APPENDIX B – SIMULATION MODEL CALIBRATION MEMORANDUM

To:	Scott Thomson	From:	Graham Winchester, EIT
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File:	I-65 Conceptual Improvements Study	Date:	October 14, 2019

Reference: Shepherdsville Traffic Simulation Model Development and Calibration

Introduction

As a part of the I-65 Conceptual Improvements Study, Stantec developed a traffic simulation model depicting existing peak hour conditions using Caliper's TransModeler (version 5) simulation package. The study area, as shown in **Figure 1**, extends from north of Exit 117 (KY 44) to just south of Exit 116 (KY 480). Based on a survey of traffic count data in the study area, the AM peak was determined to be 7:00 AM – 8:00 AM and the PM peak was determined to be 4:00 PM – 5:00 PM.

Model Development

Once the network was created, the roadway names and classifications were added to the link layer based on KYTC's HIS data. Signal timing plans were then added to the five signalized intersections for the AM and PM peak periods. Turning movement files were created for AM Autos, PM Autos, AM Trucks, and PM Trucks. Turning movement counts were taken from Kentucky Transportation Cabinet (KYTC) Item No. 5-538.

These turning movement counts were then aggregated by link to populate the following fields:

- AB_AM_TMC_Autos
- AB_AM_TMC_Trucks
- AB_PM_TMC_Autos
- AB_PM_TMC_Trucks
- BA_AM_TMC_Autos
- BA_AM_TMC_Trucks
- BA_PM_TMC_Autos
- BA_PM_TMC_Trucks

Directional traffic counts from existing KYTC count stations were used to populate links for the following fields:

- AB_AM_LC_Autos
- AB_AM_LC_Trucks
- AB_PM_LC_Autos
- AB_PM_LC_Trucks
- BA_AM_LC_Autos
- BA_AM_LC_Trucks
- BA_PM_LC_Autos
- BA_PM_LC_Trucks

Figure 1: Simulation Model Study Area

Origin-Destination Data

Origin-destination data from Streetlight was used to create seed matrices for AM Autos, AM Trucks, PM Autos, and PM Trucks. Streetlight develops trip records from two distinct sources. For this study, Navigation GPS data was used for trucks while Location-based services (LBS) data was used for autos. Both sources produce data in an unscaled index format rather than providing the actual number of trips. Data was collected from ten origin/destination zones for 2017, shown in **Figure 2**. The average weekday was determined to be Tuesday – Thursday with the AM peak 7:00 – 8:00 and the PM peak 4:00 – 5:00 PM.

The streetlight zones were matched with fifteen corresponding nodes from the simulation model. The Streetlight data was processed through pivot tables to produce a 15 x 15 matrix of the index values to create seed matrices for time period and vehicle class. TransModeler's Origin-Destination Matrix Estimation tool used the link-layer counts and turning movement counts for each time period and vehicle class to factor and scale each seed matrix to develop new trip tables for AM Autos, AM Trucks, PM Autos, and PM Trucks.

To further improve the trip tables, the time distribution of traffic was updated to a curve with four intervals. **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	25.7%
7:30	24.9%
7:45	23.6%
8:00	25.8%

Table 2: Time Distribution for PM Peak

Time	% of Total
4:30	24.3%
4:45	23.1%
5:00	26.2%
5:15	26.4%

Vehicle Class Parameters

The vehicle class parameters for the AM and PM Autos matrices were updated to values similar to the Bullitt County overall fleet characteristics:

- Car Low MPR (High performance passenger cars) – 5.31%
- Car Mid MPR (Middle performance passenger cars) – 35.05%
- Car High MPR (Low performance passenger cars) – 7.10%
- Pickup/SUV – 44.82%
- Single-Unit Truck – 4.00%
- Bus – 0.31%
- Motorcycle – 3.41%

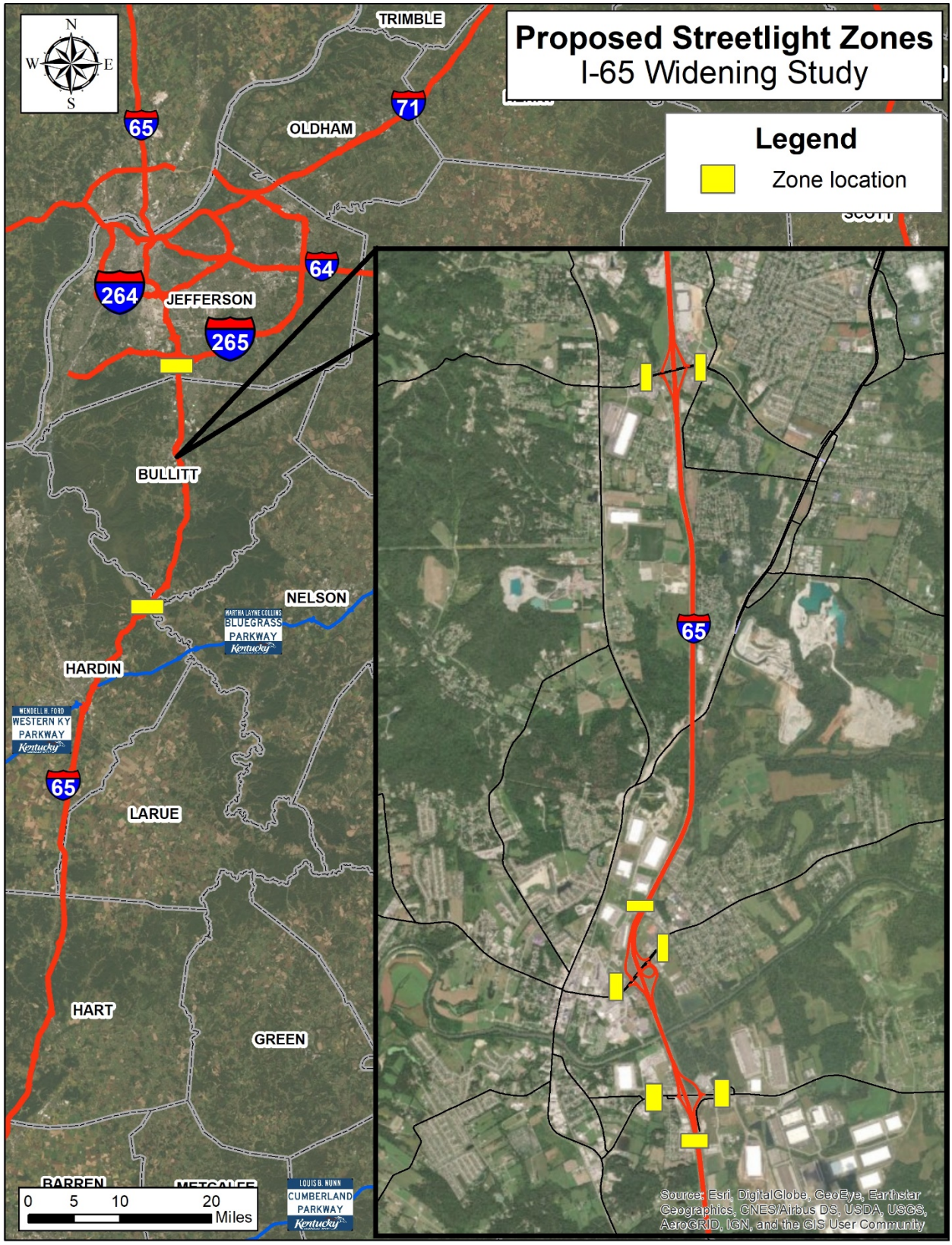

Figure 2: Streetlight Origins and Destinations

Calibration

The criteria used to confirm that the simulation model has been sufficiently calibrated were taken from FHWA's *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 heavy 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. Common corrections included the proper placement of lane connectors and the correct assignment of signal timing plan phases. Once errors in data and the model geography were resolved, areas where the traffic was inconsistent with expected volumes were reexamined. Where necessary, trip values in the trip tables were adjusted for external nodes for which no count data was available, according to professional judgement. 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 were compiled for each direction of each link and compared to actual traffic counts on the segments. Since the traffic counts were from several different years, all counts were forecasted to the base year 2019 using growth rates from the Kentuckiana Regional Planning & Development Agency (KIPDA) Travel Demand Model.

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% or lower to confirm the model was sufficiently calibrated for assigned volumes. **Table 1** presents the calibration statistics for both the AM and PM models.

Table 1: Volume Calibration Statistics

Total Volume to Count:	AM Peak Hour	PM Peak Hour
Target: within 5% of count		
Sum of assignment	46,817	70,616
Sum of counts	45,417	68,608
Sum assign/counts (within 5%)	3.08%	2.93%
Links with <700 vehicle count	60	43
Link assignments within 100 vehicles of count	58	40
Target: within 85% of links	97%	93%
Links between 700 and 2700 count	14	28
Link assignments within 20% of count	14	25
Target: within 85% of links	100%	89%
Percent Root Mean Square Error	7.26%	6.94%
Target: < 20.00%		

Average vehicle speeds are reported for each network link segment for both the AB and BA directions. The model speeds were compared to actual recorded speeds using the National Performance Management Research Data Set (NPMRDS) in the study area. Locations with the highest speed differentials were looked at first. The first step in calibrating the speeds was to ensure that the default road classification speed limit and actual speed limit were the same. Several roadways had posted speed limits that did not match up with the default road classification speed limit, causing a large discrepancy between the model speed and actual speed. These speed limits were corrected. Other locations with high speed differentials were corrected in the process above, adding or subtracting trips to the trip tables in an iterative manner. **Table 2** presents the comparison of speed and demonstrates that all but one location record falls outside of the 10 percent threshold of observed-to-modeled speed

Table 2: Model Speed Comparisons

Link	Name	AM Peak Hour				PM Peak Hour			
		Model Speed	Observed Speed	Delta	% Delta	Model Speed	Observed Speed	Delta	% Delta
1	I-65 NB (S of Exit 116)	64.7	65.0	0.3	0.39%	64.1	64.3	0.1	0.20%
2	I-65 NB (Exit 116)	65.7	66.0	0.3	0.41%	65.7	65.5	0.2	0.37%
15	I-65 NB (Between Exits 116 & 117)	62.1	63.4	1.3	2.02%	61.5	62.5	0.9	1.53%
48	I-65 NB (Exit 117)	65.2	64.3	0.9	1.40%	64.8	64.1	0.7	1.14%
9	I-65 NB (N of Exit 117)	58.2	64.9	6.7	11.60%	63.0	64.8	1.8	2.92%
18	I-65 SB (N of Exit 117)	64.5	65.5	1.0	1.50%	60.4	64.7	4.3	7.13%
19	I-65 SB (Exit 117)	66.0	64.7	1.3	1.91%	64.8	64.0	0.9	1.34%
25	I-65 SB (Between Exits 116 & 117)	65.2	61.9	3.3	5.12%	62.1	60.0	2.1	3.35%
26	I-65 SB (Exit 116)	65.7	65.2	0.5	0.74%	64.5	64.3	0.2	0.39%
32	I-65 SB (S of Exit 116)	64.1	65.0	0.8	1.31%	63.2	65.1	1.8	2.87%

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