



Metropolitan Washington Council of Governments  
National Capital Region Transportation Planning Board

Review of MPO External Trip Forecasting Methods

September 22, 2006



*Vanasse Hangen Brustlin, Inc.*

8300 Boone Blvd, Suite 700

Vienna, VA 22182

(703) 847-3071

## Executive Summary

The Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board (TPB) engaged Vanasse Hangen Brustlin (VHB) to review how high-growth MPOs forecast productions and attractions at external stations. TPB is interested in considering alternative approaches for forecasting external trips.

The current 6,800 square-mile TPB 2,191 traffic analysis zone (TAZ) system contains 47 external stations. TPB's last auto external survey was conducted in 1994 and consisted of a license plate survey of inbound vehicles crossing the expanded cordon, and a follow-up mail-out/mail-back postcard survey that yielded 16,000 responses. TPB's last truck external survey was conducted in 1996 and consisted of 5,000 surveyed trucks at 12 sites near the cordon. All surveyed trucks were inbound except at the Chesapeake Bay Bridge (William Preston Lane, Jr. Memorial Bridge) in Anne Arundel County, where information was collected from outbound trucks (east to the Eastern Shore of Maryland). Together these two surveys form the current external trip base data for the TPB model.

The literature review and survey of MPOs resulted in the conclusion that the methodology for forecasting future external trips is not a "hot" issue at this time and thus, is not receiving very much attention either from MPOs or the transportation research community. MPOs are quite focused (like TPB) on making improvements to the model chain that improve the ability to forecast travel within the modeled region. MPOs that do not use a statewide model to forecast external trips are not doing anything significantly different than TPB's current process.

However, in both high-growth regions and complex moderate-growth areas like the National Capital Region, the issue of forecasting external trips is growing in importance as jobs and household continue to locate farther away from traditional urban core areas and contribute to an increased share of external trips in overall regional travel. TPB is planning in the Version 2.2 model release to make some model improvements to address the issue of external trips.<sup>1</sup> There are pieces of the various approaches seen in this review that can be applied to the TPB process.

A possible approach is to combine elements of two procedures. First, TPB could create a model "super-region" at the super-district or county level extending as far as 150 miles from Washington, D.C. based on data available from the 2000 Census Transportation Planning Package (CTPP) and anticipated changes to the areas that regularly interact with the TPB area. The number of external stations in the model network could be increased to match each station with a super-regional county or super-district. In Maryland, Virginia, and Pennsylvania, it may be worth considering adopting the statewide model network for those areas outside the current TPB modeled area for compatibility. Following the collection of external station base counts through traditional counts and surveys, the data could be supplemented by the super-regional jurisdictions and MPOs, similar to the coordination TPB already does with BMC and FAMPO, just over a larger area. For future year external trip forecasts, rather than extrapolating or using a growth-factor, TPB could use the updated population / household and employment forecasts for the super-regional jurisdictions and convert the growth to productions and attractions and ultimately external (E-E, E-I, and I-E) trips.

---

<sup>1</sup> See COG/TPB (2006), Section 2.1.2 – Refinement of Growth Assumptions at External Stations.

Special attention will need to be paid to coordination with existing small MPOs in or near the super-region who may have existing modeling programs, such as the Hagerstown, Cumberland, and Winchester MPOs. These agencies will benefit from the use of the TPB model to produce external trip matrices for their areas.<sup>2</sup> Those areas that may have a designated MPO following the 2010 census, such as the Gettysburg, PA area, should also be considered.

### **Background: Current TPB External Trip Forecasting Process**

The current 6,800 square-mile TPB 2,191 traffic analysis zone (TAZ) system contains 47 external stations. TPB's last auto external survey was conducted in 1994 and consisted of a license plate survey of inbound vehicles crossing the expanded cordon, and a follow-up mail-out / mail-back postcard survey that yielded 16,000 responses. TPB's last truck external survey was conducted in 1996 and consisted of 5,000 surveyed trucks at 12 sites near the cordon. All surveyed trucks were inbound except at the Chesapeake Bay Bridge (William Preston Lane, Jr. Memorial Bridge) in Anne Arundel County, where information was collected from outbound trucks (east to the Eastern Shore of Maryland). Together these two surveys form the current external trip base data for the TPB model.

TPB also coordinates with the Baltimore Metropolitan Council (BMC) to ensure consistency in trip forecasts in the overlap area between the two agencies' modeled regions and to receive output from the BMC model for Baltimore County, which is *internal* to the BMC model but immediately *external* to the TPB modeled area. Finally, TPB coordinates with staff from the Virginia Department of Transportation (VDOT) and the Fredericksburg Area MPO (FAMPO) to ensure consistency in trip forecasts in the Fredericksburg area, the majority of which is within the TPB modeled area<sup>3</sup>. In general, future year external trips are determined using annual growth based on the growth in the area served by each external station, or by using the growth in trips from neighboring MPOs where available. The current TPB work program includes data collection for an auto external survey during FY2006, and processing, cleaning, and submission of the final survey report during FY2007.

### **Literature Review**

VHB staff reviewed the available literature about procedures for forecasting external trips in high-growth metropolitan areas. This review did not discover any recent documents of direct significance, although the travel modeling procedures for a range of MPOs were studied for possible relevance. Most MPOs use physical cordon counts as the basis for estimating external trips, like TPB. Some variation was found in how the MPOs applied these counts to their models, but the methods for data collection were strikingly similar.

---

<sup>2</sup> The potential benefits have led to this type of coordination being planned in Arizona; the Pima Association of Governments, the Tucson MPO, plans to perform its upcoming (next year) external survey in conjunction with MAG in Phoenix. The two cities are approximately 110 miles apart.

<sup>3</sup> FAMPO has a separate model administered by VDOT. The MWCOG modeled area does not include the area of Spotsylvania County south of VA 606.

The Model Validation and Reasonableness Checking Manual published in 1997 by FHWA indicates the need for a cordon count in order to determine the number of externally-based trips that will not be included in the regional trip generation model. A report produced in 2001 for the Puget Sound Regional Council also indicated this as the only method for updating external trip tables. The number of external stations used to collect this data varies greatly according to the geography and infrastructure of the region, although all major routes should be counted and should include a range of different facility types. This type of count can be performed as an intercept survey that gathers detailed origin and destination data as was completed for the Maricopa Association of Governments which allows the counts to be used as a supplement to the trip distribution table and preloaded onto the network. In areas that elect to only take volume counts at the external stations (as is done in Rhode Island) a gravity model is required to assign the externally-based trips onto the internal network.

In metropolitan regions that are completely enclosed within a single state, there may be a statewide model that utilizes this procedure that allows the MPO to use the state's forecasted internal trips as external trips instead of performing physical counts. Adjacent MPOs can also check their external trip forecasts with each other as is done between the Northeast Ohio Areawide Coordinating Agency (NOACA) in Cleveland and the Akron Metropolitan Area Transportation Study (ATAMS).

While cordon counts are used almost universally as the values for the base year model, several methods were found for estimating the growth of external trips. Some MPOs grow these trips based on socioeconomic forecasts from nearby cities. Linear regression using historical trip rate data is the most common method of growth estimation. NOACA uses the Fratar method to estimate the growth in external through (external-external) trips while assuming that the percentage of external trips at each station remains constant.

One final issue that was mentioned frequently in the literature was the estimation of externally based truck trips. Trucks are frequently making trips through the metropolitan areas and cannot be surveyed in the same way as passenger vehicles. Other methods, including the electronic tracking of trucks and license plate tracking can be used to determine the routes taken by these heavy vehicles. Alternatively, truck traffic can be assumed to be equal to a certain percentage of the counted passenger traffic.

## **Survey of MPOs**

VHB staff contacted 14 MPOs to obtain information about their procedures for forecasting external trips, and received responses from nine.<sup>4</sup> VHB staff also had informal, face-to-face conversations with representatives of four other MPOs to inquire about their procedures for forecasting external trips.

---

<sup>4</sup> The MPOs were chosen either because they modeled a region similar to the TPB region, or because they had been identified as high-growth in the Transportation Research Board (TRB) MPO State of the Practice Survey. In the TRB survey, high-growth MPOs are those where the percent difference between previous growth (generally through 2005) and forecast future growth (to 2025 or 2030) in population and employment was in the top 25% of those MPOs surveyed.

The results of the survey closely mirror the results of the literature review: MPOs either essentially follow the same process as TPB, or obtain external trips from a statewide model's internal trips.

### **MPOs That Essentially Follow the Same Process as TPB**

As noted in the literature review, most MPOs throughout the United States use procedures similar to those currently employed at TPB to collect base data for and forecast future external trips: collecting base data at external stations through a combination of traditional link traffic counts and license plate or mailout / mailback surveys, and forecasting future trips by using a straight-line extrapolation or a simple growth-factor. According to the survey responses, these methods are used in the following metropolitan areas: Atlanta, Georgia; Charlotte, North Carolina; Tampa, Florida; San Antonio, Texas; and Las Vegas, Nevada.

#### *Atlanta*

The Atlanta Regional Council (ARC) reports using a growth-factor method to forecast future external trips in its model set. For reasons of air quality / conformity analysis, ARC has recently expanded its modeled area to 20 counties, so the regional cordon and external stations have been relocated as many of the old external stations are now internal to the model. ARC gave no indication that their external trip forecasting procedures would change as a result of the expanded modeled area.

#### *Charlotte*

The City of Charlotte Department of Transportation (CDOT) is the lead agency for development and application of the Metrolina (Metropolitan Carolina) Regional Model, which models travel in the Charlotte area, an 11-county, bi-state area encompassing four separate MPOs that previously each had their own separate model.<sup>5</sup> The Metrolina Regional Model uses historical trends to prepare growth factors for forecasting future external trips, with the resulting growth averaging 2.5% per year through 2030.

#### *Tampa*

The Florida Department of Transportation (FDOT) District 7 is the lead agency for development and application of the Tampa Bay Regional Planning Model (TBRPM) for a five-county area.<sup>6</sup> Forecasts of external trips in the TBRPM use growth factors developed from historical trends and coordination with other outside agencies to account for special sources of travel growth.

#### *San Antonio*

The San Antonio-Bexar County MPO forecasts external trips by reviewing the regional population and employment forecasts and converting the resulting growth into total regional trips

---

<sup>5</sup> Charlotte, NC; Concord, NC; Gastonia, NC; and Rock Hill, SC

<sup>6</sup> Hillsborough, Pinellas, Pasco, Hernando, and Citrus counties. In Florida, counties frequently serve as MPOs, so the TBRPM covers four MPOs (Citrus County does not currently have a designated MPO)

for use in their travel demand model. A fixed percentage of these trips are then designated as external trips. Although external surveys are typically planned for every 3-5 years, prior to their 2005 external survey the previous survey was conducted in 1990.

### *Las Vegas*

While the Las Vegas area has and is continuing to experience very high growth, most of the growth appears to be occurring within the area already modeled by the Regional Transportation Commission of Southern Nevada (RTC), the Las Vegas MPO. Furthermore, the geography of the Las Vegas Valley and its immediate surroundings dictate a limited number of routes in and out of the area and extremely low population density along those routes; consequently there are a limited number of major cordon crossings in the RTC model and only ten external stations. RTC forecasts growth in external trips using the internal regional population projections and assumes a fixed percentage of external trips.

RTC has added a new external TAZ for the location of the Ivanpah Valley International Airport, a major new airport to be located approximately 25 miles south of Las Vegas.<sup>7</sup> The new airport is just beginning its Environmental Impact Statement (EIS) and currently is expected to be open in the year 2017, but is likely to have an impact on both the travel and development patterns in region before that time. RTC has indicated they are likely to consider a new approach for forecasting external trips in 2007, but did not indicate what alternatives are being considered. It is probable that during that review consideration will be given to expanding the modeled region to fully include the area around the new airport; such an expansion would bring the southern portion of the modeled region to the Nevada / California border, meaning RTC could use the California statewide model as a source of external trip forecasts.

### **MPOs That Obtain External Trips from a Statewide Model**

Increasingly, individual states are developing statewide travel demand models. States with fully implemented statewide models include (but are not limited to) Rhode Island, New Hampshire, Wisconsin, Kentucky, New Jersey, Oregon, Michigan, Massachusetts and Pennsylvania. Not all of the existing statewide models are sophisticated enough to provide good information on trips in areas bordering MPO modeled regions and serve as external trip inputs to the MPO models; however, this method *is* being employed by the following MPOs: Boston, Massachusetts; San Francisco, California; Los Angeles, California; and Sacramento, California.<sup>8</sup>

---

<sup>7</sup> This is approximately the same distance from downtown Washington to Dulles International Airport.

<sup>8</sup> Boston, San Francisco, and Los Angeles are included because their size and level of complexity is similar to Metropolitan Washington; Sacramento is considered a high-growth region. VHB also contacted the MPO in Modesto (Stanislaus County COG), a rapidly growing area that is ninety minutes' drive time from Sacramento and two hours from both San Francisco and San Jose. StanCOG indicated that they did not know their procedure for forecasting external trips and that a consultant performed the work, but VHB could not obtain a response from the consultant; however, it is reasonable to assume that StanCOG forecasts its external trips from a combination of coordination with adjacent MPOs (particularly for I-E trips to the north, west, and south) and the use of the statewide model.

### *California Statewide Model*

The California Statewide Model was developed by the California Department of Transportation (Caltrans) with consultant support from Dowling Associates. The model is implemented in TP+ and was specifically intended to provide external trips for the various MPOs statewide, in addition to modeling intra-state travel. Representatives from the California MPOs expressed satisfaction with the statewide model as a source for external trip forecasts for their area, stating that it made that aspect of regional forecasting easier.

### *Massachusetts Statewide Model*

The Massachusetts Statewide Model was developed by the Massachusetts Executive Office of Transportation (EOT) and is the source of external trips for the Central Transportation Planning Study (CTPS, the Boston MPO) model. Because EOT also works directly with the MPOs and their member jurisdictions to prepare statewide population and employment forecasts<sup>9</sup> that are used as inputs to the statewide model, coordination and consistency across the state is assured.

## **Recommendations**

The literature review and survey of MPOs resulted in the conclusion that the methodology for forecasting future external trips is not a “hot” issue at this time and thus, is not receiving very much attention neither from MPOs nor the transportation research community. MPOs are quite focused (like TPB) on making improvements to the model chain that improve the ability to forecast travel within the modeled region. MPOs that do not use a statewide model to forecast external trips are not doing anything significantly different than TPB’s current process.

However, in both high-growth regions and complex moderate-growth areas like the National Capital Region, the issue of forecasting external trips is growing in importance as jobs and household continue to locate farther away from traditional urban core areas and contribute to an increased share of external trips in overall regional travel. TPB is planning in the Version 2.2 model release to make some model improvements to address the issue of external trips.<sup>10</sup> There are pieces of the various approaches seen in the above review that can be applied to the TPB process.

Clearly, the use of internal trips from a statewide travel demand model as external trips for the TPB model is not a feasible approach at this time. Maryland lacks a statewide model<sup>11</sup>, and

---

<sup>9</sup> Like the rest of New England, Massachusetts has extremely weak counties and strong towns and cities and no unincorporated areas; thus a state-level agency like EOT can work with an MPO and towns and cities to create detailed, micro-level statewide forecasts.

<sup>10</sup> See COG/TPB (2006), Section 2.1.2 – Refinement of Growth Assumptions at External Stations.

<sup>11</sup> Although Maryland does not have a statewide model, URS Corporation created a model for use in the Maryland Transportation Authority (MdTA) Bay Crossing Task Force study that is examining options for increasing capacity across the Chesapeake Bay. The URS model includes all of Maryland except for Washington, Allegany, and Garrett counties. Information from URS may be helpful in developing the super-regional approach described in the memo.

although Virginia does have a statewide model,<sup>12</sup> the Virginia Department of Transportation (VDOT) has encountered problems with its application. VDOT modeling resources are currently focused on developing and applying the regional models in smaller MPOs statewide, and they expect it will be 2-3 years before the statewide model is available for regular use.

A possible approach is to combine elements of both of the above procedures. First, TPB could create a model “super-region” at the super-district or county level extending as far as 150 miles from Washington, D.C. based on data available from the 2000 Census Transportation Planning Package (CTPP) and anticipated changes to the areas that regularly interact with the TPB area (see Figure 3-1). The number of external stations in the model network could be increased to match each station with a super-regional county or super-district. In Virginia and Pennsylvania, it may be worth considering adopting the statewide model network for those areas outside the current TPB modeled area for compatibility. Following the collection of external station base counts through traditional counts and surveys, the data could be supplemented by the super-regional jurisdictions and MPOs, similar to the coordination TPB already does with BMC and FAMPO, just over a larger area. For future year external trip forecasts, rather than extrapolating or using a growth-factor, TPB could use the updated population / household and employment forecasts for the super-regional jurisdictions and convert the growth to productions and attractions and ultimately external (E-E, E-I, and I-E) trips.

Special attention will need to be paid to coordination with existing small MPOs in or near the super-region who may have existing modeling programs, such as the Hagerstown, Cumberland, and Winchester MPOs. These agencies will benefit from the use of the TPB model to produce external trip matrices for their areas.<sup>13</sup> Those areas that may have a designated MPO following the 2010 census, such as the Gettysburg, PA area, should also be considered. Finally, the super-region could encompass most or all of the State of Maryland, thus creating a *de facto* Maryland statewide model. In addition to improving TPB’s forecasting process, this model could be useful to the Baltimore Metropolitan Council (BMC), Hagerstown Eastern Panhandle MPO and other areas throughout the state. In view of the benefits accrued to areas in Maryland outside the Capital Region, this effort may be undertaken jointly with BMC and the Maryland DOT. It could also be expanded to create statewide modeling capabilities in Maryland. In view of the benefits to Maryland, TPB may wish to seek additional funding from BMC and the Maryland Department of Transportation (MDOT) to support development of this process for forecasting external trips.

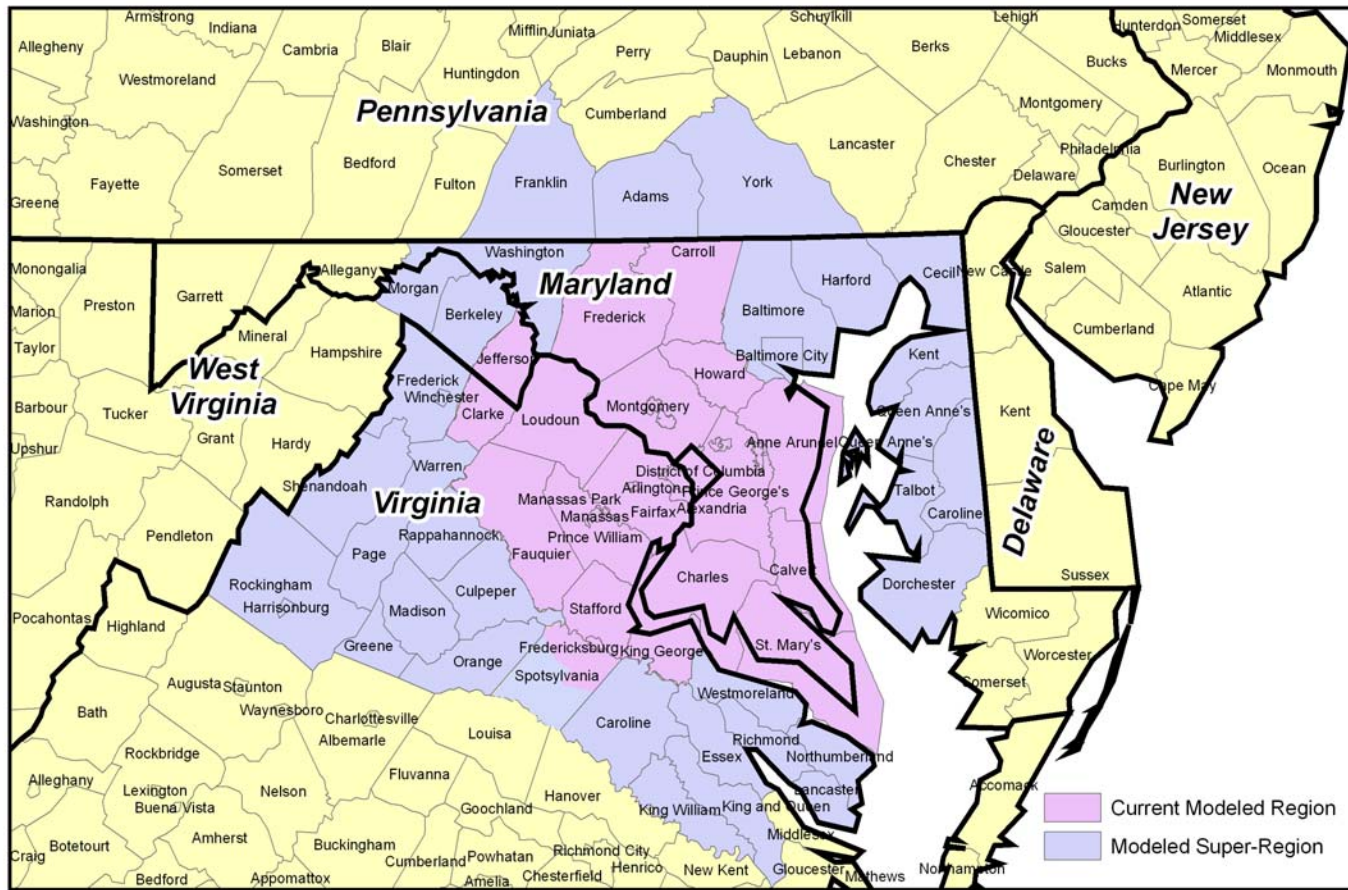
---

<sup>12</sup> Developed by Wilbur Smith Associates and completed in 2004, the Virginia statewide model implemented in TP+ breaks the Commonwealth into 200 TAZs, and contains both a macro-level model to forecast E-E trips through Virginia and a micro-level to forecast intra-state (I-I) and external (E-I and I-E) trip flows.

<sup>13</sup> The potential benefits have led to this type of coordination being planned in Arizona; the Pima Association of Governments, the Tucson MPO, plans to perform its upcoming (next year) external survey in conjunction with MAG in Phoenix. The two cities are approximately 110 miles apart.



Figure 3-1: Potential COG/TPB Super-Region for Modeling External Trips



## References

Boston MPO, 2005. Travel Modeling and Other Techniques Used for SIP Project Analysis, <http://www.bostonmpo.org/bostonmpo/SIP/Travel%20Modeling%20Techniques.pdf>.

Cambridge Systematics & Urban Analytics, September 24, 2003. Travel Demand Model Improvement Program, presented to Southern California Association of Governments Modeling Task Force.  
[http://www.scag.ca.gov/modeling/mtf/presentations/092403/Model\\_Improv\\_38\\_idge\\_System.ppt#326,2](http://www.scag.ca.gov/modeling/mtf/presentations/092403/Model_Improv_38_idge_System.ppt#326,2), Technical Approach

Charlotte Department of Transportation. Metrolina Regional Travel Demand Model, DRAFT Technical Documentation.

Denver Regional Council of Governments, 2000. Travel in the Denver Region.  
<http://www.drcog.org/documents/DRCOG%20TDR%20Report.pdf>

Email from Aichong Sun, Pima Area of Governments

Email from Anna Gallop, City of Charlotte Department of Transportation

Email from Elaine Martino, Florida Department of Transportation, District Seven

Email from Hongxiang (Sarah) Sun, Regional Transportation Commission of Southern Nevada

Email from Lark Downs, Stanislaus Council of Governments

Federal Highway Administration, 1997. Model Validation and Reasonableness Checking Manual.  
<http://tmip.fhwa.dot.gov/clearinghouse/docs/mvrcm/ch3.stm>

Horowitz, A. J., 2005. Tests of a Family of Trip Table Refinements for Long-Range, Quick-Response Travel Forecasting, Transportation Research Record.  
[http://www.trb-forecasting.org/papers/2005/ADB40/05-0100\\_Horowitz.pdf](http://www.trb-forecasting.org/papers/2005/ADB40/05-0100_Horowitz.pdf)

Metropolitan Washington Council of Governments, National Capital Regional Transportation Planning Board, 2006. Fiscal Year 2006 Development Program for TPB Travel Forecasting Models.

Murthy, S. & Salem, R. The Rhode Island Statewide Travel Demand Forecasting Model.  
<http://onlinepubs.trb.org/onlinepubs/circulars/ec011/murthy.pdf>

Parsons Transportation Group, Inc., March 5, 2001. PHOENIX EXTERNAL TRAVEL SURVEY: EXECUTIVE SUMMARY.  
<http://www.mag.maricopa.gov/pdf/cms.resource/household-travel-survey18728.pdf>

Personal conversation with Bruce Griesenbeck, Sacramento Area Council of Governments

Personal conversation with Chuck Purvis, Metropolitan Transportation Commission

Personal conversation with Guy Rousseau, Atlanta Regional Commission

Personal conversation with Keith Killough, Southern California Association of Governments

Personal and telephone conversation with Paul Agnello, Virginia Department of Transportation

Regional Transportation Commission of Southern Nevada, Regional Transportation Plan FY 2006-2030. Appendix IIB, Travel Demand Model Documentation.

Santa Barbara County Association of Governments, September 16, 2004. The 2030 Travel Forecast For Santa Barbara County: Final Report.  
<http://www.sbcag.org/PDFs/publications/2030TravelModel.pdf>

Sharag-Eldin, A. & Chow, L., June 2003. External Stations Forecast Analysis for NOACA 2025 Model Update. <http://www.noaca.org/techmemo.html>.

Sharma, S., Lyford, R. & Rossi, T. The New Hampshire Statewide Travel Model System. New Hampshire Department of Transportation & Cambridge Systematics,  
<http://onlinepubs.trb.org/onlinepubs/circulars/ec011/sharma.pdf>.

Telephone Conversation with Deardra Sprott, San Antonio / Bexar County MPO.

Telephone conversation with Scott Peterson, Central Transportation Planning Staff. *Contact at Massachusetts Executive Office of Transportation for Statewide Model is Bob Frey, (617) 973-7449.*

University of Washington, Cambridge Systematics & Bhat, C., June 30, 2001. Recommendations for Integrated Land Use and Travel Models.  
[http://www.psrc.org/datapubs/pubs/model\\_designrecommendations.pdf](http://www.psrc.org/datapubs/pubs/model_designrecommendations.pdf)