APPENDIX A: TRAFFIC SIMULATION MODEL CALIBRATION MEMORANDUM

To:	David Souleyrette	From:	Graham Winchester Ashley Williamson
	KYTC Division of Planning		Stantec
File:	KY 32 Corridor Study	Date:	November 15, 2021

Reference: KY 32 Simulation Model Calibration Memorandum

Introduction

As a part of the *KY 32 Corridor Study*, Stantec developed a traffic simulation model depicting existing peak hour conditions using Caliper's TransModeler (version 5) simulation package. **Figure 1** presents the simulation model study area, which includes the study corridor along KY 32 (Flemingsburg Rd.) from KY 377 north of the I-64 interchange to US 60 in Morehead, Kentucky.

Figure 1: KY 32 Simulation Model Study Area

Site Visit

A site visit was performed for the KY 32 Corridor Study on May 5th, 2021. During the site visit, spot counts were taken at the major driveways and queues were estimated at the signalized intersections. The observed queues were compared to model queues during the calibration process.

Model Development

The simulation model network was created by exporting the study area from KYTC's District 9 (D9) travel demand model network. Roadway names and classifications were then added to the link layer based on KYTC's HIS data. Signal timing plans, provided by KYTC District 9, were also added to the eleven signalized intersections for the AM and PM peak periods. Turning movement files were created based on turning movement counts at the following locations:

1) KY 32 at Cranston Rd. (KY 377)
2) KY 32 at Viking Dr.
3) KY 32 at Walmart Way
4) KY 32 at Kroger Centre Dr.
5) KY 32 at WB I-64 ramps
6) KY 32 at EB I-64 ramps
7) KY 32 at Fraley Dr.
8) KY 32 at Forest Hill Dr.
9) KY 32 at Old Flemingsburg Rd.
10) KY 32 at Sister Jeannette Dr.
11) KY 32 at 2nd St.
12) KY 32 at Main St.
13) KY 32 at 1st St.
14) KY 32 at US 60

Based on a review of the traffic counts, it was determined that the AM peak hour is 7:15 – 8:15 and the PM peak hour is 4:30 – 5:30.

Base Model Review Meeting

A modeling status meeting was held via Microsoft Teams on August 20, 2021 at 10:00 a.m. EDT. The following individuals were in attendance:

Jay Balaji – Central Office Planning
Stephen De Witte – Central Office Planning
Blake Jones – District 9
David Souleyrette – Central Office Planning
Beth Niemann – Central Office Planning
Scott Thomson – Central Office Planning

Brian Aldridge – Stantec
Mark Butler – Stantec
Graham Winchester – Stantec

The purpose of the meeting was to update the project team on progress to date for the D9 travel demand model and the KY 32 simulation model. Among the topics discussed were updates to the TDM 2019 socioeconomic data, coordination on growth scenarios, and existing peak hour simulation model development and queues. Stantec provided KYTC with copies of the simulation model and the updated D9 TDM after the meeting.

Model Trip Tables

Trip tables for the AM and PM peak hours were developed using a 54 x 54 matrix with rows and columns representing each of the external nodes and internal centroids in the network.

The turning movement counts were used as inputs for TransModeler's origin-destination matrix estimation procedure to develop trip tables for the AM and PM peak hours. These counts, which were collected in 15-minute intervals, were also analyzed to develop the time distribution curve of traffic in the trip tables. **Table 1** and **Table 2** present the time distribution of traffic for the AM and PM peaks.

Table 1: Time Distribution for AM Peak

Time	% of Total
7:15	19.6%
7:30	28.5%
7:45	29.6%
8:00	22.3%

Table 2: Time Distribution for PM Peak

Time	% of Total
4:30	25.4%
4:45	24.7%
5:00	26.3%
5:15	23.6%

In lieu of using a generic preload, warmup matrices were developed to ensure appropriate traffic conditions were in place at the beginning of each peak period. An analysis of turning movement counts found that the 30-minute period prior to the AM peak includes 30 percent of the peak hour traffic. Similarly, the 30-minute period prior to the PM peak includes 48 percent of the peak hour traffic. The AM and PM matrices were factored by these percentages to create the model's respective warmup matrices for each model period.

Vehicle Class Parameters

TransModeler's default vehicle fleet distribution was updated to better reflect Kentucky averages, which tend to have a higher percentage of pickups and SUVs. Since single-unit and multi-unit trucks were represented in separate matrices, the vehicle fleet mix was comprised solely of passenger vehicles. **Figure 2** presents a comparison of vehicle fleet mixes for the KY 32 simulation model, Caliper default values, and Kentucky averages. The vehicle fleet mix for this project is as follows:

- Car Low MPR (High performance passenger cars) – 6.0%
- Car Mid MPR (Middle performance passenger cars) – 21.0%
- Car High MPR (Low performance passenger cars) – 15.0%
- Pickup/SUV – 54.0%
- Bus – 3.0%
- Motorcycle – 1.0%

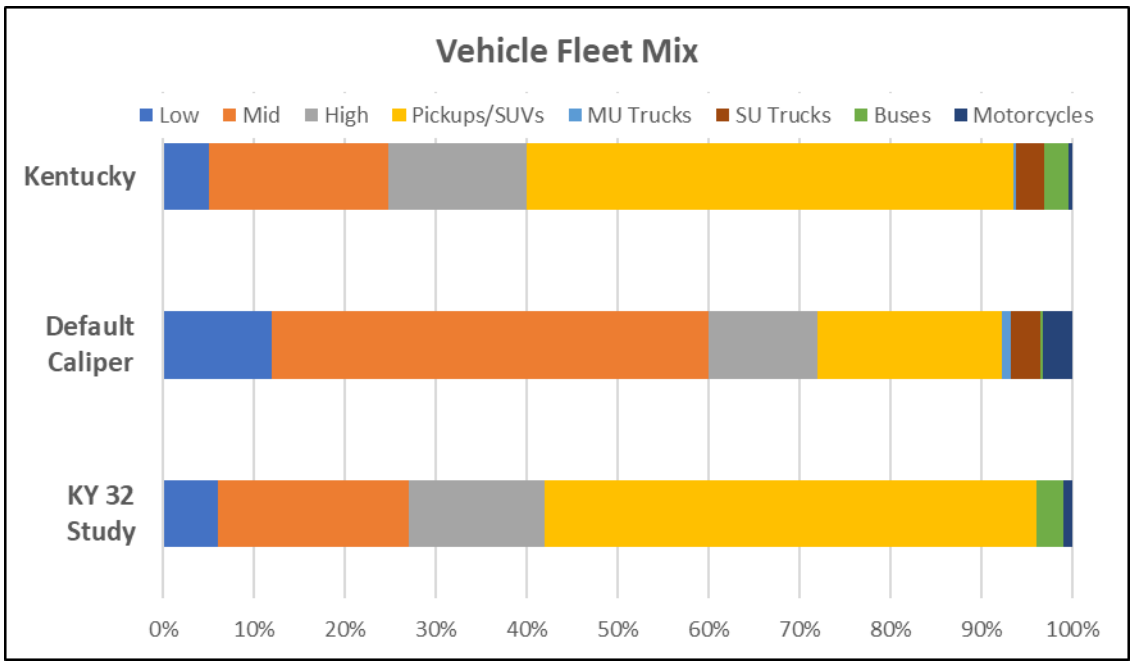

Figure 2: KY 32 Model Vehicle Fleet Mix

Matrices depicting single-unit and multi-unit trucks were developed separately and not included in the general vehicle fleet mix.

Stopped Gaps

When a vehicle comes to a stop, the spacing between vehicles can have a significant impact on queue length and capacity. Stopped gaps in Kentucky average 9.47 feet in urban areas and 11.7 feet in rural areas. Caliper's default parameters do not differentiate between urban and rural areas, instead differentiating between stopping behind a non-heavy vehicle and stopping behind a heavy vehicle. The default Caliper values are shown in **Table 3** below.

Table 3: Gaps Between Stopped Vehicles

Scenario	Default Mean (ft)	Updated Mean (ft)	St. Dev (ft)
Non-heavy vehicle in front	8.0	9.3	4.0
Heavy vehicle in front	12.0	12.0	4.0

To better reflect conditions in an urban Kentucky study area, the mean stopped gap with a non-heavy vehicle in front was raised to 9.3 feet.

Calibration

The criteria used to confirm that the simulation model has been sufficiently calibrated were taken from the Federal Highway Administration's (FHWA) *Traffic Analysis Toolbox Volume III:*

Guidelines for Applying Traffic Microsimulation Modeling Software, July 2004 (FHWA Publication No. FHWA-HRT-04-040). The specific criteria, which were originally developed by the Wisconsin Department of Transportation, are found in Table 4 on page 64 of that document. The criteria consist of three general metrics: 1) visual audits, 2) traffic flow, and 3) travel speeds. Traffic flow and travel speeds are quantifiable based on observed data and the model output while the guidance says that visual audits are to be conducted to the "analyst's satisfaction."

Visual audits were performed throughout the calibration process. At the beginning of the process, areas with congestion were specifically targeted to ensure that these areas reflected existing traffic conditions.

Intersections were checked to ensure that the turning movement and link-based counts were accurate. Once errors in data and the model geography were resolved, areas where the traffic was inconsistent with expected volumes were reexamined. In rare cases where necessary for low volume external nodes, minor adjustments were made to trip tables to reflect professional judgement of expected minimal traffic levels from those locations. An iterative process of incremental adjustments made in isolation was used to ensure the overall balance of the model was maintained.

To compare traffic flows, link-based trip volumes for the five runs were averaged and compiled for each direction of each link and compared to actual traffic counts on the segments. Several statistical measures were used to measure model assignment volumes to matched observed counts. The most important of these measures is percent root-mean-square error (RMSE) with a target threshold of 20 percent or lower to confirm the model was sufficiently calibrated for assigned volumes. **Table 4** presents the calibration statistics for both the AM and PM models.

Table 4: Volume Calibration Statistics

Total Volume to Count:	AM Peak	PM Peak
Target: within 5% of count		
Sum of assignment	50,556	62,529
Sum of counts	52,567	62,459
Sum assign/counts (within 5%)	3.83%	0.11%
Links with <700 vehicle count	79	76
Link assignments within 100 vehicles of count	79	76
Target: within 85% of links	100%	100%
Links between 700 and 2700 count	40	42
Link assignments within 20% of count	40	40
Target: within 85% of links	100%	95%
Percent Root Mean Square Error		
Target: < 20.00%	7.23%	3.73%

It was determined at the Scoping Meeting that the project team would not use the National Performance Management Research Data Set (NPMRDS) for speed comparisons. Instead, speeds from the Kentucky Statewide Model (KYSTM) were compared to speeds from the simulation model. Since the KYSTM speeds are average daily speeds, this comparison was used as a reasonableness check at the end of the calibration process. **Table 5** presents the comparison of KYSTM speeds to KY 32 simulation model speeds.

Table 5: Speed Comparison

KY 32 Location	KYSTM Speed (mph)	Simulation Model Speed (mph)			
		AM EB	AM WB	PM EB	PM WB
N of KY 377	40	39	36	39	37
Between I-64 & KY 377	32	33	36	29	42
Between Interchange ramps	27	24	24	24	24
S of I-64	28	28	40	16	35
Old Flemingsburg	55	53	54	52	54
W of US 60	18	32	10	19	10

Next Steps

The next step is to develop 2030 E+C "high" and "low" growth simulation models using annual growth rates from the D9 TDM.

STANTEC CONSULTING SERVICES INC.

Graham Winchester, PE
Transportation Engineer
Phone: (859) 422-3055
Graham.Winchester@stantec.com