

APPENDIX B – BASE YEAR SIMULATION MODEL TECHNICAL MEMORANDUM

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File:	Russellville Road (US 68X & US 231X)	Date:	July 3, 2018
	Planning Study		

Reference: Russellville Road Calibration Memorandum

Introduction

As a part of the Russellville Road (US 68X & US 231X) Study, Stantec has developed a traffic simulation model depicting existing peak hour conditions using Caliper's TransModeler (version 5) simulation package. **Figure 1** presents the study area, which focuses on the area surrounding two intersections near Western Kentucky University's (WKU) campus in Bowling Green: Morgantown Rd. (US 231X) at Russellville Rd. (US 68X) and University Dr. (US 68X/231X) at Russellville Rd. (US 68X).

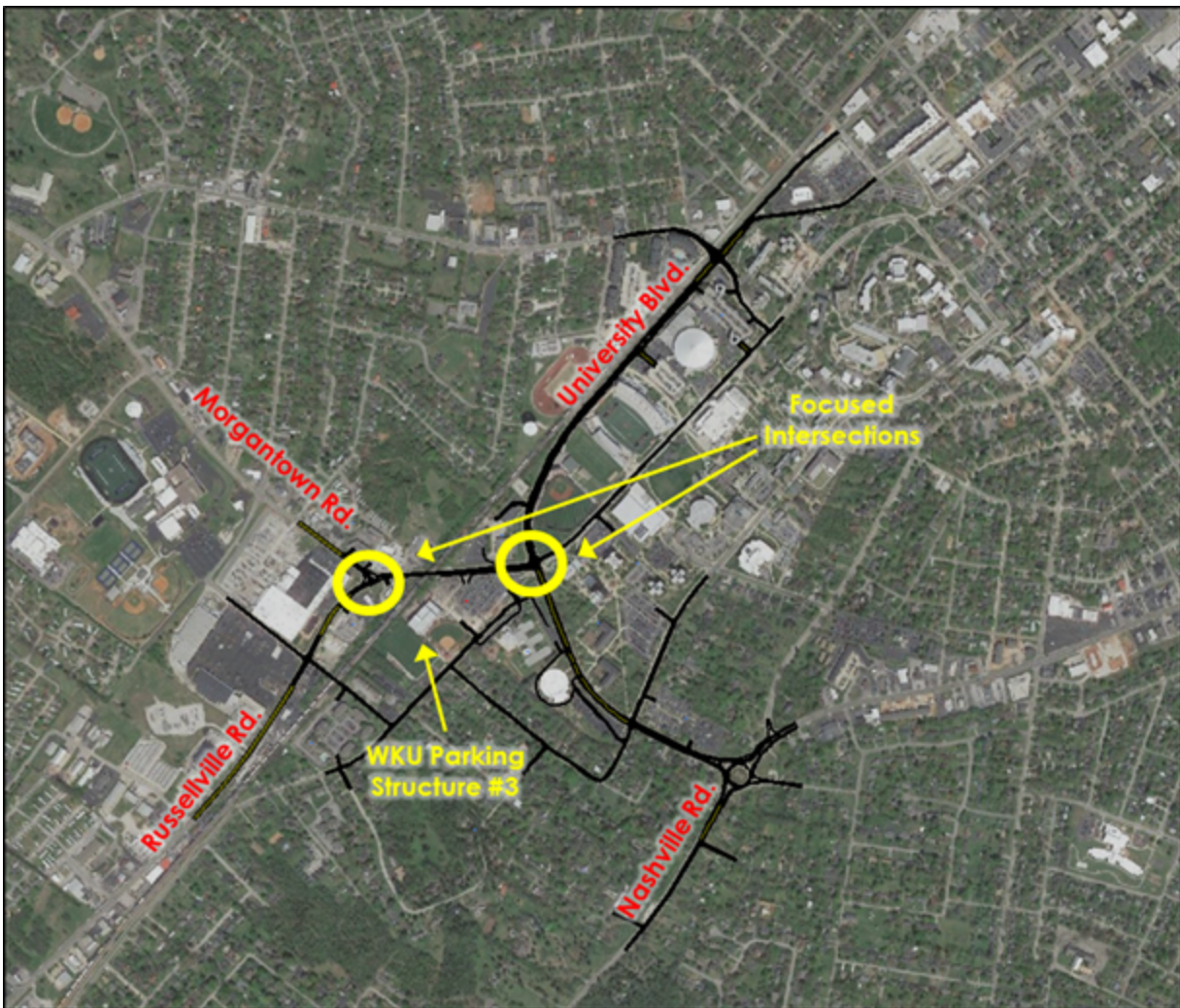


Figure 1: Russellville Road Simulation Model Study Area

Model Development

The Bowling Green Downtown Circulation Study Model was used as the initial source for the simulation model and network. The area in the current model was expanded and the area of downtown to the northeast of WKU were removed. Separate model scenarios are included for the AM peak hour and the PM peak hour. Aerial imagery and field notes were used to enhance and refine the network to include additional roadways and all appropriate roadway attributes such as turn lanes and median widths, and operational controls such as traffic signals and speed limits. Roadway names and classifications were added to the link layer based on KYTC's HIS data. Signal timing plans provided by KYTC were programmed for 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 by KYTC at the following locations:

- Russellville Road and University Boulevard
- University Boulevard and Creason Street
- Russellville Road and Morgantown Road
- Russellville Road and Robinson Avenue
- Creason Street and Robinson Avenue
- Creason Street and Sumpter Avenue
- University Boulevard and Normal Drive

Directional traffic counts from existing KYTC count stations were taken for the following locations:

- Russellville Rd. between Morgantown Rd. and University Dr.
- Russellville Rd. south of Morgantown Rd.
- University Dr. north of Russellville Rd.
- Morgantown Rd. west of Russellville Rd. intersection
- University Dr. south of Russellville Rd.
- US 31W south of University Dr.
- Old Morgantown Rd. west of University Dr.
- US 31W north of University Dr.

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

- | | |
|--------------|--------------|
| • AMcount_AB | • PMcount_AB |
| • AMcount_BA | • PMcount_BA |

Based on a survey of traffic count data in the study area, the AM peak hour was determined to be 7:30 – 8:30 AM and the PM peak hour was determined to be 4:30 – 5:30 PM.

After the collection of turn movement counts, Western Kentucky University (WKU) Parking Structure #3 opened in November 2017. A February 2018 site visit showed that the commuter garage was initially underutilized during the most recent spring semester. Presuming typically higher fall enrollment as well as the issuance of new parking permits and the establishment of new parking patterns, trips to and from the garage were estimated for the Fall Semester using the ITE Trip Generation Manual at levels reflective of structure's capacity.

Model Trip Tables

Individual auto and truck trip tables for the AM and PM peak hours were developed for a 26 x 26 matrix representing each of the external nodes and centroids in the network. A sub area analysis of the Warren County Regional Travel Demand Model was used to create seed tables for the development of AM and PM models. The model's TAZ file was adjusted to apportion student University trips and employee home-based work trips to the university area TAZs according to the latest parking information provided by WKU. The resulting subarea matrices and network link counts and turning movement counts were used inputs for TransModeler's Origin-destination matrix estimation procedure to develop trip tables for the AM Autos, AM Trucks, PM Autos, and PM Trucks. Turn movement counts, which were collected in 15-minute intervals, were 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
7:30	27.8%
7:45	29.2%
8:00	23.2%
8:15	19.8%

Table 2: Time Distribution for PM Peak

Time	% of Total
4:30	25.6%
4:45	25.0%
5:00	24.5%
5:15	24.9%

Vehicle Class Parameters

KYTC provided a vehicle fleet mix based on its analysis of regional vehicle registration data and classification count data. Based on a survey of the vehicle classification data, truck percentages were found to be 4% single-unit and 2% multi-unit trucks. The single-unit trucks were found to be distributed in the study area evenly and were included in the vehicle fleet mix. Multi-unit trucks mainly use Russellville Rd. and US 31W as external to external routes and therefore were assigned to a separate matrix that did not include trip ends to on campus parking lots. The vehicle fleet mix for autos is:

- 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%

The following Origin-Destination pairs were included in the multi-unit truck matrices:

- Russellville Rd. south (304609) to Russellville Rd. north (300999)
- Russellville Rd. north (300916) to Russellville Rd. south (304609)
- US 31W south (304655) to US 31W north (17)
- US 31W north (17) to US 31W south (304655)

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 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% 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 Hour	PM Peak Hour
Target: within 5% of count		
Sum of assignment	26,911	32,578
Sum of counts	26,111	31,663
Sum assign/counts (within 5%)	3.06%	2.89%
Links with <700 vehicle count	89	81
Link assignments within 100 vehicles of count	86	76
Target: within 85% of links	97%	94%
Links between 700 and 2700 count	14	22
Link assignments within 20% of count	12	20
Target: within 85% of links	86%	91%
Percent Root Mean Square Error	19.11%	19.30%
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 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 4** presents the comparison of speed.

Table 4: Model Speed Comparisons

Link	Direction	Name	AM Peak Hour				PM Peak Hour			
			Model Speed	Observed Speed	Delta	% Delta	Model Speed	Observed Speed	Delta	% Delta
388533	SE	Russellville Rd.	26.8	21.5	5.3	20%	17.3	19.3	-2	-11%
388558	E	Russellville Rd.	10.8	19.2	-8.4	-77%	23.2	19.2	4	17%
372658	N	University Blvd.	32.1	29.7	2.4	8%	32.1	28.0	4	13%
388524	SE	University Blvd.	26.1	24.2	1.9	7%	25.0	22.1	3	12%
388531	NW	Morgantown Rd.	16.2	21.0	-4.8	-29%	15.5	19.9	-4	-28%
388570	SW	US 31W	34.7	33.0	1.7	5%	33.9	31.4	3	7%
388417	SW	US 31W	32.1	34.4	-2.3	-7%	32.4	34.4	-2	-6%
388416	NE	US 31W	30.6	33.0	-2.4	-8%	31.5	31.4	0	0%

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