questions. The panel's recommendation for a land use forecasting model and integration with the travel model will provide the most benefit here.

10) How can the effects of gas prices or parking cost be better implemented into the agency's model stream?

    This question was not specifically discussed by the peer review panel; however guidance was given on using generalized costs in trip distribution and assignment models to reflect prices in this model and to review multi-year trends to establish calibration and validation data.

11) Do peak spreading and induced travel need to be emphasized more? If so, how?

This question was not discussed directly by the peer review panel, but the mid-term recommendation to develop a daily activity pattern model will produce estimates of induced travel and the long-term recommendation to develop a full activity-based model would include a time of day choice model to address peak spreading.

12) What recommendations are there for improving the current demographic allocation tool or for pursuing a new land-use forecasting model for alternative growth scenario testing as well as its integration to the future generation of the travel demand forecasting model?

The peer review panel recommended developing a mid-level land use forecasting model that recognizes seasonal residents and workers and that can take advantage of parcel data. The panel offered that there is a wide spectrum of land use models, ranging from more simple models like UPLAN to more complex models like UrbanSim and PECAS. It was suggested that several mid-range land use models, such as DELTA and Cube Land, require considerably less investment to build and maintain (approximately a fifth the cost) than the more complex land use models. These mid-range models can be designed to be TAZ-based but have a parcel data option and are less data hungry than the more complex models. The panel recommended investing in the more mid-range complexity land use model, especially in light of the resource constraints of the MPO. The panel also recommended that a new land use model did not necessarily need to be fully integrated or automated with the travel model to include a transportation element.

The panel recommended that AMBAG define a process for developing parcel data that could be used to support land use models through a regional data consortium. Local communities could feel a benefit from sharing data and working together by receiving information for smart growth concepts such as the '5Ds' analyses to minimize carbon footprint and VMT. This data sharing could enrich the quality of the databases and provide a cost sharing benefit.

13) What processes are we using that might not be best practices in travel demand modeling?

Refer to the 'Peer Review Panel Recommendations' section of this report.

14) Are there improvements that could be implemented immediately with limited funds or implemented in a two to three year period for an overall model development?

Improvements are listed in the short and mid-term recommendations of the 'Peer Review Panel Recommendations' section of this report.

15) How can we model weekend tourist/visitors activities?

Answers to questions 3, 5 and 12 also apply to tourist/visitor activities. In addition, the peer review panel suggested the MPO continue to get regular updates of visitor data from tourist industry. Weekend travel is not currently modeled by other MPOs or the State and if needed, can be estimated from available data sources to pivot from current weekday models.

16) How can we model farm workers travel behavior since they are transient (field to field) and seasonal?

Answers to questions 3, 5 and 12 also apply to farm worker travel behavior. Farm workers could be separated as a special generator to capture the unique aspects of this population.

17) Where should we obtain base year employment data? What do other MPOs use?

This question was not discussed by the peer review panel.

18) How much and at what level field data collection is necessary to build the best practice robust Regional Model?
19) *The panel recommended supporting a household travel supplement to the California Statewide survey and coordinating a regional on-board transit survey. Additional surveys for external travel or freight were not discussed. Speed data collection was useful, but the use of these data in the model were revised to include free flow speeds as an input and congested speeds as a validation measure.* How can we model regional diversities (socioeconomic as well as transit services)?

See answers to questions 3, 5,12, 15 and 16.

20) Should we be continuing building a regional travel demand models for all three counties and also include the neighboring region? Or also develop sub-area model?

This question was not discussed by the peer review panel.

21) Considering the SB375 requirements as well as other agency needs AMBAG has designed the Model Improvement Plan (MIP). What would be staffing and funding needs to meet these requirements or does the MPO only develop a basic regional model to meet FHWA/FTA's basic requirements and enhancements are expected to built by end users?

AMBAG needs to leverage partnerships realizing that all good information and analysis comes at a price. AMBAG already has budding relationships in place through the blueprint planning process and other planning efforts. The panel recommended that AMBAG continue to foster these relationships. The panel also suggested that the MPO could leverage existing grants, such as the grant to develop a bike model, to improve facets of the model. The panel emphasized continuing to explore additional grant funding sources. Even with these efforts, the panel recommended that AMBAG needs to increase funding for model improvements.

22) Any organizational changes that can facilitate our model development process more seamlessly?

See answer to question 21.

23) Should we start developing a freight model? If so, how?

AMBAG should replace the current truck model with goods movement model. The approach was not discussed in detail as the freight forecasting methods are changing rapidly and should be considered at the time of model development. Integration with the future statewide freight model may be beneficial.

24) Should we consider transitioning into an activity-based or tour-based model? If so, should we maintain parallel tracks of modeling? Also associated cost?

The panel suggested the MPO consider moving toward an activity-based model. Given the cost and resource constraints, it was suggested that AMBAG could do a phased approach to activity-based model implantation. A hybrid activity trip based model could use daily activity patterns and primary destination choice and auto ownership models and could leverage the statewide model population synthesizer. This was a mid-term recommendation.

It was recommended that the MPO implement a full activity-based model in the long-term. In developing a full activity-based model the MPO has the option of transferring an activity-based model from other locations and it was suggested that transferring from a smaller activity based model could be accomplished in about a year for about a third the cost of a full independent development. Second generation activity-based models will also come with a reduced cost as the first generation models had a steeper learning curve and have established a knowledge and user base from which to build. If AMBAG switched to an activity-based model, they would be in the second generation.

Maintaining parallel tracks of modeling trip and activity-based models was not recommended due to resource constraints and because second generation activity models would not need to maintain parallel tracks.

25) Should we consider a micro simulation model and how can our current model assist with that implementation?

Traffic micro simulation and dynamic traffic assignment at a regional scale was discussed by the peer review panel but placed at a lower level of priority than the other model improvements due to the needs expressed by the agencies using the model.

26) Is there any visualization techniques (sketch planning tool) available for better communications to the board and general public (education materials, flyer for "dummies") pertaining to the model methodology and results?

Incorporate land use planning visualization tools to support continuing blue print planning efforts and SB 375.

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