Memorandum

To: Charlotte Regional Transportation Planning Organization (CRTPO)

From: Adam Howell, Mohan Garakhalli, Rinal Chheda (Atkins)
Jennifer Graf, Abigail Osei-Asamoah, Joseph Schirripa, Krista Goodin, Jennifer Humphreys (CDM Smith)

Date: 01/16/2020

Subject: I-77 Corridor Study – Traffic Methodology for Task 4 – Recommended Approach

Task 4 of the study involves an existing and future conditions analysis with the objective of defining the expected mobility conditions in the study corridor, if further coordinated policy and investment decisions are not pursued. This memo documents the recommended approaches, definitions and methodology for performing Task 4.1 Travel Demand Model Review and Modification. For Task 4.1, the Metrolina Regional Tour Model (MRM1901_PPSL) will be the principal modeling tool and data set used for the analyses.

Base Year Analysis

This describes the set of proposals and recommendations proposed by the project team to be used in analysis of the base year.

Base Year Designation

An existing 2020 conditions will be developed using the 2015 base year volumes from the MRM1901_PPSL. The project team recommends applying adjustments to the 2015 base year data to develop the 2020 existing conditions model. This will be achieved by applying growth rates and scaling proportions to the 2015 base year data from observed 2020 traffic data. Once developed, the existing 2020 model will be reviewed for reasonableness to ensure that it captures the existing conditions in the study corridor.

Truck Modeling

The study team recommends no additional model calibration be done to the truck data within the MRM1901_PPSL, but rather the truck output data from the model will be checked for reasonableness using truck percentages and compared to observed data where available.

Subsequent to this reasonableness check, any anomalous deviations will be identified and presented to all stakeholders for further resolution and direction for reconciling these differences.

Corridor Validation Plan

Corridor validation plans will focus on high level validation of input data, including socioeconomic data and transportation network data within the project corridor, to check for reasonableness. Validation of travel volume outputs from the MRM1901_PPSL will be completed using observed data, where available, such as traffic counts from multiple data sources including, but not limited to the following:

- Charlotte Department of Transportation (CDOT)
- North Carolina Department of Transportation (NCDOT)
- South Carolina Department of Transportation (SCDOT)
- HERE Technologies (HERE) data

A maximum of **10** validation runs have been programmed into the project scope with traffic validation performed for only daily (24hr) traffic volumes. A validation run will consist of a unique set of adjustments consistent with each run documented to demonstrate improvement of each run and closing of run results to specified targets discussed below. These adjustments will be limited to network level adjustments including fixing network coding errors and adjusting centroid connectors to improve highway validation statistics. No adjustments will be made to socioeconomic data during these validation runs. System level validation of traffic volumes within the project corridor will include the following:

- Comparison of Modeled versus Observed Traffic Volumes by Screenline, and by facility type;
- Vehicle Miles of Travel (VMT) comparison between modeled volumes and observed counts by facility type and area type;
- Root Mean Square Error (RMSE) and Percent Root Mean Square Error (%RMSE) between model and observed counts by facility type and volume groups; and
- Growth of VMT and Vehicle Hours of Travel (VHT) between base year and future year.

Corridor Validation Targets – Traffic Volumes

Validation runs will be performed to ensure that validation of traffic volumes from the corridor meets established targets. Validation Targets available to use in the study include Federal Highway Administration (FHWA) guidelines and targets used in the– North Carolina Statewide

Transportation Model (NCSTM), the NC Small Area Models (NCSAMs) and other MPOs in North Carolina, such as the Triangle Regional Model (TRM). The study team recommends using FHWA guidelines where available, and the NCSAM targets where FHWA guidelines are not available. These validation targets are summarized in **Tables 1** to **6**. It is to be noted that although validation will be performed using daily metrics, AM and PM peak period analysis will be conducted and documented for existing conditions. This will also serve as a datum for comparative analysis of future conditions for the same time periods.

Table 1: Percent Deviation Targets for Daily Volumes by Functional Class recommended by the FHWA

Facility Type	FHWA Deviation Target
Interstates and Freeways	+/- 7 percent
Principal Arterials	+/- 10 percent
Minor Arterials	+/- 15 percent
Collectors	+/- 25 percent
Frontage Road	+/- 25 percent

Table 2: Percent Deviation Targets for Model vs. Observed VMT recommended by the FHWA

Facility Type	FHWA Deviation Target
Freeways /Expressway	+/- 7 percent
Principal Arterials	+/- 10 percent
Minor Arterials	+/- 15 percent
Collectors	+/- 25 percent

Table 3: % RMSE by Facility Type Validation Targets used in the TRM, NCSAM and NCSTM

Facility Type	% RMSE Target		
	TRM	NCSAM	NCSTM
Interstate	N/A	25%	25%
Freeway/Expressway		40%	40%
Principal Arterial		50%	50%
Minor Arterial		50%	50%
Collector		65%	65%
Total	**35%**	**30-40%**	**30-40%**

Table 4: % RMSE by Volume Group Validation Targets used in the NCSAM and NCSTM

Volume Group	NCSAM	NCSTM
0-4,999	120%	N/A
5,000-9,999	45%	45%
10,000-19,999	40%	40%
20,000-39,999	35%	35%
40,000-59,999	30%	30%
>60,000	20%	20%

Table 5: % RMSE by Volume Group Validation Targets used in the TRM

Volume Group	Target Deviation
1-1,000	150%
1,001-2,500	75%

Volume Group	Target Deviation
2,501-5,000	50%
5,001-10,000	45%
10,001-25,000	30%
≥ 25,001	23%
Total	**35%**

Table 6: Screenline Validation Targets used in the TRM

Screenline/ Cutline	Target Deviation
Screenline	+/- 10%
Cutline	+/- 15%

Future Year Analysis

This section provides a list of recommendations and proposals to be adopted for use in the future year analysis methodology. This scenario will provide a base line data set, quantifying and illustrating the performance of the highway network.

For transportation planning projects, the Future Year Scenario provides planners with a baseline condition against which proposed improvements within the planning process are compared and measured for performance. The project team recommends that the Future Year Scenario include at a minimum, the existing plus committed (E+C) project network of the MRM1901_PPSL.

Identification and Review of Potential Developments and Committed Projects

Contingent on the finalization of the study area boundary; assumed to be 3 miles to the east and west of I-77, the study team will identify and produce a list of E+C projects (initially derived from all stakeholders, specifically CRTPO and RFATS) in the study corridor. This list will be submitted to the CRTPO for review. The purpose of this review is for the CRTPO to determine which projects from the Statewide Transportation Improvement Program (STIP) and the Metropolitan Transportation Plan (MTP) will have a high likelihood of being built and for which it is desired to measure impacts with the assumption that those projects will be in place for all Future Year scenarios. Traditionally, "committed" refers to projects that are at least partially funded or have funding dedicated to the programming and construction of the project, and this review by the project team and approval by all stakeholders will support the proper identification of E+C projects.

In addition, Task 3 of the study includes a review of the planned and programmed projects in the study corridor that can either influence traffic operations or are of regional significance. Routes of regional significance are typically identified in regional studies/documents such as the Comprehensive Transportation Plan and a preliminary list of such routes will be identified and presented to the stakeholders for approval. Task 3 will include a review of current and future proposed land uses and will potentially be used to update elements of Task 4, if needed.

Measures of Effectiveness (MOEs) / Performance Measures

The study team recommends several metrics to evaluate and assess current and future conditions within the corridor for both the existing base year, and future year scenarios in Task 4. These MOEs will measure performance within the study corridor and will be derived from the outputs of the MRM1901_PPSL. This memo identifies **only** performance metrics that will be derived from the MRM1901_PPSL in Task 4.1, some of which will potentially be used in subsequent tasks in the study including Tasks 4.1 and 5. In addition, contingent on data availability, the metrics obtained from the outputs from the MRM1901_PPSL will be compared to observed data. Formulae for computing some of these metrics are provided in **Appendix A.**

Traffic Operations Performance Measures

These MOEs extracted as part of Task 4.1, will be used to assess and evaluate traffic performance with respect to mobility and congestion within the corridor. The MRM1901_PPSL produces several of these MOEs in its outputs directly or they can be computed using its outputs for both average daily traffic, and peak period traffic. To evaluate congestion and performance in the study corridor, it is recommended that both peak period metrics for the AM and the PM, be extracted in addition to that for average daily values. The following describes the recommended MOEs to be used to evaluate congestion and performance in the corridor.

Travel Time

The MRM produces both congested and free flow travel times as an output. The free flow travel times within the MRM are a function of link level free flow travel times and intersection delay. Congested travel times are extracted from the MRM when the road network has been loaded with traffic volumes. Travel times, both free flow and congested flow, can be extracted from the MRM1901_PPSL. Segment travel times can be reported for important roads and thoroughfares within the study corridor.

Average Speed

Average speed can be used to compare traffic operations between the without and with proposed improvements scenarios. It can also be used to assess existing and future travel conditions within the corridor. The MRM produces both free flow speeds and congested speeds at a link level. Average speeds can also be derived from VMT and VHT and can be summarized at a corridor level, network segment level and by facility type to determine how different segments or how different facilities in the corridor perform once they are loaded with traffic.

Delay

Delay is additional travel time experienced by a traveler as a result of congestion and is thus the difference between an ideal travel time and an actual travel time. While ideal travel time cannot be measured, free-flow travel time can be used as a surrogate for ideal travel time because free flow conditions (specifically free flow speeds and travel times) would be what a traveler would experience with no congestion on roadways. There are several ways of measuring and characterizing travel delay and this study focuses on the three methods described below. While different types of delay can be derived using inputs and outputs from the MRM, the study team recommends using both Vehicle Hours of

Delay (VHD) and Per Capita Peak Hours of Delay as performance measures for evaluating delay in the study corridor.

- ***Travel Time Delay***: This is the difference between congested and free flow travel time.
- ***Vehicle Hours of Delay (VHD*)**:** This is obtained by finding the difference between the vehicle hours traveled at congested speeds and vehicle hours traveled at free flow speeds.
- ***Per Capita Peak Hours of Delay***: This is obtained by dividing the vehicle hours of delay experienced in the peak periods by the total population.

Volume to Capacity Ratio (V/C)

This measure compares the traffic demand to the available capacity on a roadway and is defined as the ratio of the traffic volume to the capacity of the roadway. V/C ratios greater than 1.0 characterize congested travel conditions, because the traffic demand is exceeding the capacity of the roadway. V/C ratios can often be used to define level of service (LOS) for roadway links based on established criteria by state agencies and MPOs including NCDOT, CDOT, and SCDOT. Contingent of the availability of established LOS thresholds based on V/C ratios from these agencies, the study team will define LOS for the links in the corridor using these established thresholds for average daily traffic.

Travel Reliability Measures

Travel Time Reliability - Travel time index (TTI):

Travel time reliability is the consistency or dependability in travel times for a given trip. Travel Time Index (TTI) is one of the metrics used to characterize travel time reliability and is defined as the ratio of actual travel time experienced by drivers to time required to make the same trip at free flow speeds. This measure can be derived using outputs from the MRM1901_PPSL at a link level. It can also be averaged across road sections and weighted by VMT. Calculated TTIs will then be compared to CRTPO’s TTI thresholds to classify roadway operations for various analysis scenarios which will be further used to perform comparative analyses.

APPENDIX A

The following provides some of the formulae used to compute some performance measures described in this memo. Some of these formulae are directly used in the MRM1901_PPSL to produce outputs including free flow travel time, congested travel time, congested VHT, and VMT.

$$Free\ Flow\ Travel\ Time\ (TT_{free}) = Link\ Free\ Flow\ Travel\ Times\ + Intersection\ Delay\ Time$$

$$Link\ Free\ Flow\ Travel\ Times\ (hr) = \frac{Length\ of\ Link\ (mi)}{Link\ Free\ Flow\ Speed\ (mph)}$$

$$Link\ Free\ Flow\ Speed\ (mph) = Posted\ Speed\ Limit\ \times Speederfac\ \times SpFr_{Ped} \times SpFr_{DevDn} \times SpFr\_Drvwy$$

Where:

$\text{Speederfac} = \text{Speed Adjustment factor for Facility and Area Type}$

$\text{SpFr}_{\text{Ped}} = \text{Speed Adjustment factor for Intensity of Pedestrian Activity}$

$\text{SpFr}_{\text{DevDn}} = \text{Speed Adjustment factor for Development Density}$

$\text{SpFr}_{\text{Drvwy}} = \text{Speed Adjustment factor for Driveway Density}$

$$VMT = Traffic\ Volume\ (Vehicles) \times Length\ of\ Link\ (mi)$$

$$Congested\ VHT = Traffic\ Volume\ (Vehicles) \times Congested\ Travel\ Time\ (hr)$$

$$Free\ Flow\ VHT = Traffic\ Volume\ (Vehicles) \times Free\ Flow\ Travel\ Time\ (hr)$$

$$Average\ Speed = \frac{VMT}{VHT}$$

$$VHD = Congested\ VHT - Free\ Flow\ VHT$$

$$TTI = \frac{Congested\ Travel\ Time\ in\ the\ Peak\ Period}{Free\ Flow\ Travel\ Time}$$