Technical Proposal

Update and Improve the Genesee County Urban Travel Demand Model

(#15-057)

submitted to

Genesee County Metropolitan Planning Commission

Flint, Michigan

submitted by

William G. Allen, Jr., P.E.

Transportation Planning Consultant
Windsor, South Carolina

and

CDM Smith, Inc.

Lexington, Kentucky

20 May 2015

William G. Allen, Jr., P.E.

Transportation Planning Consultant

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20 May 2015

Ms. Cindy Carnes
Purchasing Manager
Genesee County Purchasing Department
1101 Beach St, Room 200
Flint, MI 48502

Re: Technical Proposal to Update and Improve the Genesee County Urban Travel Demand Model and Provide Continuing Technical Assistance
Proposal Request Number #15-057

Dear Ms. Carnes:

I am pleased to submit this proposal to update the County's travel demand model. The enclosed proposal demonstrates that our team has the necessary experience, skills, and resources to conduct this study.

I have extensive nationwide experience in developing and applying travel demand models and much of my experience is with medium-sized urban areas. For this assignment, I have teamed with CDM Smith, a nationally-known firm specializing in transportation planning. This team of experienced professionals has all of the skills and background that this project requires.

Here's why you should select our team for this project:

- **Innovative Approach**: We propose to develop a <u>tour-based model</u> for GCMPC. This is the newer, more advanced type of travel model that many MPOs are using today. I have created a simplified version that reflects the latest advancements in travel behavior understanding but is better suited to the GCMPC area and can be done within the available budget and schedule. This is not a research project – it is a production-ready process that is easier to understand and runs quicker, compared to models in larger areas. The advantages of this process are a more accurate trip table, better sensitivity to demographic changes, and greater reporting capabilities.
- **Relevant Experience**: In recent years, I have worked on model development projects in Michigan, Ohio, and South Dakota. This includes the Urban Travel

Model Improvement Program for MDOT. I have also developed simplified tour-based models in four areas. CDM Smith staff worked on an earlier version of the GCMPC model and have relevant experience applying TransCAD models nationwide.

- **Team Experience**: Our proposal features experienced professionals. There will be no "on the job" training of consultant staff on this project. I have worked with CDM Smith before.
- **Responsive**: I typically work for only a few clients at a time. This would be an important project for me and would get priority treatment. You should contact my references, who will confirm that I am very responsive to my clients' needs and schedules.

I hereby certify that I am not on the Comptroller General's list of ineligible contractors, nor is CDM Smith.

Our cost proposal is being transmitted in a separate document, as you requested.

The timing of this RFP is propitious since CDM Smith and I have created a new partnership to promote the use of Simplified Tour-Based Modelling (STM) in medium-sized urban areas nationwide. You can find a fact sheet on STM and a presentation that explains more details on my home page, www.williamgallen.com. We believe this is an exciting and innovative business venture and look forward to getting it started in Genesee County.

Although Flint is a GM town, there is a quote from Henry Ford that is apropos here. Henry was not an advocate of market research and is reported to have said "If I had asked people what they wanted, they would have said 'a faster horse'". Our proposal offers a new approach that will bring GCMPC into the 21st century.

I believe you will find this unique proposal to be responsive to your needs and look forward to working with you on this project.

Sincerely,

William G. Allen, Jr., P.E.

enclosure

table of contents

signature page

GENESEE COUNTY RFP #15-057

The undersigned represents that he or she:

1. is duly authorized to make binding offers on behalf of the company,
2. has read and understands all information, terms, and conditions in the RFP,
3. has not engaged in any collusive actions with any other potential proposers for this RFP,
4. hereby offers to enter into a binding contract with Genesee County for the products and services herein offered, if selected by Genesee County within 120 days from proposal due date,
5. certify that it, its principals, and its key employees are not "Iran linked businesses," as that term is described in the Iran Economic Sanctions Act, P.A. 2012, No. 517, codified as MCL 129.311, et seq.
6. acknowledges the following addenda issued as part of the RFP:

Addendum #1

Name (Printed): William G. Allen, Jr., P.E.

Signature: ______________________

Title: Principal

Company: William G. Allen, Jr., P.E.

Date: 15 May 2015

Contact Person

Please indicate name, telephone number, fax number, mailing address, and e-mail address of company representative for matters regarding this RFP.

CONTACT NAME	POSITION	E-MAIL
Bill Allen	Principal	wgallen@isp.com

MAILING ADDRESS	PHONE	FAX
PO Box 390, Windsor, SC 29856-0390	(803) 642-4489	(803) 642-4489

insurance checklist

GENESEE COUNTY INSURANCE CHECKLIST

Proposal Title Update and Improve the Genesee County Urban Travel Demand Model and Provide Continuing Technical Assistance

Proposal Number 15-057

Coverages Required	**Limits (Figures denote minimums)**
X 1. Workers' Compensation	Statutory limits of Michigan
X 2. Employers' Liability	$100,000 accident/disease $500,000 policy limit, disease
X 3. General Liability	Including Premises/operations $1,000,000 per occurrence with $2,000,000 aggregate
X 4. Products/Completed operations	$1,000,000 per occurrence with $2,000,000 Aggregate [If applicable]
X 5. Automobile liability	$1,000,000 combined single limit each accident- Owned, hired, nonowned

X 6. Best's rating: A VIII or better, or its equivalent (Retention Group Financial Statements)

X 7. The certificate must state Proposer number and title

X 8. Genesee County named as an additional insured on other than workers' compensation via endorsement. A copy of the endorsement must be included with the certificate. Evidence of Addition Insured under Blanket coverage within the policy language is also acceptable. However, a copy of the language applicable to this must be provided.

FAX THIS PAGE TO YOUR INSURANCE AGENT/BROKER

Insurance Agent's Statement

I have reviewed the requirements with Prospective Contractor named below. In addition:

_____ The above policies carry the following deductibles:

Liability policies are ***occurrence*** ✓ ***claims made*** _____

SANDRA M. VOGUS — Insurance Agent

Sandra M. Vogus — Signature

PLEASE NOTE #8 ABOVE. ADDING ADDITIONAL INSURED [AI] TO THE DESCRIPTION IS NOT ACCEPTABLE. AN ENDORSEMENT OR COPY OF AI LANGUAGE IS REQUIRED

Prospective Contractor's Statement

I understand the insurance requirements and will comply in full if awarded the contract.

_____________________ Proposer

_____________________ Signature

Required general insurance provisions are provided in the checklist above. These are based on the contract and exposures of the work to be completed under the Contract. Modifications to this checklist may occur at any time prior to signing of the contract. Any changes will require approval by the Prospective Contractor, the department and County Risk Manager. To the degree possible, all changes will be made as soon as feasible. REVISED 04/08/2010

business organization

Prime consultant:

William G. Allen, Jr., P.E.
Transportation Planning Consultant
791 Oak Ridge Club Rd.
PO Box 390
Windsor, SC 29856-0390

I do business as a sole proprietor and have operated in that manner since 1988.

Subcontractor:

CDM Smith, Inc.
2525 Harrodsburg Road, Suite 200
Lexington, KY 40504

CDM Smith will conduct the work at its offices in Lexington, KY, Austin, TX, and Houston, TX.

CDM Smith is a corporation, incorporated in Massachusetts.

Neither of these firms is currently licensed by the State of Michigan and this team does not include a certified DBE.

statement of the problem

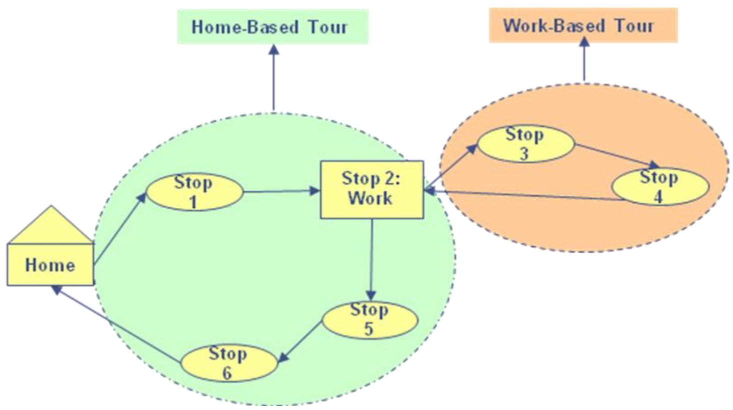
The following list summarizes what GCMPC is hoping to achieve from this study:

- New calibration/validation
  The last calibration of the model should be checked and updated as necessary. Each step of the model should be validated to the available observed data, most likely representing 2014 conditions. Sensitivity testing should be conducted to verify the reasonableness of model outputs.
- Improve/freshen the model
  The entire model chain should be reviewed to ensure that it represents the state of the art and the best practices of urban areas of similar size. Specifically, the transit, truck, and non-motorized models, and the user interface should be examined and revised for improved accuracy, reduced model run time, and ease of use.
- Update model inputs
  This involves mainly the highway and transit networks, land use, and external trips. Input files representing 2014, 2020, 2025, 2035, and 2045 must be developed in a manner that is consistent with the previously developed inputs and must also be internally consistent across time.
- Improve ease of use
  Improvements are needed in the way the model outputs are created and used by other analyses, such as MAP-21 reporting, air quality (Moves), and environmental justice planning. The model interface should provide enhanced ease of use.
- Training
  This includes clearer explanation of the model's inner workings, as well as development of the input data, use of the outputs, and how the model relates to the agency's planning needs. It also includes complete documentation, specifically a calibration report and a user's guide, as well as one years' technical support. At GCMPC's option, it may also include on-going support.

These tasks are very straightforward and our team is certainly qualified and willing to perform them. However, our proposal goes far beyond these tasks. We are proposing to provide GCMPC with an entirely new model structure: a simplified tour-based model. Given our experience in other areas, we know that this kind of model can be developed for Genesee County within the budget and schedule constraints of this project. The result will be an advanced model structure that will suit GCMPC's needs for the foreseeable future. The following discussion explains the tour-based process in more detail.

Since the development of regional travel demand modelling in the 1950's, the basic modelling methodology has been the *four-step approach*. This approach treats travel as an aggregate statistic between pairs of traffic analysis zones, stratified as being either home-based or non-home-based. This method has been used in almost every regional travel model developed in the past sixty years and describes the existing GCMPC travel model.

Since the 1990's, researchers have been developing a new way to model travel, known as *activity-based modelling* or *tour-based modelling*. This approach treats travel as individual round-trip tours (see the figure below). Each trip is represented separately, instead of using aggregate totals. This is a more realistic and accurate way of measuring travel. Most models now being developed for the largest U.S. metropolitan areas use this approach, since there is general agreement in the modelling community that this is the way in which new travel models should be developed. The greater power of desktop computers in recent years has made this process more feasible. In the past few years, several such models have been put into actual practice, with favorable results.



The major benefit of tour-based models is that they provide for better sensitivity of travel estimates to key policy and transportation system variables, resulting in more reasonable forecasts. Since important information describing each traveller is known all the way through the model chain, the model can relate travel more accurately to the characteristics of individuals. For example, in estimating the response of travellers to changes in travel cost (e.g., toll roads or gasoline prices), a disaggregate model is able to consider the household income of each traveller instead of a zonal average, which produces a more accurate sensitivity. Also, tour-based models do a better job of reporting travel impacts and other performance measures that are based on a specific population group, such as for Environmental Justice analyses. Another benefit of this approach is that it eliminates the non-home-based (NHB) trip category. In most models, NHB is a "garbage can" of many different kinds of trips, lumped together simply because neither end is the traveller's home. In a tour-based model, *all* tours begin and end at home or work and the intermediate stops are all accounted for explicitly. This has a greater likelihood of estimating these stops in the correct locations. This produces a more accurate trip table that not only results in better assignment validation, but better responsiveness to changes in future conditions.

The downside to this new style of model is that the recent versions have been *extremely* resource-intensive. Most such efforts have required new surveys, budgets of $2+ million, and several years of development time. Clearly, that kind of process is unsuited to GCMPC's needs. In response to these concerns, I have recently developed an innovative type of simplified tour-based model that is tailored to the needs of MPOs of fewer than 2 million population. This is not a research program – it is a real model system that I implemented in 2010 for Brunswick, GA (pop. 68,000), Charlotte, NC (pop. 2.1 million), and presented at the past three TRB Transportation Planning Applications Conferences (including the one in progress this week in Atlantic City, NJ). By removing needless complexity and streamlining the process to its most important elements, I have developed a brand new model structure that reflects the state of the art and can be implemented in TransCAD within the budget, schedule, and data availability of this project. It is a flexible approach that will meet GCMPC's needs for many years to come.

Because the tour-based process operates in a manner that more closely reflects how people actually travel, it will produce a trip table that more accurately matches reality, which will create assignments that more closely match the counts. Another benefit of this process is that even though it is a disaggregate tour-based model, it avoids the extreme complexity and long running time of most such models and actually borrows some of its travel relationships from the conventional four-step approach. This makes it more familiar to the user than the models that have been developed by researchers. In that sense, it is an easy transition from the four-step method. The new model will reflect the best practice from around the country for travel demand models. The County is not interested in research that pushes the state of the art, but in a model that represents rigorous, sound methods and is immediately ready to be used in production. This would provide GCMPC with one of the most sophisticated modelling processes in Michigan and it is how we propose to do this project. This proposal's Work Plan explains how that would be achieved.

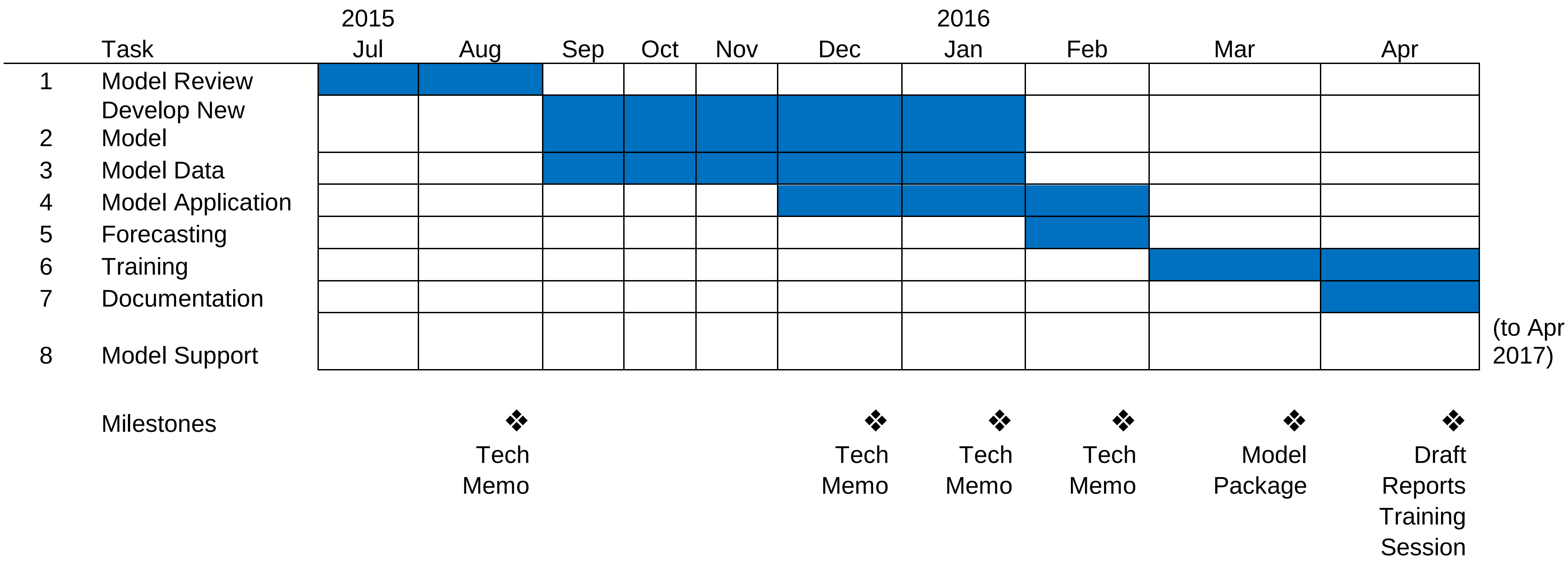
management summary

Upon first glance, it might seem unusual for a self-employed individual to be the prime contractor with a nationally known firm as a subcontractor. However, I have used this arrangement in the past with good results. I have 35 years of experience in travel demand forecasting nationwide and this background, combined with the expertise of CDM Smith (both in Genesee County and with TransCAD), is more than sufficient to complete this project in a timely and effective manner. The allocation of total budget will be roughly 42% for me (Bill Allen) and 58% for CDM Smith.

The chart on the following page shows our proposed project timetable and milestones. The products that will be delivered are as follows:

- Model Review Tech Memo
  This will summarize the review of the existing model and data, and describe the structure and calibration of the newly proposed model.
- Calibration Tech Memo
  This will summarize the development of the new tour-based model, including validation results for each model step.
- Model Data Tech Memo
  This will summarize the results of the work to develop the model input data for 2014, 2045, and the intermediate years.
- Forecast Tech Memo
  This will summarize the results of the initial forecast.
- Model Application Package
  This consists of the GISDK code to apply the new model, including development of reports and interface with Moves.
- Calibration Report
  This report describes the development of the new model, including calibration, validation, forecasting.
- User's Guide
  This report describes how to use the model, including development of input data and use of output data.
- Training Session
  The consulting team will hold a training session for GCMPC staff, with a complete orientation in how to use the model.
- Tech Support
  We propose to provide technical support for the model and data for one year following the delivery of final documentation.

Estimated Schedule



consultant qualifications and prior experience

I am a nationally recognized expert in travel demand forecasting and have been providing consulting services since 1988. I have worked on travel models in many areas of the U.S., including projects from Maine to Florida and from Arizona to Washington. I have done a wide variety of model work – all the way from network coding to developing entire model systems from scratch. My experience includes large metropolitan areas, small cities, and everything in-between.

I have previously worked with CDM Smith and am familiar with their staff capabilities. Recently, CDM Smith and I have formed a new partnership to promote the development of the Simplified Tour-Based Model nationwide, in urban areas very similar to Genesee County.

In recent years, my experience with model development in the upper midwest has included:

- Michigan DOT's Urban Model Improvement Program in 2010 (I was a subcontractor to PBS&J and developed the transit model and wrote some of the documentation)
- development of truck models for small-to-medium sized cities in Ohio for ODOT (subcontractor to AECOM)
- development and updating of a regional travel model for Sioux Falls, SD and application for long-range plan development

My specific experience with developing Simplified Tour-Based Models includes the following areas:

- Brunswick, GA (2010)
- truck models for Atlanta (2013) and Birmingham (2014)
- Charlotte, NC (2014)

CDM Smith (formerly Wilbur Smith) was a subconsultant to Bernardin Lochmueller & Associates on the development and calibration of the 2005 Genesee County Regional Model. CDM Smith's role included the development of the highway and transit networks, zonal geography, and design and estimation of the trip generation model. At the time, the Genesee County model was one of the first models to utilize the Michigan Travel Counts Household Survey. From this data, datasets were extracted for model estimation based on the TMA combined dataset and those specific to the model area. Unique data sets were developed for each model component including trip generation, trip distribution, and time of day.

The model networks (highway and transit) were developed with the latest information available from MDOT, the local jurisdiction, and the regional transit provider. Link attributes were defined to support the free flow speed and capacity logic developed for the model. The zonal geography was defined to ensure an appropriate zone size for the population and households and to maintain consistency with the 2000 Census geography.

The trip generation model developed by CDM Smith included stratification of the HBW purpose into low and high income to better align the production and attractions across the region. Non-work home-based travel was stratified into several purposes including shopping and other non-work related activities and specific school related purposes for K-12 and post-secondary students. The trip generation model was estimated from the Michigan Travel Counts Household Survey data sets and calibrated to ensure that the desired results were being output from the model. Validation of the trip generation model included comparison of the model results to other sources of data including the Census Journey to Work CTPP.

The material on the following pages reflects my experience and qualifications. This is followed by CDM Smith's staff resumes and qualifications. A list of my references is shown at the end. I encourage you to contact these references.

Travel Forecasting Experience – William Allen

Urban Travel Model Improvement Program Michigan DOT	Michigan (statewide)

This was a wide-ranging project with the objective of updating the structure and content of the travel models in eight smaller cities in Michigan (Tri-Cities, Muskegon, Kalamazoo, Jackson, Benton Harbor/St. Joseph, Battle Creek, Holland, and Niles). In addition, MDOT wanted to use a common model structure for all these areas. The project used a 2005 statewide home interview survey to calibrate a new standardized four-step model for these areas, with slight differences by area as appropriate. My role included identifying all of the key issues that a new model would need to represent the state of the art. I also developed a simplified transit trip estimation procedure that did not require a transit network. This work was conducted under subcontract to PBS&J (now Atkins).

New Travel Demand Model Maryland Mass Transportation Administration	Baltimore, MD

Maryland MTA wanted to pursue New Starts funding for its proposed Red Line rail line running east-west through Baltimore. Although the Baltimore regional travel model had recently been upgraded, it did not meet the revised standards of the Federal Transit Administration for New Starts travel forecasting. I worked with MTA and Baltimore Metropolitan Council staff to develop a completely new travel model in Cube that would both adhere to the FTA requirements and reflect the current state of the art in four-step aggregate travel modelling. The new model covers the Baltimore region and part of the Washington area and was based on surveys from both areas. It includes socioeconomic submodels, splits travel by four income groups, includes speed feedback, handles HOV travel, uses a nested logit mode choice model with HRT, LRT, and Commuter Rail modes, has a complete four-step air passenger model, a time of day model with four periods, uses composite time for distribution, has separate models for medium trucks, heavy trucks, and light-duty commercial vehicles, and performs transit assignments. Although the model was developed for the New Starts project, it was subsequently adopted by BMC as the region's official travel model. The model consists of over 18,000 lines of Cube code.

Regional Travel Demand Models Regional Planning Commission	New Orleans, LA

This project involved the development and calibration of a complete set of regional travel demand models for the New Orleans metropolitan area. The model set included trip generation, distribution, mode choice, assignment, and air quality, as well as ancillary models for preparing input. Models for truck, taxi, external, and through trips were also developed. Distribution is performed with the gravity model, specially formulated to use a composite highway-transit impedance as the separation variable. Mode choice is modelled using multinomial logit equations, with income level as the socio-economic stratifier. Both transit mode-of-access and highway carpool use can be modelled. The model chain was calibrated using 1960 O-D data and was validated to 1980 conditions.

Toll Road Traffic and Financial Forecast	Denver, CO
E-470 Authority	

E-470 is a proposed circumferential roadway around the eastern half of Denver that is being built as a toll road with a significant amount of private financing. In order to secure that financing, as well as a commitment from Colorado DOT, accurate and defensible forecasts of traffic and toll revenue must be prepared. Based on a stated preference survey, a logit path choice model was created to estimate the split between toll and non-toll paths. Although no toll roads existed in Denver, extensive sensitivity analyses suggested that the model's results were reasonable. Trip generation and distribution were performed using the regional models and traffic was assigned to a focused network that maintained considerable detail within most of the eastern half of the Denver metropolitan area. The model chain was applied numerous times to test a diverse set of land use, highway network, and toll rate alternatives for six forecast years. The first segment of the toll road opened to traffic in 1991. This work was conducted under subcontract to Vollmer Associates (now Stantec).

New Truck/Commercial Models	Washington, DC
Metropolitan Washington Council of Governments	

MWCOG developed its truck model in 1968 and had not re-examined it in over 30 years. Although MWCOG and BMC had conducted a joint truck survey in 2002, it was not found to be useful for model development. I developed an innovative technique to transfer models of heavy and medium trucks and commercial vehicles and intensively validate them to classification counts. I have used this method successfully in several other areas. "Commercial" is a new category of light-duty vehicles that includes delivery, repair, government, tradesmen, landscaping, and similar trips that are not strictly personal transportation. Modelling those trips required special counts. The resulting models matched the count data much better than the prior models.

Regional Travel Demand Models	Charlotte, NC
Charlotte Department of Transportation	

In this project, I was part of a team that developed a new regional travel model for the expanded "Metrolina" area. My role was to develop the trip generation, trip distribution, and time of day models. Charlotte DOT uses the TransCAD modelling package, but wanted a model with more capabilities than are generally available in TransCAD. Thus, the trip table estimation modules were developed in Fortran and TransCAD was used to maintain the networks and for assignment. The model uses an aggregate approach and adapts the best practices from other four-step models from around the country. Generation is based on HH size, workers, income, and HH life cycle. Distribution uses composite time and is stratified by income. Time of day is divided into two models, one applied before mode choice and one applied afterwards. The entire model chain has been used for various regional purposes, including a New Starts application for the region's light rail system. In 2011, I was again contracted to use a new home interview survey to update this model.

Countywide and Subarea Traffic Models Prince William Co. Dept. of Public Works	Prince William Co., VA

Prince William is one of the fastest growing counties in Virginia. As part of updating its Comprehensive Plan, the County retained me to create a countywide travel forecasting model in Cube. This model was developed as a window on the Metropolitan Washington COG's regional model, with additional zone and network detail. The network coding was enhanced to respond to more detailed types of improvements, such as signals and turning lanes. Subsequently, I used this model as a basis for developing a peak hour model focused on the proposed Innovation development near Manassas. I developed a site-level zone system and network (each driveway a centroid connector), revalidated the model to AM and PM peak hour turning movements, and applied it to produce turning volume forecasts for a number of development and highway scenarios. The model can also determine each site's share of the traffic on every link in the subarea, which is useful in traffic impact analyses.

Travel Forecasting for Regional Improvements Northern Virginia Transportation Alliance	Washington, DC

The Alliance is a private organization representing the business community in the Washington area. They had identified a number of transportation improvements that they thought would be productive in reducing future congestion in the region, which is one of the most congested areas in the country. I obtained the regional travel model from MWCOG, applied it to a variety of highway and transit improvements, and was able to report a variety of statistics indicating the effectiveness of these improvements.

County Travel Model Development Stafford County Transportation Department	Stafford County, VA

Stafford County is a fast-growing suburban jurisdiction at the southern edge of the Washington, DC metropolitan area, just north of Fredericksburg. The County desired a comprehensive state-of-the-art travel model to estimate travel within the county and to other parts of the Washington region. A complete new focused model was developed in Cube that merged the Metro Washington COG and Fredericksburg Area MPO regions and subdivided Stafford County into more than 900 zones. Travel relationships were based on a Washington regional home interview survey, Census, and MWCOG model estimates. Trip generation uses Work, Shop, Other, NHB, Commercial, and Truck purposes. The home-based purposes are subdivided by four household income levels. A sophisticated logit auto occupancy model was developed that is sensitive to trip purpose, trip length, and development density. Time of day models split daily travel by AM, PM, and off-peak periods, and separately by AM and PM peak hours. Traffic assignment considers HOV and truck paths, advanced toll modelling (HOT lanes), turn penalties, and Dulles Airport Access Road restrictions. The model was used to support development of a new countywide Thoroughfare Plan and will be used in a study of road impact fees.

Travel Forecasting Model Development Pennsylvania Dept. of Transportation	Reading, PA

Reading was the largest non-attainment area in Pennsylvania without a network-based travel forecasting process. This project created one "from the ground up", including zone and network development, home interview survey, roadside cordon auto and truck surveys, and a shopper survey. I calibrated a complete travel demand model set for the region in Cube, based on the most recent guidance on enhanced models for air quality planning from FHWA and EPA. The 4-mode logit mode choice model is stratified by household income level and uses an advanced nested structure (including non-motorized trips) and is sensitive to TDM actions and carpool and transit park-and-ride services. Trip distribution uses composite impedance and is also stratified by income. The procedure includes a time of day model and a network post-processor for speed feedback and MOBILE runs. I also wrote the application package. The original work was conducted under subcontract to Garmen Associates. Twenty years later, I led a team that updated this model using Census and NHTS data, under subcontract to AECOM.

New Regional Travel Model City of Sioux Falls	Sioux Falls, SD

The City of Sioux Falls is the MPO for the surrounding region. They needed a new travel model to help update their Comprehensive Plan and to perform a variety of highway studies across the region. They had purchased Cube, but needed help in using it. City staff had a network and some land use data, but the only data on observed travel was traffic counts. I synthesized a travel demand model from the literature and calibrated it to the City's satisfaction. This is a relatively sophisticated model, including a simplified mode choice/auto occupancy model, HOV and roadway pricing capabilities, and stochastic assignment by time of day. I also trained the City's staff in running the model. I updated the model in 2008 and again in 2014 (finally, using 2009 NHTS survey data) and in 2014-15 used the model to help update the region's long-range transportation plan.

Simplified Tour-Based Model Glynn County Dept. of Community Development	Brunswick, GA

Brunswick is a small (pop. 68,000) city in southeast Georgia with an economy based largely on tourism and retirees. Although GDOT had developed a conventional travel model for the area, the County wanted its own model. I developed a new type of tour-based model for the area, using survey data borrowed from a larger but similar area. The idea of simplifying an advanced disaggregate model to make it suitable for a smaller area is is an innovative concept. The process includes a conventional trip generation step, but using round-trip tours instead of trips. Tour destination choice is performed in a disaggregate fashion, but the separation function is still a gravity model, applied differently than usual. Next, an intermediate stop model applies two logit steps to estimate the number of stops on each tour and their locations. There is no transit, but mode choice includes a sophisticated auto occupancy component. Trips are split into four time periods using a disaggregate process. A trip accumulator was added to create trip tables for a conventional assignment. The process was implemented entirely in Cube without the use of custom-written software and produced better calibration results than GDOT's four-step model.

Travel Forecasting Experience – CDM Smith

Below are representative summaries of CDM Smith team projects that demonstrate our experience directly relevant to this task order.

Project Title	NCHRP Report 765 Analytical Approaches to Project Level Traffic Forecasting
Client Agency	National Academy of Science
Contracting POC	Nanda Srinivasan, 202-334-1896, nsrinivasan@nas.edu
Technical POC	Nanda Srinivasan, 202-334-1896, nsrinivasan@nas.edu
Period of Performance	March 2011 – October 2013

Brief description of contract work and specific comparability to the proposed effort:
This report is an update to *NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design* and describes methods, data sources, and procedures for producing travel forecasts for highway project-level analyses. The report provides an evaluation of currently used methods and tools. The report also includes appropriate information sources and system-level methods (ranging from readily available practices to advanced practices) to address a variety of project development purposes, needs, and impacts. The report is intended to be used by transportation planning, operations, and project development staff to better support planning, design, and operations recommendations. The report is accompanied by a CD-ROM providing spreadsheet tools developed for project-level analyses.

In 1982, TRB published *NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design.* This report compiled techniques used in urban areas to bridge the gap between system-level and project-level analyses. In 1982, there was an emphasis on new and expanded highway facilities, but today the focus has broadened to include travel demand management strategies and operational efficiency strategies. Spatial and temporal aspects of congestion are difficult to capture at the precision necessary for project-level decision making with conventional traffic forecasting techniques. For heavily congested urban study areas and corridors, it is important to capture the effects of residual demand and peak spreading at a project level. Since 1982, there have been many improvements in travel models; however, relatively few efforts have been made to meet post processing needs for project-level analysis. There was a need to evaluate currently used post processors and refinement methods and to determine how to best communicate the results so that stakeholders have a sufficient degree of understanding and acceptance. Improvements in methods were needed to provide plausible and defensible forecasts to support planning and highway project development.

The objective of this research was to evaluate and describe currently used methods, data sources, and procedures for producing travel forecasts for highway project-level analysis. The research was performed by CDM Smith and Associates in association with Alan Horowitz of the University of Wisconsin at Milwaukee, Tom Creasey of Stantec, Ram Pendyala of Arizona State University, and Mei Chen of the University of Kentucky. Information was gathered via literature review, a national survey, interviews with practitioners, focus groups, and case studies collected from metropolitan planning organizations and state departments of transportation. CDM Smith has followed this up with several webinars and presentations.

This research is comparable to the NCHRP 8-94 project since it is an NCHRP research project, is focused on traffic forecasting solutions and tools and actually contains a section on tool selection.

Project Title	CAMPO Model Validation
Client Agency	Capital Area MPO – Austin, Texas
Contracting POC	Ashby Johnson, Director
Technical POC	
Period of Performance	August 2011 - ongoing

Brief description of contract work and specific comparability to the proposed effort:
Through this effort, CDM Smith has been responsible for the implementation of several enhancements to the regional travel demand, calibrated and validated the model for 2010 and assisted the MPO in application of the model for 2040 Regional Transportation Plan that was adopted in May of 2015. The regional travel demand model for the Capital Area Metropolitan Planning Organization covers six counties and includes the Austin, Texas MSA. The total population of the region in 2010 exceeded 1.3 million and is anticipated to grow to nearly 4 million by 2040. The model is a time of day model with four periods with a mode choice component that includes a range of existing and proposed transit modes including regional and light rail, express bus, bus rapid transit and local services.

At the beginning of the contract, CDM Smith was given the opportunity to review the existing regional model and propose a set of enhancements to be completed prior to the model validation. Those enhancements selected by the MPO and were implemented included:

1. Conversion of the model to TransCAD 6: By converting all GISDK scripts in the model to be fully compatible with version 6 of TransCAD, time efficiencies and new methods available in the software could be realized.
2. Update of the Volume Delay Parameters: Prior applications of the regional model showed poor correlation with observed congestion levels attributed to its daily structure and antiquated approach to the volume delay parameters used in the model. By updating the delay function parameters, the model is now more responsive to changing traffic patterns and better replicates congestion levels.
3. Trip Generation and Trip Distribution: The CAMPO model had relied on older Fortran based programs for the trip generation and trip distribution phases of the model. CDM Smith replicated the methods used by the older programs in GISDK allowing for improved transferability of the model.
4. Mode Choice and Transit Assignment: The CDM Smith Team spent considerable effort on reviewing and updating the transit path building parameters to better replicate the scheduled service times. Transit link speeds were calibrated based on observed transit vehicle speeds by functional class and area type. The results were improved validation of the mode choice model to observed mode shares in the region.

5. Expansion of the Model Area: As part of CDM Smith's enhancements, the model was expanded to include an additional county. This effort included the development of a new zone structure, network and demographic inputs for the county.

At the completion of the enhancement phase, CDM Smith began the calibration and validation of the model to 2010. Rather than just focusing on the final model step, traffic assignment, CDM Smith considered all phases of the model in its validation effort comparing results to additional datasets not used for model calibration. The validation effort included several changes to the model including re-calibration of the gravity models to include generalized cost, mode choice updates in both the path building parameters and choice constants, new time of day factors to improve the time of day validation and implementation of a toll dampening method by corridor.

Since the completion of the model validation, CDM Smith has been assisting CAMPO staff with the application of the model including the implementation of a project based master network scheme to manage the testing of the plan projects, providing technical assistance and review of staff work product and presenting modeling results to the MPO Technical and Policy boards.

Project Title	Jeddah Strategic Travel Demand Model
Client Agency	Jeddah Municipality
Contracting POC	
Technical POC	
Period of Performance	October 2011 – October 2013

Brief description of contract work and specific comparability to the proposed effort:
CDM Smith developed a tour-based travel demand model in the VISUM software and a number of VISSIM simulation models for the Jeddah, Saudi Arabia Municipality. Special data was collected for this model including over 600 traffic counts, 100 intersection counts, 24 corridor level journey time surveys, seven external intercept surveys, a 12,000 person household survey, a taxi survey, freight establishment surveys and trip generation surveys.
The model was estimated, validated and utilized to produce traffic forecasts and performance measures for numerous scenarios to support the ongoing Jeddah Transportation Master Plan which will – in the short run – build over $13 billion worth of transit and highway projects including light rail, two new outer loops, bus rapid transit and many other projects. Due to the heavy population growth in this city of 4 million and the annual presence of 3 million pilgrims per year, the transportation challenges are unique and challenging.
The project involved a great diversity of tasks – tour based modeling, traffic simulation, all manner of data collection, strong use of performance measures – along with the need to be responsive and flexible in response to client needs. The toolkit envisioned by NCHRP 8-94 would have been very useful for the client’s understanding of available tools and achievable outcomes.

Project Title	Ohio Statewide Travel Demand Model Evaluation
Client Agency	Ohio DOT Division of Planning
Contracting POC	Greg Giaimo
Technical POC	Greg Giaimo
Period of Performance	April 2011 – Current

Brief description of contract work and specific comparability to the proposed effort:
The Ohio Statewide Travel Demand Model is an activity based model (ABM) developed by the Ohio Department of Transportation. For the Department,
CDM Smith conducted an initial evaluation of the statewide travel demand model including:

- Reviewing model documentation for clarity, completeness and veracity and recommending and/or enacting updates
- Ensure the application code implements purported methods correctly and recommend and/or enact changes as necessary
- Recommend a future enhancement program based upon an evolutionary update schedule

Currently, CDM Smith is implementing a set of enhancements to the statewide model intended to make the ABM runtimes and model flow both more transparent and more efficient. Enhancements include improvements to the model interface, reorganization of the scenario structure, and a redesign of the way that the ABM interacts with Cube.
This project, along with the Ohio Medium/Small modeling work and the Ohio Long Range Transportation Plan forecasting/modeling activities, is an excellent demonstration of a complete traffic forecasting toolkit ranging from a full blown activity based model, a focus model, a quick run model, smaller MPO models, congestion management tools and other tools integrated to provide just the right level of expertise for particular problems.

Project Title	LSIORB time of day model
Client Agency	Kentucky Transportation Cabinet
Contracting POC	Gary Valentine
Technical POC	Scott Thomson, others
Period of Performance	October 2011 – October 2012

Brief description of contract work and specific comparability to the proposed effort:
CDM Smith developed a complex project model for the Southern Indiana Louisville Ohio River Bridges project model and did it in a very fast time period (12 months). Special data was collected for this model including the following:

- Origin-destination surveys at all of the incoming interstates;
- Traffic counts for passenger cars and trucks on over 60 ramps;
- Manual intersection counts at over 30 intersections;
- Inventory of over 1100 signal locations and implementation of signal delay into the model;
- Inventory of over 1,400 traffic count locations to use in validating the model.

The model was estimated, validated and utilized to make vital traffic forecasts for two new bridges that will cross the Ohio River. These forecasts included adding various toll rates and scenarios since tolls will be necessary to finance this $3 billion investment. This project involved detailed methodology review by the FHWA and intense scrutiny from citizen's groups. The project involved detailed scoping at the beginning since the MPO model was deemed incapable of providing the level of detail and accuracy needed for the project. The scoping project involved several tasks that could occur in the NCHRP 8-94 forecast tool selection process.

Project Title	Indiana DOT on-call planning
Client Agency	Indiana DOT, Multimodal Planning Division
Contracting POC	Roy Nunnally
Technical POC	Roy Nunnally
Period of Performance	April 2011 - ongoing

Brief description of contract work and specific comparability to the proposed effort:
CDM Smith is performing and/or has completed three separate tasks for the Indiana DOT. CDM Smith assisted the Indiana DOT in updating their statewide model to 2010. CDM Smith was tasked with the following:

- Updating the network with new links, traffic counts and vehicle classification data.
- Updating the TAZ file with new socio-economic data and splitting zones as needed to reflect the updated network and to improve model results.
- Develop an updated truck model using GPS truck data developed by ATRI. The ATRI data was used to develop a seed trip table based on real origin-destination data throughout Indiana and from border states.
- Validate the model based on the new traffic counts, truck model, socio-economic data and new trip generation equations generated from the 2009 National Household Travel Survey add-on collected for Indiana.
- Develop an updated model interface between the Indiana statewide model and the I-69 subarea model.

The Indiana DOT needs to assist the fourteen MPOs in the state of Indiana in performing air quality analysis. CDM Smith provided consultant assistance to review/use the new county-level data sets and to implement the new MOVES2010 software to perform the air quality analysis. CDM Smith performed the five tasks: develop MOVES 2010 data method; prepare MOVES2010 input data; run MOVES2010 and calculate emissions rates; develop air quality post-processor; and calculate emissions and planning support.
Finally, CDM Smith is providing significant enhancements to the toll model element of the statewide model which is ongoing. This cross section of work shows the variety of different modeling tasks that CDM Smith has undertaken on one project for just one client!

William Allen references

1.	Client	City of Sioux Falls Planning Dept.
	Contact	Sam Trebilcock
	Address	224 W 9th St, Sioux Falls, SD 57104
	Phone	(605) 367-8890, STrebilcock@siouxfalls.org
	Project	Travel Model Update & Application for Long-Range Plan
	Budget	$26,000
2.	Client	City of Charlotte DOT
	Contact	Anna Hayes Gallup
	Address	600 E 4th St, Charlotte, NC 28202
	Phone	(704) 336-8034, agallup@ci.charlotte.nc.us
	Project	New Tour-Based Travel Model
	Budget	$70,000
3.	Client	Prince William County DOT
	Contact	Elizabeth Scullin
	Address	5 County Complex, Prince William, VA 22192
	Phone	(703) 792-4051, GSteverson@pwcgov.org
	Project	New Countywide Travel Model, Comprehensive Plan Analysis
	Budget	$30,000

work plan

Task 1 Review of Existing Model and Data

1.1 Review Existing Model

The existing GCMPC model was last updated in 2008. It represents a reasonable effort for a four-step model in an area the size of Genesee County. The improvements made at that time brought this model close to the state of the art in four-step aggregate models. In fact, there doesn't seem to be much room for significant improvement of the existing model structure. This is a key reason why we are proposing a new tour-based model structure.

But a new structure is unlikely to be successful if it doesn't build upon the current process. A major benefit of the proposed simplified tour-based process is that it is not *completely* different from the current model. Many features of the current model can and should be retained in the new model, because they are sufficiently rigorous and as a way to provide greater familiarity for staff. For example, it may well be possible to retain the current model's technique for household stratification. But instead of applying it in its present aggregate form, we would convert it into a *Household Synthesis* step, to estimate the characteristics of individual households. We expect that there will be other such opportunities to adopt features from the current model and will investigate these at the start. We will also review the need to update any of these components with newer or better data.

The major part of this subtask consists of deciding how best to integrate the Simplified Tour-Based Model structure within the GCMPC model system. We propose to retain those components of the existing model that reflect the best practices of similar areas. Where changes are indicated, we will describe the rationale. This will allow us to present a coherent, manageable new model structure to the Study Committee for review.

1.2 Review Existing Data

GCMPC's model documentation provides some background on the available data from the existing travel model. We have reviewed this report and believe that it will be feasible to make extensive use of the existing data, thereby saving time and budget. We will assemble the available data and review it for accuracy, consistency, and suitability. At this point, we believe it is very likely that the current model data, including highway and transit networks, socioeconomic data, and external volumes, will be generally sufficient for the development of the new tour-based model. As noted in the RFP, there may be exceptions for EPA's Moves program, which may require new information.

Another part of this subtask involves identifying sources of new data. This includes traffic counts, Census data (2010 count, ACS data), survey information (NHTS, MDOT), etc. The availability of certain kinds of information is what drives the process to update the existing GCMPC data. This sub-task will especially focus on identifying information that can be used to validate each component of the model, as described in the RFP. Typically, that kind of data is available only from a survey. We will pay special attention to the 2005 Michigan Counts I survey. Although this data is 10 years old, it may still be suitable and have a large enough sample size for the needs of this study. The 2009 Michigan Counts II survey includes a sample of the same households surveyed in 2005 and should provide a unique opportunity to learn about actual changes in travel habits, although it is much smaller. If the 2005 and/or 2009 survey data should prove suitable, then we would use it to calibrate the new model. Otherwise, we would transfer a similar model from another area and adjust it to reflect local conditions.

Strictly speaking, *calibration* and *validation* are two separate tasks. "Calibration" refers to the creation of a model, including its structure and parameters and "validation" refers to the process of comparing that model's outputs to separate sources of observed data, that were not used in the original calibration. However, many people use these two terms interchangeably, to mean the development of a model from some data and the application of that model to the *same data*. Obviously, these two interpretations have different implications for the data needs. We will review these concepts with the Study Committee to ensure a common understanding.

For most components of the tour-based model, validation requires survey data that is organized by tours. If only one source of such data is available, one technique that is sometimes used is to split the data in half – use one half for calibration, and the other half for validation. Although this is theoretically proper, it cuts the number of observations in half, which could lead to a less acceptable model.

The major focus of this subtask is to identify any gaps or problems with the available data that would affect our proposed methodology or GCMPC's expectations.

1.3 Outline Methodology

Based on the data and model review, we will finalize the technical approach to this project. We will write a report explaining the different elements of the new model, how they work together, how we will use the data to calibrate the model, and any other recommendations for model improvement. We will submit this technical paper to the Study Committee for their review.

Task 2 Model Development and Estimation

2.1 Household Synthesis

All disaggregate models begin with a step that identifies the characteristics of individual households (HH) and/or persons. It turns out to be fairly difficult to get the HH characteristics right and the person characteristics right, simultaneously. We propose to synthesize households, which is a major simplification of the process. The current GCMPC model includes a socioeconomic stratification model that splits the HHs by zone by the following categories:

- Household Size: 1, 2, 3 and 4+ Persons
- Household Workers: 0, 1, 2, and 3+ Workers per Household
- Vehicles per Household: 0, 1, 2 and 3+ Vehicles per Household
- Household Income: Low and High (below/above $42,500)

We propose to retain these attributes. Most likely, the only change would be to reexamine whether $42,500 is still a suitable threshold for the income stratification.

The current model includes a set of equations that are used to stratify zonal HHs by size, workers, vehicles, and income; we propose to retain those equations. Our experience is that the relationships between the zonal averages and the distributions is relatively stable over time and is not likely to have changed much from 2000 to 2010. However, the equations would now be applied in disaggregate form. That is, the new output of the process would be a list of HHs in each zone, with specific attributes. Table 1 shows what the first few records of this file would look like.

Table 1
Sample HH Data

Zone	Size	Workers	Vehicles	Income
1	1	0	0	low
1	1	1	1	high
1	2	2	2	high
2	4	2	2	high
2	1	0	1	low
2	2	1	2	low
2	3	2	3	high

This process is very straightforward and would be implemented the same way as it was in the Charlotte tour-based model. At the end, there would be about 145,000 records (one per HH) and a cross-tabulation of this file would produce summaries that closely match those from the Census.

We propose to validate this model by comparing its initial estimates to tabulations of HHs by size, workers, vehicles, and income calculated from the most recent American Community Survey PUMS data for Genesee County.

2.2 Tour Frequency

The *tour frequency* model is the disaggregate version of the trip generation step. This model estimates the probability of each HH making 0,1, 2, 3, … daily round-trip tours by purpose. This includes all tours by all household members. We propose to maintain most of the existing GCMPC trip purposes: work, shop, other, school, and university. There is no need to use a separate purpose for work/low income and work/high income, since the HH income group will be stored on all tour records. There will be a new purpose: At-Work, which represents subtours made from the workplace (lunch, meetings, etc.) and includes some of the existing Non-Home-Based Work category. We propose to relabel light-duty truck trips as *Commercial.* This is a purpose that is new to many models and is used to represent passenger car and delivery truck trips made for non-personal purposes (service technicians, package delivery, taxi, etc.); prior surveys have shown that this is about 8% of the total traffic volume.

One category that is missing from this list is *non-home-based* (NHB) travel. Nearly all aggregate four-step models include such a purpose, to represent a wide variety of trips made as part of a larger tour. Relatively little is really known about these trips and they are usually a wide variety of miscellaneous trips that are unaccounted for elsewhere. The advanced model structure that we propose does away with the need for a NHB purpose. Such trips are now modelled explicitly as intermediate stops on a work or non-work tour. Most surveys indicate that such travel is increasing over time, making it all the more important to capture it accurately with a tour-based model structure.

Typically, the structure of the tour frequency model is a logit equation of the type shown below:

$$p_k = \frac{e^{U_k}}{\sum_n e^U} \qquad (1)$$

where
p_k=probability of selecting option k
U=linear function of the attributes of option k
n=list of all available options
e=base of natural logarithms (2.718…)

This function is very common in travel forecasting and is used throughout the model chain. One such model would be developed for each purpose. Here, *n* represents the number of round-trip tours made in a day. Typically, the options (*k*) are no tours, 1 tour, 2 tours, and 3 or more tours, depending on the purpose. This information is converted into one or more tour records based on *Monte Carlo simulation*. In this process, the probabilities estimated by equation (1) are converted into actual tours. For example, say that the model calculates that a HH has a 40% chance of making one round-trip Work tour. A random number is then generated between 0 and 1. If the random number is 0.40 or less, then a Work tour record is created.

The *U* functions would be based on the HH attributes mentioned above, possibly also including the area type of the home zone. It is worth noting that round-trip tour rates are about 40-45% of conventional trip rates, which makes comparing the intermediate estimates to prior models difficult. The trip ends estimated with this function are considered tour *productions* because they are associated with the tripmaker's home zone.

We propose to calibrate this model using the Michigan Counts survey data, should that data prove to be suitable. The *trip* records would be converted to *tour* records, by looking at the sequence of each person's stops and grouping them according to the main tours made throughout the day. A tour begins at home or work and goes to work, school, or another location of highest duration. Information from the model (zonal socioeconomic data, network data, derived data) is then attached to each tour record and the resulting data is input to a logit estimation program such as ALOGIT. Based on the model structure and hypothesized independent variables, ALOGIT indicates the goodness of fit for the data. This would be done separately by purpose. Table 2 shows the surveyed fraction of households by number of round-trip tours by purpose from the Charlotte, NC data.

In general, calibrating a logit model requires the following specific steps:

- The travel survey must be reformulated to represent round-trip tours. This requires careful examination of the trip patterns of each individual, to identify the true origin and destination of each tour, along with any intermediate stops. The traveller's household attributes are attached to each tour.
- Identify the available independent variables. These should be items that one would logically expect would influence the travel phenomenon being modelled. They must also be measurable and forecastable. The base year values are calculated – these represent the values seen by the surveyed travellers.

- Identify the available options for the phenomenon being modelled. For example, for tour frequency, determine how many tour choices will be included for each trip purpose.
- Create a calibration file. This consists of a set of observations (for each household or traveller) that include the chosen option and the variable values associated with all of the available options.
- Hypothesize some initial logit models. This mainly consists of identifying which variables should be in the utility equations and which variables should have common coefficients.
- Input the hypothesized models and the calibration file to a logit estimation program such as ALOGIT. The program identifies the coefficient values and other statistics and indicates how well the model fits the data.
- Based on these results, hypothesize some additional models and/or modify the initial models and test these as well. It is important to remember that the estimation program does not by itself identify the “best” model. It is a tool used to aid the judgment of the analyst.
- From the various candidate models, select the “best” one. This is the one that best fits the data and includes reasonable variables with valid coefficients.
- Write an application program to apply the selected model and apply it using the base year data. Validate the model by comparing the estimated results to another source of observed data. Based on that comparison, it may be necessary to make minor adjustments to the coefficient values.

This is a generic description of the process used to develop most components of the tour-based model: tour frequency, destination choice, intermediate stops, mode choice.

Table 2
Fraction of Households by Tours (Charlotte)

tours	sch	hbu	hbw	hbs	hbo	atw
0	0.757	0.963	0.519	0.677	0.354	0.941
1	0.117	0.032	0.292	0.220	0.266	0.053
2	0.091	0.004	0.150	0.077	0.197	0.006
3	0.028	0.001	0.031	0.019	0.081	
4	0.006		0.007	0.005	0.049	
5	0.001		0.001	0.001	0.022	
6				0.001	0.017	
7					0.006	
8					0.005	
9					0.002	
10					0.001	
	1.000	1.000	1.000	1.000	1.000	1.000

Most advanced models don't include a tour attraction model. This is because they use singly-constrained destination choice models that do not attempt to match a set of calculated attractions. Instead, we propose to estimate a tour attraction model (this is another opportunity to adopt part of the existing GCMPC model). Work done for the Charlotte model found that using an attraction model and a doubly-constrained destination choice model produced results that were more logical.

We propose that this step include all *person travel*: both the tours that use a vehicle (auto/bus) and those that are non-motorized (walk/bike). These will then be split into motorized and non-motorized components in the mode choice step, based mainly on HH characteristics and zonal attributes (such as the development density of the home zone and the zones adjacent to it).

Some tours involve multiple stops. In that case, it can be difficult to establish which stop represents the "main" stop of the tour. This is important, as a tour is defined by the traveller's home at one end and an *anchor* zone at the other end. This is usually determined via a hierarchy, as follows:

- if any of the stops is for Work, it's a Work tour and the workplace is the anchor
- otherwise, if any of the stops is for School, it's a School tour and that's the anchor
- otherwise, the location where the person spent the most time is the anchor; if this cannot be determined, the stop that is farthest from home is the anchor

Based on our experience, it is likely that this model will be based mostly on HH characteristics (size, income, vehicles, workers), area type, and the estimate of tours for other purposes. In this model, a hierarchy of purposes will be established. Prior models have prioritized travel by School, University, Work, Shop, and Other. So for example, a HH's Work travel is influenced by the number of School tours. This information is available to the Work model, because the School model is applied before the Work model.

The output of this step is a set of tour production records describing the attributes of the tripmaker's HH and the tour's purpose (one record per round-trip tour) and a set of tour attraction records describing the number of tour attractions by zone and purpose.

2.3 Tour Destination Choice

In this step the productions are connected to the attractions to create tour records. That is, for each tour production record, all the zones are examined (specifically, their distance to the home zone and their attraction total) and one zone is selected as the most likely destination anchor zone for this tour. Typically, the logit function in equation (1) is used again. In this case, the choices *k* represent all possible attraction zones and *U* is a function that describes the separation between zones and the characteristics of each zone and of the HH.

As noted above, some planners create destination choice models to be *singly-constrained*. This means that tours are allocated to attraction zones without regard to any prior estimate of the number of tours that should be attracted to each zone. We recommend the old-fashioned *double-constrained* approach. This means that the trips that are attracted to a zone should be more a function of the land use in that zone than its relative accessibility. We have figured out how to incorporate the conventional doubly-constrained adjustment process in a disaggregate destination choice model, such that it matches the estimated attractions to within a specified tolerance.

A key advantage of a logit destination choice model over the four-step gravity model is that it can include variables other than just highway time and zonal employment which influence the choice of destination. This includes various forms of accessibility, area type variables, transit time, jurisdictional dummy variables, etc. In addition, it is easier to incorporate the effect of household income on destination choice, which most models have shown to be a significant influence.

The output of this step is a list of round-trip tour records, with the HH characteristics, tour purpose, tour production zone, and tour destination (anchor) zone.

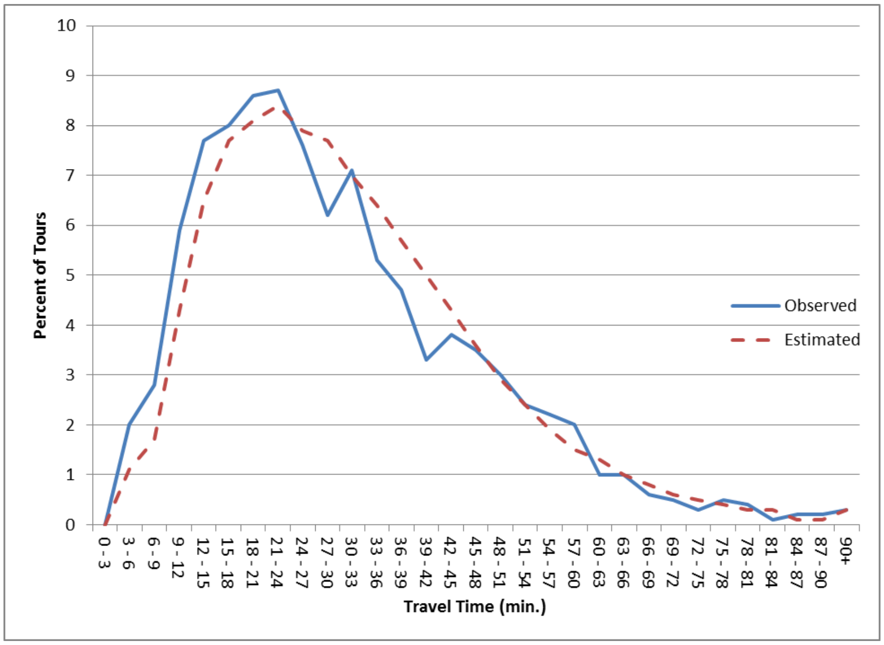
It should be possible to validate the Work tour model by comparing the estimated tours by tour length and the average tour length to those from the ACS. In addition, traditional comparisons of tour length can be computed, as shown in Figure 1 from Charlotte.

2.3.1 External Modelling

In nearly all activity-based models, external trips are modelled separately and are not considered as part of the tour-based structure. I believe that is a mistake and I propose to specifically model *external tours* and fully integrate them with the internal travel estimates. This is particularly important in an area the size of Genesee County, which sees a relatively higher share of external travel than, say, Detroit.

The tour generation model estimates total tours from each household: I/I and I/X. The destination choice model includes a step to estimate the probability that a tour leaves the region (is I/X). This is a negative exponential function of the zone's proximity to the cordon, as shown in Figure 2. Experience in other areas indicates that zones that are closer to the cordon have a higher share of I/X travel.

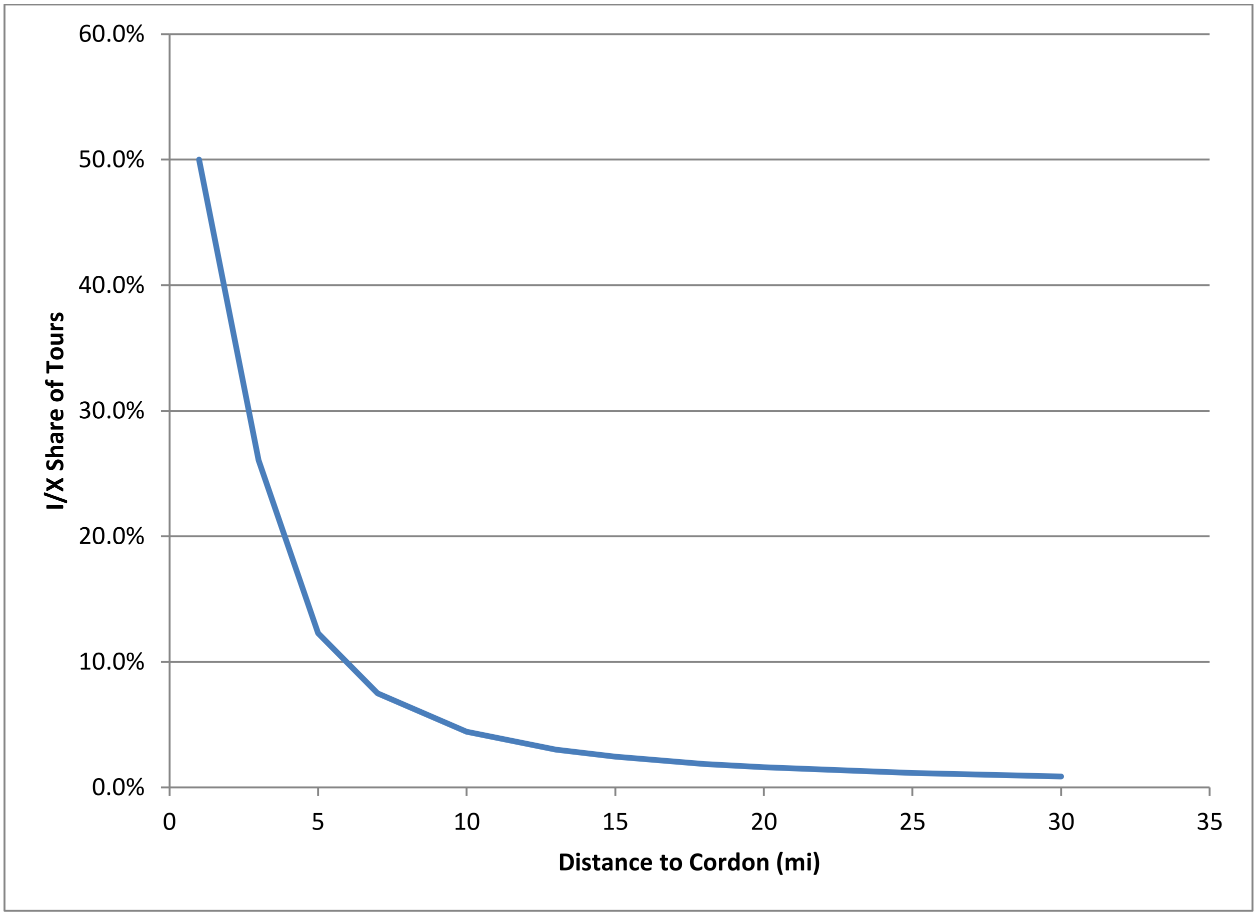
Figure 1
Work Tour Length Frequency Distribution (Charlotte)



The I/X tours are identified separately for each trip purpose and output to a separate file. All I/X tours are then grouped together and subsequently treated as a single "I/X" purpose. These tour records continue through the remainder of the model (intermediate stop, mode choice, time of day).

The I/X destination choice model estimates which external station each I/X tour goes to. That model is based on the location of the home zone, the total cordon volume at each station, and possibly other information from the statewide travel model. It is then possible to calculate the X/I tours. These are the remainder of the total cordon volume minus the I/X tours, minus the X/X trips, calculated at each station (with appropriate adjustments for auto occupancy). (X/X trips are estimated separately, based on data from the statewide model, in a manner similar to the current GCMPC model.) In this manner, there is complete consistency among the cordon total, I/X tours, and X/I tours.

Figure 2
Sample External Share Model



The resulting X/I tours are split by Work and Non-Work based on data from the statewide model. We expect that this split is roughly 50/50. This creates two new trip purposes: X/I Work and X/I Non-Work. Unless external survey data or very good information is available from the statewide model, there is almost no observed data on these tours. Most likely, a modified version of the I/I destination choice models for Work and Other would be used to estimate the internal destinations of these tours. After that step, these tour records continue through the remainder of the model (intermediate stop, mode choice, time of day). Thus, external travel is handled in a tour-based manner, with intermediate stops, transit share and auto occupancy, and time of day split that are analogous to the same process for I/I travel.

2.4 Intermediate Stop Model

Tabulations of recent surveys have indicated that 30-40% of all tours have at least one intermediate stop. While such tours are not the majority, they are too numerous to ignore. In addition, many planners believe that a key response of people to higher fuel costs and greater congestion is to increase their *trip chaining* activity, i.e., to increase the number of these intermediate stops. Therefore, this component is a very important element of a tour-based model and one that truly sets it apart from an aggregate four-step model.

This model consists of two logit submodels for each purpose (equation (1) again). The first estimates the number of stops on the tour, separately by each half of the tour (*from* home and *to* home). It estimates the probability of there being 0, 1, 2, 3, … intermediate stops on each half of the tour. This is based on HH size, income, total number of tours, tour length, production (P) and attraction (A) zone area types, and employment or employment density in the area between the P and A zones, or near the P and A zones. The number of stops on the "from home" half-tour is estimated first. The number of stops on the "to home" half-tour is influenced by the number of stops on the "from home" half-tour, which is known.

The second submodel estimates the locations of the intermediate stops. It is a logit destination choice model, similar to the tour destination choice model. The main variables that define each candidate stop (zone) are retail employment, population, area type, employment accessibility, and the *detour time* (defined as P-stop-A time minus direct P-A time). Table 3 shows an example of the validation of the number of intermediate stops models by purpose, for the P/A (from home) direction, from Charlotte.

The output of this step is a list of round-trip tour records, with the HH characteristics, tour purpose, production zone, attraction zone, the number of intermediate stops P-A and A-P, the stop locations P-A, and the stop locations A-P.

2.5 Mode Choice

Mode choice is the process of splitting person tours by their mode of travel. Many travel models, especially in larger areas, include a complex mode choice model, again using equation (1) to compare the attributes of the different available travel modes for every origin zone-destination zone pair. The existing GCMPC logit mode choice model is a sufficiently rigorous process and we propose to examine it carefully, with one option being to adopt it as is. The difference is that it will be applied to individual tours instead of aggregate zone-to-zone trips. For each tour, the probability of its using each available modal option is calculated, a random number is generated, and based on that number, the tour is assigned to a particular travel mode. It is sufficiently accurate to assume that a tour has only one mode. In the end, if you summarized the mode choice of all tours, you would get the same overall regional percentage of travel by mode as with the original aggregate model.

Table 3
Validation of Intermediate Stops (Charlotte)

survey	I/I tours	------------	------------	------------	------------	------------	
PAstops	HBW	SCH	HBU	HBS	HBO	ATW	I/X
0	0.856	0.902	0.918	0.718	0.845	0.891	0.773
1	0.112	0.087	0.063	0.185	0.108	0.085	0.135
2	0.022	0.010	0.019	0.062	0.029	0.010	0.049
3	0.006	0.001		0.026	0.009	0.003	0.018
4	0.003			0.007	0.005	0.011	0.019
5	0.001			0.001	0.002		0.006
6				0.001	0.001		
7					0.001		
	1.000	1.000	1.000	1.000	1.000	1.000	1.000
avg stops	0.19	0.11	0.10	0.43	0.24	0.16	0.39
estimated							
PAstops	HBW	SCH	HBU	HBS	HBO	ATW	I/X
0	0.853	0.908	0.917	0.719	0.846	0.895	0.769
1	0.119	0.081	0.074	0.183	0.106	0.081	0.146
2	0.020	0.010	0.009	0.064	0.029	0.009	0.047
3	0.005	0.001		0.025	0.009	0.004	0.016
4	0.003			0.007	0.005	0.011	0.017
5	0.001			0.001	0.002		0.005
6				0.001	0.001		
7					0.002		
	1.001	1.000	1.000	1.000	1.000	1.000	1.000
avg stops	0.19	0.10	0.09	0.43	0.24	0.16	0.38

The current GCMPC mode choice model includes all travel (including non-motorized) and includes walk and bike among the modal choices. In most areas the size of Genesee County, walk/bike trips are not included in the mode choice step. Instead, they are initially estimated in trip generation but then immediately removed. The walk/bike (non-motorized) share is computed as a zonal variable, typically as a function of trip purpose and area type. Removing these trips at an early stage can simplify and improve the accuracy of the destination choice step. We will discuss this with the Study Committee before making any decisions.

Another issue with the current mode choice model is that its coefficients are different from those favored by the Federal Transit Administration for use in New Starts project forecasting. From its review of dozens of transit projects nationwide, FTA has established a set of "nationwide default" coefficients and variables for mode choice models. It might be a while before GCMPC ever applies to FTA for New Starts funds and until that time, FTA's values are not binding on GCMPC. Still, there may be some value in making the mode choice model FTA-compliant at this time. We will discuss this with the Study Committee before making any decisions.

The transit component of the model can be validated by comparing the estimated transit trips with trips reported by Flint MTA. The Work trip percent by mode can be compared to ACS data.

The output of this step is a list of round-trip tour records, with the HH characteristics, tour purpose, production zone, attraction zone, the number of intermediate stops P-A and A-P, the stop locations P-A, the stop locations A-P, and the travel mode of the tour.

2.6 Time of Day

The current GCMPC model splits modal travel by four periods: 6 – 9 A, 9 A – 3 P, 3 – 6 P, and 6 P – 6 A, based on the trip purpose and start time. The factors are based on the MI Travel Counts survey. This represents the best modelling practice among areas of this size and we propose to adopt basically the same approach for the new model. The main difference is that the model will be applied in discrete fashion to each half-tour within each individual tour.

We will use the MI Travel Counts survey data to create a table of the percent of tours by purpose, start period of the from-home leg, and start period of the to-home leg. This will be applied using Monte Carlo simulation to assign a specific period to each leg of each tour. Table 4 shows an example of such a table, from the Brunswick, GA model.

If traffic volume counts and transit passenger counts are available by time period, those would be used to validate the model.

The output of this step is a list of round-trip tour records, with the HH characteristics, tour purpose, production zone, attraction zone, the number of intermediate stops P-A and A-P, the stop locations P-A, the stop locations A-P, the travel mode of the tour, the period for the first half of the tour, and the period for the second half of the tour.

Table 4
Sample Time of Day Fractions (Brunswick)

HBW	AM	MD	PM	NT
AM	0.71%	11.71%	42.78%	6.83%
MD	0.00%	2.59%	4.39%	5.48%
PM	0.00%	0.11%	0.19%	2.40%
NT	0.71%	6.23%	11.41%	4.47%
SCH				
AM	0.44%	61.00%	21.00%	1.00%
MD	0.00%	4.89%	3.33%	0.33%
PM	0.00%	0.00%	0.22%	3.78%
NT	0.00%	2.11%	0.67%	1.22%
HBS				
AM	5.14%	7.05%	0.29%	0.11%
MD	0.00%	39.81%	8.09%	0.36%
PM	0.00%	0.22%	12.33%	9.56%
NT	0.25%	0.22%	0.14%	16.43%
HBO				
AM	6.87%	10.70%	3.17%	0.98%
MD	0.00%	22.44%	10.26%	3.85%
PM	0.07%	0.27%	7.98%	12.18%
NT	1.08%	1.96%	1.47%	16.70%

Note: The time period for the from-home half-tour is down the left side (rows), the period for the to-home half-tour is along the top (columns).

2.7 Truck/Commercial

In 2013 I developed truck tour-based models for Atlanta, GA and Birmingham, AL using GPS data. We propose to transfer the Birmingham model for use in Genesee County. That model includes both single-unit and combination trucks. It operates in a very similar manner as the proposed person travel tour-based model. The Birmingham model would then be expanded to include GCMPC's existing four-tire category of vehicles, which is also known as "Commercial" travel. This includes autos, vans, SUVs, and light trucks that are used for business or government purposes, but which are not considered "trucks" and are not included in the personal travel model. As it turns out, due to the nature of truck and commercial vehicles, the tour-based structure is particularly well-suited towards modelling this kind of travel.

The truck/commercial tour model is actually a hybrid model: it starts with a conventional aggregate generation step, except that this includes tours instead of trips. The output of that step is a list of tours by zone. From that point, the same kind of destination choice, intermediate stop, and time of day models described above are applied.

Some planners have advocated using FHWA's Freight Analysis Framework (FAF) data. This is a nationwide goods movement database that with considerable manipulation, can be converted into a truck trip table. But even with this kind of data, the profession is still a long way from developing a true goods movement model. In my view, a tour-based truck model that is supported with the largest possible set of classification counts produces an estimate of truck travel that is well-suited to the needs of planning agencies.

The result is a set of truck tour records with vehicle type (truck vs. commercial), intermediate stop, and time period data. These are input to the trip accumulator step (below) to obtain the necessary trip tables.

2.8 Trip Accumulator

In this step, the complete tour records are converted to trip records and a set of conventional trip tables are built. This step categorizes each segment of a tour by its origin zone, destination zone, time period, and occupancy level/vehicle type. The time periods described above are used. The occupancy/type classes will be: LOV (low-occupancy vehicle, defined here as one person per vehicle), HOV (high-occupancy vehicle, defined as two or more persons/vehicle), and TRK (heavy truck).

The tours are split into individual trip segments based on the intermediate stops and separate trip records are created for each segment. For example, a tour that had one stop in the first half-tour and one stop in the second half-tour would become four trip segments: origin-stop, stop-destination, destination-stop, stop-origin. The resulting trip segment records are sorted in ascending order of origin zone and then converted into TransCAD binary matrix files containing separate tables by period and vehicle type.

The vehicle trip tables resulting from these calculations are described as being in *origin/destination* (O/D) format. In this format, trips are stored in the trip table matrix in the actual direction of movement during each period. Normally, trip tables must be in this format in order to be assigned to a network.

2.9 Assignment

The current GCMPC model assigns vehicle trips by period using TransCAD's Multi-modal Multi-class assignment procedure, using the user equilibrium protocol. Speed feedback is implemented via the Method of Successive Averaging. We will review this protocol and the associated parameters, such as the period capacity factors, volume/delay functions, and value of time. But we believe it is likely that most if not all of the current process will be retained.

Transit assignment in TransCAD is more complex, because the path-building process is more detailed and there are numerous options and parameters that must be selected. The final methodology should be the one that produces line loadings that best match the transit counts, uses a reasonable generalized cost function, and whose parameter values are consistent with those of other areas (and, perhaps, FTA preferences).

Traffic assignment is validated by comparing the estimated link volumes and VMT to the counted values. This will be done by time period, if period-based counts are available. Truck and auto volumes will be checked separately, if classification counts are available. The volume vs. count comparisons will meet the MDOT standards, i.e., as summarized by screenline, facility type, and volume group. If observed speed data is available, we will check the estimated vs. observed speeds as well.

Transit assignment is validated by comparing the estimated bus line daily boardings to counts, assuming passenger counts are available.

Task 3 Model Data

3.1 Socioeconomic Data

In the last GCMPC model update, very rigorous procedures were used to develop values for socioeconomic data by TAZ for 2011, 2018, 2025, and 2035. We propose to follow similar procedures for the development of the model input data required by this study for 2014, 2020, 2025, 2035, and 2045. The new numbers must reflect the latest available information on the automotive industry, the effects of the 2008-10 recession, and the most recent data on the likely future conditions in Flint and surrounding areas. In addition, there may be newly available sources of socioeconomic data and methods (such as www.economy.com and NCHRP Report 08-36, *Improving Employment Data for Transportation Planning*) which should be consulted.

We believe that the current 639 internal zones is reasonable for an area of this size and propose to retain that system. However, it may be necessary to make a few exceptions in areas where relatively high growth is expected or where the current model is especially inaccurate.

We believe the current set of zonal socioeconomic variables will probably be sufficient for the development of the tour-based model. It may be useful to also consider "group quarters population", which are the people living in nursing homes, military barracks, prisons, dormitories, and other types of group housing.

Another important zonal variable is *area type*. The current GCMPC model uses five of these (CBD, Urban, Suburban, Fringe, Rural). These are used in the highway network, to define speed and capacity, and in other places throughout the model. However, it is unclear from the documentation how this variable is estimated for future years. As an urban area changes, it is reasonable to expect that the area type of many zones would change. It is our experience that manually forecasting this variable by zone is so cumbersome as to be all but impossible. The current best practice is to use a sub-model to estimate the area type of each zone based on its area and the forecasted population and employment. This is almost always a look-up table based on ranges of population density and ranges of employment density. In many cases, the density of surrounding zones is also considered, using what is called the *floating zone* process. If the current GCMPC model does not include a method for forecasting area type, we will create one based on our experience in other areas. This is the only feasible way of forecasting area type at the zone level. The base and future results will be carefully reviewed with the Study Committee.

3.2 Highway Network

The current highway network appears to be robust and it is likely that few changes to it are required (although as the RFP notes, a few changes are needed to prepare model output for the EPA Moves program). We will review the current coding with respect to the best practice in other areas and suggest changes for the Study Committee's consideration. Examples include an expansion of the "allowed use" coding to handle truck restrictions, variables to reflect different kinds of tolling schemes (fixed or mileage-based tolls), and variables to allow reversible lane operation and closure of certain lanes during certain periods. We will review Google Earth satellite photos and any local source of aerial photographs to check the base network and ensure that it is accurate as of December 2014.

A standard requirement in travel modelling is that the model must be able to replicate actual traffic counts for the base year conditions. We assume that all the necessary traffic counts are already available -- this proposal includes no budget or scope to perform new counts. We will work with GCMPC and MDOT staff to identify all sources of traffic counts. These will be adjusted as necessary to reflect a common year. Typically, daily counts (24 hours) are used for model calibration. If any hourly or peak period counts are available, these would be very helpful in checking the time of day model.

There is no "magic" minimum number of counts required to calibrate a model, but the general rule is the more counts, the better. The available count data will be "cleaned" to ensure its quality and then coded into the highway network. These values will be examined carefully to be sure they are logical and reasonable.

3.3 Transit Network

The existing transit network route system file will be updated to reflect conditions as of December 2014, including stops. We will pay special attention to the issue of zonal accessibility, ensuring that any zone whose residents can actually walk to a bus stop is accurately reflected as such.

3.4 External Data

The key item of external data is accurate 2014 weekday traffic counts on the external station links, at the modelled cordon. These should be stratified by auto vs. heavy truck if possible. In many urban areas, 2014 counts are below values seen in 2007, before the recession. We will carefully review any stations where the volume appears to have decreased in recent years. For stations where several years' worth of volume data are available, we will examine these trends to ensure that the 2014 values are logical and consistent.

We will examine the Michigan statewide model to determine how it can be used to inform Genesee County external travel. At the minimum, the statewide model should be able to provide data for the development of new base auto and truck X/X tables. It may also be possible to obtain other usable data on travel characteristics from this source.

Task 4 Model Application

4.1 Application Code

Model *calibration* consists of establishing relationships and identifying key variables and parameter values. The next step is to write the *application code*. This is the GISDK program that applies the model within the TransCAD 6.0 framework. The Charlotte tour-based model runs in a TransCAD environment and we will take advantage of that to shorten the development time for the Genesee County model. We will also look closely at the existing model and discuss with GCMPC staff any changes they would like to see in the model interface.

4.2 Post-Processing

It is critical that the model application package produce a variety of reports that describe and summarize the results of each model run. These reports must respond to the on-going planning needs of GCMPC staff. We will examine the existing POST_ALT and CAL-REP programs to determine how they can be improved and implement such improvements. The use of the new tour-based structure will suggest additional reports that the staff might want to see, to ensure confidence in the results. Figures 3 and 4 show different kinds of model output reports that we have developed.

Figure 3
Sample Assignment Summary Report

Sioux Falls Traffic Model Assignment Report (Sep 2014)
Alternative: 2040 Base

Roadway Lane-Miles by Facility Type and Daily Level of Service

Model Run: 2040 Base

	Level of Service							
	A	B	C	D	E	F	Total	% of Total
Freeway/Ramp	110	185	68	14	8	5	390	16%
Major Art/Exp	51	147	60	9	0	0	267	11%
Minor Art	46	124	201	57	20	1	449	18%
Major Coll	11	81	92	80	97	10	371	15%
Minor Coll	234	364	131	68	86	5	888	36%
Local	15	24	15	16	15	1	86	4%
Total	467	925	567	244	226	22	2,451	
% of Total	19%	38%	23%	10%	9%	1%	100%	

Base: 2013 Base

	Level of Service							
	A	B	C	D	E	F	Total	% of Total
Freeway/Ramp	279	82	18	6	3	1	389	17%
Major Art/Exp	68	36	4	0	0	0	108	5%
Minor Art	71	94	75	17	4	0	261	12%
Major Coll	15	147	114	79	54	6	415	18%
Minor Coll	405	343	122	43	29	1	943	42%
Local	69	38	21	5	2	0	135	6%
Total	907	740	354	150	92	8	2,251	
% of Total	40%	33%	16%	7%	4%	0%	100%	

VMT/VHT/Speed Summary#

	2040 Base	2013 Base	Difference	Pct Diff.
Vehicle-mi of travel	9,462,000	5,181,000	4,281,000	83%
Congested veh-hours	279,000	143,000	136,000	95%
Free-flow veh-hours	224,000	125,000	99,000	79%
Delay (aggregate hrs)	55,000	18,000	37,000	206%
Pct Congested Delay	25%	14%	10%	71%
Avg Congested Speed	34	36	-2	-6%

Entire network, excluding centroid connectors.

Figure 4
Sample Trip Generation Report

Demographic Characteristics (Input)

	Regional	Bastrop	Burnet	Caldwell	Hays	Travis	Williamson	
Total Population	4,078,460	198,263	72,618	74,582	621,291	1,709,791	1,401,915	persons
Total Households	1,592,022	66,099	29,279	27,147	229,264	683,927	556,306	households
Total Employment	2,324,736	64,184	27,990	21,032	270,170	1,195,660	745,700	jobs

Trips by Purpose (Output)

Trip Purpose	Regional	Bastrop	Burnet	Caldwell	Hays	Travis	Williamson	
HBW	2,836,130	117,743	52,155	48,357	408,390	1,218,534	990,952	person-trips
HBNW-Retail	2,662,324	110,519	48,955	45,390	383,335	1,143,965	930,158	person-trips
HBNW-Other	2,127,197	88,289	39,108	36,260	306,229	914,251	743,060	person-trips
HBNW-Educ1	2,244,471	93,188	41,278	38,272	323,222	964,217	784,294	person-trips
HBNW-Educ2	114,641	4,078	1,011	951	21,782	69,470	17,349	person-trips
HBNW-Univ	95,722	494	0	152	1,335	92,004	1,737	person-trips
NW-Airport	49,797	1,034	458	425	3,586	35,595	8,700	person-trips
NHB-Work	1,363,503	39,727	16,371	10,844	185,212	669,885	441,463	person-trips
NHB-Other	2,457,604	70,575	29,330	19,016	331,719	1,213,216	793,748	person-trips
Total	13,951,389	525,646	228,667	199,668	1,964,810	6,321,137	4,711,460	person-trips
NHB-EX	623,005	16,144	6,406	4,209	80,685	319,472	196,088	vehicle-trips
TRTX	944,800	22,719	8,788	6,301	114,237	487,929	304,827	vehicle-trips
EXLOA	462,209	24,071	9,626	6,337	120,983	78,895	222,297	vehicle-trips
EXLOT	70,089	1,815	723	476	9,035	36,021	22,019	vehicle-trips
EE-Auto	38,172	0	0	0	0	0	0	vehicle-trips
EE-Truck	16,289	0	0	0	0	0	0	vehicle-trips
Total	2,154,564	64,749	25,543	17,322	324,940	922,317	745,231	vehicle-trips
Total Trips	16,105,953	590,395	254,210	216,990	2,289,751	7,243,454	5,456,692	

Trip Statistics

	Regional	Bastrop	Burnet	Caldwell	Hays	Travis	Williamson
Average internal trips per person	3.42	2.65	3.15	2.68	3.16	3.70	3.36
Average internal trips per household	8.76	7.95	7.81	7.36	8.57	9.24	8.47

We will ensure that the model can produce reports and graphics that translate the results into a form that is easily understood by decision-makers and other reviewers. This will include summaries of the assignment results and thematic maps that display key measures of effectiveness, as defined by the Study Committee.

We will review the model outputs carefully and discuss them with the Study Committee to ensure that they are reasonable. The estimated travel patterns should match local understanding of trip movements. The estimated locations of high congestion should reflect the public's awareness of congestion. The model's summary reports should meet the expectations and needs of GCMPC staff and other stakeholders. These reports must provide an accurate picture of traffic conditions and must be able to effectively illustrate the effects of highway and land use changes.

We will specifically examine the needs of EPA's Moves program and will create the routines necessary to produce the output data needed by that program. Similarly, we will examine the work done by GCMPC and others in Environmental Justice reporting to ensure that data to support EJ analysis is produced.

Task 5 Forecasting

5.1 Future Land Use

The first step in preparing a traffic forecast is to estimate the land use by zone for the forecast year. We will start with the model input data that exists for 2018, 2025, and 2035. The socioeconomic data files will be updated to the years required by this study: 2020, 2025, 2035, and 2045. These forecasts will be made in a manner consistent with the current forecasts and will take into account changes in the local economy and development patterns that have occurred since the last model update in 2008.

Forecasting land use data by zone usually uses a combination of the "top down" and "bottom up" approaches. The top down approach identifies estimates of total GCMPC population, housing, and employment, usually produced by other agencies such as Census or the state data center. An increasing number of commercial sources now provide this information, although these are sometimes expensive. These forecasts do not provide much geographic detail and may not fully consider recent local development patterns. This is why such data are combined with the bottom up approach, which starts with the base year values by zone and then examines specific development information to determine where houses and jobs should be added. This may include individual development proposals, projects that are in various stages of the planning pipeline, recent trends in utility connections, etc.

Certain other guidelines should be observed, such as:

- average household size has been declining for many years and is expected to continue to decline, up to a point
- some new houses are fairly large, although there has been a recent trend towards smaller home and lot sizes, especially for retirement and vacation housing
- the countywide ratio of jobs to population should probably not change dramatically (if it does, then the external volumes may need to be adjusted, to ensure enough adults are available to fill the jobs)

- forecasting average household income by zone is extremely difficult and politically sensitive; many areas simply use the base values to represent the future, unless a specific area is known to be undergoing a transformation upwards or downwards in income
- basic logic checks should always be done; for example, the average household size for a zone must always be 1.0 or more
- another basic check is to prepare a thematic map of area types; comparing the maps of future and base year area types makes it easier to see if zones are growing in the manner expected
- there is value in examining the state data center's forecast of land use
- the forecast trend should be compared with available historical data to be sure that any major differences can be explained
- the estimated percentage growth in housing and jobs will most likely exceed the estimated percentage growth in roadway capacity (lane-miles), but if these growth rates are extremely different, this should be examined further
- the estimated growth rates in housing and jobs should be compared to the estimated growth rate in external traffic volume to be sure the region is not importing or exporting too many workers

In addition, the daily traffic volume at each external station will need to be forecast. Typically, this is done by extrapolating past trends in traffic counts, either in linear or non-linear fashion. Another approach is to calculate growth rates for the modelled region, adjacent counties, and the state as a whole and use one or more of these growth factors to estimate future external trips by station. As noted above, it is important to consider the internal growth in housing and jobs in this step, so that the region's internal travel and external travel do not get out of balance.

We will summarize the forecast data by district and prepare zone-level thematic maps of the changes, for the Study Committee's review.

5.2 Future Networks

In the case of the highway and transit networks, we will also look at "top down" and "bottom up" approaches. The bottom up approach starts with the base 2014 network and adds specific improvement projects. The top down approach starts with the current 2018, 2025, and 2035 networks. Projects would be removed from the 2025 network to create 2020 and added to the 2035 network to create 2045.

The list of projects will be drawn from the existing short- and long-range transportation plans and will initially include only those projects for which funding can reasonably be anticipated. We will perform basic quality control checks on all of the networks. These include tabulating lane-miles of roadway by facility type, checking links for proper facility type and lane coding, updating turn penalties, and reviewing sample O/D paths for network integrity.

5.3 Model Application

We will perform the initial model runs using the forecast year inputs, to ensure that the model is performing properly. These model runs will include all of the desired outputs that have been built into the model script, including a loaded network, district trip table, and assignment reports. We will specifically compare the model outputs between base and forecast year, and relate these to the change in model inputs from base to forecast year. This analysis will include our observations about the performance of the future year networks.

5.4 Sensitivity Testing

We will draw upon the Study Committee and our experience to identify changes to the model inputs that would best highlight the model's capabilities and responsiveness. This will focus on the 2045 forecast. The changes will be relatively simple, so that the changes in model output can be more easily compared to the changes in model input. This includes key inputs such as land use, travel times, transit service, and costs. This task will give the GCMPC staff greater confidence that the application code is working properly and that the model is responding in a reasonable manner.

Task 6 Training

6.1 Training Session

We will provide GCMPC with the User's Guide and two copies of the entire model and all input data. We will follow this submittal up with a visit to provide a hands-on model training and instruction session for GCMPC and MDOT staff.

Task 7 Documentation

7.1 Calibration Report

All of the major tasks of this project will be documented in a draft report, submitted to the Study Committee for review. We expect that the calibration report will be organized along these lines:

- Model Calibration
    - Description of base year data
    - How the model was developed

    - Description of key rates, parameters, and coefficients
    - Basic assumptions
    - Suggestions for future improvements
- Base Year Run
    - Development of land use (assumptions, methodology, and results)
    - Development of network (assumptions, methodology, and results)
    - Development of other files (external volumes, turn penalties, etc.)
    - Results of base year model application
    - Validation of each model component
- Future Year Runs
    - Land use forecast (assumptions, methodology, and results)
    - List of assumed future highway projects
    - Network coding (assumptions, methodology, and results)
    - Development of other files (external volumes, turn penalties, etc.)
    - Results of future year model application
    - Commentary on results

7.2 User's Guide

We will prepare a User's Guide for the new model. Given the new model structure, this is likely to be an entirely new document. This report will include at a minimum:

- How to forecast land use
- How to code network changes
- How to run the model
- How to produce and interpret the outputs

Task 8 Model Support

8.1 Model Support

Our proposal includes 60 hours of technical support for the model, data, and documentation, for a period of one year after the calibration report is delivered. We anticipate that this can be done by e-mail and telephone. This will consist of answering questions about model development, validation, and use in forecasting.

8.2 Optional Support

As requested in the RFP, our cost estimate shows a separate amount for an optional task to provide on-going technical support for the model and input data. We anticipate that this can be done by e-mail and telephone but consulting staff would be available to make site visits if budget permits.

The assignment of staff time by person and task is shown in the table below:

	Task	Hours Allen	Bostrom	Avner	Lancaster	Amar	Total
1	Model Review	32	16	16	4	0	68
2	Develop New Model	320	8	80	100	8	516
3	Model Data	16	16	8	8	60	108
4	Model Application	8	12	4	24	40	88
5	Forecasting	8	8	32	16	0	64
6	Training	8	4	32	2	2	48
7	Documentation	40	8	16	4	8	76
8	Model Support	12	4	32	8	4	60
	Total Hours	444	76	220	166	122	1,028

key personnel

We propose a team of experienced professionals:

- Bill Allen will be the Project Manager, provide the principal interface with GCMPC staff, will develop and validate the tour-based model components, and will prepare the calibration report.
- Rob Bostrom of CDM Smith is the Deputy Project Manager and will oversee the development of model data for forecasting.
- Jonathan Avner of CDM Smith will develop the GISDK code for the new model, perform assignment validation, improve the ease of use of the model's interface, write the user's guide, and lead the training/technical support effort.
- Kevin Lancaster of CDM Smith will assist Jonathan with assignment validation.
- Liza Amar of CDM Smith will assist Jonathan with data development and model interface.

The proposed allocation of staff time is roughly 42% Bill Allen, 58% CDMS staff. The Project Management section includes a chart with our proposed staff organization. We show only the people who will actually do the work. Their resumes are on the following pages. The assignment of staff hours by task is on the next following page. The proposed project schedule is shown on page 8. The proposed staffing organization chart is on page 59.

Resume

William G. Allen, Jr., P.E.

Experience

Transportation Planning Consultant — Windsor, South Carolina, 2006 - present
Mitchells, Virginia, 1990 - 2006
Mahwah, New Jersey, 1988 - 1990

Started a consulting practice in 1988 to provide transportation planning services to a limited number of clients. My main area of specialty is travel demand modelling. Typical projects:

◊ Transit model, other model components, project documentation, Michigan DOT
◊ New simplified tour-based models, Brunswick, GA and Charlotte, NC
◊ New truck and commercial trip models, Washington, DC, Baltimore, MD, Atlanta, GA, Kansas City, MO/KS, Puerto Rico (islandwide), and 8 cities in Ohio
◊ Use of 2009 NHTS data to calibrate new regional travel models for Fredericksburg, Richmond, and Norfolk, VA metropolitan areas
◊ Development of complete travel forecasting model sets for Harrisonburg, VA, Reading, PA, Lehigh Valley, PA, Sioux Falls, SD, Baltimore, MD, New Orleans, LA, Bronx, NY
◊ Development of suburban travel forecasting models for Stafford, Fairfax, Prince William, Loudoun, and Spotsylvania Counties, VA
◊ Review of model components and input data, Mackay, Queensland (Australia)
◊ Preparation of traffic and toll revenue forecasts for E-470 and Northwest Parkway, Denver; Steel Bridge, Chesapeake, VA, Lafayette Regional Expressway, Baton Rouge, LA, Dulles Greenway, Leesburg, VA, SR 91 extension, Riverside, CA
◊ Specification of new trip distribution and mode choice models, Puget Sound Regional Council (Seattle)
◊ Review of the state of the art in activity-based modelling, Prince George's Co., MD
◊ Evaluation of traffic impacts of downtown development scenarios, Virginia Beach, VA
◊ Application of suburban travel model to support calculation of highway impact fees, Stafford County and Spotsylvania County, VA
◊ Application of travel model to support long-range plan development, Honolulu, HI

Volvo Cars of North America, Rockleigh, New Jersey, 1983 - 1988
Engineer, Regulatory Affairs

Responsible for monitoring, analyzing, and interpreting future automotive regulatory requirements, and communicating these to the European and North American offices. Represented Volvo in industry meetings and before government agencies. Prepared comments concerning proposed Federal regulations on emissions, fuel economy, and theft prevention, and Canadian requirements, and California emissions requirements.

Barton-Aschman Associates, Inc., Washington, D.C., 1977 - 1983
Senior Associate; Transportation/Transit Planner

Directed and participated in a variety of transportation and transit planning projects, with emphasis on travel demand modelling. These involved the development of all kinds of multi-modal transportation models, including large-scale regional model systems, sketch planning methods, and microcomputer-based techniques. Also assisted on a variety of short-range transit, traffic, and parking studies. Typical projects:

Travel Demand Analysis

◊ Analysis of transit commuting trends in Washington, DC in connection with Metrorail expansion
◊ Calibration and testing of travel demand models for long-range transit system planning in Seattle, Houston, New Orleans, Buenos Aires, and southeast Florida
◊ Application of travel models for air quality analysis (New Orleans) and subway system alternatives and toll road planning (Buenos Aires)
◊ Development of sketch planning techniques for the analysis of transit improvement alternatives in New Orleans
◊ Survey analysis and development of planning methods for a regional transportation plan for Mexico City

Transportation Planning

◊ Preparation of a transportation plan for Harford County, Maryland
◊ Analysis of long-distance commuting alternatives in Northern Virginia
◊ CBD transit, traffic, and parking analyses for Atlantic City, Birmingham, Newport News, and Columbus (OH)
◊ Central area parking management program for Lancaster, PA

Transit Planning and Operations

◊ Development and application of rail transit operating cost models for Buenos Aires and New York City
◊ Preparation of route and schedule plan for Springfield, MO
◊ Analysis of private sector transit alternatives for Montgomery Co., MD and Hickory, NC

Sverdrup & Parcel and Associates, Inc. 1975 - 1977
Transportation Planner

Worked on transportation studies and project proposals. Areas of practice included paratransit planning, and site traffic circulation and parking analyses. Typical projects:

◊ Analysis of alternatives to Sunday bus service, Arlington County, Virginia
◊ Study of shared-ride taxi service for Arlington County, Virginia
◊ Traffic and parking studies for airports, hospitals, and college campuses in North Carolina, District of Columbia, and West Virginia

Education

Bachelor of Science in Civil Engineering, Rensselaer Polytechnic Institute, 1974
Master of Engineering in Civil Engineering, Rensselaer Polytechnic Institute, 1975

Professional Affiliations

Institute of Transportation Engineers
Society of Automotive Engineers
Registered Professional Engineer: South Carolina (No. 29421), Virginia (No. 040221779), New Jersey (No. 24GE03061400)

Selected Publications

Helpful Hints on Subarea Focusing, presented at the TRB Third Conference on Application of Transportation Planning Methods, 1991

A New Method for Estimating Cold Start VMT, presented at the 63rd Annual Meeting of the Institute of Transportation Engineers, 1993 (with G. Davies)

Use of GIS in Transit Alternatives Analysis, presented at the TRB Fourth Conference on Application of Transportation Planning Methods, 1993 (with S. Mukundan)

Model Improvements for Evaluating Pricing Strategies, presented at the 74th Annual Meeting of the Transportation Research Board, 1995

Multiple Occupancy Criterion HOV Modelling, presented at the TRB Fifth Conference on Application of Transportation Planning Methods, 1995

Calibration of an Employee Commute Options Model, presented at the TRB Fifth Conference on Application of Transportation Planning Methods, 1995

Forecasting the Cost of Driving, ITE Journal, February 1996

Using Traffic Models to Support Proffers, Planning in Virginia, Virginia Chapter, American Planning Association, November 1996

Modelling Carpool and Transit Park-and-Ride Lots, presented at the TRB Sixth Conference on Application of Transportation Planning Methods, 1997

Adaptable Assignment, presented at the TRB Sixth Conference on Application of Transportation Planning Methods, 1997

Modelling Commercial Vehicle Travel, presented at the TRB Ninth Conference on Application of Transportation Planning Methods, 2003 (with P. Agnello)

A Model of Journey Frequency, presented at the TRB Ninth Conference on Application of Transportation Planning Methods, 2003 (with G. Schultz)

Using Your Model Effectively, presented at the TRB Tenth Conference on Application of Transportation Planning Methods, 2005 (with D. Schmitt)

Analysis of Time of Day Models from Various Urban Areas, presented at the TRB 11th Conference on Application of Transportation Planning Methods, 2007

A New Technique for Destination Choice, presented at the TRB 12th Conference on Application of Transportation Planning Methods, 2009

An Approach to Using a Regional Travel Demand Model for Park and Ride Forecasting, presented at the TRB 12th Conference on Application of Transportation Planning Methods, 2009 (with D. Goldfarb)

Tour-Based Model for a Small Area, presented at the TRB 13th Conference on Application of Transportation Planning Methods, 2011

Using NHTS Data for Model Development: The Virginia Experience, presented at the TRB Workshop on Using National Household Travel Survey Data for Transportation Decision Making, 2011 (with P. Coleman, J. Chen, and P. Agnello)

Further Test of a Simplified Tour-Based Model, presented at the TRB 14th Conference on Application of Transportation Planning Methods, 2013

Trends in Complex Travel, presented at the TRB 15th Conference on Application of Transportation Planning Methods, 2015

A Caution on GPS Truck Data, presented at the TRB 15th Conference on Application of Transportation Planning Methods, 2015

Modelling Intermediate Stops, presented at the TRB 15th Conference on Application of Transportation Planning Methods, 2015

CDM Smith resumes

Niels Robert (Rob) Bostrom, P.E.
Principal

Mr. Bostrom, practice leader for the travel demand modeling for CDM Smith, has been responsible for participating in key work elements involved in statewide travel demand models, traffic forecasts, urban area transportation studies, traffic engineering analyses/traffic impact assessments, and transportation data collection programs.

Travel Demand Model Development

Project Manager, CAMPO Travel Demand Validation (2012-Ongoing). Mr. Bostrom serves as project manager for the validation of the Capital Area MPO (Austin, TX) Travel Demand Model.

Project Manager, Washington Statewide Model Blueprint Study (2014-ongoing). Mr. Bostrom served as project manager and lead writer for developing a model architecture document for the Washington State DOT.

Project Manager, Ohio Department of Transportation Statewide Model Evaluation (2011-Ongoing). Mr. Bostrom serves as project manager for the Ohio statewide model review and enhancements as they are needed.

Task Leader, Pennsylvania Statewide Model Development (2013-Ongoing). Mr. Bostrom serves as task leader for the development of the Pennsylvania Statewide Model.

Task Leader, Texas Freight Mobility Plan (2013-2015). Mr. Bostrom serves as task leader for the development of traffic forecasts for the Texas Freight Mobility Plan.

Project Manager, Arizona Department of Transportation Mode Choice Model (2011-2015). Mr. Bostrom serves as project manager for this project developing mode choice model for the statewide travel demand model

Project Manager, Indiana Department of Transportation On-call Planning Contract (2011-2014). Mr. Bostrom served as project manager for this study to develop MOVES post-processor, providing refinements to the Indiana statewide freight model, TAZs and network. Most recently a toll model has been under development.

Project Manager, Ohio Department of Transportation Medium and Small MPO Model Update (2013-Ongoing). Mr. Bostrom serves as task manager for the Ohio small and medium sized MPO enhancements.

Project Manager, APCOG Regional Model Development (2011-2013). Mr. Bostrom served as deputy project manager for the development of the APCOG (SC) Model.

Project Manager, Louisiana Statewide Model Development (2012-2013). Mr. Bostrom served as project manager for the development of the Louisiana Statewide Model.

CDM Smith

Education

B.S. – Civil Engineering, University of Kentucky, 1985
M.S. – Civil Engineering, University of Kentucky, 1991

Registration

Kentucky #16190
Mississippi #17898
North Carolina #34899
Arkansas #13967
Texas #112487

Professional Activities

Transportation Research Board

-Member of Traffic Forecasting Resource Committee (ADB45)
-Co-chair of Statewide Travel Forecasting Subcommittee (ADA10(2)).

-Member, American Society of Professional Engineers

-Retired member, Kentucky Association of Transportation Engineers

Task Leader, Jeddah Municipal Model Development (2012-2013). Mr. Bostrom served as task leader for the development of the Jeddah (Saudi Arabia) Municipal Model.

Project Manager, Louisville-Southern Indiana Ohio River Bridges Time of Day Model Development Phase 2, Kentucky and Indiana (2010-2011). Mr. Bostrom served as project manager for the development of time of day model for the Louisville Bridge tolling project.

Project Manager, Maricopa Association of Governments Behavioral Freight Data Development (2015-ongoing) Network Expansion and Trip Generation Model Update, Arizona (2010-2011) & . Mr. Bostrom served as project manager for the on-call modeling task orders for developing data sources for the SHRP2 behavioral freight model currently under way plus earlier work on network expansion and for the trip generation model update.

Project Manager, Mississippi Long-Range Transportation Plan Travel Demand Model Development (2010). Mr. Bostrom served as project manager for the development of the Mississippi Statewide Travel Demand Model for the Mississippi Department of Transportation. This project included the MOVES Post-processor. The model was used to update the Mississippi Statewide Plan.

Project Manager, Mississippi Small Urban Area Travel Demand Model Development (2008). Mr. Bostrom served as project manager for the development of travel demand models for the cities of Tupelo and Picayune for the Mississippi Department of Transportation.

Travel Demand Modeling Applications

Task Manager, Access Ohio 2040 (2012-2013). Mr. Bostrom served as the task leader for the model related tasks in the Access Ohio study.

Project Manager, Milton-Madison Bridge Replacement and Rehabilitation, Ohio River Crossing, Kentucky and Indiana (2008-2009). As task manager and head model developer, Mr. Bostrom was responsible for developing a bi-state Kentucky/Indiana model that was used for traffic forecasting project corridors for the bridge replacement project over the Ohio River between Milton, KY and Madison, IN. This project was featured at the 2010 Transportation Research Board Planning Applications Conference.

Planning/Forecasting/Modeling Research Studies

Principal Investigator, NCHRP Report 765, Traffic Forecasting Analytical Methods, Develop Traffic Forecasting Guidebook to Replace NCHRP 255 (2011-2013). Mr. Bostrom served as the principal investigator for this study that developed national traffic forecasting guidelines. These guidelines update the NCHRP 255.

Project Manager, Ohio Certified Traffic Manual - Development of Guidelines for Certified Traffic Forecasts and Development of Training (2007). CDM Smith developed a certified traffic forecasting manual for the Ohio Department of Transportation. Mr. Bostrom served as a project manager, report writer, and trainer. In these roles, he was responsible for overall project coordination, documentation, training, model development, and client relations.

CDM Smith Travel Demand Modeling National Practice Leader (2005-present). Mr. Bostrom is responsible for coordinating CDM Smith's national modeling team composed of 30 travel demand modelers spread through 13 different offices. The team works with travel demand models that include statewide models, county-level models, MPO models, toll models and transit models.

Jonathan S. Avner, PTP
Senior Planner

Mr. Avner has more than 16 years of experience working with travel demand models across the United States and the Middle East. His experience has focused on multi-modal passenger and freight modeling at a local, statewide and national scale. He has worked with MPOs and DOTs developing and applying travel demand models for plan updates, preliminary toll feasibilities, and corridor studies. His experience includes all aspects of travel demand modeling including model development (estimation, calibration, and validation), application and refinement of models, and development of customized model applications in TransCAD and CUBE Voyager. Mr. Avner's experience includes freight forecasting and freight planning project experience in the United States and internationally. His relevant project experience includes:

Deputy Project Manager, Model Calibration and Validation, Austin, Texas (2012 – 2015). CDM Smith worked with the Capital Area Metropolitan Planning Organization (CAMPO) to calibrate and validate their 2010 four step travel demand model. Tasks included several model enhancements, including the development of a new trip generation and distribution steps outside of TxDOT programs, and a new approach to the calculation of speed and capacity based on the operational characteristics of the roadways. Mr. Avner was the deputy project manager responsible for project communications, and was task manager for the model validation task.

Senior Transport Modeler, Ohio Medium and Small MPO Model Update, (2013 – 2015). CDM Smith worked with the Ohio Department of Transportation to update the standard medium and small MPO models for use in plan development. Mr. Avner was responsible for the testing of alternative assignment methods and impacts on convergence, and for testing the impact of free flow, warm start, and feedback on the distribution patterns. In addition, Mr. Avner worked with household survey datasets for the nine MPOs to re-estimate the home based school trip purposes in all areas.

Senior Travel Demand Modeler, Louisville Southern Indiana Ohio River Bridge Project, Louisville, Kentucky (2010-2012). CDM Smith was asked by the Kentucky Transport Cabinet (KYTC) to develop a project travel demand model for the seven county region to support the environmental impact statement and future toll and revenue studies. The model was built from the existing MPO model, but added significant enhancements including mode choice, time of day, and feedback. Mr. Avner was the senior modeler responsible for model estimation and validation.

Travel Demand Modeler, I-275 at Ford Road, Canton Township Michigan (2012). CDM Smith was the prime consultant to the Michigan Department of Transportation studying the feasibility of improvements to the I-275 and Ford Road Interchange in Canton Township, a suburb of Detroit, Michigan. Ford Road was a highly congested corridor because of a high concentration of retail shopping and as a corridor to the residential areas in Canton Township. As part of the project, CDM Smith developed design alternatives for Ford Road and the interchange to improve traffic conditions in the study area. Mr. Avner tested the alternative designs using the SEMCOG Travel Demand Model and developed outputs for use in the operational analysis.

Education
B.A. - Urban Geography, McMaster University, 1997

Registration
Professional Transportation Planner (#0001), Transportation Professional Certification Board, Expires May 2016

Certifications
TxDOT Certifications:
1.1.1 – Policy Planning
1.1.2 – Systems Planning
1.1.3 – Subarea/ Corridor Planning

Travel Demand Modeler, Genesee County Urban Travel Demand Model Improvements, Genesee County, Michigan (2008). CDM Smith was the sub consultant for the development of a new model for Genesee County, Michigan, including the city of Flint. CDM Smith was responsible for the development of the highway and transit networks, zonal geography, and calibration of a new trip generation model. Mr. Avner was the lead person on the trip generation component. The Michigan Travel Count Household Survey was used for the calibration. The transferability of household survey data between areas was evaluated as part of this project.

Senior Modeler, Indiana Statewide Model Enhancement, Indiana (2011-2012). CDM Smith was selected by the Indiana Department of Transportation to assist in the enhancement of the truck component of the statewide model. The existing truck model included a national freight model combined with local short haul truck movements. As part of this project, CDM Smith utilized GPS truck location data from the American Trucking Research Institute (ATRI) to develop a seed trip table for adjustment of model outputs. Mr. Avner was the senior modeler on this task and was responsible for the analysis of the GPS data and model design. In addition, Mr. Avner was a co-author a paper presented at the TRB Travel Model Innovations Conference, 2012 on this project.

Senior Travel Demand Modeler, South Carolina Long Range Plan Update, South Carolina (2013-2015). As part of the update to the state's long range transportation plan, CDM Smith was asked to develop a new statewide model for the state. New zones and network are being developed based on utilizing MPO model networks and zones were available and Census Data in the rural areas resulting in a very refined model. The model structure includes short and long distance trips as well as local and long distance truck movements. Global Insight TRANSEARCH data was used for development of the long distance truck movements. Add-on surveys from the NHTS are providing the input to the model estimation. Mr. Avner was the task manager for the model design and model implementation phases including development of model steps and graphical user interface.

Senior Travel Demand Modeler, Indiana Statewide Model Update – Toll Model Implementation Task Order (2013 – 2014). CDM Smith received a task order from the Indiana Department of Transportation to implement a toll model as part of the Indiana Statewide Travel Demand Model (ISTDM). The design elements for the model were to allow for unique toll rates by vehicle class (auto, single unit and multi-unit trucks), and allow the use of purpose specific values of time and finally allow for the modeling of both barrier and ticket based toll systems. Mr. Avner's responsibilities on this project included the design of the toll model, oversight of the implementation and calibration of the parameters.

Publications

Using Large Sample GPS Data to Develop an Improved Truck Trip Table for the Indiana Statewide Model presented at the 4th International Conference on Innovations in Travel Modeling (May, 2012).

Kevin K. Lancaster
Planner

Education
B.A. – Business Management, Southwest Texas State University, 1999

Mr. Lancaster has more than 13 years of experience performing analysis and modeling of demographics and highway/ transit systems from within TransCAD and consultant developed software. His experience includes all phases of the 4 Step Model with considerable experience on Texas MPO models. He has worked with several Texas MPOs on development of their regional model for long range planning purposes and for project specific uses. The Texas State Wide Analysis model is another area of experience that he was worked with. Mr. Lancaster is an experienced developer of custom GISDK scripts for model application and post processing. In addition to his experience with travel demand modeling he has experience in project level traffic forecasting, data preparation for input into models, as well as post processing of model outputs. His experience has included over ten years of working with Texas DOT custom application including TripCal5 and Atom2 as well as over seven years of experience with TransCAD GISDK.

Transport Modeler, Iowa Statewide Model – Passenger Rail Model Update (iTRAM), Iowa Department of Transportation, (2014). As part of the ongoing development of the Iowa Statewide Model (iTRAM), CDM Smith was asked to incorporate the previously developed rail passenger model into the updated 2010 iTRAM model. The purpose of the model was to forecast intercity rail passenger travel within the model area and surrounding buffer zones. The model utilized a mode choice framework to compare available modes for long distance travel within the market shed for each intercity rail station. The model was used by DOT staff to consider the development of additional intercity rail corridors in the state. Mr. Lancaster's involvement included coding the model improvements in GISDK to be compliant with the transition into TransCAD version 6 as well as the development of a graphical user's interface that is tied into the iTRAM model's graphical user interface.

Transport Modeler, Indiana Statewide Model Update – Toll Model Implementation Task Order, Indiana Department of Transportation (2013 – 2014). CDM Smith received a task order from the Indiana Department of Transportation to implement a toll model as part of the Indiana Statewide Travel Demand Model (ISTDM). The design elements for the model were to allow for unique toll rates by vehicle class (auto, single unit and multi-unit trucks), and allow the use of purpose specific values of time and finally allow for the modeling of both barrier and ticket based toll systems. Mr. Lancaster's responsibilities on this project included the coding of the toll model in GISDK, implementation and calibration of the parameters.

Transport Modeler, Capital Area Metropolitan Planning Organization 2010 Model Calibration and Validation, Austin, Texas, (2013-Ongoing). Mr. Lancaster performed work on this project which included updating of the CAMPO TDM to bring the generation and distribution models into GISDK, merging of HBW trip purposes, using a consistent value of time through the full model process and updating the reports generated by the model. Additionally, the base year model needed to be calibrated and validated to base year conditions. Mr. Lancaster was involved in the calibration/validation of the base year and assisted with other aspects of the model due to his previous experience in running the model. He also was directly involved with the updating of the report generation.

Transport Modeler, South Carolina Long Range Plan Update, SCDOT, South Carolina, (2013-Ongoing). As part of the update to the state's long range transportation plan, CDM Smith was asked to develop a new statewide model for the state. New zones and network were developed based on utilizing MPO model networks and zones were available and Census Data in the rural areas resulting in a very refined model. The model structure included short and long distance trips as well as local and long distance truck movements. Global Insight TRANSEARCH data was used for development of the long distance truck movements. Add-on surveys from the NHTS were providing the input to the model estimation. Mr. Lancaster assisted in the development of the highway network, demographic zone development and compilation and development of the socio-economic data for the base year and forecast years at the TAZ level.

Transport Modeler, CTDOT I-84 Value Pricing Pilot Study, Hartford, Connecticut, (2013-Ongoing). Mr. Lancaster was the transportation Modeler for This FHWA funded traffic and revenue forecasts for the I-84 Value Pricing Pilot study in the Hartford Metro region. The study focused on the potential to introduce tolling to help reduce congestion but also to provide a much needed source of revenue to reconstruct an aging viaduct in downtown Hartford. The study considered a wide range of physical and operational alternatives, and culminated in the development of toll revenue forecasts. Options that were considered for the analysis includes managed lanes, building extra lanes and tolling only those lanes among other options. Mr. Lancaster' responsibilities included updating the CRCOG model to include time of day analysis, enhanced toll modeling, reporting of volume and delay for corridor analysis and the implementation of selecting highway and transit scenario files for running through the model. He was also tasked with coding these improvements into the existing model architecture within GISDK.

Transport Modeler, Iowa Statewide Model – Passenger Rail Model (iTRAM), Iowa Department of Transportation, (2013). As part of the ongoing development of the Iowa Statewide Model (iTRAM), CDM Smith was asked to develop a passenger rail model component. The purpose of the model was to forecast intercity rail passenger travel within the model area and surrounding buffer zones. The model utilized a mode choice framework to compare available modes for long distance travel within the market shed for each intercity rail station. The model was used by DOT staff to consider the development of additional intercity rail corridors in the state. Mr. Lancaster's involvement included coding the model improvements in GISDK and calibration/validation of the model components added.

Professional Activities

Chair, CAMPO Travel Demand Model Users Group

Publications

Lancaster, K. Feedback on Feedback: "CAMPO's Findings from Testing Various Feedback Approaches." Presented at the 13th TRB Conference on Transportation Planning Applications Conference, Reno, Nevada. May 2011.

Elizabeth (Liza) Runey Amar, AICP, EI
Transportation Planner

Ms. Amar began her career in 2006 in the firm's Charleston, South Carolina, office as a transportation engineer. In 2009, she transferred to the Houston office, where she now serves as a transportation planner and modeler. As a planner, Ms. Amar evaluates existing transportation facilities, identifies potential new or expanded ones, and makes recommendations. As a modeler, she often performs four-step travel demand modeling for small to medium-sized areas as well as state-wide areas, and is skilled in writing model scripts.

Education

B.S. - Civil Engineering, North Carolina State University, NC, 2004

M.S. - Transportation Planning, North

Years of Experience

Total Years: 9

CDM Smith: 9

Certifications

American Institute of Certified Planners: 2010

Engineering Intern: North Carolina, 2004

Honors/Awards

Transportation Research Board – Certificate of Appreciation: Paper Review Coordinator, January 2011, 2012

Recent Work Experience

Transportation Modeler, INDOT Toll Model Implementation, Indiana (June 2013 – November 2014). For this contract, CDM Smith provides consulting services for the implementation of a toll model in the Indiana statewide travel demand model (ISTDM). Ms. Amar conducted research on the existing ISTDM and other toll models used in the state. She developed an approach to implement a toll model that provides INDOT with a model that is sensitive to toll. Additionally, Ms. Amar implemented and calibrated the toll model and tested the sensitivity of the new tolling components. Currently, the model is being validated with the new toll enhancements as well as with revised K-factors used in the capacity and post processing analysis.

Transportation Modeler, INDOT On-Call Planning: STDM and AQ, Indiana (May 2011 – August 2012). For this on-call contract, CDM Smith provided technical travel demand modeling assistance and training to the Indiana Department of Transportation. As a modeler, Ms. Amar served as an on-call consultant for the INDOT and enhanced the statewide model zone and network systems to year 2010. She developed a comprehensive vehicle classification count database of traffic counts throughout the state as well as the 5 adjacent states to Indian. She enhanced the truck component of the statewide model utilizing ATRI datasets and ODME analysis. Additionally, Ms. Amar developed an air quality post processor for the state of Indiana to calculate emissions for various areas throughout the state. The post processor is a standalone tool with an interface and analysis performed in the TransCAD software. As an update to this task order Ms. Amar was responsible for the validation of the statewide model. This included additional calibration efforts to validate the base year and forecast year models.

Transportation Modeler, Louisville-Southern Indiana Ohio River Bridges Time of Day Model Phase 2, Louisville, Kentucky (October 2010 – March 2011). CDM Smith conducted extensive data collection in the study area including an origin-destination survey and created a four-step time of day and feedback model, with detail into tolling options like time of day tolling and variable pricing. Ms. Amar's main tasks included developing input highway, transit, signal, and external database files, model parameters, writing the model scripts, and developing model methodology. Additionally, Ms. Amar was responsible for verifying the origin-destination study using such sources as CTPP. The model scripts included a new graphical user interface that includes a scenario manager, the running of multiple scenarios at one time, and post-processing of model outputs and reporting (summary tables and maps). Additionally, Ms. Amar evaluated the sensitivity of traffic (both cars and trucks) to varying toll rates by time-of-day and vehicle class in future year scenarios. This information will help to understand how to balance the need to keep tolls low while still achieving revenue large enough to meet the project delivery needs.

Transportation Planner and Modeler, Economics and Travel Demand Modeling, South Carolina (June 2013 – Present). CDM Smith was contracted to develop a plan and tools to provide economic perspective and inputs into the overall evaluation of highway projects for prioritization. One tool includes the development of a statewide travel demand model that can be used to evaluate the effect of infrastructure improvements on travel patterns and provide metrics for a statewide prioritization analysis. Ms. Amar was responsible for the development of the statewide travel demand model design and implementation. Additionally, she coordinated model runs and outputs for input into economic model analysis for project prioritization.

Transportation Planner and Modeler, SCDOT On-Call Modeling, South Carolina (March 2007 – Present). For this on-call contract, CDM Smith provides planning experience and technical travel demand modeling assistance and training to the South Carolina Department of Transportation's Office of Statewide Planning. As a modeler, Ms. Amar served as an on-call consultant for the SCDOT and developed various travel demand models. She trained users on how to develop, calibrate, apply, and evaluate the models. She also created user interfaces, notebooks, and model reports over the multi-year contract. The model notebooks were created for each travel demand model as a tool to organize data input sources, methodologies, and output measures and analysis. Ms. Amar conducted training courses for the model users at completion of the model development. As part of an extension to this contract Ms. Amar is in the process of developing a regional travel demand model for the Appalachian region, which is a 7 county region including three MPOs. Extensive data collection including a Bluetooth Origin-Destination survey, development of highway and TAZs geographies and attributes, and analysis of NHTS data are a few of the tasks completed in this project. Currently, Ms. Amar is conducting a Bluetooth study of a 9 county region associated with the proposed I-73 project.

Transportation Modeler, Travel Demand Model 2010 Validation and On-Call Services, Texas (August 2012 – Present). As a transportation modeler, Ms. Amar provided recommendations and methodology to enhance the CAMPO travel demand model and assisted in the development of a validation plan for the updated model. In phase II of the study, Ms. Amar applied enhancements to the CAMPO travel demand model, including updating the model to TransCAD6 and performing software version comparisons, implementing a revised master network structure, conversion of TripCAL (TxDOT's trip generation program) to GISDK, conversion of ATOM (TxDOT's trip distribution program) to GISDK, implementing functionality for tolling features (value of time by trip purpose and time of day and generalized cost in distribution), and calibration and validation of the 2010 model. She assisted with the implementation of customized reporting features in GISDK and in Excel using visual basic for various performance measures.

Professional Activities

Member, Transportation Research Board, Committee on Transportation Planning Applications (ADB50); Paper Review Coordinator

Member, Women's Transportation Seminar; Corporate Relations Chair

Member, American Planning Association

project management

The proposed allocation of staff time is roughly 42% Bill Allen, 58% CDMS staff. The chart below shows our proposed staff organization. We show only the people who will actually do the work.

The RFP mentions a variety of techniques to assure proper administration of this project. This proposal simplifies that process greatly: the GCMPC Project Manager will work directly with me (Bill Allen). Since I am a one-person practice, there is no need for elaborate bureaucracy. You will deal directly with the person who is in charge of the consulting team and who is performing much of the work. I have no other major commitments for the time frame of this project and this would be a high priority project for me. I am the only person from this team authorized to negotiate this contract with GCMPC.