To:	Connor Schurman KYTC Division of Planning	From:	Graham Winchester Stantec
File:	Smiths Grove Traffic Operations Study	Date:	December 19, 2022

Reference: Smiths Grove Simulation Model Calibration Memo

Introduction

As a part of the *Smiths Grove Traffic Operations Study*, Stantec developed a traffic simulation model depicting existing peak hour conditions using Caliper's TransModeler (version 6.0 Build 8085) simulation package. **Figure 1** presents the simulation model study area, which includes the study corridor along KY 101 from just north of US 68 to just south of Lawson Street in Smiths Grove, Kentucky.

Figure 1: Simulation Model Study Area

Model Development

The simulation model network was created by exporting the study area from KYTC's Bowling Green/Warren County Regional Travel Demand Model. Roadway names and classifications were then added to the link layer based on KYTC's HIS data. Turning movement files were created based on turning movement counts at the following locations (shown in Figure 1):

1) KY 101 at I-65 Northbound Ramps
2) KY 101 at I-65 Southbound Ramps
3) KY 101 at Jim Burrell Lane
4) KY 101 at Vincent Street

Cameras were set up at various business entrances/driveways north of the interstate, including Crossroads IGA, Smiths Grove Travel Center, Wendy's, Bryce Inn, Speedway, and Marathon. Counts at these locations were also entered into the turning movement file.

Based on a review of the traffic counts, it was determined that the AM peak hour is 7:15 AM – 8:15 AM, the PM peak hour is 3:30 PM – 4:30 PM, and the Saturday peak is 11:45 – 12:45.

Model Trip Tables

Trip tables for the AM and PM peak hours were developed using a 21 x 21 matrix with rows and columns representing each of the external nodes and internal centroids in the network. AM and PM seed matrices were extracted from the Warren County Travel Demand Model using the model software's subarea analysis tool. The Saturday seed matrix was developed using Streetlight origin-destination data.

The turning movement counts were used as inputs for TransModeler's origin-destination matrix estimation procedure, which uses an iterative algorithm to estimate trip tables for the peak hour trip patterns reflected in the counts. 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**, **Table 2**, and **Table 3** present the time distribution of traffic for the AM, PM, and Saturday peaks.

Table 1: Time Distribution for AM Peak

Time	% of Total
7:15	23.47%
7:30	33.06%
7:45	16.82%
8:00	26.65%

Table 2: Time Distribution for PM Peak

Time	% of Total
3:30	26.24%
3:45	25.26%
4:00	25.08%
4:15	23.42%

Table 3: Time Distribution for Saturday Peak

Time	% of Total
11:45	22.10%
12:00	25.49%
12:15	26.97%
12:30	25.45%

Vehicle Fleet

TransModeler's default vehicle fleet distribution was updated to better reflect Warren County averages, which tend to have a higher percentage of pickups and SUVs. **Figure 2** presents a comparison of vehicle fleet mixes for the KY 101 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) – 3.22%
- Car Mid MPR (Middle performance passenger cars) – 14.16%
- Car High MPR (Low performance passenger cars) – 17.61%
- Pickup/SUV – 59.22%
- SU Truck – 2.65%
- Bus – 0.53%
- Motorcycle – 2.61%

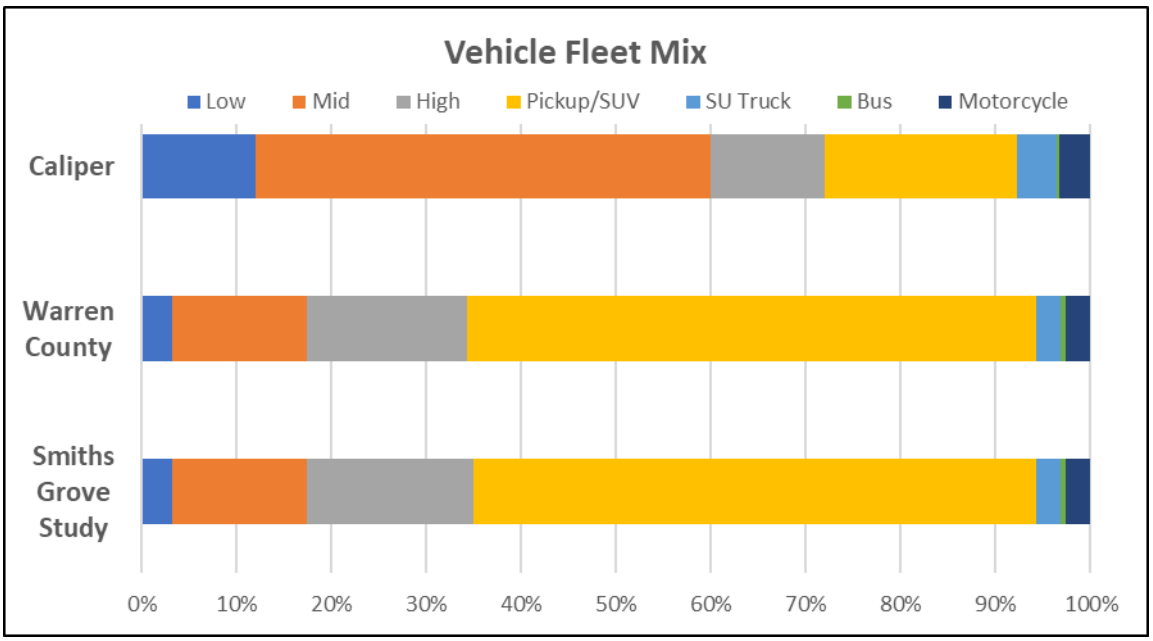

Figure 2: Smiths Grove Study Vehicle Fleet Mix

A matrix defining multi-unit truck trips was developed separately and not included in the general vehicle fleet mix.

Parameters & Road Class Definitions

The KYTC Microsimulation Guidelines provide a framework for conducting simulation analysis in Kentucky. The TransModeler Seed file, which includes a parameters file and a road class definition file, were used to update default Caliper values for the following parameters:

- Time Headway
- Minimum Headway
- Standstill Distance
- Acceleration
- Deceleration

- Lane Change Distance
- Vehicle Speed Ranges
- Truck Weight/Power

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 3** presents the calibration statistics for both the AM and PM models.

Table 3: Volume Calibration Statistics

Total Volume to Count:	AM Peak	PM Peak	Saturday Peak
Target: within 5% of count			
Sum of assignment	11,959	13,815	10,285
Sum of counts	11,570	13,516	10,156
Sum assign/counts (within 5%)	3.36%	2.21%	1.27%
Percent Root Mean Square Error			
Target: < 20.00%	7.42%	5.66%	5.39%

Average vehicle speeds are reported for each network link segment for both the AB and BA directions. The model speeds were compared to HERE speed data provided by KYTC. **Table 4** presents the comparison of HERE speeds to KY 101 simulation model speeds. As table 4 demonstrates, average model speeds are within 10% of observed speeds in all locations.

Table 4: Speed Comparison

Segment	Route	AM Peak			PM Peak		
		Observed Speed	Model Speed	Delta	Observed Speed	Model Speed	Delta
South of Interchange	NB KY 101	36.8	34.3	2.5	36.9	34.9	2.0
	SB KY 101	38.2	34.7	3.5	37.6	36.0	1.6
Between Interchange Ramps	NB KY 101	31.8	33.0	-1.2	28.0	30.8	-2.8
	SB KY 101	32.1	32.2	-0.1	28.0	30.4	-2.4
North of Interchange	NB KY 101	31.6	32.8	-1.2	30.0	31.5	-1.5
	SB KY 101	33.0	31.1	1.9	29.0	30.1	-1.1

Next Steps

With the model sufficiently calibrated to simulate existing conditions, the next step is to develop a base year scenario which includes expected Buc-ees traffic and expected roadway improvements.

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