Attachment 2 Exhibit A

FY 2016 Project Scope of Work and Budget

Introduction

The following scope of work is presented as the proposed work plan for the TRM Service Bureau and Model Team for the budget year July 1, 2015 – June 30, 2016. The primary efforts outlined in this scope are intended to focus the efforts of the Service Bureau and Model Team on developing an improved parking constraint model, and beginning development of a new TRMv7 for the Triangle region. During this budget year work will continue on collecting household and transit on-board survey data to support developing future models. Refer to Appendix A for an overall vision for v6 and v7 models.

Several assumptions are made within the context of this scope.

1. Each signatory agency's one half FTE contribution may include staff time from people other than their TRM Team member, but the TRM Team member will play a key role and other staff must be adequately trained to meet the needs of the TRM Team.
2. All TRM staff representing the signatory agencies will, as needed, work on site at ITRE, including any third person who is providing services in the name of a signatory agency. This enables the Team to work together on issues that require the input of multiple team members and reduces the tendency for team members to be reassigned to other tasks in their home offices.
3. The TRM Program Manager will assign tasks with associated deliverables and target dates. TRM Team members will agree to take responsibility for specific tasks and will be held accountable for completion of those tasks. The responsible team member (stakeholder and TRM Service Bureau) will be responsible for **monthly** reporting on progress via an email attachment including 1) status, 2) changes in anticipated completion dates, 3) reasons for change, and 4) hours spent on model development work for the month reported.
4. Signatory agencies will commit one half FTE per agency to the completion of the list of tasks outlined in this work plan. The TRM Program Manager will assume responsibility for providing adequate work to meet this obligation by specifying the task description, deliverables, and person hours required. This information will be provided at least quarterly and will be sufficient to fully incorporate the one half FTE required of each agency.
5. All intermediate and final products of this work program belong to the four stakeholders (NCDOT, CAMPO, DCHC, and Triangle Transit) and these will be delivered to the stakeholders in a form and via media acceptable to each stakeholder at the end of the contract year or before. The products include: model files including input files; scripts and program source code; all technical memoranda; estimation data file inputs and outputs; technical reports and user guides.

Note on model version names: the following version names will be used in this scope of work consistent with model team recommendations (for detailed TRM name history, please refer to Appendix B "TRM History" section).

- **TRM v5:** Based on structure of v4-2008 with revisions to model specifications and using 2006 household survey and 2006 on board transit survey data for estimating model components with an expanded study area [v5 TAZ system]. The enhancements requested by the stakeholders have been included. (see Appendix B "TRM History" for detailed list of enhancements) This version will be used for the Alternatives Analysis and Air Quality Conformity Analysis for the 2040 Metropolitan Transportation Plans.
- **TRM v6:** Updated and enhanced trip based model based on the v5 model. TRM

v6 (with a 2010 estimation year, and 2013 base year) will be delivered in August, 2015 and will be used for the Alternatives Analysis and Air Quality Conformity Analysis for the 2045 Metropolitan Transportation Plan, transit analysis, and Comprehensive Transportation Plan analysis.

- **TRM v7:** New tour based or activity based model designed to address policy testing needs not sufficiently addressed by TRM v6. TRM v7 will be delivered in December, 2018 and will be used for the Alternatives Analysis and Air Quality Conformity Analysis for the 2050 Long Range Transportation Plan.

Note: Tasks marked with an asterisk (*) will be included in the TRMv6 deliverables (2010 and 2013 base year models), and all other tasks will be included in subsequent versions of the TRM.

Overall Work Program Summary Task Table (including stakeholder work hours)

Task Number	Task Title	Task Hours	% of Total
1.1	Advice and management of parking beh. data collection	152	1.5%
1.2	Household survey data collection	560	5.6%
1.3	Transit on-board survey data collection	488	4.9%
1.4	Gather locally collected data	280	2.8%
2.1	Maintain and update hwy. & transit networks, SE data	608	6.1%
2.2	Modify Net Manager to work with v6 model networks	40	0.4%
2.3	Zone geography	0	0%
2.4	Develop highway network procedures	0	0%
2.5	Transit networks	64	0.6%
2.6	Zonal data & models	1,304	13.1%
2.7	Develop an improved parking constraint model	1,320	13.3%
2.8	Data systems	240	2.4%
2.9	Develop an improved transit fare model	760	7.6%
3.1	Re-estimation and/or re-calibration of trip production models	0	0%
4.1	Peak spreading model	0	0%
5.1	Develop an improved destination choice model	0	0%
6.1	Estimation and calibration of non-motorized models	0	0%
7.1	Calibration of mode choice models	0	0%
8.1	Develop improved commercial vehicle model (CVM)	0	0%
8.2	University student model	0	0%
8.3	Land use models	0	0%
8.4	External travel models	240	2.4%

Task Number	Task Title	Task Hours	% of Total
8.5	Links to MOVES air quality models	136	1.4%
8.6	Sub-area and corridor analysis procedures	200	2.0%
9.1	Investigate improving hwy. assignment	128	1.3%
9.2	TRM v6 model assignment & overall model calibration	280	2.8%
10.1	TRM v6 documentation	224	2.3%
11.1	Assist with MTP model application	160	1.6%
11.2	Assistance with TRM model application	160	1.6%
11.3	Action items	704	7.1%
12.1	Oversight and reporting	1,608	16.2%
12.2	Training	280	2.8%

1 Data collection

1.1 *Advice and management of parking behavior data collection*

Parking related behavior data will be collected for later use in developing the models designed in FY 13. This task was deferred at stakeholder request during FY 2015 to be completed during FY 2016.

Deliverables:

A. By survey consulting firm:
   1) Survey designs (sample plan, instrument etc.)
   2) Pilot survey report on details and issues
   3) Full survey report (usual survey contents)
   4) Complete final cleaned/Geo-coded full survey and pilot survey data, fully expanded/weighted, ready to use; with complete data dictionary
   5) Working data used (including but not limited to recruitment data, expansion/weighting source data and working files)
   6) Training session for stakeholders

B. By TRM team:

Technical memoranda on

   1) Stakeholders review and approve survey sampling plan including parking facilities in each PASA to be surveyed, because the survey is not expected to be a simple random sample
   2) Pilot survey procedure/instrument and data QA/QC issues and suggested resolution
   3) Pilot survey data analysis result
   4) Full survey data QAQC issues and resolutions

Est. start date: 7/1/2015

Est. end date: 10/25/2015

ID	Task Description	Person Days
1.1	**Parking behavior data collection management**	**19**
a)	Design and review data collection procedure	1
b)	Design and review sample plan including team member review	3
c)	Design and review survey instruments	2
d)	Review preliminary design for stakeholders approval	1
e)	Management of pilot data collection [including but not limited to signing contract, overseeing survey consulting firm process, communication, issue resolving, budget/time control]	1
f)	QAQC and analyze pilot data; provide feedback to survey consultant and document	4
g)	Advice for management of full data collection [including but not limited to overseeing survey consulting firm process, communication, issue resolving, budget/time control; final training]	2
h)	QAQC full survey data; provide feedback to survey consultant and document	5

** Note: This effort estimate assumes a one for one matching effort will be provided by the stakeholder that contracts for survey data collection*

1.2 *Household survey data collection*

A household survey is anticipated to be conducted by the region to support future model development efforts. A sample of households for the region is expected to be surveyed during 2015 and 2016. This task will manage survey data collection by a contractor. Tasks will include reviewing designs for sampling and survey materials, overseeing a pilot survey and reviewing recommendations for modifications to survey materials and procedures, and reviewing weekly progress reporting, and review of final deliverables for the project.

Deliverables:

a) Technical memorandum: Review of survey instruments, data collection procedures, and pilot survey design

b) Technical memorandum: Review of pilot survey results

c) Institutional Review Board package including any needed revisions for an amended submission after conducting the pilot survey

By contractor:

a) Recommended sample plan, survey approach and survey materials

b) Pilot survey report and recommendations for full survey

Est. start date: 7/1/2015

Est. end date: 6/30/2016

ID	Task Description	Person Days
1.2	**Household survey data collection management**	**70**
a)	Oversee data collection efforts of contractor for pilot survey including Model Team and IRB review of survey materials and approach including stakeholder team member review	13
b)	Review pilot survey results and participate in contractor debriefing meeting including stakeholder team member review and data QA/QC	10
c)	Review the recommendations for refining the survey including revised survey materials	7
d)	Oversee conduct of survey by contractor including reviewing weekly progress reports and periodic conference calls over a period of approximately eight weeks	15
e)	Review data weighting and expansion technical memo and provide comments	5
f)	Review final data set provided by contractor	5
g)	Review draft survey report and provide comments to the contractor including review by stakeholder team members	15

1.3 *Transit on-board survey data collection*

A transit on-board survey of passengers is anticipated to be conducted by the region during 2015 or 2016 to support model development. Note that it is understood that it will not be necessary to survey transit routes in the DCHC jurisdiction that were surveyed by GoTriangle during 2014.

Deliverables:

a) Technical memorandum: Review of approach for surveying transit services in the region including a description of services to be sampled and elements of questionnaire design (interview or self-administered)

b) Institutional Review Board application package for conducting the survey

Est. start date: 7/1/2015

Est. end date: 6/30/2016

ID	Task Description	Person Days
1.3	**Transit on-board survey data collection management**	**61**
a)	Conduct start up meeting with selected contractor and stakeholder team members and collect data on transit services to be surveyed to provide to contractor	10
b)	Conduct review of proposed sampling plan including stakeholder team member review	7
c)	Prepare IRB package for survey and submit for approval	2
d)	Oversee pilot survey including reviewing results and data QA/QC	10
e)	Oversee on board data collection including reviewing intermediate data products	15
f)	Review weighting and expansion factors approach and resulting factors	2
g)	Review final survey deliverables including data products and final report	15

1.4 *Gather locally collected data*

Stakeholders and local governments routinely collect many types of data that could be used for developing the TRM, such as traffic counts, turning movement counts, and transit passenger counts. In order to use the locally collected data for developing the TRM, it needs to be gathered from the agencies that collect it, to organize it for use, and to document it. This task will contact local agencies and compile a catalog of locally collected data including contact information and information about when and how often data is collected. A set of file folders will be created to organize the data, and to make it easy for team members to find it. Finally documentation will be prepared for the data gathered.

Deliverable:

Locally collected data gathered, organized, stored, and documented

Est. start date: 7/1/2015

Est. end date: 6/30/2016

ID	Task Description	Person Days
1.4	**Gather locally collected data**	**35**
a)	Identify data collected by stakeholders and local governments	1
b)	Contact agencies that collect data and arrange for transfer	10
c)	Organize storage for data	2
d)	Load data collected into storage including cleaning and formatting	20
e)	Prepare/update documentation	2

2 Model inputs

2.1 *Maintain and update networks, and zonal data*

Maintain and update highway and transit networks, and zonal data whenever new data (such as school enrollment or zonal path density and average block size) are available, new attributes (such as on-street parking, truck prohibited links and lanes indicator) are needed in the model, new projects are completed, or errors are discovered.

2.1.1 Develop a tool to facilitate external review of highway and transit networks

Highway and transit networks ideally should be reviewed by local planning staff and be updated annually. This task will develop a tool to make TRM networks with attributes available to local planning staff for review and comment perhaps similarly to the employment geo-coder tool. The task includes specifying the review to be done by the planners, designing a way to accomplish the review, and implementing the design. The task also includes developing instructions for performing the review of highway and transit networks.

Deliverable:

Working tool and documentation for tool developed

Est. start date: 10/5/2015

Est. end date: 12/16/2015

ID	Task Description	Person Days
2.1.1	**Develop a tool to facilitate external review of highway and transit networks**	**20**
a)	Specify review to be done by local planners	2
b)	Design an approach to accomplish the review specified in a) above	2
c)	Implement the approach designed in b) above including testing & debugging	10
d)	Document tool developed & prepare instructions for use/delivery	6

*2.1.2 Develop 2013 base year highway and transit network and SE data **

The region has determined that in order to have a new base year for developing the next Metropolitan Transportation Plan (2045 MTP), a base year of 2013 will need to be developed. These model inputs will be tested to make sure they work in the TRM v6 model, and the model results will be compared to model validation targets.

Deliverables:

2013 base year model validation report

Est. start date: 7/1/2015

Est. end date: 8/31/2015

ID	Task Description	Person Days
2.1.2	**Develop 2013 base year highway and transit network and SE data**	**40**
a)	Gather from stakeholders all needed information	0
b)	Enter new transit system data and any service changes in 2013	0
c)	Prepare new SE data table for 2013 and any derived variables including employment by type and earnings and synthesize 2013 population	0
d)	Test 2013 highway and transit networks and SE data in TRM v6	0
e)	Check modeled bus speeds against observed	5
f)	Prepare average weekday fares from system data provided by stakeholders	0
g)	Prepare summary of transit riders by company for validation	0
h)	Prepare traffic count summaries for peak hour and period and vehicle type by direction and associate with network links, screen lines and cut lines	10
i)	Run 2013 model and compare results to validation traffic counts and transit passenger counts including screen lines and cut lines	10
j)	Address any issues identified in the validation comparisons	10
k)	Prepare documentation for the 2013 model including validation report	5

*2.1.5 Develop network coding manual and procedures including QA/QC**

A network coding manual will be developed to describe how to represent existing and future highway and transit facilities. This will supplement the User's Guide by providing guidance for handling specific situations and where possible examples will be provided.

Deliverable:

Network coding manual document that can be distributed with model files

Est. start date: 1/6/2016

Est. end date: 2/25/2016

ID	Task Description	Person Days
2.1.5	**Develop network coding manual and procedures including QA/QC**	**16**
a)	Develop draft network coding manual for team review	8
b)	Team review of network coding manual including suggested additions	6
c)	Prepare network coding manual for distribution	2

2.2 *Enhance Net Manager to work with v6 model networks*

2.2.2 Debug Net Manager for v6 network & train team members

It is expected that as MPO staff use Net Manager for preparing scenarios for the 2045 MTP, that issues will be identified that will need to be addressed, and that team members will need training in order to use the tool.

ID	Task Description	Person Days
2.2.2	**Debug Net Manager for v6 network & train team members**	**5**
a)	Debug issues as they are identified with Net Manager and provide training	5

2.5 *Transit networks*

*2.5.2 Develop transit select link analysis tool **

It has been suggested that a tool be created to allow users to perform select link analysis on transit model output (a postprocessor). While tools to perform this analysis are available in TransCAD, it is desired to make the process available directly from the TRM user interface, and to make it easier to use by scripting it.

Deliverable:

Script developed to perform transit select link analysis and technical memorandum describing the enhancement.

Est. start date: 1/6/2016

Est. end date: 1/28/2016

ID	Task Description	Person Days
2.5.2	**Develop transit select link analysis tool**	**8**
a)	Design tool to add to user interface to perform transit select link analysis	1
b)	Develop module to perform transit select link analysis	5
c)	Prepare technical memorandum	2

2.6 *Zonal data & models*

2.6.1 Population synthesizer

Objectives:

To extend and improve population synthesis procedures to support further disaggregation of the TRM

Previous work:

Work took place to develop a population synthesizer element for the TRM starting in FY 2013 and was completed during FY 2014

2.6.1.7 Extend and improve population synthesis

This task will extend the existing population synthesis procedure to include persons by age and will improve the current procedure for preparing the marginal values used in the population synthesis procedure.

Deliverable:

Technical memorandum on techniques for preparing marginal values for input to population synthesis

Set of improved procedures for preparing marginal values for input to population synthesis including scripts

Set of procedures for incorporating age in population synthesis in TRM including scripts

Documentation of new procedures for preparing synthetic population

Est. start date: 1/4/2016

Est. end date: 4/11/2016

ID	Task Description	Person Days
2.6.1.7	**Extend and improve population synthesis**	**70**
a)	Investigate methods used for preparing marginal values for input to population synthesis and prepare technical memorandum	10
b)	Select preferred method for preparing marginal values and determine if it can be integrated with Community Viz for forecasting marginal inputs	20
c)	Develop tools to prepare improved marginal values for population synthesis	20
d)	Determine preferred method for adding age to synthesized population	10
e)	Compare performance of improved approach to available census data and make any needed adjustments	5
f)	Prepare documentation for all revised procedures	5

2.6.1.8 Investigate ways to utilize full range of Community Viz information

This task will explore all Community Viz data to determine ways to incorporate it fully into the inputs to the TRM.

Deliverable:

Technical memorandum on findings of investigation

Est. start date: 4/12/2016

Est. end date: 5/17/2016

ID	Task Description	Person Days
2.6.1.8	**Investigate ways to utilize full range of Community Viz information**	**26**
a)	Obtain documentation from MPOs that use visualization tools (Community Viz, iPlaces, others) as a part of the forecasting process	5
b)	Review information available for Community Viz 2.0 process in the Triangle	2
c)	Obtain Community Viz 2.0 files and set up within Model Team for detailed review	2
d)	Test relationship between Community Viz variables and TRM variables	10
e)	Document findings and formulate recommendations for developing tools to link Community Viz information to the TRM (Python scripts, GISDK or other as appropriate)	5
f)	Prepare technical memorandum on all findings and present to Model Team	2

2.6.3 Employment synthesizer

Work on this task took place during FY 2013 and FY 2014. An approach was developed and a prototype was tested to link Community Viz information with future forecasts, but work is still needed to develop a set of tools and instructions for creating employment by type and earnings at the establishment end during the creation of forecasts.

2.6.3.7 Employment synthesizer toolkit

This task will create tools to create inputs needed by the TRMv6 model when preparing forecasts.

Deliverable:

Set of tools with instructions (User's Guide) for preparing forecasts of employment by type and earning using Community Viz information.

Est. start date: 7/1/2015

Est. end date: 9/3/2015

ID	Task Description	Person Days
2.6.3.7	**Employment synthesizer toolkit**	**20**
a)	Design toolkit to convert CommunityViz forecast allocation output to TRM employment by type and earning	5
b)	Develop set of tools "toolkit" to convert CommunityViz output to TRM inputs	10
c)	Prepare User's Guide for toolkit	5

2.6.4 Long-term decision models

It is possible to distinguish between decisions people make at long intervals (new home location, new employment location, school location, auto purchase), and decisions that are made at short intervals or even every day (shopping, recreation). Models of the decisions made at long intervals are developed early in model development, so later models can be conditional on the long interval decisions. The auto ownership model is proposed to be prepared first.

2.6.4.1 Auto ownership model

Auto ownership plays a role in travel choices throughout the TRM. An important difference between aggregate trip based models and activity-based models is that in trip based models the auto ownership model usually comes before trip generation, whereas with activity-based models it usually comes after the models of usual workplace, and school locations. This reflects that if the work location is farther away, a household is more likely to purchase more cars (both for the worker(s) and for other non-worker(s). For the approach to add new components to the trip based model, it may make sense to develop an auto ownership model before trip generation, but it is very likely that it will be re-estimated for a later tour or activity-based model.

2.6.4.1.2 Estimation of an Auto Ownership Model for TRM

An auto ownership model is recommended for the next version of the TRM. This task will specify an auto ownership model, prepare data for estimating an auto ownership model using the 2006 household survey data, and estimate the specified auto ownership model.

Deliverable:

Estimated coefficients for an auto ownership model

Technical memorandum documenting the model estimation

Est. start date: 2/1/2016

Est. end date: 3/8/2016

ID	Task Description	Person Days
2.6.4.1.2	**Estimation of an Auto Ownership Model for TRM**	**27**
a)	Specify auto ownership model for TRMv7	5
b)	Prepare data for estimating the specified auto ownership model	10
c)	Estimate auto ownership model for TRM v7	5
d)	Prepare calibration data and calibrate model	5
e)	Prepare technical memorandum documenting model estimation	2

2.6.4.2 Usual workplace location model

In tour based and activity based models the workplace location is a key anchor for workers along with the home location that determines how other activities may be planned throughout the day. It also helps determine if other stops will be made on the trip to and from work. This task will develop a usual workplace location model as part of TRMv7.

2.6.4.2.1 Investigation

Work on the usual workplace location model will begin with a review of approaches that have been used by other metropolitan areas. Criteria to select an appropriate usual workplace location model for the TRM will be developed and a technical memorandum will be prepared to enable the Model Team to make a recommendation of the model form to develop for application in the TRM.

Deliverable:

Technical memorandum

Est. start date: 4/1/2017

Est. end date: 4/14/2017

ID	Task Description	Person Days
2.6.4.2.1	**Investigation**	**10**
a)	Review usual workplace location modeling approaches	5
b)	Document findings in draft technical memorandum	3
c)	Revise technical memorandum	2

2.6.4.3 Usual school location model

For school children the usual school location plays a similar role to that of the workplace location for workers in that the school location is an anchor for planning other activities. The school location will also help explain whether a worker drops off a child at school on the way to work, or if a non-working member of the household drops off the child at school. In the latter case the school location becomes an anchor for a school based tour for the non-working member of the household. This task will develop a model of usual school location for school age children including forecasting future school locations for TRMv7.

2.6.4.3.1 Investigation

Work on the usual school location model will begin with a review of approaches that have been used by other metropolitan areas. Criteria to select an appropriate usual school location model for the TRM will be developed and a technical memorandum will be prepared to enable the Model Team to make a recommendation of the model form to develop for application in the TRM.

Deliverable:

Technical memorandum

Est. start date: 4/15/2017

Est. end date: 4/28/2017

ID	Task Description	Person Days
2.6.4.3.1	**Investigation**	**10**
a)	Review usual school location modeling approaches	5
b)	Document findings in draft technical memorandum	3
c)	Revise technical memorandum	2

2.7 *Develop an improved parking constraint model*

Purpose: Improve parking constraint model to better address regional policy issues with sub-area analysis within a PASA.

Objective: Finalize improved parking cost and capacity constraint model specifications; review parking analysis sub-area (PASA); design parking behavior data collection plan and instrument; collect, process and analyze data; prepare parking behavior data for model development; collect, process and analyze parking inventory data (facility location, capacity by use type, parking rate, and usage); prepare parking inventory data for model development; and develop and implement improved parking constraint models in TRM v6. If possible and appropriate data is available, a TAZ level model will be developed for application.

Previous work:

In FY 2012 TRM SB staff reviewed and evaluated other region's parking constraint model

practice and associated parking data collection approach. In FY 2013 the Model Team approved the initial design of new parking constraint models for TRM v6. During FY 2014 the parking analysis sub areas were reviewed and revised. During FY 2015 parking related model data for 2013 was collected including a parking inventory (facility location, capacity, rate and usage) for model estimation. Parking facility information was updated to 2015 for use during the parking behavior data collection.

FY 2016 main tasks:

1) Collect parking behavior data. A survey consultant will be hired by a stakeholder partner to conduct the survey, while TRM SB will provide advice, including pilot and final survey data QA/QC (see task 1.1 above)
2) Process and analyze parking behavior data for model development use
3) Develop improved parking models [estimation, calibration and validation]
4) Implement improved parking models in TRM v6 model stream (updating TransCAD script, FORTRAN program and so on)
5) Document the TRM v6 improved parking model development

Effort estimated for the sub-tasks is based on the assumption that all three of the proposed parking choice models will be developed, while time needed for each model is given separately.

2.7.4 Analyze parking behavior survey data and prepare estimation data

Deliverables:

1) Technical memorandum summarizing parking behavior survey data analysis
2) Technical memorandum on parking behavior survey data process and preparation
3) Model estimation data files ready to use

Est. start date: 10/23/2015

Est. end date: 12/14/2015

ID	Task Description	Person Days
2.7.4	**Analyze parking behavior survey data and prepare estimation data**	**37**
a)	Parking Location Choice Model: Analyze parking behavior survey data (on relations to be used in v6 model estimation)	19
b)	Parking Reserved Space Choice Model: Analyze parking behavior survey data (on relations to be used in v6 estimation)	9
c)	Parking Monetary Subsidy Choice Model: Process and prepare parking behavior survey data (on relations to be used in v6 model estimation)	9

2.7.5 Develop implementation specification in TRM stream

It is anticipated that the model will be applied at the TAZ level if data to support TAZ level application can be developed.

Deliverables:

1) Input files (in addition to the parking behavior data files) ready to use
2) TransCAD script/FORTRAN program and model input/output structure ready to use

Est. start date: 12/15/2015

Est. end date: 1/22/2016

ID	Task Description	Person Days
2.7.5	**Develop implementation specification into TRM stream**	**29**
a)	Parking Location Choice Model	17
b)	Parking Reserved Space Choice Model	6
c)	Parking Monetary Subsidy Choice Model	6

2.7.6 Estimate TRM v6 parking constraint models

Est. start date: 1/25/2016

Est. end date: 3/3/2016

ID	Task Description	Person Days
2.7.6	**Estimate TRM v6 parking constraint model**	**29**
a)	Parking Location Choice Model	17
b)	Parking Reserved Space Choice Model	6
c)	Parking Monetary Subsidy Choice Model	6

2.7.7 Calibrate TRM v6 parking constraint models

Deliverables:

1) Technical memorandum documents v6 parking model estimation and calibration process, with statistical test results; and model performance
2) Calibrated model (parameters, any input files))

Est. start date: 3/4/2016

Est. end date: 4/15/2016

ID	Task Description	Person Days
2.7.7	**Calibrate model**	**31**
a)	Parking Location Choice Model	21
b)	Parking Reserved Space Choice Model	5
c)	Parking Monetary Subsidy Choice Model	5

2.7.8 Validate TRM v6 parking constraint models and final adjustment

Deliverables:

1) Technical memorandum document on TRM v6 parking model validation process
2) Finalized model specification and parameters (and input files)

Est. start date: 4/18/2016

Est. end date: 5/26/2016

ID	Task Description	Person Days
2.7.8	**Validate model and final adjustment**	**29**
a)	Parking Location Choice Model	15
b)	Parking Reserved Space Choice Model	7
c)	Parking Monetary Subsidy Choice Model	7

2.7.9 Final documentation

Deliverables:

1) Technical memorandum on entire Task 2.7 TRM v6 Parking cost/capacity constraint model development
2) Ready to use model components (TransCAD script, FORTRAN program, parameters, model structure, input files)

Est. start date: 5/27/2016

Est. end date: 6/9/2016

ID	Task Description	Person Days
2.7.9	**Final documentation**	**10**

2.8 *Data management systems*

To develop a regional model, large amounts of data of different types need to be used, as has been demonstrated during development of the TRM model. The data include, but are not limited to: network data (highway, transit, bicycle-path, and pedestrian/sidewalks), socio-economic data (census, ACS, CTPP, InfoUSA), travel survey data (household, transit on board, external station, commercial vehicle, college student), traffic OD flow data (CTPP and cell phone location), traffic count, speed, and travel time data (NCDOT, INRIX, Traffic.com), and so forth. It is expected that more efficient and effective use can be made of the data if it is organized into an integrated data management system. It is also expected that more advanced models will require new approaches to storing and processing data. For example, disaggregate or person based models process lists of related data instead of matrices of zone based data. All these suggest that design of an integrated data system should be undertaken, especially in the early stage of development of the new model. Since an incremental approach to developing the new model is proposed, it will also be good to consider how components developed as additions to the trip based model will be modified to work in a new model system.

2.8.1 Investigation

An investigation will be made of the ways that regions have organized data storage and systems for advanced models. Tools for managing large databases or data files will be investigated. This task will consider the choice of an appropriate data management system and appropriate programming language(s) for the application development. Particular attention will be paid to the tradeoff between borrowing tools developed for application in other regions versus the effort needed to program new application procedures. This task will also recommend the expertise needed for system design and programming. Collaboration with computer science students and professors will be sought for this task with a view toward building an arrangement to carry through to the end of the project to develop the new model. A summary of findings will be provided in a technical memorandum.

Deliverable:

Technical memorandum

Est. start date: 5/4/2016

Est. end date: 6/30/2016

ID	Task Description	Person Days
2.8.1	**Investigation of data systems**	**30**
a)	Review existing approaches to organize and store data systems for advanced models	10
b)	Investigate tools for managing large databases	20
c)	Efforts to establish collaboration with computer science (5 days for this task deferred to FY 2017)	0
d)	Prepare a summary of investigation findings in technical memorandum (5 days for this task deferred to FY 2017)	0
e)	Conduct and document requirements analysis and (if time allows) database system design (30 days for this task deferred to FY 2017)	0

2.9 *Develop an improved transit fare model*

Purpose:

To better represent transit fares (costs) for faced by travelers

Objective:

The current treatment of transit fares in the TRM relies on a weighted average fare based on actual transit passenger riding numbers by fare paid. While this allows for representing employer paid pass subsidies, it applies them to all transit services provided by each transit company by local and express service types. This task will develop an approach to represent transit fare subsidies in a way that can be used to test different policies, such as for more employers in a specific geographic area to offer pass subsidies and to better represent transit cost faced by travelers when making choice of mode for a trip.

Previous work:

None

2.9.1 Investigate approaches to represent transit fare subsidies

This task will investigate the approaches that have been used to represent transit fare subsidies and will report on any experience with use of the approaches.

Deliverables:

1) Technical memorandum with findings regarding approaches used to represent transit fare subsidies

Est. start date: 12/17/2015

Est. end date: 1/1/2016

ID	Task Description	Person Days
2.9.1	**Investigate approaches to represent transit fare subsidies**	**12**
a)	Collect information on representation of transit fare in travel models	10
b)	Prepare technical memorandum	2

2.9.2 Design and specify transit fare subsidy model

This task will design a transit fare subsidy model based upon the findings of the investigation.

Deliverables:

1) Technical memorandum describing design and specification for transit fare subsidy model

Est. start date: 1/4/2016

Est. end date: 1/18/2016

ID	Task Description	Person Days
2.9.2	**Design and specify transit fare subsidy model**	**11**
a)	Develop model specification	10
b)	Prepare technical memorandum	1

2.9.3 Analyze transit on board survey data and prepare estimation data

The transit on board survey data will be analyzed and prepared for model estimation. This will include adding any needed calculated variables not currently existing in the survey data.

Deliverables:

1) Technical memorandum for on board survey data analysis and preparation
2) Model estimation data files ready to use

Est. start date: 1/19/2016

Est. end date: 2/15/2016

ID	Task Description	Person Days
2.9.3	**Analyze transit on board survey data and prepare estimation data**	**20**
a)	Analyze transit on board survey data to determine relationships for model estimation	9
b)	Prepare estimation data	10
c)	Prepare technical memorandum	1

2.9.4 Estimate transit fare subsidy model

The model or models specified will be estimated using the transit on board survey data and other available data needed.

Est. start date: 2/16/2016

Est. end date: 2/29/2016

ID	Task Description	Person Days
2.9.4	**Estimate transit fare model**	**10**
a)	Estimate transit fare model	10

2.9.5 Develop model application and calibrate model

Needed modifications to model scripts and application programs will be developed and tested. The model will be applied and will be adjusted to match calibration targets prepared using the transit on board survey data.

Deliverables:

1) Technical memorandum for transit fare model estimation and calibration process, with statistical test results; and model performance
2) Model application
3) Calibrated model (parameters, needed input files)

Est. start date: 3/1/2016

Est. end date: 3/22/2016

ID	Task Description	Person Days
2.9.5	**Calibrate model**	**16**
a)	Develop model application scripts	10
b)	Prepare model calibration data	3
c)	Adjust model parameters to meet calibration targets	2
d)	Prepare technical memorandum	1

2.9.6 Validate model & final adjustment

After applying the model, the results will be compared to transit fare usage data provided by transit companies in the model region that charge a fare. Results will be compared for the region as a whole; for transit companies; and if by appropriate geography.

Deliverables:

1) Technical memorandum for transit fare model validation process
2) Finalized model specification and parameters (and input files)

Est. start date: 3/23/2016

Est. end date: 4/13/2016

ID	Task Description	Person Days
2.9.6	**Validate model and final adjustment**	**16**
a)	Develop validation data from fare use data	5
b)	Apply transit fare model and compare to validation data	5
c)	Make any needed adjustments to model parameters and scripts to match validation targets	5
d)	Prepare technical memorandum	1

2.9.7 Documentation

Deliverables:

1) Technical memorandum for Task 2.9 Transit fare model development
2) Ready to use model components (TransCAD script, application program, parameters, model structure, input files)

Est. start date: 4/14/2016

Est. end date: 4/27/2016

ID	Task Description	Person Days
2.9.7	**Documentation**	**10**

8 Special models

8.4 *Update external travel models (I-E, E-I, and EE)*

External travel models need to be updated for TRM v6 to accommodate changes in TAZs.

*8.4.1 Update external travel models **

New work will include scripting the external transit trip inputs. This task will also include an investigation of using alternative sources of external travel data to augment the information provided by the NC Statewide Model. Specifically, data will be sought to provide information for lower level facilities not included in the NC Statewide Model.

Deliverable:

Updated model inputs for external travel models, script for preparing external transit trip tables and documentation for all updates

Est. start date: 11/5/2015

Est. end date: 12/16/2015

ID	Task Description	Person Days
8.4.1	**Update external travel models**	**30**
a)	Make any needed script revisions for TRM v6 (completed FY 2015)	0
b)	Update input files as needed for external travel (completed FY 2015)	0
c)	Investigation of alternate sources of external travel data	5
d)	Develop script to automate creation of transit external trip table and test it	10
e)	Address any enhancements needed after testing and application of model	10
f)	Documentation for all updates & results of investigation	5

8.5 *Links to MOVES air quality models*

MOVES is now required for performing air quality analysis for long range transportation plan conformity determinations. It is desired to create procedures within the TRM to prepare output data for MOVES analysis. This task will identify the best approach to integrate MOVES analysis in the TRM and prepare scripting to implement it.

*8.5.1 Develop module to link MOVES air quality models with TRM **

A module will be designed based on approaches used by other regions to link MOVES air quality models with aggregate trip based models. This work will be coordinated with air quality staff at the NC Dept. of Environment and Natural Resources, and NCDOT.

Deliverable:

A working module to prepare TRM output for MOVES analysis. Documentation of module developed.

Est. start date: 7/8/2015

Est. end date: 9/2/2015

ID	Task Description	Person Days
8.5.1	**Develop module to link MOVES air quality models with TRM**	**17**
a)	Obtain information on and review approaches used in other regions to link model output to MOVES	0
b)	Design module to prepare MOVES model inputs from TRM output	2
c)	Implement module designed in b) above, and test	12
d)	Document module created in c) above	3

8.6 *Sub-area and corridor analysis procedures*

When applying a regional model to a sub-area or corridor level of analysis, special procedures are needed. This task will investigate approaches used in other regions and recommend an approach to apply to the TRM. Depending on the approach that is recommended, subsequent tasks will design and implement the recommended procedure in the TRM.

8.6.1 Procedures for performing sub-area and corridor analysis - investigation

Procedures for performing sub-area and corridor analyses will be investigated. Practice at other MPOs will be described. A recommendation will be made for procedures to implement in the TRM.

Deliverable:

A technical memorandum describing procedures used at MPOs elsewhere and a recommendation for procedures to implement in the TRM

Est. start date: 10/1/2015

Est. end date: 10/15/2015

ID	Task Description	Person Days
8.6.1	**Procedures for performing sub-area and corridor analyses - investigation**	**5**
a)	Obtain information on approaches used in other regions to perform sub-area and corridor level analyses using aggregate trip based models	3
b)	Prepare technical memorandum summarizing findings and recommendation	2

8.6.2 Prepare set of procedures for performing sub-area and corridor analysis

Based on recommendation made in 8.6.1 above develop/prepare a set of tools and scripts to implement the recommended approach. A set of instructions will be developed for users.

Deliverable:

A set of tools and/or scripts along with a set of instructions

Est. start date: 10/21/2015

Est. end date: 12/24/2015

ID	Task Description	Person Days
8.6.2	**Prepare set of procedures for performing sub-area and corridor analyses**	**20**
a)	Design set of tools to perform sub-area and corridor level analyses using the TRM	5
b)	Based on the design in item a), create tools or scripts to implement it, and test them	10
c)	Prepare set of instructions for use of the tools developed in b) above	5

9 Trip assignment, calibration & validation

The v6 model while similar to the v5 model will have many improved components that will affect the results of highway and transit assignment. One major improvement is the new highway network procedure. This new procedure might have a large impact on the highway and transit assignments because, a) intersection delays are considered in the v6 model but not in the v5 model, therefore speeds on interrupted facilities in the v6 model will generally be lower than those in the v5 model; b) the facility types and corresponding free-flow speeds and capacities used in the v6 model are different from those in the v5 model. It is still unclear how large the impacts are. All the model estimations and calibrations before highway assignments will use the network skims based on the congested speeds from assigning the v5 model output on the v6 network. When the initial highway assignments are completed in the v6 model, it might be necessary to re-estimate and/or re-calibrate all the previous models.

This task will apply the model with 2010 model inputs and the resulting highway and transit assignments will be compared to calibration targets. Data for observed speeds will be compared to model speeds. Comparisons will be made for peak periods as well as for the whole day.

9.1 *Investigate improving highway assignment*

9.1.1 Dynamic traffic assignment

Dynamic traffic assignment is being considered for both pricing and safety planning applications, and tools are being developed that may be appropriate for application in the Triangle region. These include DTALite being developed under an FHWA research project, and the SHRP 2 C10 project combining an activity based model with Dynus T.

An investigation of dynamic traffic assignment was conducted during FY 2013. This task is a placeholder for possible future work with dynamic traffic assignment in the TRM.

Timetable:

FY 2016: Select a DTA platform and prepare network and other inputs for a proof of concept

FY 2017: Begin creating a DTA application for TRMv7 using TRM inputs including post processors for new data formats as well as any new input data needed for DTA

9.1.2 Prepare proof of concept for DTA within the TRM

Based on the investigation carried out in FY 2013, a DTA platform will be selected to serve as a proof of concept for incorporating DTA in the TRM.

Deliverable:

Technical memorandum describing the DTA platform chosen and documenting the preparation of files and inputs within the TRM and the performance of the assignment model.

Est. start date: 4/4/2016

Est. end date: 4/25/2016

ID	Task Description	Person Days
9.1.2	**Prepare proof of concept for DTA within the TRM**	**16**
a)	Select DTA tool for proof of concept	2
b)	Using TRMv6 prepare inputs for the chosen DTA platform and run it	11
c)	Prepare technical memorandum documenting the setup and performance of DTA	3

9.2 *V6 model assignment and overall model calibration*

9.2.3 Model chain calibration/validation

Most of this task was completed during FY 2015

a) Inputs for the adopted 2040 Metropolitan Transportation Plan will be converted to TRMv6 including: adapting SE data to TRMv6 TAZs and modifying university student inputs, preparing a synthesized population, converting TRMv5 employment categories to TRMv6, preparing highway network with TRMv6 attributes and any needed additional centroid connectors, adapting transit route system to modified highway network, making any other needed modifications, setting up the model and testing.
b) Sensitivity tests will be performed with inputs developed for the recently adopted 2040 Metropolitan Transportation Plan converted for application with TRMv6. Model results will be checked for reasonableness and any problems discovered will be documented and addressed.
c) A technical memorandum will be written to document model performance testing and all adjustments made to the model during the process of calibration and validation, including adjustments that are made to components already calibrated during model estimation steps (trip generation, trip distribution, non-motorized, and mode choice) completed earlier.

Deliverables:

Technical Memorandum on Highway and Transit assignments and model calibration/validation

Est. start date: 7/1/2015

Est. end date: 8/18/2015

ID	Task Description	Person Days
9.2.3	**Model chain calibration/validation**	**35**
a)	Traffic counts adapted to work with v6 screen lines and cut lines including by time of day/direction and by vehicle class as available	0
b)	Initial calibration summaries prepared and detailed review of results performed including thematic plots and review of outliers and network speeds	0
c)	If problems are found, diagnose cause of problems	0
d)	Design adjustments to address problems	0
e)	Calibration checks made after adjustments	0
f)	If adjustments are made, model components checked for calibration	0
g)	Iterate until overall model meets calibration and validation targets	0
h)	Prepare 2040 MTP inputs for application in TRMv6	20
i)	Perform sensitivity tests	10
j)	Technical memorandum prepared documenting calibration/validation	5

10 TRM Documentation

As a large, complex model system, the TRM needs to be well documented so it can be understood and be used effectively by stakeholders and others.

10.1 *TRMv6 Documentation*

Documentation will be prepared describing all elements of TRMv6 including data used for model development, estimated and calibrated coefficients, and model performance.

Deliverables:

1. Technical report compilation of technical memoranda

2. TRMv6 model report for a more general audience

3. Updated User's Guide for TRMv6

Est. start date: 7/1/2015

Est. end date: 11/30/2015

ID	Task Description	Person Days
10.1	**TRMv6 Documentation**	**28**
a)	Prepare draft TRMv6 documentation and review by Model Team	28

11 Technical Assistance

11.1 *Assistance with model application for developing the Metropolitan Transportation Plan*

Objective:

To enable stakeholders to prepare alternatives using TRMv6 for MTP analysis

TRM Service Bureau staff will provide assistance for stakeholder partners when they are developing alternatives using the TRM. This will include answering questions and providing assistance when problems arise.

11.2 *Technical assistance with TRM model application on as needed basis*

Objective:

To enable stakeholders (including stakeholder contractors) to apply the model as needed

TRM Service Bureau staff will provide technical assistance for stakeholder partners on an as needed basis when they are applying the TRM. This will include providing model files and documentation to contractors working on the behalf of stakeholder partners. It will also include answering questions and providing assistance when problems arise.

11.3 *Action items*

Objective:

To address issues identified by stakeholders as Action Items.

From time to time the stakeholders may determine that there are work tasks not covered elsewhere in the work program that nonetheless must be done. During FY2014 such action items were requested by stakeholders. The action item work program element sets aside time for conducting work on tasks as determined by the stakeholders. These tasks will result in a work product, such as a technical memorandum that will document the work done and the completion of the task. Unused time can be allocated to other work tasks after the end of the second quarter.

11.3.1 Stakeholder requested tasks

As stakeholders request tasks not listed elsewhere in the scope of work, a task description will be developed for the task, the task will be completed, and a technical memorandum will be prepared.

11.3.1.1 Addition to TRM of tools developed by stakeholders and others

This task will manage the addition to the TRM of tools developed by stakeholders and others. A workshop type meeting will be held to solicit input including what contractors have found or developed for highways, transit, and the NC Statewide Model. Under this task, the team will decide which tools should be made part of the model interface to be maintained by the Model Team and which will be optional post processors, or not be included at all. Stakeholders and the Model Team will own all the tools to be included in the TRM.

11.3.2 Decide type of model to build for TRMv7

The Model Team needs to decide the type of model to build for TRMv7 based on the needs of the TRM stakeholders. This decision making process will rely on information previously gathered through the expert panel convened during 2011 and additional information collected on recent work by other MPOs to further extend the capabilities of trip based models. A workshop will be held to consider the needs of TRM stakeholders and to determine the type of model appropriate to address stakeholder needs.

11.3.2.1 Investigate advanced trip based models at other MPOs

This task will collect four to six examples of advanced trip based models in use, and from model documentation determine there are advanced practices that might be helpful to add to the TRM.

Deliverables:

Technical memorandum

Est. start date: 1/4/2016

Est. end date: 1/29/2016

ID	Task Description	Person Days
11.3.2.1	**Investigate advanced trip based models**	**20**
a)	Contact 4-6 MPOs with advanced trip based models and obtain documentation	5
b)	Review model documentation to determine any elements not currently in TRM	5
c)	Prepare technical memorandum and review with stakeholders	10

11.3.2.2 Conduct decision making process to select model type for TRMv7

The Model Team and Executive Committee will conduct a decision making process to select the model type to develop for TRMv7. The technical memoranda that have been prepared will be distributed prior to the working session.

Deliverables:

1. Technical report

2. Model specification for TRMv7

Est. start date: 2/1/2016

Est. end date: 2/11/2016

ID	Task Description	Person Days
11.3.2.2	**Conduct decision making process to select model type for TRMv7**	**15**
a)	Prepare resource documents and distribute to stakeholders	2
b)	Conduct workshop to set analysis needs and review available options	7
c)	Document results of workshop	1
d)	Prepare model specification for TRMv7 based on workshop results	5

12 Oversight, reporting, and training

Objective:

To enable efficient and effective team communication and project management.

This task includes necessary administrative tasks and meetings needed for project oversight and communication with stakeholders such as Executive Committee, Model Team, and internal TRM Service Bureau meetings. Periodically team members meet both internally and with stakeholders to review task progress and approaches, solve problems, and keep stakeholders informed of work taking place on the project. The project also requires developing an annual work program, task assignments, and monthly team reporting.

12.1 *Oversight & reporting*

12.1.1 Oversight

TRM Team Meetings will be held monthly on the 3rd Thursday of each month unless there are no items to discuss. Model Team members may convene a technical team meeting to review task approaches in detail and develop recommendations for tasks on an as needed basis. Task includes preparation of all presentation materials for meetings.

Executive Committee meetings will be held every other month on Tuesday afternoons, or as designated by executive committee members.

Quarterly progress reports will be prepared in October, January, April, and July. Monthly status reports will be prepared.

A web site for team collaboration will be maintained to allow the team to share data, analysis, calendar, and documentation to improve collaboration and efficiency.

TRM Service Bureau team members will attend up to a total of four stakeholder project team meetings or one meeting per team member in the course of the project year.

12.2 *Training*

12.2.1 TRM training

Training modules will be developed for stakeholder staff, model users, and consultants. These three groups will be briefly surveyed regarding their needs for training in the use of the TRM. Based on the survey results it is anticipated that three training modules will be developed with each tailored to the needs of each group. Each of the three modules will be given once during the year, and evaluation forms will be distributed to participants. The evaluations will be used to make adjustments to the training modules for future sessions. The training sessions will be conducted in such a way as to obtain feedback from model users regarding their experience with the model.

ID	Task Description	Person Days
12.2.1	**TRM training**	**7.5**
a)	Conduct survey of stakeholders, model users, and consultants to determine needed training modules	2
b)	Develop stakeholder training module	2
c)	Develop model users module	1
d)	Develop consultant module	1
e)	Provide ½ day training for each of three groups	1.5

12.2.2 Staff training

The highly technical nature of the work on the Triangle Regional Model requires that team members update their skills by attending training sessions, using on-line training opportunities, watching Travel Model Improvement Program webinars, and attending model user group meetings. This task will help ensure that up to date skills are applied when performing TRM work.

Appendix A

Vision for Developing the v6 and v7 Models

Policy Testing Needs Identified by Stakeholder Partners

Policy Testing Needs Identified by EC 10/20/2009	**Part of Model?**
1. Dynamic Tolls	Part of model
2. Greenhouse gas – land use change (Urban Sim)	Part of model
3. Peak spreading (a result)	Part of model
4. Parking constraint in CBD and elsewhere	Part of model
5. Environmental Justice (EJ) impacts (a result)	Analysis done outside model
6. Change mix of land uses within TAZs & consider design of land uses	Part of model
7. TDM policies	Analysis done outside model
8. ITS	Analysis done outside model
9. Making decisions on modal investments	Analysis done outside model

Suggested Elements of New Models or Work Programs

Suggested Elements (FY 2012 list)	**In v6**	**In v7**	**Invest.**	**Notes**
1. Improved Commercial Vehicle Model	X			DCHC #1
2. Improved Transit Assignment		X		DCHC #2
3a. Static Traffic Assignment Improvements	X		X	DCHC #3
3b. Dynamic Traffic Assignment		X		DCHC #3
4. Area Type Sub-model		X		DCHC #4
5. Population Synthesizer		X		DCHC #5

Suggested Elements (FY 2012 list)	In v6	In v7	Invest.	Notes
6. Trip Attraction and Destination Choice Sub-model	X			DCHC #6
7. University Student Trip Model		X		DCHC #7
8. Walk Access - Transit Link		X		DCHC #8
9. Employment Category and Special Trip Generators		X		DCHC #9
10. System Optimization	X			DCHC #10
11. Time of Day Model		X		DCHC #11
12. Parking Survey and/or Behavior Study		X	X	DCHC #12 Tri. Tran. req.
13a. Link Capacity Calculation			X	DCHC #13 CAMPO req.
13b. Intersection Delay			X	DCHC #13
14. HBW Journey or Tour Based Model		X		
15. Strategic data collection plan			X	MPO req.
16. TAZ review			X	

Suggested Elements (FY 2013 list)	In v6	In v7	Invest.	Notes
1. University student trip model	X			DCHC #1
2. Validation on person and CV trip rate	X			DCHC #2
3. Attraction share and destination choice improvement	X			DCHC #3
4. Mode choice estimation/calibration	X		X	DCHC #4
5. Transit model [updates]	X			DCHC #5
6. Time of day	X			DCHC #6
7. Disaggregated population synthesizer	X			DCHC #7

Suggested Elements (FY 2013 list)	In v6	In v7	Invest.	Notes
8. Auto ownership model	X			DCHC #8
9. Meso-scopic dynamic traffic assignment			X	DCHC #9
10. Action items				CAMPO
12. Parking Survey and/or Behavior Study	X			Tri. Tran.

Suggested Elements (FY 2014 list)	In v6	In v7	Invest.	Notes
1. Transit select link analysis tool	X			CAMPO
2. TRM training for stakeholders, model users, & consultants				CAMPO
3. Attend stakeholder project meetings				CAMPO

Suggested Elements (FY 2015 list)	In v6	In v7	Invest.	Notes
1. Procedure for including tools developed by stakeholders and others in TRM				CAMPO
2. Develop a tool to facilitate review of networks	X			CAMPO

Suggested Elements (FY 2016 list)	In v6	In v7	Invest.	Notes
1. Address model fundamentals and performance measures	X			CAMPO
2. Symposium or training to obtain feedback from stakeholders, model users, & consultants	X			CAMPO
3. Test parking policies & constraints in geographic areas where they are not observed today	X			GO Triangle

V6 Model

The v6 model will continue to be an aggregate trip based model based on the v5 model. It is expected the v6 model will be used for the 2045 Metropolitan Transportation Plan (MTP) development starting in 2015. The focus for this model will be on further enhancement of the aggregate trip based model.

Fiscal Year	TRM v6 Development	Notes
Year 1 July 1, 2011 - June 30, 2012	Design new commercial vehicle model Optimize model run time performance TAZ modifications Modifications of SE data and SE models Develop improved transit network procedures Investigate and specify enhancements below: 1) definition of facility types 2) link capacity calculation 3) update link free flow speeds 4) intersection delay 5) develop GIS approach to changing future road characteristics 6) improve highway traffic assignment 7) employment categories and special generator definitions 8) investigate and implement improvements to area type calculations	
Year 2 July 1, 2012 - June 30, 2013	Design improved destination choice – attraction share model Develop and implement enhancements below: 1) reviewed & revised employment types for v6, developed and implemented SESyn to estimate population types, HH types, and employee by type at both residence and establishment locations 2) recommended changes to the trip attraction/destination choice sub model using new employment types 3) intersection delay & link capacity calculation implementation including data collection and input 4) designed improved parking constraint models specification and data collection. 5) develop peak spreading model 6) develop university student model Trip generation will be re-estimated using existing survey data.	
Year 3 July 1, 2013 - June 30, 2014	Complete the following enhancements: 1) commercial vehicle model, 2) develop new parking constraint models, 3) develop new university student travel models All remaining model components will be re-estimated using existing survey data. Highway assignment will be QA/QC'd.	
Year 4 July 1, 2014 - June 30, 2015	Model calibration and validation. Work tasks will include calibrating and validating model components and overall model performance. A 2013 base year model will be prepared. Sensitivity tests will be conducted for a forecast year.	

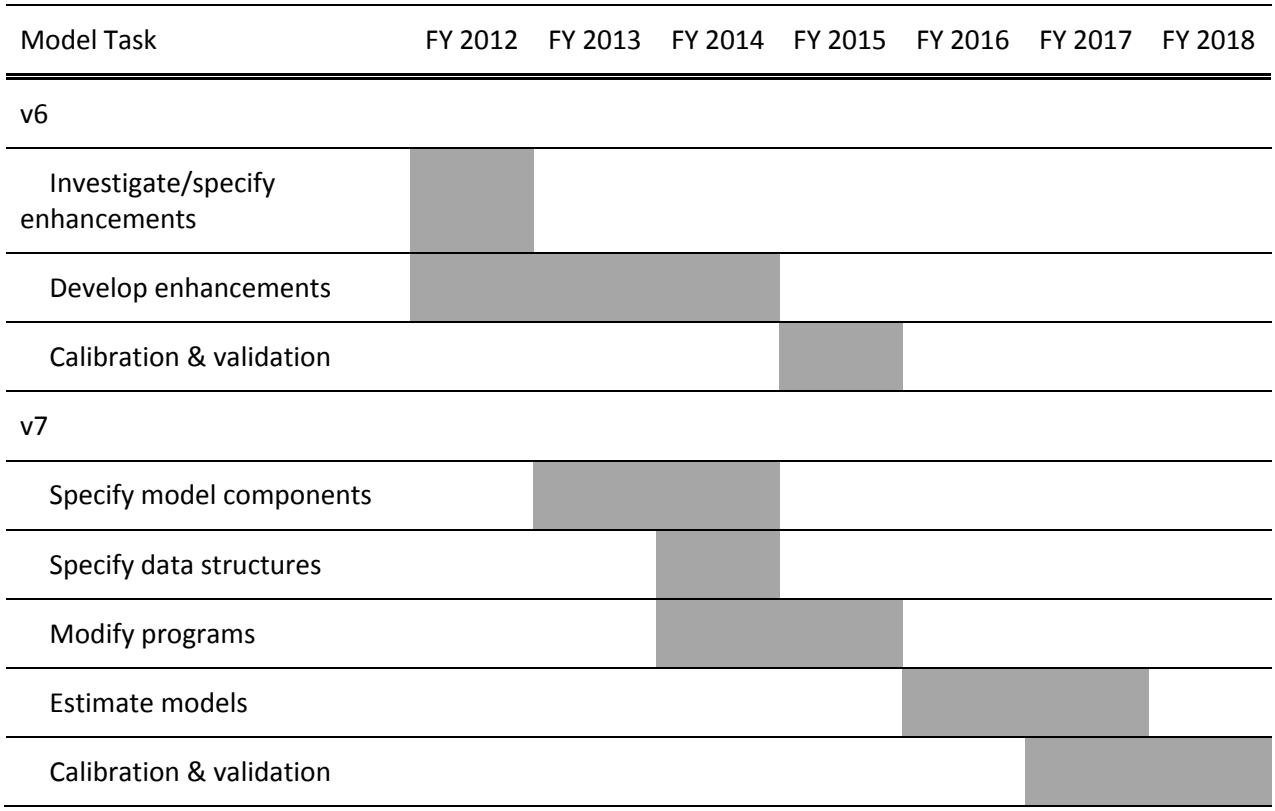
V7 Model

The v7 model will be either an enhanced trip based, a tour based or activity based model depending on stakeholder direction and perhaps beginning with modifications to the university student components. It is expected the v7 model will be used for 2050 MTP development starting in 2018. This will address policy testing needs that require consideration of how travelers change their daily schedules in response to policies intended to reduce peak congestion.

Fiscal Year	TRM v7 Development	Notes
Year 1 July 1, 2011 - June 30, 2012	Stakeholders agree on concept for v7 1) Convene expert panel 2) Develop work plan for v7 model development	
Year 2 July 1, 2012 - June 30, 2013	Investigation/specification of model structure and components: 1) population synthesizer, 2) land use models. 3) auto ownership model	
Year 3 July 1, 2013 - June 30, 2014		
Year 4 July 1, 2014 - June 30, 2015		
Year 5 July 1, 2015 - June 30, 2016	Investigation/specification of model structure and components: 1) Usual work place location model 2) Usual school location model. Estimate long term decision models: 1) Auto ownership model Investigation/specification of model structure and components: 1) Tour/activity scheduler,	

Fiscal Year	TRM v7 Development	Notes
	2) Router. Investigate/specify and develop data structures. Determine best data structures for storing, processing and updating model elements. Approaches will be sought that maximize analyst productivity and model runtime performance.	
Year 6 July 1, 2016 - June 30, 2017	Estimate long term decision models: 1) Usual work location model 2) Usual school location model Available data will be prepare in the chosen data structure. Modify programs as needed to implement the chosen model specification including: 1) population synthesizer, 2) tour/activity scheduler, 3) router. Model component programs may be borrowed and adapted for use in the Triangle region. Estimate models and implement. Recent survey data will be used to estimate model components specified during years one to three [population synthesizer, tour/activity scheduler, router]. Other model components (commercial vehicles, external models) will be incorporated in overall model structure.	
Year 7 July 1, 2017 - June 30, 2018	Model calibration and validation. Initial model will be applied and any problems will be noted and addressed. This process will be iterated until all problems discovered have been addressed. The model will then be validated to observed conditions.	

Conceptual Schedule for Model Development



Appendix B

TRM History

Version - Release Year [Delivered Time]	**Key Features Enhancements vs. Previous Version**	**Base Year**	**Use**
v.1 - 2006 [Not to Stakeholder]	TTA New Start model converted to the TransCad platform with a 2002 base year as delivered by the contractor [Parsons Brinckerhoff] in Fall of 2006	2002	
v.2- 2006 [delivered 12/2006]	Revised and calibrated/validated to 2005 base year highway data only	2005	
v.3 - 2007 [β test version delivered 4/2007]	1. Updated mode choice ASC calibration using 2006 Household Interview Survey and 2006 Transit On Board Survey data 2. Repaired trip generation program and 3. Revised **2005** Socio Economic data provided by the MPOs.	**2005**	**1)** Transit Infrastructure Blueprint, **2)** the Chapel Hill Long Range Transit Plan, **3)** the Orange County Greenhouse Gas project and **4)** the Deficiency and Needs Analysis for the 2035 Long Range Transportation Plans.
v.4 - 2008 [Delivered 1/2008; approved spring; adopted 8/2008]	Improved v3-2007 ready for application and including HOV/HOT and toll capabilities.	**2005**	**1)** Alternatives Analysis and **2)** Air Quality Conformity Analysis for the 2035 Long Range Transportation Plans.

Version - Release Year [Delivered Time]	**Key Features Enhancements vs. Previous Version**	**Base Year**	**Use**
v.5 - 2011 Delivered 6/2011	**New:** 1. Parking capacity constraint 2. Airport trip making model 3. Bicycle and pedestrian travel submodels through trip distribution. 4. External station forecasts methodology. 5. Hourly capacity and traffic assignment 6. Use of Logsum in destination choice 7. Stratified utility coefficients by income in mode choice: 8. Summit analysis for FTA New Start analysis. [planned] 9. An off model GIS approach to forecast changes in road characteristics over time as rural areas become more urbanized [planned] 10. Travel by people from outside the region on transit. [planned] **Improved:** 1. Parking cost model improved; New: capacity constraint components added 2. Bus speed model: adjusted and validated vs. 2006 bus schedules. 3. Revise Federal Functional Class. Federal Functional Class has been updated in the 2010 v5 model to be consistent with NCDOT updates. **Investigated:** Cost of Auto Travel [e.g. gas price component]	2005, 2010	**1)** Alternatives Analysis and **2)** Air Quality Conformity Analysis for the 2040 Long Range Transportation Plans.

Version - Release Year [Delivered Time]	**Key Features Enhancements vs. Previous Version**	**Base Year**	**Use**
V6. 2015		2010, 2013	Alternatives Analysis for the 2045 Metropolitan Transportation Plans

Appendix C

TRM Calibration and Validation Statistics

Triangle Regional Model components will be calibrated and validated to the following targets. These tests based on local and national targets will be used to evaluate the quality of model components.

Calibration/validation Statistics

Model Inputs

Model demographic data inputs will be checked against benchmarks at a regional level for persons/household, employment/population ratio, and autos/household. Plots of persons per household and household income by zone (TAZ) will be compared to census values. A report will document all findings.

Model highway and transit networks will be checked for reasonableness and the results will be reported. Maps of various network characteristics (area types, lanes, speeds, counts, screenlines, and transit routes by company) will be plotted to aid in the checks and to document the process used. The transit on board survey data will be assigned by access mode to the transit network and comparisons of transfer rates and assignments by transit line and company will be made to determine if problems exist. The results will be reported.

Model output from the household and person model (workers, non-workers, and children), and by household strata will be compared to census and other data for the region and sub region levels as appropriate (county and district) depending on the availability of data. This comparison will be documented in a report.

Trip Generation

Work trips per worker match survey work trips per worker

Ratio of region wide trip productions to trip attractions by trip purpose +/- 10%

Summaries comparing observed and model estimated trips by trip purpose will be prepared

Daily trips by trip purpose will be compared to determine if proportions of daily travel by purpose match survey data and proportions from other areas (benchmarks)

Overall trip rates by trip purpose will be compared to those reported for other areas

Trip productions per household and per capita will be compared to standard reasonable ranges

Summary comparisons will be made at the region, county, and district levels

Work trip attractions will be compared to total employment, K-12 school trips will be compared to total school enrollments, and shopping trips will be compared to total retail employment

Trip Distribution

Percent Deviation of Average Trip Length (minutes) for all trip purposes +/- 5%

District to district comparisons will be made of observed and model estimated trips. Trip length frequency distributions by time and distance will be prepared by trip purpose by strata. Coincidence ratios will be prepared for the trip length frequency distributions with a target of >70% coincidence.

Percent intra zonal trips by purpose will be compared to benchmarks.

Mode Choice

All trip purposes will match observed mode shares for auto and transit modes (+/- 2%), though not for transit by access mode to avoid over calibrating

Summaries by trip purpose will be prepared comparing observed mode shares to model estimated mode shares. Work trip mode shares will be compared to census (CTPP) mode share data. District summaries will be prepared. Auto occupancies will be compared to survey auto occupancies. Mean transit trip lengths will be compared to observed and these will be expected to fall within +/- 5%. Parameters will be compared to acceptable ranges.

Validation Statistics[*]

Vehicle Miles Traveled (VMT) by Federal Functional Class (based on links with counts)

Functional Class	Target % Deviation
Freeway	7%
Principal Arterial	10%
Minor Arterial	10%
Collector	15%
Local	15%
Total	5%

Screenline Comparison

Screenline Name	Target % Deviation
I-85	10%
I-40	10%
Wake/Durham County Line	10%

[*] All traffic counts used for validation will be factored in a consistent way

Cutline Comparison

Cutline Name	Target % Deviation
SW Durham	15%
Durham	15%
Johnston County	15%
Chatham County	15%
North Raleigh	15%
Eastern Wake	15%
US 1 South	15%
North Wake	15%
US 70	15%

* If unable to match this best practice target, then a secondary check will be performed based on the overall volume of the cutline

Percent Difference of Total Traffic Count Volume and Total Model Assigned Volumes by County and Area Type

Summary Level	% Difference Target (+/-)
County	
Durham	10%
Orange	10%
Wake	10%
Chatham	10%
Harnett	10%
Johnston	10%
Nash	10%
Franklin	10%

Granville	10%
Person	10%
Area Type	
Urban	10%
Suburban	10%
Rural	10%

Percent Difference of Model Estimated Daily Traffic Volumes by Federal Functional Class

Federal Functional Class	FHWA Target (+/-)	TRM Target (+/-)
Freeway	7%	5%
Principal Arterial	10%	8%
Minor Arterial	15%	10%
Collector	25%	15%
Local	25%	15%

Percent Difference of Model Estimated Daily Traffic Volumes by Volume Group

Volume Group	Target % Deviation
1 -1000	55%
1001 – 2500	50%
2501 – 5000	30%
5001 – 10000	25%
10001 – 25000	20%
25001 – 50000	15%
>= 50001	10%
Total	5%

R-Square for Region wide Estimated Volumes vs. Traffic Counts

Target R^2 >= 0.88

Root Mean Square Error (RMSE) of Estimated Traffic Volumes

Target RMSE <= 35%

Evaluation of Peak Period Assignments for AM and PM Peak Periods

Screenline Comparison AM and PM Peak

Screenline Name	Target % Deviation
I-85	10%
I-40	10%
Wake/Durham County Line	10%

Cutline Comparison AM and PM Peak

Cutline Name	Target % Deviation
SW Durham	15%
Durham	15%
Johnston County	15%
Chatham County	15%
North Raleigh	15%
Eastern Wake	15%
US 1 South	15%
North Wake	15%
US 70	15%

* If unable to match this best practice target, then a secondary check will be performed based on the overall volume of the cutline

AM and PM Peak Period Percent Difference of Total Traffic Count Volume and Total Model Assigned Volumes by County and Area Type Based on Links with Hourly Traffic Counts

Summary Level	% Difference Target (+/-)
County	
Durham	10%
Orange	10%
Wake	10%
Chatham	10%
Harnett	10%
Johnston	10%
Nash	10%
Franklin	10%
Granville	10%
Person	10%
Area Type	
Urban	10%
Suburban	10%
Rural	10%

Overall average speeds will be reported for AM peak, PM peak and off peak periods.

Transit Ridership Assigned

Total transit riders target +/- 5%

Target for individual companies +/- 10%

Transit riders by corridor +/- 15% for the following corridors:

US 15-501 between Chapel Hill and Durham

NC 147 between Durham and RTP

I-40 between Chapel Hill and RTP

US 1 North between Raleigh and Wake Forest

US 70 East between Raleigh and Garner

Appendix D – FY 2016 Budget

DCHC STAKEHOLDER BUDGET
TRIANGLE REGIONAL MODEL SERVICE BUREAU
BUDGET FOR YEAR 13: July 1, 2015 to June 30, 2016

Budget Items	Description of Level of Effort	Budget FY 2015-16
Salaries and Wages (Personnel) *		
ITRE Director	1.25 % effort for 12 mo	$ 1,538
Director	25 % effort for 12 mo	$ 24,432
Senior Research Associate	25 % effort for 12 mo	$ 20,172
Senior Research Associate	25 % effort for 12 mo	$ 19,988
Senior Research Associate	12.5 % effort for 12 mo	$ 8,391
Graduate Intern	50 % /sem; 100 % summer	$ 1,722
SUBTOTAL PERSONNEL		$ 76,243
Staff Benefits		
Staff (30%)		$ 22,356
Graduate Intern (21%)		$ 586
SUBTOTAL STAFF BENEFITS		$ 22,942
TOTAL PERSONNEL & BENEFITS		**$ 99,185**
Supplies and Materials		
(Supplies, plotter paper, plotter ink)		$ 50
		$ -
Travel		
In State		$ 138
Out of State		$ -
Training		$ 750
Current Services		
Communications (long distance)		$ 37
Printing and Binding		$ -
Contracted Services		
On-call technical assistance		$ 5,000
		$ -
		$ -
Fixed Charges		
Rental of Equipment/State Vehicles		$ 75
Other Fixed Charges (software maintenance fees, $1,800/yr/key)		$ 2,450
Student Aid / Tuition Remission		

In State	$	-
Subcontract		
Household travel survey	$	84,370
Transit on-board survey	$	-
TOTAL OTHER DIRECT COSTS	**$**	**92,870**
Facilities & Administrative Costs		
20% of MTDC **	**$**	**26,536**
TOTAL BUDGET	**$**	**218,591**

* Uses a 3% growth factor/yr
** 20% based on one contract through the Master Agreement between NCSU-ITRE and NCDOT.