Southeast Michigan Council of Governments (SEMCOG) Travel Model Peer Review Report

December 2011

TMIP

Better Methods. Better Outcomes.

U.S. Department of Transportation
Federal Highway Administration

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Table of Contents

Introduction

1.1 Disclaimer

The views expressed in this document do not represent the opinions of FHWA and do not constitute an endorsement, recommendation or specification by FHWA. The document is based solely on the discussions that took place during the peer review sessions and supporting technical documentation provided by Southeast Michigan Council of Governments (SEMCOG).

1.2 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 SEMCOG travel demand forecast model (TDFM) and for sharing their valuable experience.

The Peer Review Panel Members were:

- Chaushie Chu (Los Angeles County Metropolitan Transportation Authority)
- T. Keith Lawton
- Eric Miller (University of Toronto)
- Kermit Wies (Chicago Metropolitan Agency for Planning)
- Johanna Zmud (RAND Corporation).

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

1.3 Report Purpose

This report summarizes the results of a peer review of the SEMCOG TDFM with a focus on recommendations for new model development. 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 practice and the growing demands by decision-makers for information about policy alternatives, it is essential that travel forecasting practitioners have the opportunity to share experiences and insights. The TMIP-supported peer review provides a forum for this knowledge exchange.

1.4 Report Organization

This report is organized into the following sections:

- *Overview of SEMCOG* – this section gives an introduction to the demographics, land use and transportation characteristics of the region, SEMCOG's planning responsibilities, and their goals for the peer review.
- *Development of the SEMCOG TDFM* – this section provides a historical context of travel modeling at SEMCOG, including past and current model versions and SEMCOG's current model improvement program.
- *SEMCOG TDFM assessment and discussion* – this section covers an assessment of SEMCOG's future analytical needs and discussion of model enhancements plans developed by SEMCOG.

- *Peer review panel recommendations* – this section provides the peer review panel's recommendations to SEMCOG including prioritized next steps.

In addition, the report includes three appendices:

- *Appendix A* – list of peer review participants
- *Appendix B* – peer review meeting agenda
- *Appendix C* – biographies for each of the peer review panel members.

Southeast Michigan Council of Governments Overview

2.1 SEMCOG Responsibilities

SEMCOG, the Southeast Michigan Council of Governments, is the metropolitan planning organization (MPO) for the seven-county southeast Michigan region of Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne Counties, and which includes the City of Detroit and the surrounding metropolitan area. SEMCOG was established in 1968 as a regional planning partnership in southeast Michigan. The agency is responsible for developing the federally-mandated Regional Transportation Plan (RTP) and the Transportation Improvement Program (TIP). SEMCOG is also responsible for calculating and documenting on-road mobile source emissions for both the State Implementation Plan (SIP) and the regional air quality/conformity analysis. The TDFM and its underlying theory are key support tools for this core work.

2.2 Regional Characteristics

In its application for the TMIP peer review, SEMCOG outlined some of the characteristics and trends in the southeast Michigan region that offer unique challenges to their travel demand modeling efforts. These include decline in population, significant changes in land use and the structure of the workforce, the decline of certain economic sectors and opportunities for the growth of others. The region is tightly knit from a supply chain standpoint with Ontario, Canada, with a substantial amount of the automotive industry operating on both sides of the border. Some MPOs are grappling with these challenges, but most are not experiencing the same loss of jobs and attendant lack of economic growth that SEMCOG is facing.

The population of the region increased from 4,833,368 in 2000 to a peak of 4,898,449 in 2005, before declining to 4,782,407 in 2010.[1] Wayne County was the only county that saw a decline in its population in the last decade from 2,061,162 in 2000 to 1,897, 499, but its decline in population surpasses the gains in the rest of the region's counties combined. The population decline has been driven by out-migration, with net out-migration of about 270,000 between 2000 and 2010.

The depressed economy and weak housing market during the second half of the last decade have resulted in very little homebuilding activity in the region. In 2009, 1,590 new home permits were issued in the region, which was only seven percent of the annual average number of permits issued during the first half of the decade. Population losses, coupled with the housing crash, have resulted in nearly 236,000 vacant housing units in the region. Between 2000 and 2010, vacant housing units in the region increased by more than 120 percent.

The employment market in the region contained a total of 1,874,815 jobs[2] at the end of the first quarter of 2009. The size of the job market declined by 8.3% between the first quarters of 2008 and 2009, which followed annual declines in total jobs in every year since 2001.

The falling population and weak economy have contributed to a decline in traffic in the region. Between 2004 and 2009, weekday traffic decreased each year from 142.7 million vehicle miles

[1] Population and Households in Southeast Michigan, 2000-2010, available at http://library.semcog.org/InmagicGenie/DocumentFolder/PopulationAndHouseholdsInSoutheastMichigan.pdf

[2] Jobs and Earnings in Southeast Michigan, First Quarter 2008 and 2009, available at http://library.semcog.org/InmagicGenie/DocumentFolder/Jobs_and_Earnings_QuickFacts_051210.pdf

traveled in 2003 to 123.7 million vehicle miles traveled in 2009, a decline of more than 13 percent. Weekend travel was also down by nearly 10 percent over the same time period.[3]

2.3 SEMCOG Goals for Peer Review

SEMCOG applied for this peer review as they were coming close to completing over a decade of model and data improvements that have resulted in what the agency describes as a "best practice trip-based travel modeling system", which has included interaction with an UrbanSim land use model for the past several years. The recent development path of the model is based in part on an earlier TMIP peer review panel that met in December 2004. At the time of this peer review in December 2011, most of the major recommendations of the 2004 peer review panel have been completed or are close to implementation.

SEMCOG expects to gradually transition from a trip-based model to an advanced model, as both the 2004 peer review panel and consultants working for SEMCOG have recommended the consideration of advanced models in the longer term. SEMCOG engaged the consultant Parsons Brinckerhoff in 2011 to independently assess the agency's modeling program and plans for future improvements. Part of their role was to recommend a future for travel modeling at SEMCOG.

While SEMCOG expressed keen interest in the panel's recommendations about all aspects of their modeling program, their specific goal for the peer review was to discuss three subjects:

- The case for moving to advanced models, including the strengths and weaknesses of their use in application.
- The panel's ideas on how travel models – whether best practice trip models or advanced formulations – can usefully inform issues specifically faced in Southeast Michigan.
- What the panel believe the future of travel data collection looks like, and the steps that SEMCOG should take to capitalize upon new methods for collecting travel data.

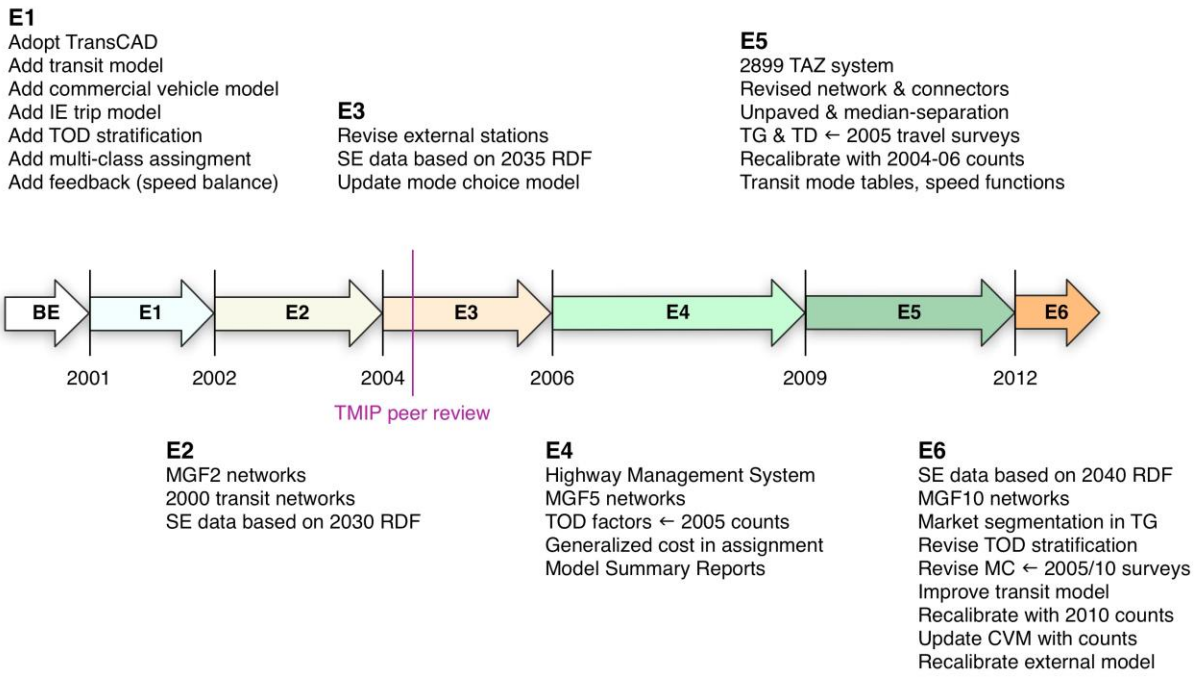
[3] Traffic decline continues in Southeast Michigan, available at http://library.semcog.org/InmagicGenie/DocumentFolder/TrafficDecline.4-10.pdf

Development of the Southeast Michigan Council of Governments TDFM

3.1 Introduction

This section of the report provides an overview of the development of the SEMCOG TDFM, including a description of the current version of the model, the current uses of the model, the updates made in response to the 2004 TMIP peer review, and the status of updates to the model that are currently underway. Figure 1 shows a chronology of the model versions that have been in use since 2001, when the "E series" of models was introduced, through the current version of the TDFM, Version E5, and the version of the TDFM that is under development, Version E6. If a transition to advanced models does takes place, SEMCOG expects that Version E6 might be one of the final model versions in this generation of trip-based models.

Figure 1: Progression of recent SEMCOG travel model improvements



3.2 History of SEMCOG TDFM Version E5

3.2.1 Development of TDFM Version E1

The documentation for the TDFM[4] discusses the development path that led to Version E5. Starting in 1991, SEMCOG developed a multi-year plan to improve and maintain its TDFM,

[4] Travel Demand Forecast Model: Version E5, June 2010, available at http://www.semcog.org/uploadedFiles/Programs_and_Projects/Transportation/Travel_Forecast/E5SEMCOGModelDocument.pdf

evaluated the modeling process, and developed a strategy for model improvement and associated data collection. SEMCOG conducted several important surveys, such as the 1994 household survey, the 1996 Detroit Department of Transportation (DDOT) transit on-board survey, the 1996 external station survey, and the 1999 commercial vehicle survey.. Some of the survey results were used to improve SEMCOG's TRANPLAN model.

The TRANPLAN model was principally a highway only model with three modules: trip generation, trip distribution, and highway assignment. The trip generation used cross-classification for trip productions and regression formulae for trip attractions. The trip distribution was a standard gravity model. The highway assignment was an equilibrium 24-hour one period assignment with 10-hour network capacity. Commercial vehicle movement was incorporated into the model trip table by factoring the expanded trips from the 1999 survey.

SEMCOG further improved its travel model in 2001, to create TDFM Version E1. A formal mode choice model and integrated highway and transit networks were introduced. The model platform was transformed from DOS based TRANPLAN to Windows based TransCAD. The project was completed in fall of 2002. As a result, SEMCOG upgraded its travel model from a highway only model to a four-step multi-modal travel demand-forecasting model.

3.2.2 Model Improvements from Version E1 to Version E4

Since the inception of TDFM Version E1 in 2002, SEMCOG implemented several improvements and updates as the model progressed to Version E4

- **Base Model Consolidation** – The Version E1 network was essentially a TRANPLAN based stick network. A database consolidation process was designed and implemented to establish better highway network geo-positions, completed in mid-2002. Version E2 used a revised Michigan Geographic Framework Version 2 (MGF2) year 2000 highway network. The transit network was completely re-coded using the year 2000 published routes and schedules from transit providers DDOT, SMART and AATA. The highway and transit networks greatly improved network accuracy and database transformability. Socioeconomic data from SEMCOG's new 2030 Regional Development Forecast (RDF) was also incorporated in the E2 version.
- **External Model Calibration** – Year 2000 traffic counts were collected to revise the external zone control totals. Based on the socio-economic data growth, external traffic counts were projected from year 2005 through 2030 with 5-year increments. External trips were made independent of the internal trip purposes.
- **Modified Mode Choice Model** – The mode choice model in Version E1 used a four-period mode choice model to produce auto and transit trips. For the work trip purpose, the mode choice model generated three modes: auto, drive access-transit and walk access-transit. The mode choice model was revised to eliminate the drive access-transit mode for the off-peak operation. The boarding distribution difference between urban and suburban transit providers was too large, and so dummy variables were introduced into the utility functions in the mode choice model to compensate for the difference. The revised mode choice model, incorporated in Version E3, significantly improved the transit boarding estimation.
- **Time of Day Validation** – The 1994 Household Survey data established a base for initial time-of-day (TOD) factors used in the travel model. Three measures were used to compare the model volumes with observed traffic patterns: 1) Peak hour factors: peak one hour volume vs. all day volume, 2) Period conversion factors: peak one hour

volumes vs. period volume, and 3) Volume distribution factors: peak period volume vs. all day volume. After the adjustment, the VMT distribution among the four period assignments was very close to observations and the relative speed distribution among the modeled periods also improved.

- **Model Output Summary Reports Development** – TransCAD does not provide formatted model output summary routines. In Version E4, a standalone Visual Basic application was developed to produce regional travel performance measure statistics, such as VMT, VHT, transit boarding, modal shares, and other similar factors.

3.3 Current SEMCOG TDFM: TDFM Version E5

SEMCOG TDFM Version E5 is thoroughly described in the model documentation[5]. The status of the model has recently been reviewed by the consultant Parsons Brinckerhoff as part of their engagement by SEMCOG to assess the agency's modeling program. This section of the report summarizes the presentation given by Rick Donnelly of Parsons Brinckerhoff during the peer review meeting.

3.3.1 Overall Structure

The model is a trip-based model which (for modeling person travel) includes the typical four-step model structure. In addition there is a three-step truck model to represent commercial vehicle movements and separate external trip generation and distribution components.

3.3.2 Data Engine

The model uses a collection of survey data and data inventories as its basis. These include national datasets such as NHTS and locally collected data such as:

- 1994 External station surveys
- 1996 Commercial vehicle survey
- 2004 MI TravelCounts
- 2005 SEMCOG travel survey
- Michigan Geographic Framework network master
- 2005 fixed route transit networks
- 2006-2007 cutline vehicle classification counts
- Regional traffic count database
- 2035 RDF socioeconomic data.

3.3.3 Trip Generation

The trip generation model uses a standard approach, estimating and balancing trip productions and attractions at a traffic analysis zone (TAZ) level for six trip purposes (home based work,

[5] Travel Demand Forecast Model: Version E5, June 2010, available at http://www.semcog.org/uploadedFiles/Programs_and_Projects/Transportation/Travel_Forecast/E5SEMCOGModelDocument.pdf

home based shopping, home based school, home based other, non-home based non-work, and non-home based other). It was re-estimated using 2005 survey data.

Productions are estimated using a cross classification model. Home based productions are a function of household size and the number of workers in a household, and auto ownership, while non-home based productions are a function of the number of jobs and households in a zone. Attractions are estimated using linear regression models. Productions and attractions are balanced in a standard manner, with home based work productions balanced to attractions and attractions for other trip purposes balanced to productions.

3.3.4 Trip Distribution

The distribution model uses a gravity model, which again conforms to typical practice. The model is calibrated to trip length frequency distributions using friction factors based on weighted average travel time and K-factors. The model's feedback loop provides updated weighted travel times during each model iteration. SEMCOG noted that the model produces a very good replication of the average trip lengths and trip length distributions and reasonable intrazonal trip percentages, but that it produces large errors in county to county work flows.

3.3.5 External Travel

The representation of external travel is described by Parsons Brinckerhoff as innovative but dated. The generation of external trips uses link types as a surrogate for trip purposes. Generated trips are subtracted from the trip generation model output. Attractions are a function of a zone's distance from the edge of the model region and internal attractions. External trips are distributed using a gravity model that employs friction factors. The external model overestimates trip lengths by between 7% and 62% by trip purpose. The model uses adjusted through trips from the Michigan statewide model. The temporal distribution of external trips is taken directly from counts.

3.3.6 Truck Travel

The representation of truck travel is also described by Parsons Brinckerhoff as innovative but dated. The model estimates travel by all commercial vehicles. The trip generation model was estimated for 248 districts but is applied at a TAZ level. Trips are generated for light, medium, and heavy trucks and are a function of the number of households and jobs, and area. The models contain statistically significant variables but the overall fit is mediocre, which is not uncommon. The truck trip distribution model is also a gravity model that uses friction factors. It reproduces regional average trip lengths and distributions. The time of day distribution is based on the 1999 Commercial Vehicle Survey and not truck counts. Through truck trips are taken from the Michigan statewide model.

3.3.7 Time of Day

This model component is established prior to mode choice, which is relatively uncommon. The time of day model conforms to typical practice. It factors the output from trip distribution by period and by directionality. It was originally based on the 1994 SEMCOG travel survey but has been updated using regional traffic pattern data.

3.3.8 Mode Choice

The mode choice model has a standard nested structure. The model is estimated using relatively aged data: the 1994 home interview survey, 1995 DDOT on-board survey, and the

1996 SMART on-board survey. The mode choice model uses a collapsed set of trip purposes: home based work, non-home based work, and non-home based.

3.3.9 Trip Assignment

The highway trip assignment model is described by Parsons Brinckerhoff as best practice. Highway assignment uses multi-class static user equilibrium. The classes include single occupancy vehicles, high occupancy vehicles with two occupants, high occupancy vehicles with three or more occupants, light trucks, medium trucks, and heavy trucks. The volume delay function is a Bureau of Public Roads function adjusted to match Highway Capacity Manual 2000 speed flow relationships. The generalized cost equation used to calculate the shortest path is a function of travel times, congestion, link length, and assumptions on value of time and vehicle operating costs.

Transit assignment conforms to typical practice. The model uses the TransCAD Pathfinder, with a generalized cost that is a function of travel time, wait time, and fare. Walk and auto access are available on both ends of a trip.

The feedback in the model uses Sheffi's MSA methodology, which is deemed best practice by Parsons Brinckerhoff.

3.3.10 Validation Summaries

The model produces a set of validation summaries covering both highway and transit outputs. For highway outputs, these include highway volumes by period and total daily results for various regions within the model area and for external stations, segmented by functional class and volume range. For transit outputs, these include boardings by line and daily trips by service provider.

3.4 SEMCOG 2004 TMIP Peer Review

SEMCOG's first TMIP peer review took place in 2004. The 2004 TMIP peer review report[6] summarizes the results of the two-day peer review meeting. During the 2004 TMIP peer review, SEMCOG requested that the peer review panelists examine its existing model and the agency's plans for future model improvement and enhancements, as recommended by its consultant (Cambridge Systematics, Inc.). SEMCOG asked for assistance with prioritizing near-term and long-term model enhancements and also for recommendations for transitioning to more advanced travel demand modeling methodologies.

After a day of SEMCOG presentations on the current travel demand model and plans for model improvements, the peer review panel met in private to discuss the model and make recommendations for model enhancements. The peer review panel felt that the existing model represented the "state of the practice." The panel felt that the model addressed time-of-day, commercial vehicle, and external trips particularly well.

The 2004 TMIP peer review report documents 20 specific recommendations, which SEMCOG has been working to address since 2004. Their status is as follows (the numbers in parentheses refer to the recommendation numbering using in the 2004 TMIP peer review report):

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[6] Summary Report of the Peer Review Panel for the Southeast Michigan Council of Governments Travel Model Improvement Effort, available at http://www.semcog.org/uploadedFiles/Programs_and_Projects/Transportation/Travel_Forecast/2004%20SEMCOG_PeerReviewReport_FINAL.doc

Implemented

- Existing data inventory (1)
- Vehicle classification counts (2)
- Network coding and TAZ structure (3)
- Land use modeling (4)
- Trip generation and distribution review (6)
- Traffic assignment (10)
- Air quality model integration (11)
- Minor ("uncertain") model improvements: area types (15)
- Validations (17)
- Travel speed verification (18)
- Travel model sharing (20)

In progress

- Additional trip purposes (HBW segmentation, HBU) (5)
- Transition from trip distribution to destination choice (8)
- Mode choice (9)
- Airport access modeling (12)
- Enhanced freight modeling (13)
- External trips (14)

Not addressed

- Non-motorized modes (7)
- Minor ("uncertain") model improvements: HOV, differential peaking (15)
- Activity-based modeling (16)
- Traffic operations tools. (19)

3.5 Status of SEMCOG TDFM Version E6

As outlined above, there are a set of model improvement recommendations made during the 2004 TMIP peer review that SEMCOG is currently working to address. SEMCOG's consultant, Cambridge Systematics, Inc., is currently developing a new version of the SEMCOG TDFM, Version E6, which will include those improvements. This section of the report summarizes the presentation describing the status of Version E6 given by Liyang Feng of SEMCOG and Tom Rossi of Cambridge Systematics, Inc. during the peer review meeting. In addition to implementing several of the remaining recommendations from the 2004 TMIP peer review, SEMCOG intends the transition to Version E6 to improve model components as needed to analyze key projects and policies and to reflect the most recent available data. The update work includes model estimation, application programming in TransCAD, and validation at a model

component level. At the time of the peer review meeting, work was underway on each of the model components, with some being estimated and others awaiting final validation.

3.5.1 Data Sources

The model updates that are taking place rely on several data sources:

- 2004-2005 household surveys (SEMCOG and MI Travel Counts)
- 2010-2011 transit on-board survey
- SEMCOG traffic count database, including commercial vehicle counts
- Information from transit providers such as ridership counts and schedules
- 2040 Regional Development Forecast
- Updated highway and transit networks using MGF Version 10.

3.5.2 Trip Generation

Several elements of the trip generation model are being updated. The trip generation rates are being updated using the latest household survey data. Income segmentation has been introduced for some trip purposes (home based work, home based shopping, and home based other), primarily for environmental justice analysis. The home based school purpose was found to be insensitive to income and is instead a function of household size and the number of children in a household. Home based university was added as a trip purpose, with trip rates per person to the 25 largest colleges by type and distance. Home based university attractions are based on total enrollment minus group quarters population. Other updates include reclassifying employment types, adding factors to separate non-motorized travel, and updating the air passenger model. An area type adjustment factor that distinguishes between rural and non-rural areas has been calibrated, and the trip generation model is now awaiting final validation.

3.5.3 Trip Distribution

The gravity model parameters have been recalibrated by trip purpose to include the income segmentation used in the home based work, home based shopping, and home based other trip purposes. In addition, a destination choice model using a logit model form is to be estimated. This will be estimated using the most recent survey data and will be compared with the existing gravity model to test whether the destination choice model produces better results. If that proves to be the case, the destination choice model will be implemented; if not, the existing gravity model will be retained and validated using the model recent survey data.

3.5.4 Time of Day

New time periods have been defined that are useful for both highway and transit analysis. The day has been divided into five time periods and time of day factors have been re-estimated using the household survey data.

3.5.5 Transit Model

Work on the transit model has focused on the transit network parameters and the path building processes. The review of transit network parameters has considered travel times, fares, maximum access time, bus speeds, transfer rules, and mode choice related parameters. The updates have made use of new on-board survey data that allowed comparison between observed and modeled paths and supported adjustments to the path building settings to

improve the match. SEMCOG compared modeled auto time and 2010 scheduled bus times for 145 routes operated by AATA, DDOT, and SMART, and used that analysis to adjust the relationship between bus travel times and modeled auto travel times. The work included developing operator specific dwell time assumptions. Transit walk access time was capped at 18 minutes in TDFM Version E5. Based on the on-board survey data, this has been increased to 36 minutes.

3.5.6 Mode Choice

The existing mode choice is being re-evaluated for several reasons:

- To support a range of current and potential transit services
- To allow FTA New Starts analysis
- So that it can project impacts on population segments
- To incorporate transit model improvements
- To use recent counts and survey data
- To improve the efficiency of the model structure and procedures
- To improve the validity of results.

Several nesting structures are currently being explored during model estimation. The revised mode choice model is intended to support the evaluation of new modes including Arterial Rapid Transit (ART), Bus Rapid Transit (BRT), Light Rail (LRT) (including on Woodward), and Commuter Rail (CRT) (from Detroit to Ann Arbor).

3.5.7 Commercial Vehicle Model

The commercial vehicle model is a three step model, with trip generation, trip distribution, and assignment steps. During this update, vehicle classification count data has been adjusted to account for growth and decline in the region, model parameters have been updated to reflect current data, and adjustments have been made to reflect changes in external station volumes.

3.5.8 System Calibration

The final part of the model update process will be to complete a system calibration. Individual model components are being validated as they are developed. Recent data is being used to see “what has changed” to enhance the short term forecasting capability. The overall aims of the calibration are to get the big picture correct, examine trouble spots from previous model versions, and ensure that forecasts are reasonable. The calibration work is expected to be complete in March 2012.

Southeast Michigan Council of Governments TDFM Assessment and Discussion

Following presentations related to the development of the current SEMCOG TDFM, Version E5, and the in progress updates that will lead to a new version of the SEMCOG TDFM, Version E6, in March 2012, the peer review moved on to presentations about the analytical needs of SEMCOG and model enhancement recommendations. This section of the report covers those presentations given by Rick Donnelly of Parsons Brinckerhoff.

4.1 Analytical Needs

The analytical needs of SEMCOG with respect to travel modeling were categorized into three groups: 1) national issues and trends, 2) Federal requirements (e.g. model certification by FHWA, and applications for FTA New Starts funding), and 3) Local requirements (comprising strategic uses, tactical uses, and performance measures).

4.1.1 National Issues and Trends

The context for the discussion of analytical needs was set by referring TRB Special Report 288, Metropolitan Travel Forecasting: Current Practice and Future Direction (2007)[7] and specifically this quote:

> "The committee therefore recommends development and implementation of new modeling approaches to demand forecasting that are better suited to providing reliable information for such applications as multimodal investment analyses, operational analyses, environmental assessments, evaluations of a wide range of policy alternatives, toll-facility revenue forecasts, and freight forecasts, and to meeting federal and state regulatory requirements."

4.1.2 Federal Requirements

The presentation of analytical needs noted several important aspects of the Federal requirements, in terms of both the FHWA certification process and the use of the travel model to support FTA New Starts funding applications. FHWA has established a certification process and checklist for MPO models to ensure that they are capable of informing federally mandated air quality and transportation planning requirements. Other than certain requirements that affect the use of model outputs for air quality modeling, the certification checklist is not definitive about the structure or capabilities of travel demand models. FHWA acknowledges that analytical requirements vary from one MPO to another. However, the process is designed to ensure that the models that are in place are adequate for current and anticipated applications of the model. Moreover, they outline a series of questions to assess how well the modeling program addresses analytical risks, the agency's technical capabilities, and documentation. The documentation considered during certification includes, but is not necessarily limited to, three major areas:

- An inventory of the current state of transportation in the metropolitan area
- Key planning assumptions used in developing the forecasts
- Descriptions of the methods used to develop forecasts of future travel demand.

[7] TRB Special Report 288 is available at http://onlinepubs.trb.org/onlinepubs/sr/sr288.pdf

While FTA does not approve models on a set schedule similar to FHWA's certification process, they do review models as part of their forecast review during consideration of New Starts applications. In general, FTA prefers to see a model with the following features:

- Asymptomatic standard practice model
- Internal consistency between a robust mode choice model and transit path building and assignment
- Standardized reporting of user benefits using FTA's SUMMIT software.

4.1.3 Local Requirements

Local requirements were presented in two main categories: strategic versus tactical uses of the model. Strategic uses include long-range transportation plans, transportation improvement plans, and analyses of region-wide impacts and opportunities. Tactical uses focus on specific projects or programs, whose effects are usually localized or concentrated in certain corridors or smaller study areas.

An additional local requirement that was discussed is the use of the TDFM to report performance measures. The transportation-related measures that the TDFM will likely be called upon to inform about include:

- Infrastructure utilization rates
- Peak transportation infrastructure service, demand, and total consumption
- Transit ridership
- Percentage of time in compliance with air quality standards.

The presentation of local requirements assigned the strategic and tactical requirements (including the performance measures) to travel model capabilities that are traditional and those are non-traditional as shown in Figure 2.

Figure 2: Assessment of local requirements

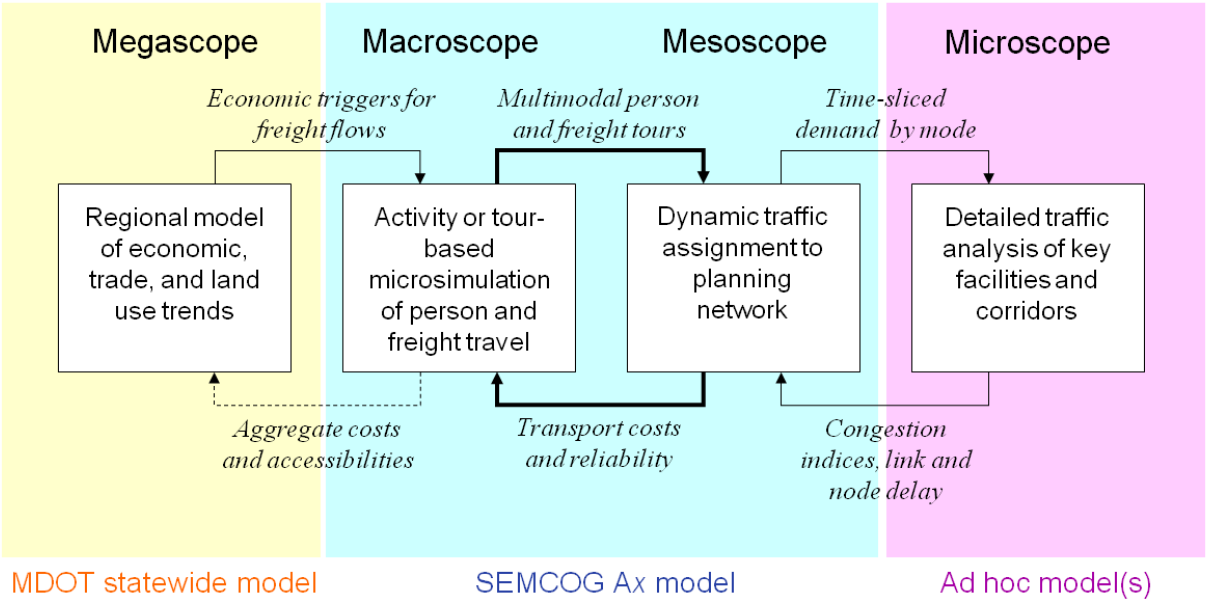
	Tactical	**Strategic**
Traditional	Subarea analysis Selected link analysis Transit corridor or project analyses Traffic impact studies Time and cost savings of projects Performance Measures	Update RTP and TIP Project prioritization and programming Air quality conformity Assessment of regional strategies Trade-off analysis Improving regional mobility Demand management vs. capacity TOD and 4D analyses Evaluating new transport modes
Non-Traditional	Construction and detour analyses Work zone staging and management Linkage with traffic operations models Signal timing optimization Traffic impact studies Network reliability Equity and environmental justice impacts	Capacity reduction strategies Market accessibility and competitiveness Economic impacts of transport Understanding freight and supply chains Impact of fuel price increases Equity and environmental justice impacts

While the traditional travel model capabilities could be supported by a best practice trip-based model and would suggest that a continuation of SEMCOG's E Series models was sufficient, Parsons Brinckerhoff presentations identified that a dynamic traffic assignment (DTA) model would be required to support the non-traditional tactical requirements, while an integrated land use-transportation model would be required to support the non-traditional strategic requirements. Together, these two model requirements suggest the need for an activity based (AB) travel demand model.

4.2 SEMCOG Model Enhancement Recommendations

Following on from the discussion of analytical needs, Rick Donnelly of Parsons Brinckerhoff presented a summary of model enhancement recommendations that would achieve those analytical needs. The recommendations were introduced with reference back to the three categories of analytical needs. While the current model meets FHWA certification requirements and could support FTA New Starts applications and many of the local requirements, advanced models are becoming the state of the practice and are needed for many of the local requirements. The concept of multi-scale travel modeling was introduced to describe the roles that a new SEMCOG advanced model would cover and its linkages to both larger and smaller scale models (Figure 3).

Figure 3: Parsons Brinckerhoff's vision for multi-scale travel modeling



The presentation described an incremental strategy for gradually moving from current trip-based models to advanced models. The incremental strategy would make use of shared components, such as travel behavior data (e.g. surveys), networks, and target and validation data. The gradual transition would allow for staff development, and maintain fully operational models at each stage. The following sections outline transition strategies for the demand side, supply side, and data programs. The model enhancement recommendations were summarized as:

- Finish the E Series trip-based travel demand forecasting models
- Phased transition to an AB model, starting with importing an existing AB model and calibrating it

- Phased transition to a regional DTA model
- Ad hoc traffic microsimulation
- New overhauled data programs
- Comparable investment in staff development required.

4.2.1 Transition Strategy: Demand Side

Transitioning to an AB model for the demand side of the TDFM was described as providing several advantages, including deeper insights into travel behavior, more realistic representation of travel dynamics, making linkages to a DTA more straightforward, eliminating non-home based trips, and improving the ability to support equity and pricing studies. The following stages were laid out:

0. **Best Practice Model Implementation (Version E6/E7)**
    - Complete market segmentation by income
    - Destination choice model
    - Calibrated mode choice model
1. **Enhanced Trip-Based Model (Version A1)**
    - Linked trips (half tours) to reduce non-home based trips
    - Tour analysis of travel surveys
    - Trip frequency choice model
    - Finer temporal allocation factors
    - Sub-county validation targets
2. **Population synthesizer and daily travel activity patterns (Version A2)**
    - Adapt UrbanSim population synthesizer
    - Integrate trip generation into daily activity pattern models
    - Application of daily activity patterns to synthetic population
3. **Tour-based mode and destination choice models (Version A3)**
    - Primary tour destination and mode choice
    - Stop frequency and location choice
    - Trip mode choice
    - Implementation in microsimulation framework
4. **Fully integrated model (Version A4)**
    - Time-of-day choice (activity scheduling)
    - Time-space constraints
    - Inter-household interactions and constraints
    - Full integration with dynamic network models.

4.2.2 Transition Strategy: Supply Side

Transitioning to a DTA model for the supply side of the TDFM was described as providing several advantages, including enabling robust tactical solutions, and more realistic representation of travel dynamics. The following stages were laid out:

1. **Data development**
    - Expanded traffic counts (hourly by vehicle type)
    - Probe data
    - Advanced traffic management system data feeds
    - Performance reporting
2. **"Planning level" DTA**
    - Revision of link capacity functions
    - Quantifying network reliability
    - Use in parallel with static user equilibrium model(s)
3. **Simulation-based DTA**
    - Intersection coding templates
    - Expansion of network coding to include intersections
    - Signal timing heuristics
    - Network summarization and reporting tools
    - Micro and macro-level validations.

4.2.3 Transition Strategy: Data Programs

The following steps were laid out to transition to a data program that would support the development of advanced models:

1. **Second generation MI TravelCounts program**
    - Move to a continuous data collection program
    - Tour-building heuristics
    - Tweak to better understand intra-household interactions
2. **External travel survey**
    - Retrospective long-distance survey as TravelCounts add-on
    - Mode-specific visitor surveys
    - Focus on Freight Analysis Framework Version 3 synergies
3. **Commercial travel survey(s)**
    - Collaborate with CMAP (follow protocol)
    - Focus of Freight Analysis Framework Version 3 synergies
    - Major freight facilities database

- Commercial vehicle tracking programs

4. **Network data program**

   These are data development steps that would assist with the collection and maintenance of the more detailed highway and transit network data required to support more advanced representation of transportation supply in, for example, DTA models:

   - Evolution of Network Master
   - Build off of OpenStreetMap and Google
   - Network design problem – hourly classification counts
   - Intersection coding templates
   - Signal timing heuristics
   - Network summarization and reporting tools
   - Micro and macro-level validations

5. **Passive tracking**

   Passive data collection of traveler data using, for example, data collected from GPS enabled smart phones, is starting to become a viable approach

   - Evolution from self-reporting of travel to self-describing passively reported travel
   - Pattern recognition and artificial intelligence constructs to mine and analyze large quantities of passively collecting data.

Panel Discussion and Recommendations

Following the presentations by SEMCOG staff and their consultants, the panel convened to discuss and develop their recommendations. These recommendations were presented to the attendees at the peer review meeting and are described in this section of the report. The peer review panel grouped their recommendations into six main topics, and for each of these topics provided a topic definition, planning objective, problem statement, basic solution, advanced solution, and resources. The basic solutions are intended to be short term recommendations that are applicable to SEMCOG's current model development program, while the advanced solutions are intended to be long term recommendations that are intended to inform SEMCOG's planning for future model enhancements. The six topics are as follows and are discussed in turn below:

- Data needs and methods
- Operations modeling
- Freight modeling
- Public transit
- Economic and land use modeling
- Equity (fairness).

5.1 Data Needs and Methods

5.1.1 Summary

- Definition: Raw data for performance measurement and model development
- Planning objective: Need for direct planning indicators and prediction tools
- Problem statement: traditional methods are becoming too expensive and unreliable
- Basic solution: continue data collection for performance measurement and validation
- Advanced solution: explore new paradigms for effective data collection designed specifically for advanced modeling needs.

5.1.2 Discussion

Household surveys are becoming increasingly difficult. For example, the usefulness of telephone surveys ended when wireless telephones became ubiquitous. Therefore, it is clear that a new paradigm is required.

The American Community Survey administered by the Census Bureau is an example of a continuous survey that is easier to budget for and provides the opportunity to correct and improve the survey incrementally. However, it is becoming clear that the expected cost efficiency of this type of survey is not materializing. Instead, new approaches such as using probe data might become the state of the practice. Sampling is also a growing issue, with non-response bias a concern. This suggests the need to focus more efforts on hard to reach populations and then deal with the subsequent weighting issues.

With respect to the development of activity based models, it will be important to focus on just the data items that are required to support those models, and use more innovative survey forms such as stated preference surveys to help understand travel behavior.

It is important to distinguish between external travel surveys and long distance travel surveys. The panel recommends not doing long distance surveys as part of a household survey as the level of success of these types of surveys is low. Instead targeted surveys at borders, hotels, and convention centers should be considered.

Freight model data needs are growing but it is important to recognize the difference between truck trip table development and understanding the bigger picture. Understanding the bigger picture, where truck travel is derived from freight movement and the economy means that some understanding and linkages with economic modeling and planning are required. Collecting data in this area is likely to require infiltrating the freight industry to investigate supply chains and answer questions about how commodity movement decisions are made, how industry transformations will affect truck trips, and how through movements such as intermodal container transfers operate.

The panel recognized that SEMCOG has very good highway network performance data. They recommended that SEMCOG investigate partnering with GM OnStar as a potential source for probe data on speeds and reliability. GM OnStar might be interested in sharing their data for the public good in their home city.

To support equity analysis, the panel recommended careful consideration of special surveys for special needs. For example, transit modeling is typically focused on the trade-off between transit and auto for those who have that choice and less on the mobility benefits for people who have no choice but to use transit. Adequately representing the travel choices of this group might mean understanding issues such as the effects of job-housing balance, the locations of affordable housing, undocumented residents, and the underground economy.

5.2 Operations Modeling

5.2.1 Summary

- Definition: dynamic traffic assignment at multiple scales of granularity and analysis precision
- Planning objective: desire to analyze construction zones, incident management, traffic flow, intersections, and signal timings
- Problem statement: static assignment is not intended to measure actual traffic flows
- Basic solution: static assignment is a good tool but needs good validation and post processing
- Advanced solution: true network microsimulation requires AB model integration for valid supply and demand analysis
- Resources: Investigate DTA platforms (DynusT, MATSIM, TRANSIMS, DynaSmart). Internal expertise and interest are desirable but this will require consulting/university support.

5.2.2 Discussion

The panel recognized that static assignment is adequate for planning capacity additions but it is not adequate for measuring system efficiency. For that, DTA is the tool but it is still experimental. Furthermore, for the benefits of DTA to be fully realized it needs to be coupled to an activity based demand model. Coupling a DTA to a trip-based model with temporal and spatial disaggregation will achieve some of the benefits. DTA packages are not off the shelf yet and so the panel recommends that SEMCOG consider developing internal skills to support implementing a DTA. However, DTA is still the province of consultants working on SHRP, NHCRP and FHWA funded research projects, and universities.

The panel confirmed that their recommendations for operations modeling are in line with the recommendations to transition from SEMCOG's E series models to the A series models made by Parsons Brinckerhoff.

5.3 Freight Modeling

5.3.1 Summary

- Definition: commodity flow analysis, logistics and supply chain modeling, and heavy commercial vehicle movements
- Planning objective: explain the economics of the freight industry and its relationship with the manufacturing base
- Problem statement: true freight modeling is undeveloped, but traditional methods of truck trip table preparation are wrong
- Basic solution: continue with robust data collection program and use to develop synthetic truck trip tables. Examine use of statewide model and expand (inter)national sensitivity if needed
- Advanced solution: adopt a freight analysis construct that incorporates supply chain and logistics analysis, multiple freight modes, and specialized network microsimulation.

5.3.2 Discussion

Freight modeling is a growth area for travel modeling: the current practice is wrong, but more advanced methods are currently undeveloped. The status of freight modeling in the Chicago region was discussed by the panel. CMAP (the Chicago MPO) is moving towards implementation of the framework that was initially developed by LA Metro. This was partially implemented as CMAP mesoscale freight model, and is now moving forward with the demonstration of a combined supply chain and truck touring model, supported by an FHWA funded project that is nearing completion.

5.4 Public Transit

5.4.1 Summary

- Definition: demand for public transit modes, and ridership estimates
- Planning objective: promote alternative to automobile, and provide mobility to populations in need

- Problem statement: transit share is so small that elaborate transit modeling procedures may not be warranted
- Basic solution: keep mode choice simple, for example by using a mode choice model to pivot from a robust trip table of existing transit riders.
- Advanced solution: identify travel market segments more fully and develop specific models in the AB model context. This means moving towards population synthesis and microsimulation.

5.4.2 Discussion

The panel discussed the conflicting needs for transit modeling in the SEMCOG region, including maintaining a complex transit model to represent a system with low ridership, supporting the very specific requirements of preparing New Starts forecasts, and how transit modeling will fit into the advanced modeling framework being considered.

The panel recommended that, if the transit modeling needs are limited to smaller incremental changes to the transit system, then simple mode choice approaches, such as a pivot analysis from a trip table of existing transit riders, should be used. The most important variables describing likelihood to use transit might be auto availability and age. In general, only the travelers with auto availability can respond to relative levels of service represented by variables such as in-vehicle time, wait and fare. Riders without an auto available might respond to changes in transit routes by walking to another line, changing to bicycle, finding a ride from someone, or not traveling.

However, as the transition to more advanced models is made and more significant transit improvements are considered, in order to predict behavior accurately it is very important to identify travel market segments more fully and develop models that represent those markets in the AB model context. This means that they must be represented in the population synthesis and in the travel microsimulation. For example, the physically handicapped population might be much more likely than the able bodied population to use transit. To represent this in the travel model it is necessary to survey them, model them, and represent them in the population synthesis and all subsequent stages in the microsimulation.

5.5 Economic and Land Use Modeling

5.5.1 Summary

- Definition: the spatial dynamics of social and economic change
- Planning objective: understand the outcome of policy actions oriented toward fundamental change
- Problem statement: travel demand models are not fully integrated with land use and economic prediction tools
- Basic solution: use demand model accessibility to identify future land use potential (sketch level)
- Advanced solution: develop an economic and land use simulation that is sensitive to declines and shifts in economic relationships (dynamic).

5.5.2 Discussion

Traditional four step models use economic and land use inputs as fixed inputs, but this is now recognized as being wrong. The panel recommended starting with SEMCOG's existing UrbanSim model and experimenting with feeding back accessibility measures from the TDFM. The panel suggested more advanced modeling would involve use of an economic and land use simulation that is sensitive to declines and shifts in economic relationships; however, they recognized that there are no tools available that deal with permanent or sustained regional economic decline. Oregon provides a good example of a possible approach for Michigan and the SEMCOG region, with a PECAS model implemented at the statewide level that is used for economic forecasting, and then metropolitan land use models that are used for land use allocation.

5.6 Equity (Fairness)

5.6.1 Summary

- Definition: individual benefits and burdens associate with public actions
- Planning objective: demonstrate that public actions are equitably distributed across the region
- Problem statement: modeling tools are used to predict the distribution of benefits
- Basic solution: develop a broad range of metrics intended to communicate and educate audiences on the dimensions of the topic
- Advanced solution: orient AB model development to rigorously track equity indicators at the person level.

5.6.2 Discussion

The panel explained that in order to adequately model equity impacts, microsimulating people is key, which is a feature of AB models. The aspects that must be represented in the model include the connection of people to land use; for example, correct representation of demographics and the connection of people to work and school, and how these relationships might change over time as land uses change.

Appendix A List of Peer Review Panel Participants

This section contains a list of the peer review participants, including the panel members, local agency staff, and TMIP documentation support staff.

A.1 Peer Review Panel Members

Panel Member	Affiliation
Chaushie Chu	Los Angeles County Metropolitan Transportation Authority
T. Keith Lawton	
Eric Miller	University of Toronto
Kermit Wies	Chicago Metropolitan Agency for Planning
Johanna Zmud	RAND Corporation

A.2 Local Agency and Partner Agency Staff

Name	Affiliation
Tom Bruff	SEMCOG
Liyang Feng	SEMCOG
Carmine Palombo	SEMCOG
Paul Tait	SEMCOG
Kathleen Lomako	SEMCOG
Chuck Hersey	SEMCOG
Sayeed Mallick	SEMCOG
Trevor Brydon	SEMCOG
Saima Masud	SEMCOG
Joan Weidner	SEMCOG
Alex Bourgeau	SEMCOG
Guangyu Li	SEMCOG
Brian Mohr	SEMCOG
Terri Blackmore	Washtenaw Area Transportation Study
Brad Winkler	Michigan Department of Transportation
John Watkin	Michigan Department of Transportation
Donna Wittl	Michigan Department of Transportation

Brad Sharlow	Michigan Department of Transportation
Lindsay Wallace	St. Clair County Metropolitan Planning Commission
Andy Pickard	FHWA, Michigan Division

A.3 Consultant Staff

Name	Affiliation
Rick Donnelly	Parsons Brinckerhoff
Barbara J. Arens	Parsons Brinckerhoff
Sara Binkowski	Parsons Brinckerhoff
Tom Rossi	Cambridge Systematics

A.4 TMIP Peer Review Support Staff

Name	Affiliation
Colin Smith (Peer Documenter)	Resource Systems Group, Inc.

Appendix B Peer Review Panel Meeting Agenda

B.1 Southeast Michigan Council of Governments Model Peer Review

December 12 and 13, 2011

December 12 (Day 1)	
08:30–08:45 a.m.	I. Welcome and introductions (Bruff/Palombo)
08:45–09:00 a.m.	II. Context for the meeting (Bruff/Donnelly)
09:00–09:45 a.m.	III. Current status of the E6 model update (Feng/Rossi)
09:45–10:00 a.m.	Break
10:00–10:30 a.m.	IV. Analytical requirements (Donnelly)
10:30–11:30 a.m.	V. Draft recommendations for model improvement (Bruff/Donnelly)
11:30 a.m.–1:00 p.m.	Lunch
1:00–2:00 p.m.	VI. Questions and answers
2:00–4:30 p.m.	VII. Panel work session (panelists only)

Date (Day 2)	
08:30–10:00 a.m.	VIII. Panel work session (panelists only)
10:00–10:15 a.m.	Break
10:15–10:45 a.m.	IX. Presentation of findings and recommendations (panelists)
10:45 a.m.–12:00 p.m.	X. Discussion of panel findings and next steps (Bruff/Palombo)
12:00–1:00 p.m.	Lunch (attendees free to depart as needed)

Appendix C Peer Review Panel Biographies

C.1 Chaushie Chu (Los Angeles County Metropolitan Transportation Authority)

Chaushie Chu is the director of systems analysis at the Los Angeles County Metropolitan Transportation Authority (LA Metro), a position he has held for over 15 years. While there he has developed and implemented comprehensive transit modeling capabilities for the LA region that have been used to support eight successful New Starts investments, support of regional transit planning, and service planning. Chaushie also has modeled and published several papers on the use of discrete choice models of housing price, residential location choice, and its relationship to work travel. Chaushie earned his PhD from Northwestern University in 1981, and is an active member of the Transportation Research Board.

C.2 Keith Lawton

Keith Lawton is an independent consultant, recently retired from Portland Metro. He is widely recognized as a pioneer in the field of travel demand modeling, having been the first agency to adopt interactive planning software in the 1980s, prototype tour-based models for pricing analyses in the 1990s, and TRANSIMS early deployment in 2004-07. He is an emeritus (distinguished) member of TRB's Travel Demand Forecasting Committee, where he served for over 20 years, including as chairman. He is presently involved in the development of new survey and modeling methods for the Oregon DOT, and has played a key role in several dozen peer reviews across North America.

C.3 Eric Miller (University of Toronto)

Eric Miller is a professor of civil engineering at the University of Toronto, and chair of TRB's Subcommittee on Integrated Land Use-Transportation Modeling. He has over 20 years of experience pioneering the integration of these models, to include a highly successful microsimulation model of land use for Toronto. He is one of the few experts in this realm who are not also developers and proponents of their own software, giving him greater flexibility in defining the range of possibilities open to SEMCOG. Eric is also a distinguished emeritus member of TRB's Travel Demand Forecasting Committee.

C.4 Kermit Wies (Chicago Metropolitan Agency for Planning)

Kermit Wies, Deputy Executive Director for Research and Analysis, CMAP, has over 24 years' experience in urban systems modeling and planning and is the principal author of the 2030 Regional Transportation Plan for the Chicago metropolitan area. Kermit recently served as project manager for the Chicago regional household travel and activity inventory which involves detailed interviewing and tracking travel of over 10,000 households. He is now leading CMAP's evolution from traditional travel demand modeling to an advanced practice framework including land use integration, activity-based travel demand estimation and microsimulation. Kermit has overall responsibility for CMAP's research, analysis and evaluation work program in support of developing the Chicago region's 2040 comprehensive land use and transportation plan.

C.5 Johanna Zmud (RAND Corporation)

Johanna Zmud is a former chair of TRB's Travel Survey Methods Committee and a widely respected expert in travel data programs. She is currently working at the RAND Corporation,

where she is continuing research into travel behavior and transportation policies. Prior to that she was the President of NuStats, one of the largest market research firms specializing in travel data collection. In her role there, she directed scores of large-scale surveys, and pioneered the use of GPS in travel data collection.

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