Chittenden County Metropolitan Planning Organization (CCMPO) Travel Model Peer Review Report

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U.S. Department of Transportation
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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 the peer review host agency.

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 Chittenden County Metropolitan Planning Organization (CCMPO) travel demand model and for sharing their valuable experience.

The Peer Review Panel Members were:

Rebekah Anderson (ODOT)
Kyung-Hwa Kim (ARC)
MaryAnn Waldinger (COMPASS)
Richard Walker (Portland Metro)

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

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 CCMPO peer review;
- Planning responsibilities of CCMPO;
- Introduction to the demographics, land use and transportation characteristics of the CCMPO region;
- A brief history of travel demand modeling at CCMPO;
- Discussion of how the CCMPO travel demand model is used and a review of model inputs and each component of the CCMPO model. This section includes the majority of the discussion that took place during the peer review;
- Additional discussion of future enhancements to the CCMPO model; and
- Peer review panel recommendations.

In addition to the main body of the report, there are five appendices. Appendix A is a list of peer review participants. Appendix B contains brief biographies for each of the peer review panel members. Appendix C is the TMIP peer review application submitted to FHWA by CCMPO. Appendix D is a list of technical questions about the travel model submitted by the panel. And Appendix E is a list of short-term and long-term modeling priorities developed by CCMPO.

Report Purpose

This report summarizes the results of a peer review of the CCMPO 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 practice

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.

CCMPO applied for the peer review to obtain a better understanding of their current models capabilities and to help address new travel demand modeling needs in their region. The CCMPO travel demand model was recently updated to a full daily model and was re-validated using newly acquired 2009 National Household Travel Survey (NHTS) add-on data. Informal peer reviews have been conducted in the past by local transportation planning and modeling professionals, but a review by practitioners with a broader range of experience was desired. The TMIP peer review provided an excellent means to assess CCMPO's existing model system and provide recommendations for our ongoing model updates in order to maximize limited resources. Of particular interest are suggestions related to multimodal modeling of mixed use centers in smaller urban areas and the potential advantages and difficulties associated with moving to an activity-based modeling system.

The peer review was convened to provide guidance to CCMPO so that its travel demand model can meet the ever growing list of challenges. The primary goals of this peer review were to:

1) Identify techniques for modeling mixed housing and employment land use areas which are designed to support additional non-motorized and transit use.
2) Identify procedures for improving air quality and climate change modeling.
3) Prioritize areas for inclusion if the model geography were to expand outside the county boundary.
4) Elicit recommendations regarding the general interaction between regional models and microsimulation tools.
5) Identify how the effects of increased travel costs (e.g. gas prices) can be better implemented in the model.
6) Identify possible refinements to the FHWA Quick Response Freight Manual techniques for representing light, medium, and heavy truck freight in the regional model.
7) Discuss the considerations associated with the transitioning into an activity-based or tour-based model.
8) Elicit recommendations regarding land use forecasting tools, including the existing Land Use Allocation Module (LUAM) included in CCMPO's current model.
9) Elicit recommendations on visualization techniques and performance measures for better communication to stakeholders.
10) Discuss additional improvements CCMPO should consider to maintain a model consistent with current best practices.

Virtual Peer Review Format

The format for the CCMPO Peer Review was a bit different than typical TMIP Peer Reviews. Standard practice is to hold a one to two day in-person on-site meeting at the agency's offices thereby requiring travel by the invited panel members.

The meeting agenda is usually broken into two main parts. First, the agency presents and discusses the organization's responsibilities, characteristics, and planning objectives followed by a detailed overview of the existing regional travel demand model. Second, the panel then

typically meets independently to formalize their recommendations which are presented and discussed with the agency and meeting participants prior to concluding the peer review.

CCMPO staff was mindful of the resources and scheduling difficulties associated with an in-person peer review process. To that end, the agency proposed initiating a 'virtual' peer review which was completed over the course of four online webinar sessions. The intent was to remove potential barriers to participation for panelists, decrease costs, and still provide thoughtful reviews to assist in determining future model investments.

Four separate roughly two-hour meetings were held via web-conference. The meetings were organized and hosted by FHWA with support from the Volpe Center which also recorded the audio portion of the meetings. Each meeting session is described below.

Session #1
Date: February 15, 2011, 2pm – 4pm EST

Agenda: Introductions, background, review of existing model, potential improvements

Session #2
Date: March 1, 2011, 1:00 – 3:30pm EST

Agenda: Discussion of key issues and questions, areas for improvement

Session #3
Date: April 8, 2011, 3:00 – 4:30pm EST

Agenda: Independent panel meeting convened to assemble comments and feedback

Session #4
Date: April 12, 2011, 2:00 – 4:00pm EST

Agenda: Comments and feedback presented by peer review panel to broader group

1.0 CCMPO Responsibilities

The Chittenden County Metropolitan Planning Organization (CCMPO) is the federally designated Metropolitan Planning Organization (MPO) for the Burlington, Vermont metropolitan area. CCMPO was established in 1983 and currently encompasses Chittenden County, Vermont as the MPO's planning area. The region is a smaller-sized urban area with approximately 105,000 residents in the urbanized area as of the 2000 census. CCMPO is the only MPO in the state of Vermont.

As the MPO for this area, CCMPO is charged with creating and maintaining a regional long-range transportation plan (LRTP) that coordinates and prioritizes regional transportation improvements, and performing other planning functions such as allocating Federal funds to selected projects through short-term programming documents such as the Transportation Improvement Program (TIP). CCMPO's travel demand model, which covers the extent of the county, is used by CCMPO staff and contracted consultants for the development of the LRTP, the TIP, and various transportation planning studies.

2.0 Regional Characteristics

Chittenden County has about 155,000 people and 95,000 jobs as of 2010. The MPO's sister agency, the Chittenden County Regional Planning Commission (CCRPC) recently approved a 2035 population forecast of 205,000, representing about 1.1% annual growth. Burlington is the

largest city in the region with approximately 40,000 people. The University of Vermont, IBM, and Fletcher Allen Health Care are among the largest regional employers.

Interstate 89 is the only interstate highway passing through the county and runs from the Canadian border to the north through Chittenden County and then heads southeast to Montpelier, VT and southern New England.

The regional Annual Vehicle Miles of Travel (AVMT) reported by the Vermont Agency of Transportation (VTrans) in 2009 was approximately 1.5 billion VMT. The model area is comprised of 335 internal traffic analysis zones (TAZ) and 17 external stations.

Average commute time is relatively short; as it is relatively easy to get around. The region does not experience severe levels of congestion on its roadways, and the freeway system performs well. Most travel to work is in single occupant vehicles, with very little transit usage.

3.0 Travel Demand Modeling at CCMPO

Chittenden County transportation modeling history dates back to the late 1960's. CCMPO has managed the regional transportation model for many years with ongoing updates and refinements reflecting new data and planning techniques. Model applications have included several regional transportation plans and corridor studies along with smaller area studies, including traffic impact studies for large development projects.

The modern history of CCMPO's basic model framework dates to 1993 when an AM and PM peak period model was introduced with two significant changes from previous Chittenden County models. First, mode choice was incorporated to allow explicit modeling of bus, rail, and non-motorized transportation. Second, the 1993 model included an integrated Land Use Allocation Module (LUAM) which used transportation accessibility in conjunction with other factors to estimate the location of new housing and employment in the county. The LUAM uses local zoning and environmental constraints to establish the maximum amount of housing and employment possible in a particular zone to constrain the amount of growth. The total amount of growth in housing and employment is an exogenous input to the model based on regional forecasts developed by the CCRPC. Another 1993 model refinement was the addition of feedback loops from assignment back to distribution and mode choice as well as from LUAM back to trip generation. The LUAM feedback provides the model structure to calculate "induced" land development as areas become more accessible with transportation projects included in future years of a model analysis.

The next significant model update was in 1998 and included base year land use reflecting 1998 conditions and a regional household travel survey to re-estimate parameters for the trip generation and trip distribution. Several new TAZs were created by subdividing zones in the rural areas to allow for more detailed analysis outside the urban core. This model received an award of excellence from the national Association of Metropolitan Planning Organizations (AMPO) in 1999.

In 2005, the AM and PM peak period models were converted to use the TransCAD software modeling platform. Previous model versions used a custom program developed by Resource Systems Group, Inc (RSG) referred to as the Integrated Transportation Model (ITM) for all steps except for assignment, which was handled with the T-Model program. The use of TransCAD introduced new capabilities for assignment using an algorithm designed to accomplish user equilibrium. RSG developed a specialized routine within TransCAD to explicitly include intersection delays in the link travel times input into the assignment.

The land use in the 2005 model was updated to 2000 base year conditions and data from the 1998 Household Survey, the 2000 Census Transportation Planning Package, and other sources were used in re-estimating model parameters. This update also included a license plate survey of vehicles traveling on Interstate 89 at the county boundaries to better estimate through trips also referred to as external to external or XX trips in the model.

The most recent 2008-2010 CCMPO model updates have followed a two phase process following a competitive consultant selection process. This work is now nearing completion – Phase I of the update was completed approximately one year ago and included updating the base year housing and employment data to 2005 and a transition to a daily model with hourly assignments. The previous 1993-2005 models only represented AM and PM peak hours. The transition to a daily model allows more detailed analysis of air quality issues associated with transportation while still retaining the capability to examine peak period travel demand. Phase II of this update included re-estimation of several model parameters following receipt of the 2009 National Household Travel Survey (NHTS) Vermont add-on data funded by CCMPO, VTrans, and the University of Vermont Transportation Research Center. Several additional refinements were made in support of CCMPO's long range transportation plan update currently underway.

As the travel demand forecast modeling practice has continued to progress, CCMPO staff have recognized that the agency's model system needs to be upgraded to keep pace with recent developments, and to provide the policy sensitivities required by decision-makers. A primary purpose of the CCMPO peer review was to develop a list of recommended improvements to the travel demand model and provide guidance on which would be of greatest value to CCMPO. Upon receiving the feedback from the peer review panel, CCMPO will begin to implement the prioritized improvements as funding and staff time allow.

4.0 Current CCMPO Model

4.1 Model Applications

The CCMPO travel demand model is expected to be used primarily for the following purposes:

- during the development of the LRTP;
- for project level forecasting at two scales: intersection level analysis and larger scale projects;
- and it is anticipated that a future use of the model may be for air quality conformity analysis.

The CCMPO uses the integrated land-use and transportation model regularly for long-range planning and corridor studies. The regional transportation plan is updated every three to five years and the model is a valuable tool in that process.

The model has been used for a broad range of applications, including allocating future land-use growth, understanding the traffic impacts of large developments, as well as analyzing the merits of enhancements to the existing transportation system and new roadway and transit facilities.

4.2 CCMPO Model Inputs and Model Components Peer Discussion

After introducing the history of the travel demand model, and its current uses, CCMPO and the agency's primary modeling consultant Resource Systems Group, Inc. (RSG) presented information about the inputs to the model and each of the individual model components currently in use. The following sections summarize the information provided by CCMPO staff, as

well as comments from peer review participants. CCMPO provided the peer review panel with model documentation. The "*CCMPO Regional Travel Model Documentation Version 3.2*" describes all of the model components and input data and presents a summary of model validation results.

4.2.1 Highway Network

The CCMPO travel demand model covers all of Chittenden County in the northwestern corner of Vermont. For modeling purposes, major roadways within the modeling region were selected to reliably represent the entire road network. Within the model boundary, the network consists of all roads that have a federal functional classification above local streets as well as some roads that are not classified but that are important for network connectivity. There are over 1,800 road segments represented as links, of which approximately 200 are one-way only.

The network is based on a GIS file of centerlines with various network attributes that describe the roadway characteristics. The network has posted speeds and hourly capacity. The hourly capacity is based on the hourly ultimate capacity, that is, the point at which the Level of Service (LOS) changes from an "E" to an "F" as defined by the Highway Capacity Manual.

Capacity varies by functional class, presence of turn lanes, and the number of lanes. The model includes delay from both links and intersections using a logit-based volume delay function which calculates a link and node contribution to total delay using assumed link and node capacities and vehicle flows.

4.2.2 Transit Network

Transit routes are coded into the model based on information obtained from the Chittenden County Transportation Authority (CCTA), including routes, fares, and headway information. Because stops along a route are likely to change frequently, the current physical route stops are not modeled precisely. Instead, a stop was placed on nodes along the route's path as appropriate to represent the service provided by each route. All links from the roads layer are included as non-transit links in the transit network, allowing travel by foot, bike, or car (to rail only) from anywhere in the network to any transit route. The transit network includes bus routes and the option to include rail routes although no rail service currently exists in the region.

4.2.3 Zone Structure

The CCMPO travel demand model, as is typical, uses traffic analysis zones (TAZ) as the base geographic unit. CCMPO forecasts the number of employees (retail and non-retail), and the number of households to determine the number of trips generated in each zone. The CCMPO model has 335 TAZs (not including external station TAZs), which approximates a modeling guideline of 0.6 TAZs per square mile. TAZs are derived from census tracts and block groups, some of which are subdivided as necessary. In creating TAZs, CCMPO's goal was to represent how traffic enters and exits a particular TAZ. Therefore, major roads or other features that create barriers between adjacent land uses are normally used as TAZ boundaries.

4.2.4 Socioeconomic Data

CCMPO prepares their base year household location information using housing data collected by the Chittenden County Regional Planning Commission (CCRPC) based on the 2005 municipal 'Grand List'. The data was then compared to the available parcel data, the 2000 Census data, building permits, and a random windshield survey. Based on these comparisons, the 2005 Grand List was determined to be the most accurate data source.

The housing data includes the total number of households per TAZ, classified by household size (0,1,2,3,4+) and auto ownership (0,1,2,3+). The household size and auto ownership distribution assumptions come from the 2000 Census, at the Census tract level.

CCMPO and CCRPC collected employment land use data from two distinct sources: infoUSA (a commercial data provider) and the Vermont Deptartment of Employment and Training (DET). Since the VT DET employment has a privacy agreement and use restrictions, the CCMPO chose to use the infoUSA data and supplemented gaps in the infoUSA data using the VT DET data. The infoUSA data contains information such as the name of the employer, the address of the employer, the general number of employees, and the employer's Standard Industrial Classification (SIC) code.

Based on the addresses of the employers, CCMPO was able to geocode more than 90 percent of the total employers. For those addresses that were not easily geocoded, CCMPO focused more resources to those employers with more than 5 employees. Based on this effort, CCMPO was able to geocode more than 98 percent of the total employees included in the dataset.

Once the employment data was geocoded, each employer could be assigned to one of the 335 internal transportation analysis zones (TAZs).

Employment was then disaggregated into nine employment categories created to reflect particular trip attraction similarities: Accomodations, College, Commercial, Industrial, Institutional, K-12 School, Retail, Special Commercial, and Special Retail.

CCMPO develops control totals for housing, and employment in the future year (2030) for the entire CCMPO region and then allocates these to the TAZs based on the availability of land for development and the attractiveness of the TAZ based on a number of factors. CCMPO uses their own LUAM, a model developed by RSG that has been calibrated to be reflective of local development patterns.

The purpose of the land use allocation model (LUAM) is to create land use scenarios that are realistic, based on land policies in effect, internally consistent with the transportation system, and can be easily updated. These future transportation/land use scenarios must also be realistically influenced by transportation measures including transit improvements and land use policy decisions. The land use allocation model is used to allocate user defined land use control totals of county-wide housing and employment to the transportation analysis zone (TAZ) structure.

The allocation process generally takes three effects in to account: 1) The availability of land in each TAZ specified in the allowable land use file, 2) the accessibility of each TAZ (composite impedances) calculated by the mode choice model of the transportation model, and 3) the existing land use already in place specified in the existing land use file.

The LUAM was initially calibrated for the 1998 model. The calibration was revisited as part of the development of the new 2005 base year daily model. RSG used historical parcel data, 1990 Census data, and the observed 2005 land-use to assemble a 1990 land-use dataset for Chittenden County. The 1990 dataset was then used as an input to the LUAM to forecast land-use in 2005. The forecasted land-use was then compared to the observed land-use in 2005 at an aggregate level. The parameters of the LUAM were then modified so the forecasted data matched the observed 2005 data more closely.

Panel Discussion

The panel discussed the merits of adding a vehicle ownership model to the regional travel demand model. In the current model, the auto ownership distribution is extracted from Census data and zonal shares by auto ownership category are held constant in future analysis years.

An auto ownership sub-model would estimate probability distributions for four different choices: own zero, own one, own two, or own three or more vehicles. The panel suggested one principal advantage to incorporating an auto ownership model is the added sensitivity to urban form variables that could be realized. In addition the panel suggested it would be relatively easy and straight forward to implement a borrowed logit model structure and parameters from other regions that have successfully implemented vehicle ownership models.

4.2.5 Trip Generation

The Trip Generation model estimates the number of trips that each TAZ produces or attracts, and CCMPO implements this process within the TransCAD model structure using a series of GISDK scripts.

The CCMPO model uses a cross-classification approach to estimating trip productions. This approach is widely used in other regional network models. For each TAZ, households are cross-classified according to size (1 person, 2 persons, 3 persons, or 4+ persons) and auto ownership (0 auto, 1 auto, 2 autos, or 3+ autos). The cross-classification approach requires that separate trip production estimates be developed for each of the resulting 16 household types. The production rates were estimated using the 1998 Chittenden County household survey and the 2001 NHTS survey. CCMPO purchased the Add-On data for the 2009 NHTS which was also used to check and update the trip production rates.

Trip productions are estimated for three internal person trip purposes, Home-based work (HBW), home-based other (HBO), and nonhome-based (NHB).

Trip attraction models for HBW, HBO and NHB trip purposes were developed originally from the CCMPO household diary survey. Commercial trip purposes are also included so as to explicitly account for the commercial trip demand which makes up a significant share of total daily travel. Light duty vehicles (4-tire), Medium (6-tire) and Heavy (> 6-tire) commercial trip rates came from FHWA's Quick Response Freight Manual. The estimated model coefficients were then calibrated so that trip attractions by purpose would be consistent with trip productions and proportionate to ITE trip generation rates by land use type.

Panel Discussion

The panel suggested that CCMPO consider adding more market segmentation to the Trip Generation module by adding more trip purposes and more employment categories.

The panel recommended adding a home-based shopping (HBSh) trip purpose which is currently represented by the home-based other purpose. The region does have distinct retail centers and therefore representing shopping trips explicitly could improve the model.

The panel also suggested adding home-based school (HBSch) and a home-based university (HBUniv) trip purposes. Given the region is home to a number of colleges and the University of Vermont most notably among them, a university purpose has been considered in the past. The panel described HBUniv models that rely on student and employee zip-code information collected from the institution that can be used instead of applying a gravity model.

The panel stressed the importance of disaggregating these purposes from a basic home-based other trip purpose due to unique time of day patterns and mode choices associated with these trip purposes.

Finally, beyond including more trip purposes, the panel recommended utilizing a different cross-classification scheme using either workers and/or income in place of auto ownership in the trip production models. Income and presence of workers might be a better predictor of household trip-making than whether or not the household owns an automobile. In the attraction models, the panel suggested using two-digit NAICS employment codes which would result in more detailed employment types beyond the nine employment types currently utilized in the model.

4.2.6 External Travel

The CCMPO travel demand model contains 17 external stations. The most significant external stations are located at the Interstate 89 points of entry/exit which is the only interstate in the model region.

In the base year, the total internal-external (IX), external-internal (XI) and external-external (XX) trips are set to match base year traffic count data at the external stations. The percent of XX trips is derived in large part from an external license plate survey, while the remaining external trips are split among IX and XI trips based on the AM and PM directional imbalance observed in traffic counts as a proxy for the home-end (production) locations of the trips. The model assumes for most external TAZs that the IX and XI trips will be 35 percent internal-to-external (IX) and 65 percent external-to-internal (XI), meaning approximately 2/3 of the IXXI demand will be generated externally (i.e. by people who live outside the region). These assumptions are allowed to vary by external TAZ location and do on Interstate 89 south of the region, where the split is 55 percent XI and 45 percent IX. . These assumptions have been recently validated using NHTS data.

Future year external trips are assumed to grow annually at a user-specified rate, which can vary by external TAZ. In the model, the external trips are initially assumed to have a growth rate of 1 percent per year but this rate is adjustable.

Panel Discussion

The panel suggested that applying a 1 percent per year growth rate to establish future year external trips was somewhat arbitrary. The panel recommended developing a regression using historical count data along with a procedure that takes into account both historical counts and growth in population and employment for zones proximate to the external stations.

4.2.7 Trip Distribution

The trip distribution model matches the productions and attractions of each TAZ with productions or attractions from other TAZs using a gravity model. The intra-zonal travel times used in the gravity model are an average of the travel time to the three nearest TAZs. The gravity model uses an exponential gamma function to develop the friction factors. All trip purposes are doubly constrained with the exception of external trips which are singly-constrained to the external end. Different gravity model parameters are used for each trip purpose.

4.2.8 Mode Choice

Non-motorized and transit trips comprise a small portion of the total trips in the CCMPO region. In 2009, the local transit provider, Chittenden County Transit Authority (CCTA), was averaging

about 7,800 boardings per day. Roughly 90% of the trips in the CCMPO utilize the auto mode. However, the CCMPO Regional Travel Demand Model does include a mode choice component to split trips into non-motorized, auto, bus, and rail modes.

The CCMPO travel model includes a new pre-distribution non-motorized binomial logit model where non-motorized shares are related to residential density, employment density, and intersection density, which serve as proxies for urban form variables which tend to increase walking and bicycling activity. A subsequent post-distribution nested multinomial logit-form mode choice model is used to estimate the split among auto trips, bus trips, and rail trips, and there are separate mode choice models for work and non-work trips. There is currently no rail in the CCMPO region, so the rail mode has not been calibrated, though the model functionality is in place and is set to use the same choice parameters as bus transit. This is the current Federal Transit Administration (FTA) recommended practice for analyzing rail transit alternatives.

Panel Discussion

The panel had some concerns about the overall structure of the mode choice models. The panel questioned whether identifying the split of motorized and non-motorized trips before trip distribution with a binomial logit model and subsequently splitting the motorized trips into auto and bus (or rail) with a nested multinomial logit model after trip distribution might lead to some inconsistencies and obfuscate the relationship among the parameters utilized in each model.

CCMPO explained that previous versions of the mode choice model included the non-motorized (walk/bike) modes as a separate nest in the multinomial logit model applied after distribution. The new model was intended to be more sensitive to urban form variables and avoid cases where the walk/bike mode is only a competitive option when weighed against very short drive trips.

The panel also discussed whether the post-distribution mode choice module should be included within the Distribution-Assignment feedback loop. In the current CCMPO model, the Mode Choice module was deliberately not included in the feedback loop since transit usage in the region is low and this approach significantly reduces model complexity and overall runtime.

Finally, the panel discussed the merits of adding a school bus mode in the context of also adding a home-based school trip purpose in the trip generation module. The panel explained that bus routes need not however, be explicitly coded into the transit route layer.

4.2.9 Highway Assignment

The purpose of the assignment model is to locate a specific route along links and through intersections for every vehicle trip. The vehicle trips calculated in the mode split model, which are in the form of an origin/destination matrix, are "assigned" to the network based on a user equilibrium model. The trip table is then input to a user equilibrium model, which uses an iterative process to achieve a convergent solution in which no travelers can improve their travel times by switching to another route.

The assignment model includes travel delay from five sources:

1) Volume-dependant link delay – calculated using volume delay functions documented below,
2) Volume-dependant node delay – calculated using volume delay functions documented below,

3) Global turn penalties – specified as 10 seconds per left turn, no delay for right and through movements. U-turns are prohibited,
4) Facility type penalties – specified as 60 seconds for ramp access from arterials, collectors, and locals to reduce the number of very short trips routed via interstates/freeways, and
5) Specific turn prohibitions – specified in the turn penalty table, and are based on the prohibitions included in the model.

In travel demand modeling, delay is typically considered a function of the ratio of volume to capacity (v/c). As v/c ratios near 1.0, the delays become more severe. The delays attributed to v/c ratios are based on the volume-delay function parameters. The CCMPO travel model vehicle assignment algorithm uses a logit based volume delay function available within the TransCAD software developed by the Israel Institute of Transportation Research and Planning (IITPR). The function has the characteristics of including both link delay as well as delay caused at intersections. The total delay on a link is calculated as the sum of the link delay and an estimated intersection delay.

Panel Discussion

The panel recommended that a relative gap closure of 0.0001 and maximum iterations of between 50 and 100 iterations be utilized in the iterative assignment process. The current vehicle assignment module uses a fixed number of 30 assignment iterations.

4.2.10 Feedback and Convergence

The CCMPO travel demand model includes a feedback loop from assignment to trip distribution and uses the method of successive averages (MSA) to average results from each iteration with the average of previous iterations to reach convergence. As noted earlier the mode choice models are not included in the distribution feedback loop.

Panel Discussion

The reasonableness of the convergence quit criteria being applied in the CCMPO model was reviewed. Both the change in link volumes and the change in trip zone-to-zone interchanges from one iteration to the other are examined in determining convergence. The panel thought the approach and criteria being applied in the CCMPO model were sound.

5.0 Technical Questions

During Session #1, CCMPO staff presented information about the region, the local planning agencies, history of model development in the region and an overview of the current regional travel demand model.

Between Sessions #1 and #2, panel members submitted technical questions to CCMPO and RSG that were not touched upon during the first meeting session given time constraints. The technical questions and the corresponding responses are provided in Appendix D. This document was provided to the panel members prior to Session #2.

6.0 CCMPO Modeling Priorities

To help focus the peer panel's recommendations and review, CCMPO staff provided a list of Short (one to two years) and Long Term (two to five years) modeling priorities given available

resources and on-going planning initiatives. The modeling priorities document circulated to the panel prior to Session #3 is provided in Appendix E.

6.1 Short-Term Priorities

Modeling mixed land uses to support additional non-motorized and transit use

Many CCMPO policies and planning goals are supportive of mixed use dense clusters of land use and analytical tools which are sensitive to these characteristics are critical.

Improving air quality and climate change modeling

CCMPO is participating in efforts to inventory greenhouse gas emissions and has a good chance of going out of air quality attainment for ozone. The transportation model will likely be used in concert with other tools (e.g. MOVES) to support analysis of these issues in the near future.

Reviewing sensitivity to increased travel costs (e.g. gasoline) in the model

Gasoline prices are on the rise again and it would be very helpful to have guidance regarding how other regions are considering this in their regional modeling efforts.

Refinements to 1996 FHWA Quick Response Freight Manual truck modeling

The current quick response based truck modeling approach used in the model generates a significant number of light truck trips (e.g. service and delivery vehicles) – about 100,000 or 13 percent of the total daily trips in the model. CCMPO is interested in examining this aspect of the model to see if a different approach or parameters are warranted for this and potentially other truck trip types.

Visualization techniques and performance measures for better communication to stakeholders

CCMPO has used flow maps, measures of VMT, congested VMT, hours of delay, and other commonly used techniques to present model results to policy makers and the general public. Feedback from peers on any particularly effective measures or techniques to communicate modeling output to a broad audience is of great interest to the MPO.

6.2 Long-Term Priorities

Recommendations regarding interaction/integration between model and microsimulation tools

CCMPO has a number of corridor studies planned over the next few years. The regional model is expected to be used in most of these studies along with other more detailed capacity analysis tools, such as Synchro or VISSIM. One approach under consideration is developing a protocol to interact between TransCAD and the PTV Vision suite (VISUM and VISSIM). Another approach to this issue would be the use of Dynamic Traffic Assignment tools. Feedback from peers on the above or other corridor-level analysis techniques would be very helpful.

Transition to activity-based demand models

There are compelling reasons to consider transitioning to an activity-based model approach, including the fact that RSG has already completed initial work on a DaySim implementation for Chittenden County related to a research study for which they received US DOT funding. The increased complexity of preparing model inputs for future years is of concern to CCMPO staff. A review of the potential pros and cons of moving from a more traditional 4-step model to an activity based model from the peers would be helpful in determining where this change fits in with CCMPO's resources.

Expanding the model geography and integration with State-wide model

This will be an on-going policy discussion with our neighboring jurisdictions and will also require coordination with the Vermont Agency of Transportation and the University of Vermont Transportation Research Center. The feedback received in the first two peer review sessions has highlighted several issues to be studied on this topic. Any additional thoughts are welcome.

Recommendations regarding land use forecasting tools and existing LUAM

Land use forecasting tools have not been a focus of discussion in the review process to date. Based on the brief conversation at the end of Session #2 regarding this subject, CCMPO may pursue additional feedback outside of this peer process. Suggestions from reviewers regarding land use forecasting models or techniques which may be suitable for CCMPO and references to applications in other regions would be valuable.

7.0 Peer Review Panel Recommendations

The panel convened separately in Session #3 to discuss specific recommendations, feedback and model development goals. Following this independent panel caucus, the panel presented a summary of their recommendations during Session #4 to CCMPO staff and the other attendees at the peer review.

The panel utilized the stated modeling priorities as a template for making their final recommendations. Each panel member was charged with developing content for a specific topic area following a 10-15 minute discussion of each of the short and long term priorities among all the panel members in Session #3.

7.1 Short-Term Priorities

Modeling mixed land uses to support additional non-motorized and transit use

The peer review panel recommended that CCMPO refer to two separate studies pertaining to the modeling of mixed land uses to support additional non-motorized and transit use.

The first is the "*Statistical Analysis of Urban Design Variables and Their Use in Travel Demand Models*" prepared by Portland Metro and the Oregon Department of Transportation in November 2003. The executive summary states:

> "Many travel demand models do not account for land use mixing and urban design effects. The purpose of this study is to further the understanding of how aspects of urban design influence transportation choices. This research identifies where it is important for models to account for urban design issues and where there would be minimal or no effect. It is intended to show how much land use change is necessary to significantly affect travel behavior."

The second reference cited by the panel was the report entitled "*Non-Vehicle Accessibility in the Atlanta Region*" (D'Onofrio and Kim). The report identifies a number of non-motorized performance measures that can be used to assist in spatially assessing current conditions and

establishing project prioritization. Specifically, the Potential Walking Demand Measure and the MultiModal Accessibility Measure are identified, described, and illustrated.

Finally, the panel recommended that robust and simple mixed used variables like the ones present in the pre-distribution non-motorized mode choice model should be considered for the post-distribution motorized mode choice model.

Improving air quality and climate change modeling

The panel identified a number of resources pertaining to the Motor Vehicle Emissions Simulator (MOVES) emissions model including the resources available on the Office of Transportation and Air Quality (OTAQ) website. The panel also recommended that CCMPO and State agencies pursue formalized MOVES training with the software just prior to beginning the preparation of inputs and testing.

The panel also stressed the importance of building partnerships and "making friends" with other critical agencies such as State environmental planning agencies, VTrans, and the regional EPA and FHWA Division offices. The panel also recommended reaching out to other MPOs in New England who have or will soon make the transition to MOVES to get their feedback and insights on their own experiences.

The panel highlighted some of the data requirements and information required by MOVES and the additional spatial, temporal and seasonal detail that is required.

Finally, the panel described some of the Sketch Planning tools which are now available that can be used to quickly evaluate different alternatives. Examples include Rapid Fire, Envision Tomorrow, and GreenSTEP, among others.

Reviewing sensitivity to increased travel costs (e.g. gasoline) in the model

The panel was sympathetic to the question often asked by stakeholders about whether or not the regional travel model is responsive to the cost of gasoline. Especially in light of current increases in the cost of gasoline as $4 per gallon is approached and will perhaps be exceeded.

The panel stressed the short and long term effects associated with increases in travel costs such as gasoline. Modal shifts may be short-lived while long term effects could include change in urban form. Form changes might include people living closer to their jobs or jobs moving to the suburbs.

In addition, there are traveler responses where a household might elect to purchase a more fuel efficient vehicle as well as government and/or industry responses based on more stringent standards and/or consumer demands.

All of these factors make it very challenging to capture these effects in traditional regional demand models. Auto operating cost is a typical model application variable that assumes a per mile cost such as $0.12/mile which is applied in the current CCMPO travel model. However, the panel presented research showing the auto operating cost as being fairly stable historically.

The panel pointed to the emerging research of household incomes and household travel budgets. Disposable income drives travel behavior and choices when costs increase. Households with less disposable income will be forced to make notable changes while households with more disposable income will make fewer behavorial changes.

The panel concluded that there is no easy fix and sound theoretical approaches to incorporating these factors into the existing travel model would be expensive. In a nutshell, these tools do about as good a job as we can expect until more is learned from the research.

Refinements to 1996 FHWA Quick Response Freight Manual truck modeling

The panel acknowledged that the QRFM is generally the most widely used and is generally thought to be acceptable.

The panel identified a number of resources which they suggested CCMPO review and consider (NCHRP 384, NCHRP 570, NCFRP 8, NCHRP 594, NCHRP 410).

Visualization techniques and performance measures for better communication to stakeholders

The panel agreed that presenting performance measures and visualizations of model output data to stakeholders can be very challenging, but is also critically important. Effective communication of key issues often requires that simple and clear graphics that make intuitive sense be developed.

The panel presented a number of examples from their own project work and modeling experience as reference for CCMPO. The samples included tabular data, maps, charts, and other visualizations of travel model input and output data.

7.2 Long-Term Priorities

Recommendations regarding interaction/integration between model and microsimulation tools

The panel recommended that CCMPO consider Dynamic Traffic Assignment (DTA) for inclusion in the regional travel demand model citing the increased temporal resolution of minute-by-minute link flows, queues and congested speeds. A discussion of experienced travel time and time-dependent shortest paths which are a hallmark of DTA were discussed.

The panel cautioned that implementing DTA in a regional context, even in a small to mid-size geography like CCMPO will not be a trivial exercise. The panel believes the benefits are significant and therefore warrant the investment.

The panel recommended that CCMPO consider hiring a contractor for the initial DTA implementation work with a focus on network preparation, establishing the flow models, and validation. Once in place, the panel felt that CCMPO could easily continue to work with and manage the DTA implementation moving forward.

Finally, the panel suggested that DTA might be powerful enough in and of itself and provide answers to the kinds of policy questions being asked by CCMPO and the region's stakeholders to potentially eliminate the need for microsimulation.

The region might also benefit from the lessons learned and experiences gained from past and current research being conducted with TRANSIMS in the Burlington, Vermont region. A Track 1 TRANSIMS implementation was conducted in the Burlington region in 2006-2007 and current work as part of the SHRP2-C10A project is seeking to integrate an activity-based demand model and the TRANSIMS microsimulator using Burlington as a test bed.

Transition to activity-based demand models

The panel strongly recommends that CCMPO transition to activity/tour based demand models in the long-term because of the increased policy sensitivities. The panel felt CCMPO is in a very unique position in light of the fact that it may be able to pivot off research work currently being conducted by RSG as part of the SHRP2-C10A project. In this research work being funded by the Transportation Research Board (TRB), the DaySim activity-based demand model has been

implemented in Burlington. In many ways, CCMPO would not be starting from scratch since many of the required data inputs would be the same even in the event an alternative activity-based software package was preferred.

The panel understands the concerns of CCMPO staff when it comes to the transition to an activity-based disaggregate model framework. The increased complexity of the model system and the additional time and resources needed to develop and maintain future year inputs are the primary concerns. The panel suggested that the implementation need not be overly complex and stressed that once the model system is configured and built any additional costs to maintain and run the model system would be minimal as compared to the existing aggregate trip-based model.

Expanding the model geography and integration with State-wide model

In the existing CCMPO regional travel model, external trips account for 12 percent of the total demand and 40 percent of the total network vehicle miles of travel. As such, expanding the model boundary outside of Chittenden County has been considered for some time.

The panel recommended that now would be a good time to expand the model geography with the release of the 2010 Census data products. The panel also recommended that concave areas in the model geography should be eliminated, and that traffic analysis zone boundaries need not conform to Census zone boundaries.

The panel also suggested that CCMPO consider what the eventual non-attainment area might be in the event CCMPO becomes non-attainment for ozone and expand the model boundary to include the affected areas.

Finally, the panel provided reference material pertaining to the expansion of travel model systems including a report entitled, "*Update and Expansion of Lima Travel Demand Model To Cover All of Allen County*" by the Ohio Department of Transportation that provides technical documentation on the geographic expansion of the Lima, Ohio travel model.

In terms of integration with the Statewide Travel Model the panel recommended that it is important to determine what data should and can be extracted from the broader model, whether that is commercial vehicle trip tables, freight trip tables, and/or external trip tables.

The VTrans Statewide Travel Model is currently being reviewed and updated by the University of Vermont Transportation Research Center (TRC). The panel recommended that CCMPO staff stay involved in the Statewide model development efforts especially when it comes to defining zone geographies.

Finally, the panel suggested that in general, freight and commodity flow modeling is typically handled within the statewide model as freight movement is national and in the case of Vermont international in scope. When and if the Statewide model can provide useful data related to freight movements these should be incorporated into the CCMPO regional travel model where possible.

Recommendations regarding land use forecasting tools and existing LUAM

The panel recommended that CCMPO perform a detailed review of the LUAM and identify the strengths and weaknesses of the existing land use allocation model to help narrow the research into new, better tools and more complex tools.

CCMPO also must determine 'needs' and 'wants' for the land use allocation model. Are tools needed to help determine population, household and employment control totals? Are tools needed to allocate pre-determined demographic controls totals? Are tools needed to develop

multiple land use scenarios for comparisons? The answers to these kinds of questions will help determine what kind of land use modeling tool should ultimately be selected.

The panel identified a number of resources for CCMPO to review including "*A Study of Alternative Land Use Forecasting Models*" (Zhao, 2006) prepared for Florida DOT. The panel also highlighted two upcoming TMIP webinars dedicated to the I-PLACES and PECAS modeling frameworks.

Finally, the panel members described the tools and processes in place at their own planning organizations. COMPASS uses committee and workgroups of city planners, developers, and public works employees to ensure as much good local knowledge as possible. Tools utilized by COMPASS in their own land-use allocation process include GIS, Excel, and UPlan. The process in Ohio is also generally demographer based with an Excel macro utilized to allocate development.

7.3 Virtual Peer Review Format

To our knowledge this is the first TMIP Peer Review which has been conducted remotely via web-conferencing instead of as an in-person on-site meeting. CCMPO staff was mindful of the resources and scheduling difficulties associated with an in-person peer review process. Therefore, the agency proposed initiating a 'virtual' peer review which was completed over the course of four online webinar sessions. The intent was to remove potential barriers to participation for panelists, decrease costs, and still provide thoughtful reviews to assist in determining future model investments.

The on-line sessions were hosted by FHWA using Adobe Connect Pro. In addition, the visual and audio portions of the web-meetings were recorded by support staff at the Volpe Center. No information technology issues or snafus were encountered. It was very easy to upload content to the web-meeting room such as the powerpoint slides, as well as supporting documentation such as Word and PDF documents. Panelists did not encounter any difficulties with the conference calling number dial-ins and the fidelity of the audio recordings was surprisingly good.

The meetings were scheduled using Doodle Poll results in order to select meeting dates and times most convenient for the panel members and all other meeting participants.

The panel agreed that something is lost when face-to-face meetings are eliminated. The most compelling advantage is that the agency was able to invite panelists that might not have likely been able to participate in a more typical review format given time and resources constraints. The panelists agreed that four roughly two-hour web-meetings were more than sufficient to cover the material and enabled them to make substantive comments and recommendations.

The panel concluded that the virtual peer review format is a very good approach for small and mid-sized MPOs with relatively simple and straight forward travel demand model implementations. The panel cautioned though that large regions and those with more complex model systems should likely still opt for the traditional on-site in-person TMIP peer review format.

Appendix A List of Peer Review Panel Participants

Peer Review Panel Members:

Rebekah Anderson	Ohio Department of Transportation (ODOT)
Kyung-Hwa Kim	Atlanta Regional Commission (ARC)
Mary Ann Waldinger	Community Planning Association (COMPASS)
Richard Walker	Portland Metro

Local Agency Staff:

Dave Roberts	CCMPO
Jim Sullivan	University of Vermont (UVM)

Consultant Staff:

John Lobb	Resource Systems Group, Inc. (RSG)

Supporting Staff to Peer Review Panel Members:

Brian Grady (Peer Documenter)	Resource Systems Group, Inc. (RSG)
Mike Razo	Volpe Center

Appendix B Peer Review Panel Biographies

Rebekah Anderson (ODOT)

Rebekah Anderson is a Transportation Engineer for the Ohio Department of Transportation. She works with the Columbus, Newark, Cincinnati and Dayton MPOs on the development and implementation of their travel forecasting models. Her areas of expertise are disaggregate/tour-based modeling, transit modeling, freight modeling, and transportation project funding.

Kyung-Hwa Kim (ARC)

Kyung-Hwa Kim is a Sr. Principal Planner at Atlanta Regional Commission (ARC), Atlanta Georgia.Before she joined at ARC, She worked at Metro in Portland, Oregon for 20 years as a modeler. She joined ARC as an Application manager in 2008. Her 20 years of experience at Metro covers from simple data analysis to complicated activity model development. Now she manages Air Quality, Congestion Management Planning, Safety, Performance measure, and Project Prioritization at ARC. She has been served for numerous peer modeling review committee, member of the Modeling Steering Committee, Transportation Research Board (TRB) Transportation Survey Methods Committee, and Transportation Research Board (TRB) Task Force on Moving Activity-Based Approaches to Practice Committee.

Mary Ann Waldinger (COMPASS)

MaryAnn Waldinger is a Principal Planner with COMPASS, the MPO for Ada and Canyon Counties, Idaho. She has been with the MPO for 15 years and is responsible for the regional travel demand model, air quality conformity and congestion management system. She has been primarily responsible for the development, maintenance and application of the regional model since 1999 with most work being done in-house.

Richard Walker (METRO)

Richard Walker is the manager for the Modeling and Forecasting Division at Metro Portland, the MPO for Portland, Oregon. He manages all programs related to travel forecasting: including data collection, model development, and model applications. His areas of expertise include multimodal, freight, transit, and air quality conformity modeling. He has participated in the peer review of metropolitan travel forecasting models in Santa Cruz, Salt Lake City, Las Vegas, Anchorage, Phoenix, and Philadelphia. In Oregon, Mr. Walker has chaired the Modeling Steering Committee and currently is the chair of the Modeling Program Coordination Committee. He is currently the co-chair of the TRB Special Committee on the Travel Forecasting Resource. He holds a BS degree in civil engineering from Montana State University.

Appendix C CCMPO TMIP Peer Review Application

FHWA Travel Model Improvement Program Peer Review Program Application

Chittenden County Metropolitan Planning Organization
December 23, 2010

Contact:

David Roberts, Senior Transportation Planning Engineer
Chittenden County Metropolitan Planning Organization
110 West Canal St, Suite 202
Winooski, VT 05404

802.660.4071 x16
droberts@ccmpo.org
www.ccmpo.org

1. CCMPO Peer Review Request Introduction

The Chittenden County MPO (CCMPO) is the federally designated Metropolitan Planning Organization (MPO) for the Burlington, Vermont metropolitan area. CCMPO was established in 1983 and currently encompasses Chittenden County, Vermont as the MPO's planning area. The region is a smaller-sized urban area with approximately 105,000 residents in the urbanized area as of the 2000 census. CCMPO is the only MPO in the state of Vermont.

CCMPO has devoted substantial resources to transportation modeling since the late 1980's to support planning analyses for long range and corridor study plans. CCMPO is currently nearing completion of an updated model to a 2005 base year which will be a daily model with hourly assignments. Recent model improvements have focused on updated housing and employment data for the 2005 base year, updated household survey information for trip generation characteristics (CCMPO was an add-on for the 2009 National Household Travel Survey), daily travel representation (from an AM and PM peak hour only model), and refined mode choice algorithms.

These specific refinements were selected to retain confidence in this planning tool and better position the region if we go out of attainment with the National Ambient Air Quality Standards (NAAQS). The County is very close to the current ozone non-attainment threshold. Desire for policy sensitivity to global warming issues also contributed to model refinements.

CCMPO has additional funding set aside to continue advancing the regional transportation model in our current FY2011 Unified Planning Work Program (UPWP) and will soon begin work on our FY2012 UPWP which will go into effect on July 1, 2011.

The proposed peer review will be an excellent means to assess CCMPO's existing model system and provide recommendations for our ongoing model updates in order to maximize limited resources. Of particular interest are suggestions related to multimodal modeling of mixed use centers in smaller urban areas and the potential advantages and difficulties associated with moving to an activity-based modeling system.

2. The Chittenden County Region

Chittenden County has about 155,000 people and 95,000 jobs as of 2010. The MPO's sister agency, the Chittenden County Regional Planning Commission (CCRPC) recently approved a 2035 population forecast of 205,000 – about 1.1% annual growth. Burlington is the largest city in the region with approximately 40,000 people. The University of Vermont, IBM, and Fletcher Allen Health Care are among the largest regional employers. Table 1 below includes a summary of employment in the County.

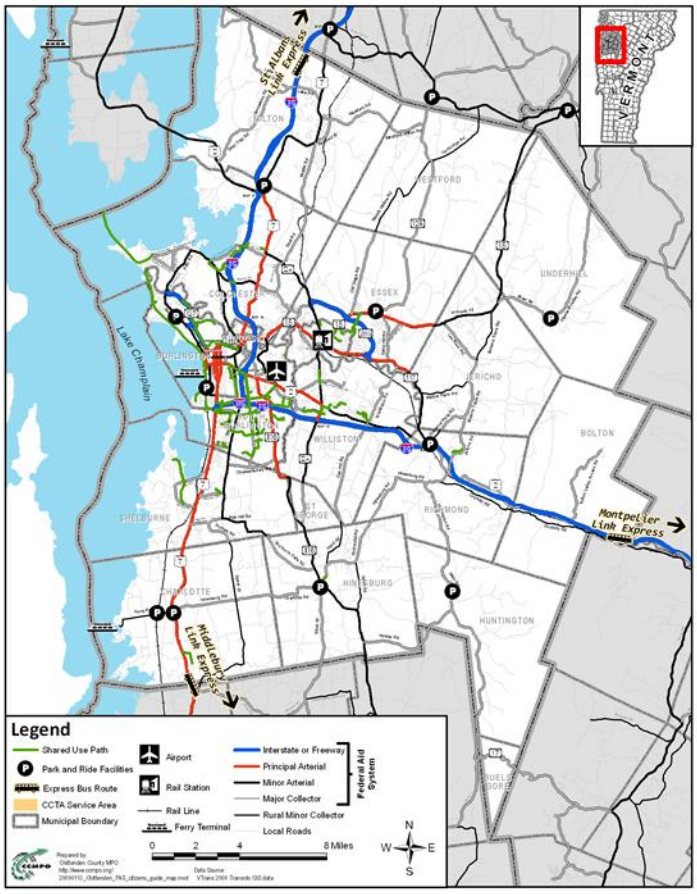
Table 1: Chittenden County 2008 Employment by Industry

Industry Sector	Employment	Percent of Total Employment (rounded)
Manufacturing and Goods Producing	16,700	20%
Services	62,800	65%
Government	15,000	15%
TOTAL	*94,500*	*100%*

Source: Vermont Department of Labor Economic and Demographic Profile Series 2010

Interstate 89 is the only interstate highway passing through the county and runs from the Canadian border to the north through Chittenden County and then heads southeast to Montpelier and southern New England. A regional map, including major transportation facilities, is included as Figure 1 below.

Figure 1: Chittenden County Transportation System Map



The regional Annual Vehicle Miles of Travel (AVMT) reported by the Vermont Agency of Transportation in 2009 was approximately 1.5 billion VMT. The model area is comprised of 335 internal traffic analysis zones (TAZ) and 17 external stations.

3. CCMPO Model Background

Chittenden County transportation modeling history dates back to the late 1960's. CCMPO has managed the regional transportation model for many years with ongoing updates and refinements reflecting new data and planning techniques. Model applications have included several regional transportation plans and corridor studies along with smaller area studies, including traffic impact studies for large development projects.

The modern history of CCMPO's basic model framework dates to 1993 when an AM and PM peak period model was introduced with two significant changes from previous Chittenden County models. First, mode choice was incorporated to allow explicit modeling of bus, rail, and non-motorized transportation. Second, the 1993 model included an integrated Land Use Allocation Module (LUAM) which used transportation accessibility in conjunction with other factors to estimate the location of new housing and employment in the county. LUAM uses local zoning and environmental constraints to establish the maximum amount of housing and employment possible in a particular zone to constrain the amount of growth. The total amount of growth in housing and employment is an exogenous input to the model based on regional forecasts developed by the CCRPC. Another 1993 model refinement was the addition of

feedback loops from assignment back to distribution and mode choice as well as from LUAM back to trip generation. The LUAM feedback provides the model structure to calculate "induced" land development as areas become more accessible with transportation projects included in future years of a model analysis.

The next significant model update was in 1998 and included base year land use reflecting 1998 conditions and a regional household travel survey to re-estimate parameters for the trip generation and trip distribution. Several TAZs were created by subdividing zones in the rural areas to allow for more detailed analysis outside the urban core. This model received an award of excellence from the national Association of Metropolitan Planning Organizations (AMPO) in 1999.

In 2005 the AM and PM peak period model was converted to use the TransCAD model platform. Previous model versions used a custom program developed by Resource Systems Group, Inc (RSG) referred to as the Integrated Transportation Model (ITM) for all steps except for assignment, which was handled with the T-Model program. The use of TransCAD introduced new capabilities for assignment using an algorithm designed to accomplish user equilibrium. RSG developed a specialized routine within TransCAD to explicitly include intersection delays in the link travel times input into the assignment.

The land use in the 2005 model was updated to 2000 base year conditions and data from the 1998 Household Survey, the 2000 Census Transportation Planning Package, and other sources was used in re-estimating model parameters. This update also included a license plate survey of vehicles traveling on Interstate 89 at the county boundaries to better estimate through trips which do not have an origin or destination in the county (also referred to as external to external or E-E trips in the model).

The most recent 2008-2010 CCMPO model updates have followed a two phase process following a competitive consultant selection process. This work is now nearing completion – Phase I of the update was completed approximately one year ago and included updating the base year housing and employment data to 2005 and a transition to a daily model with hourly assignments. The previous 1993-2005 models only represented AM and PM peak hours. The transition to a daily model allows more detailed analysis of air quality issues associated with transportation while still retaining the capability to examine peak period travel demand. Phase II of this update included re-estimation of several model parameters following receipt of the 2009 National Household Travel Survey (NHTS) Vermont add-on data funded by CCMPO, VTrans, and the University of Vermont Transportation Research Center. Several additional refinements were made in support of CCMPO's long range transportation plan update currently underway.

All of the current model functions are coded in TransCAD GISDK scripts and can be made available to reviewers following receipt of a model release agreement prepared by CCMPO. More detailed information on the model is available in the draft model documentation prepared by CCMPO's consultant, RSG, a copy of which is attached to this application.

4. Peer Review Issues of Interest

CCMPO's ongoing model improvements have supported a variety of planning initiatives over the past 20 years. The organization intends to continue supporting our planning efforts and member communities with the best tools available for transportation and land use analysis.

Specific items of interest for the proposed peer review include the following:

1) Are there additional techniques we should consider in modeling mixed housing and employment land use areas which are designed to support additional non-motorized and transit use?
2) Are there recommendations for improving air quality and climate change modeling procedures? We are currently in attainment, but our policy makers have expressed significant interest in these issues.
3) The model includes a significant number of External-Internal and Internal-External trips into and out of the County. How should we prioritize areas for inclusion if the model geography were to expand outside the County boundary? Should we consider greater integration between the VTrans statewide modeling software and CCMPO's regional model?
4) CCMPO has a license for the PTV suite of the VISUM modeling program and VISSIM micro-simulation software. We would like to use this for corridor level analysis in conjunction with our existing TransCAD regional model and would be interested in recommendations regarding the general interaction between regional models and microsimulation tools as well as specific thoughts regarding the use of TransCAD and PTV software.
5) Should / how can the effects of increased travel costs (e.g. gas prices) be better implemented in the model?
6) We currently represent light, medium, and heavy truck freight in the regional model using procedures from the 1996 FHWA Quick Response Freight Manual[1]. Are there refinements to the quick response techniques we should consider for our region?
7) RSG has used Chittenden County as a research test case for implementing the DaySim activity-based model. Should the MPO consider transitioning into an activity-based or tour-based model?
8) Review and recommendations regarding land use forecasting tools, including the existing Land Use Allocation Module (LUAM) included in CCMPO's current model as well as the potential for UrbanSim and other tools.
9) Recommendations on visualization techniques and performance measures for better communications to stakeholders.
10) Any additional improvements CCMPO should consider to maintain a model consistent with current best practices.

5. Peer Review Administrative Details and Scheduling

CCMPO staff is mindful of the resources and scheduling difficulties associated with in-person peer review processes. To this end we would propose initiating a virtual peer review which could be completed over the course of two to three webinar-like sessions. The intent is for this to remove potential barriers to participation for panelists, decrease costs, and still provide thoughtful reviews to assist in determining future model investments.

If the TMIP staff agrees this approach merits consideration we could discuss additional details on how to accomplish this. We do not have specific panelists in mind at this point in time and

[1] http://tmip.fhwa.dot.gov/resources/clearinghouse/docs/quick/quick.pdf

would welcome assistance from TMIP or Volpe Center staff regarding participants in our process.

CCMPO's model consultants, Resource Systems Group, will be available to support the peer review. In addition, we have approximately $5,000 in funding available to support a review process which could be spent on small stipends for reviewers and/or potential travel costs if TMIP staff feels a virtual review would not provide adequate discussion opportunities.

We would like to initiate the peer review process as soon as possible in the new year. We will be drafting our work program for FY2012 in the early part of next year and would like to have the peer review results available to integrate into this process.

Please contact David Roberts on the CCMPO staff with any questions or responses to this application.

Appendix D Peer Review Panel Technical Questions

CCMPO Model Peer Review

Session 1 Follow-up – 2/28/2011

Below are two series of issues related to the CCMPO review discussion. First are several technical questions related to the existing model formulation. Brief responses to these technical questions are provided below. Second are suggested topics of discussion regarding potential model improvements – these issues will be reviewed in more detail during our next session on Thursday, 3/3/2011 at 1 pm EST.

Technical Questions

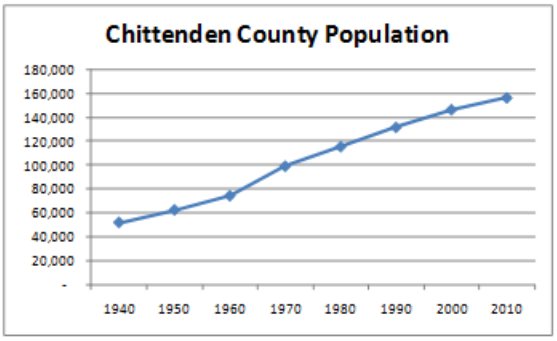
1) *Has the CCMPO TRANSIMS Track1 Implementation Model been utilized by the agency?*

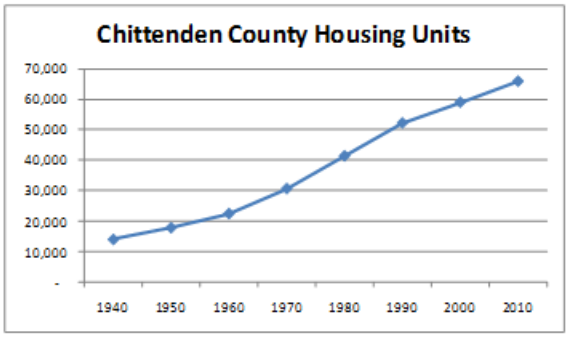
The TRANSIMS work has not been utilized by CCMPO in-house, but some of the work performed by RSG was used to further examine traffic operations near a proposed new interchange near Burlington. MPO staff has concerns about the usability of the TRANSIMS network editing and presentation tools. As TRANSIMS is refined, the MPO may consider implementing this tool, but it is not included in the current work program.

The TRANSIMS work is one example of on-going research in the region. For example, the University of Vermont has built an UrbanSim land-use model with support from RSG on the model integration piece. Additionally, RSG is working on the SHRP2-C10A project (Jacksonville, Burlington) which is building upon this original TRANSIMS work and incorporating DaySim.

2) *What are the historical demographics? Stable, low growth?*

Overall, the county has a fairly stable but modest growth rate. Housing unit growth is a little faster than population growth as average HH size has declined over the years, a consistent trend throughout Vermont. The 2000-2010 compound annual population growth rate was 0.7%; for housing growth was 1.1% annually. As the charts below illustrate, growth occurred at higher rates between 1960-1990.





3) *Has ACS data been examined and/or utilized?*

ACS data was examined for recent trends in journey to work modes as part of CCMPO's review of the model. Future model updates will likely rely more heavily on the ACS as additional CTPP products based on the ACS are released at smaller geographies.

4) *How many Census tracts are there in the region?*

The CCMPO model has 335 internal TAZs; the latest 2010 Census TIGER data has 35 Census Tracts and 100 Block Groups in Chittenden County.

5) *What are the Production/Attraction ratios before balancing is performed?*

HBW P/A = 1.13 HBO P/A = 0.63 NHB P/A = 1.01

The home-based other balancing ratio is admittedly larger than we would like to be.

6) *Were other variables considered for the cross-class trip production rates? (income, workers, etc)*

Cross-class rates by income were included in the model a number of years ago. At the time it was concluded that differences in auto ownership in the urban -vs- rural areas was a more important factor to take into account. This decision has been in place for a number of years, predating all those currently involved with the model and could easily be revisited. Regardless, neither auto ownership nor any other SE variable is carried beyond trip generation in the model sequence.

7) *Was there a methodology to specify the three I-I trip types (HBW, HBO, NHB) versus other potential trip types? Did the NHTS data lead in this direction?*

These are the three internal trip purposes that have been included in the model historically. The NHTS data was therefore reviewed with these trip purposes in mind. We are interested in the panel's feedback on the value of adding additional trip purposes such as shopping, school/univ, etc. We would want to carry these trip purposes through at least trip distribution to be meaningful.

8) *Was there a review of trip attraction coefficients from the NHTS in lieu of using ITE rates?*

No.

9) *Are the node delays movement specific?*

No, the node delays calculated by the volume delay function are approach-specific and not movement specific. The only movement specific delays come from turning penalties (left turns).

10) *Are all the counts factored to an average September weekday?*

Yes, all the counts were factored to September 2005 using monthly adjustment factors.

11) *How many feedback iterations are performed? Quit criteria?*

Distribution-Assignment feedback is performed until a quit criteria is satisfied. Two quit criteria must be satisfied. In the base year, 4 feedback iterations are usually required to satisfy the quit criteria. The link measure is typically satisfied before the matrix measure.

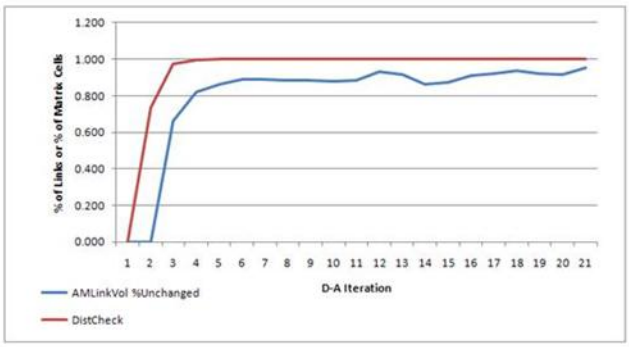
1) Change in link volumes
    a. If less than 5% of links have a volume change less than 10%
2) Change in trip interchanges
    a. If less than 2% of zone-to-zone interchanges have a change less than 1%

We've tested more stringent criteria, such as:

Link = Change less than 0.1% -or- less than 2 vehicles
quit when %Unchanged > 0.95
Matrix = Change less than 0.1% -or- less than 0.5 trips
quit when DistCheck > 0.98

Iteration	AMLinkVol %Unchanged	DistCheck	End Iteration Time
1	0.000	0.000	1.08
2	0.000	0.739	1.94
3	0.663	0.973	2.79
4	0.823	0.996	3.64
5	0.865	0.999	4.49
6	0.889	1.000	5.38
7	0.891	1.000	6.23
8	0.886	1.000	7.08
9	0.883	1.000	7.94
10	0.877	1.000	8.81
11	0.885	1.000	9.69
12	0.933	1.000	10.6
13	0.917	1.000	11.48
14	0.861	1.000	12.29
15	0.875	1.000	13.16
16	0.913	1.000	13.99
17	0.922	1.000	14.86
18	0.936	1.000	15.72
19	0.924	1.000	16.57
20	0.915	1.000	17.41
21	0.955	1.000	18.26

QUIT



Our perspective on this has been that convergence of the trip distribution matrices is the most important consideration. As you can see, trip distribution matrices converge tightly within 5 iterations. The networks, however, take 20 or so iterations to converge.

We are interested in the group's feedback on recommended convergence measures and thresholds, and specifically a recommendation with respect to the value of converging on the roadway volumes tightly in the feedback loop if we can demonstrate that skims don't change after a certain iteration.

12) Are the volume-delay functions facility specific?

Yes, the link and node parameters in the IITPR.vdf are facility-type specific. See Figure 31 in the model documentation. Different parameters are used for interstates and surface streets (arterials and collectors).

13) How are vehicle speeds determined? Facility type lookup tables or individual link settings?

Individual links are assigned a free-flow speed, which is typically the speed limit. If no speed is coded in the network a facility type lookup is utilized.

Facility	Speed (mph)	Capacity (vphpl)
Interstate	65	1,900
Limited Access Hwy	50	1,900
Principal Arterial	45	1,600
Minor Arterial	35	1,200
Major Collector	35	800
Urban Local	25	800
Rural Major Collector	30	650
Ramps	35	1,170
Internal Centroid	15	5,000
External Centroid	30	5,000

14) What impedances are used in the D-A feedback?

Peak travel time for work and off-peak travel time for non-work.

15) How are group quarters handled in the model?

Group quarters are included in the household and population inputs. Base year has 4,517 institutional group quarter residents. Group quarters are treated as 50% one person-zero vehicle and 50% two person-one vehicle households for determining trip generation. Group quarters are associated with institutional housing for higher education (e.g. Univ of VT students). There is a regional correctional facility, but inmates are not included in the model group quarters estimates.

16) Is your employment data expanded to BEA control totals? How is agricultural employment handled? How do you deal with the "headquarters" effect in employment data?

Employment is based on infoUSA data with supplemental corrections applied by the MPO to reduce issues associated with the headquarters effect and account for major employers not included in the infoUSA dataset. The employment is not expanded to BEA control totals. Agricultural employment is located at commercial farms and related enterprises included in the infoUSA dataset.

17) Did the NHTS have a GPS correction factor?

The NHTS does not include a GPS component and haven't attempted to inflate trip generation rates to account for non-reporting a GPS survey might find. We are interested in learning about the experience in Ohio (and perhaps elsewhere) in this regard.

18) Do the assignment impedance equations include time and distance?

The assignment objective function is based solely on time.

19) Is the mode choice model applied by hour or by day?

The mode choice model is applied to a daily trip table. Peak impedances are used for work and offpeak impedances are used for non-work.

20) ozone air quality analysis will require re-factoring September model output to peak ozone period in July. Should the use of September as the base month be revisited?

Perhaps. September was selected to reflect colleges/schools being in session. Chittenden County is home to a number of small colleges and universities, University of Vermont among them. Presumably September VMT can also be adjusted based on seasonal factors to estimate July travel.

21) Is the Huntington region in the model located in a State Park? Recommend avoiding concave model geography to avoid issues with I-E and E-I trips.

There is a state park in a portion of the town of Huntington's land area, but most of the town is a river valley, which basically follows the town boundary on the internal side of the model (western edge of town), so there should not be an issue with concave model geography here.

Panel Suggested Topics for Discussion

1) Incremental improvements to trip-based model
    a. Developing and applying a vehicle ownership model
    b. Additional trip purposes (shopping, school, university)
    c. Trip generation
        i. Cross-classified trip rates using different variables (workers, income)
        ii. Potential for using 2-digit NAICS for trip attraction equations
    d. Mode choice
        i. Including Mode Choice within the Distribution-Assignment feedback loop
        ii. Adding a school bus mode
        iii. Including land form variables in the mode choice models
        iv. Mode choice parameters (relationship between variables)
2) Expanding the model geography & zone splitting
3) Use of automated license plate matching or Bluetooth equipment to better refine external travel parameters.
4) Advanced models
    a. Knoxville 'Hybrid' Model
    b. Dynamic Traffic Assignment (DTA)
    c. Activity-based demand models & DaySim

Appendix E CCMPO Modeling Priorities

CCMPO Regional Transportation Modeling Priorities
March 22, 2011

Analytical tools to support transportation decision-making have long been a priority for CCMPO's Board of Directors and staff. The regional transportation model has gone through several iterations over the past ten years, most recently bringing us to a daily model updated with data from the 2009 NHTS Add-on for Vermont.

CCMPO will consider future model improvements within the context of what the MPO is able to fund and support. The TMIP Peer Review application included several issues of interest to the MPO which are roughly prioritized below based on a distillation of the peer review discussions to date and anticipated resources for modeling in the next Unified Planning Work Program of the MPO. Activity based modeling is listed as a longer term improvement, but CCMPO could still initiate work on certain aspects of this transition in an earlier timeframe.

Several of these issues are intertwined, but we have continued to maintain discrete points for each one to facilitate discussion and provide a more manageable approach to prioritizing potential improvements. Further refinement of these priorities will be based on feedback from the peer review process.

Short Term (1-2 years)

1) *Modeling mixed land uses to support additional nonmotorized and transit use*
   - Many CCMPO policies and planning goals are supportive of mixed use dense clusters of land use and analytical tools which are sensitive to these characteristics are critical.
2) *Improving air quality and climate change modeling*
   - CCMPO is participating in efforts to inventory greenhouse gas emissions and has a good chance of going out of air quality attainment for ozone. The transportation model will likely be used in concert with other tools (e.g. MOVES) to support analysis of these issues in the near future.
3) *Reviewing sensitivity to increased travel costs (e.g. gasoline) in the model*
   - Gasoline prices are on the rise again and it would be very helpful to have guidance regarding how other regions are considering this in their regional modeling efforts.
4) *Refinements to 1996 FHWA Quick Response Freight Manual truck modeling*
   - The current quick response based truck modeling approach used in our model generates a significant number of light truck trips (e.g. service and delivery vehicles) – about 100,000 or 13% of the total daily trips in the model. CCMPO is interested in examining this aspect of the model to see if a different approach or parameters are warranted for this and potentially other truck trip types.
5) *Visualization techniques and performance measures for better communication to stakeholders*
   - CCMPO has used flow maps, measures of VMT, congested VMT, hours of delay, and other commonly used techniques to present model results to policy makers and the general public. Feedback from peers on any particularly effective measures or

techniques to communicate modeling output to a broad audience is of great interest to the MPO.

Longer Term (2-5 years)

1) *Recommendations regarding interaction/integration between model and microsimulation tools*
   - CCMPO has a number of corridor studies planned over the next few years. The regional model is expected to be used in most of these studies along with other more detailed capacity analysis tools, such as Synchro or VISSIM. One approach under consideration is developing a protocol to interact between TransCAD and the PTV Vision suite (VISUM and VISSIM). Another approach to this issue would be the use of Dynamic Traffic Assignment tools. Feedback from peers on the above or other corridor-level analysis techniques would be very helpful.
2) *Transition to activity-based demand models*
   - There are compelling reasons to consider transitioning to an activity-based model approach, including the fact that RSG has already completed initial work on a DaySim implementation for Chittenden County related to a research study they received US DOT funding for. The increased complexity of preparing model inputs for future years is of concern to CCMPO staff. A review of the potential pros and cons of moving from a more traditional 4-step model to an activity based model from the peers would be helpful in determining where this change fits in with CCMPO's resources.
3) *Expanding the model geography and integration with Statewide model*
   - This will be an ongoing policy discussion with our neighboring jurisdictions and will also require coordination with the Vermont Agency of Transportation and the University of Vermont Transportation Research Center. The feedback received in the first two peer review sessions has highlighted several issues to be studied on this topic. Any additional thoughts are welcome.
4) *Recommendations regarding land use forecasting tools and existing LUAM*
   - Land use forecasting tools have not been a focus of discussion in the review process to date. Based on the brief conversation at the end of session 2 regarding this subject, CCMPO may pursue additional feedback outside of this peer process. Suggestions from reviewers regarding land use forecasting models or techniques which may be suitable for CCMPO and references to applications in other regions would be valuable.

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