Russellville Road
(US 68X and US 231X) Planning Study

Warren County
KYTC Item No. N/A

FINAL REPORT

November 2019

KENTUCKY TRANSPORTATION CABINET

Stantec

EXECUTIVE SUMMARY

INTRODUCTION

The Russellville Road (US 68X and US 231X) Planning Study was initiated by the Kentucky Transportation Cabinet (KYTC) to evaluate the need for and impacts of transportation improvements along portions of Russellville Road and adjacent roadway facilities in Warren County. The study area, shown on **Figure ES-1**, includes approximately 86 acres surrounding US 68X (Russellville Road/University Boulevard) and US 231X (University Boulevard/Morgantown Road) in central Bowling Green, Kentucky and includes portions of the Western Kentucky University (WKU) campus.

The study includes US 68X from south of Robinson Avenue (MP 1.000) to north of Avenue of Champions (MP 1.626) and US 231X from north of Normal Street (MP 2.300) to south of Holly Drive (MP 2.600) along with portions of Robinson Avenue and Creason Street. This study serves as the first step in establishing goals, completing an existing conditions analysis, identifying potential needs and concerns, evaluating improvement concepts, and developing cost estimates in the study area.

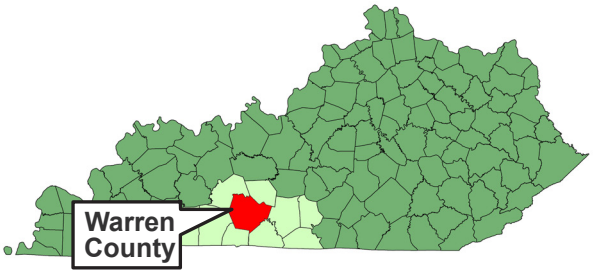

Figure ES-1*: Study Area (Not to Scale)*

PURPOSE AND NEED

The purpose of the Russellville Road study is to improve safety, reduce congestion, and better accommodate all modes of travel on US 68X (Russellville Road/University Boulevard) and US 231X (University Boulevard/Morgantown Road) in Bowling Green, KY.

Purpose & Need

- Safety, congestion, and multimodal travel are the primary concerns in the study area.
- Multimodal travel in the area includes pedestrians, bicyclists, and buses.

Over the three-year period between January 1, 2014 and December 31, 2016, there were 315 crashes reported in the study area. This included 35 injury collisions and zero fatal collisions. Of the 315 reported crashes, the most common were rear end collisions (114 crashes, 36 percent) with angle (65, 21 percent) and sideswipe collisions (63, 20 percent) the next most common. These types of crashes are often indicative of congested roadways and can be a symptom of poor access control. During this same three-year time period, there were six vehicle collisions with pedestrians, five of which resulted in injuries and zero fatalities. Critical crash rate factors (CRF's) were calculated for the three-year study period between January 1, 2014 and December 31, 2016. There is one high crash segment and eight high crash spots (0.1 miles in length) with CRF values greater than 1.0. The high crash spots and segments are shown in **Figure ES-2**.

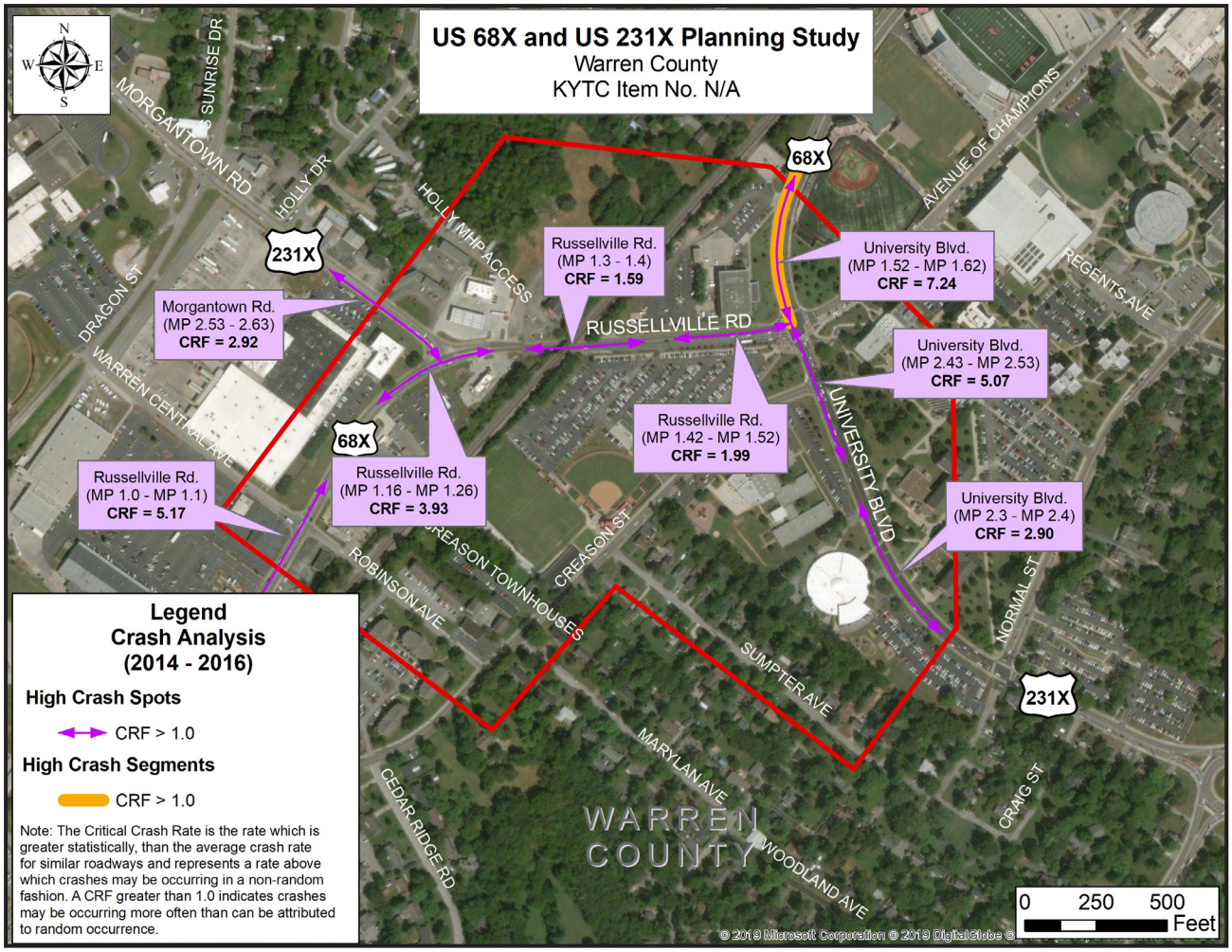

Figure ES-2*: High Crash Spots and Segments*

With the study area's proximity to WKU, traffic demand includes a mix of commuter travel into campus and local traffic traveling to/from downtown Bowling Green and the surrounding areas. Russellville Road has the highest Average Annual Daily Traffic (AADT) volume in the study area with 25,000 – 27,000 vehicles per day (VPD). University Boulevard (US 68X/US 231X) carries 16,500 – 19,000 VPD and Morgantown Road (US 68X) carries 13,600 VPD. The high traffic volumes on Russellville Road along with the proximity of the Morgantown Road

and University Boulevard intersections cause congestion issues, especially during the PM peak hour (4:30 to 5:30 PM). Currently, the Russellville Road intersection with University Boulevard operates at an undesirable Level of Service (LOS) E during the PM peak hour. LOS is a qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience.

Midblock Pedestrian Crossing on University Boulevard

Due to the proximity of WKU, there are high volumes of pedestrians and bicyclists in the study area. This is especially the case at the Russellville Road intersection with University Boulevard, where pedestrians using the Creason parking facilities cross to access campus. Many students also utilize Topper Transit, WKU's campus bus system. The Red, White, and Green Lines all travel through the study area. A 700-space parking garage on the Creason Parking Lot (WKU Parking Structure No. 3) was opened in November 2017, which has increased pedestrian travel in the area.

IMPROVEMENT CONCEPTS

Community outreach helped guide the study, particularly in identifying potential issues and developing improvement concepts. Over the course of the study, the project team held three in-person project team meetings, two local officials/stakeholders meetings, one meeting with the WKU Master Plan Committee, and one meeting with CSX Railroad. The project team also conducted public outreach that included mailing 3,200 survey postcards to addresses in and around the study area and sending a WKU campus-wide email with information on the project and a link to the survey.

Of the 421 responses from the online survey, approximately 36 percent were WKU faculty/staff, 32 percent were Bowling Green residents, and 29 percent were WKU students. The majority (84 percent) of the respondents travel the study area at least two times per week, with 58 percent living in the study area. 95 percent of respondents indicated that improvements were needed within the study area. When asked which improvements are most important, respondents indicated that widening Russellville Road and improving the intersection at University Boulevard were most important, as shown in **Figure ES-3**.

Respondents were then asked, understanding the lengthy road closures needed to replace the railroad bridge on Russellville Road (up to one year), should Russellville Road be widened to improve traffic flow and provide dedicated bicycle and pedestrian facilities? 79 percent of respondents indicated that Russellville Road should be widened even if lengthy road closures are needed.

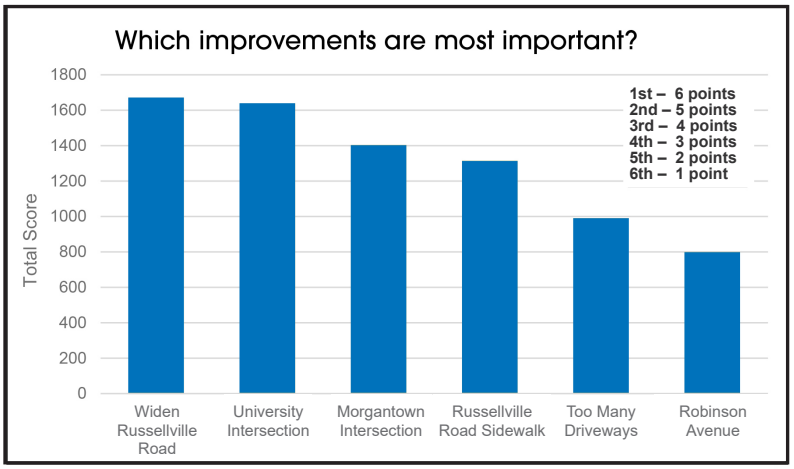

Figure ES-3*: Online Survey Responses*

Improvement concepts were developed based on a combination of input from the public and local stakeholders, a review of existing conditions, simulation model traffic analyses, and field reconnaissance. Along with the No-Build, this study examined several other types of improvements, as described below:

- **No-Build** – This option would make no transportation improvements. The No-Build serves as a baseline for comparison of improvement concepts.
- **Improvement Concept 1** – Signal optimization at the University Boulevard intersection and provide a sidewalk on Russellville Road. This improvement concept was modeled at the beginning of the concept development process and did not provide sufficient congestion relief and was therefore eliminated from further consideration.
- **Improvement Concept 2** – Add additional turn lanes at the University Boulevard intersection and provide a sidewalk on Russellville Road.
- **Improvement Concept 3** – Construct a roundabout at the University Boulevard intersection with a signalized midblock pedestrian crossing and provide a sidewalk on Russellville Road.

- **Improvement Concept 4** – Add additional turn lanes at the University Boulevard intersection and widen Russellville Road to four lanes including bicycle and pedestrian accommodations.
- **Improvement Concept 5** – Construct a roundabout at the University Boulevard intersection with a signalized midblock pedestrian crossing and widen Russellville Road to four lanes including bicycle and pedestrian accommodations.
- **Improvement Concept 6** – Construct a roundabout at the University Boulevard intersection with a signalized midblock pedestrian crossing, construct a roundabout at the Morgantown Road intersection, and widen Russellville Road to four lanes including bicycle and pedestrian accommodations.
- **Improvement Concept 7** – Construct a bike/ped tunnel under University Boulevard from the Creason Parking Lot. The cost of this improvement concept far outweighed the congestion relief and was therefore eliminated from further consideration.
- **Improvement Concept 8** – Construct a flyover to take Russellville Road over the existing CSX railroad bridge. The grades would be too steep for a flyover to tie into the adjacent intersections and was therefore eliminated from further consideration.

EVALUATION MATRIX

The improvement concepts were evaluated using detailed traffic microsimulation models to help the project team make recommendations regarding concept(s) to be carried forward for future project development. A summary of the complete evaluation matrix is shown in **Table ES-1**. Crash reduction and congestion relief benefits were used along with planning level cost estimates, which were prepared for each improvement concept based on average KYTC unit costs plus additional costs for special features such as bridges and traffic signals. Improvement Concepts 4, 5, and 6 include the widening of Russellville Road, which requires the replacement of the existing CSX bridge. These estimates include costs for a 30 mph "shoofly" which utilizes a temporary railroad alignment and a temporary railroad bridge for bypass track(s) while the existing railroad bridge is being replaced.

Table ES-1: *Evaluation Matrix*

Evaluation Matrix and Cost Estimates														
Improvement Concepts	Traffic at Russellville Rd/University Blvd Intersection				Bike/Ped Facilities on Russellville Road		2018 Cost Estimates (millions)					10-Year Benefit-Cost Ratio (BCR)		
	Year 2018 PM Peak Hour		Year 2040 PM Peak Hour											
	Intersection Delay (sec)	Intersection LOS[1]	Intersection Delay (sec)	Intersection LOS[1]	Pedestrian Accomodations	Bicycle Accomodations	Design	Right-of Way	Utility	Construction	Total	Crash Reduction (millions)	Congestion Relief[2] (millions)	BCR
No-Build	76	E	117	F	No	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Improvement Concept 2 Intersection Improvements at University Boulevard and Sidewalk on Russellville Road	36	D	74	F	Yes	No	$0.2	$2.0	$0.5	$1.0	$3.7	0.7	11.0	3.16
Improvement Concept 3 Roundabout at University Boulevard with Signalized Midblock Pedestrian Crossing and Sidewalk on Russellville Road	27	D	50	E	Yes	No	$0.3	$2.4	$1.9	$2.5	$7.1	3.4	7.5	1.54
Improvement Concept 4 Widen Russellville Road with intersection improvements at University Boulevard	36	D	68	E	Yes	Yes	$1.0	$2.7	$4.4	$8.6	$16.7	4.9	11.1	0.96
Improvement Concept 5 Widen Russellville Road with Roundabout at University Boulevard and Signalized Midblock Pedestrian Crossing	27	D	40	E	Yes	Yes	$1.1	$2.7	$4.4	$9.6	$17.8	7.5	9.1	0.93
Improvement Concept 6 Widen Russellville Road and Roundabout at University Boulevard with Signalized Midblock Pedestrian Crossing and Roundabout at Morgantown Road	19	C	43	E	Yes	Yes	$1.3	$2.9	$5.4	$11.0	$20.6	10.5	9.8	0.99

[1] In urban areas a LOS D or better is desirable.
[2] Based on reduction in average delay from AM and PM peak hours between 2018 and 2028 and average hourly rate of $19.09 per hour (source: Bureau of Labor Statistics)

RECOMMENDATIONS

Considering the technical data, comments from local officials/stakeholders, results from the public outreach survey, and results from the benefit-to-cost analysis, the project team chose to recommend a short-term project and a long-term project. Improvement Concept 2, improving the University Boulevard intersection and providing a sidewalk on Russellville Road, is the recommended short-term improvement. This concept is shown in **Figure ES-4**.

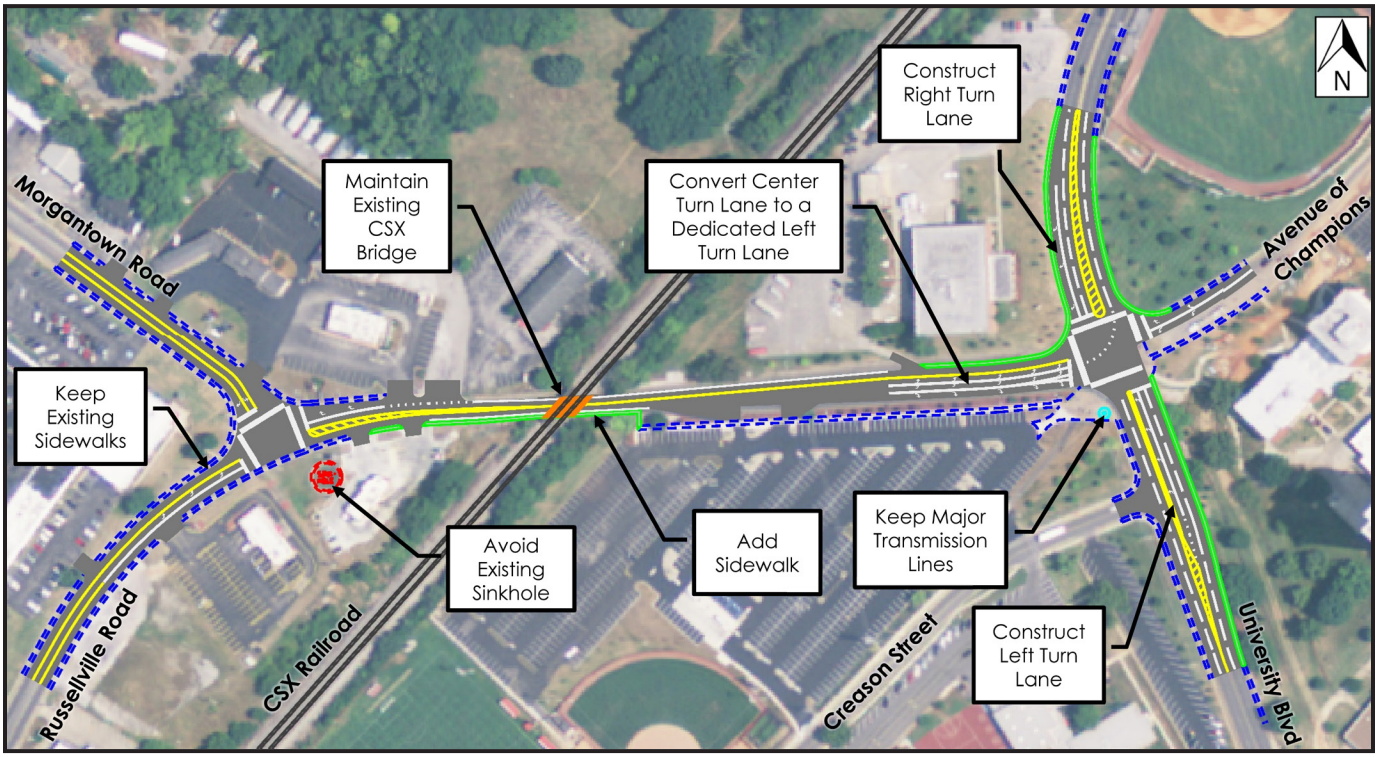

Figure ES-4*: Improvement Concept 2*

Improvement Concept 4, improving the University Boulevard intersection and widening Russellville Road to four lanes including a raised median and bicycle/pedestrian facilities, is the recommended long-term improvement. This concept is shown in **Figure ES-5**. Improvement Concept 4 utilizes the same intersection improvements at Russellville Road and University Boulevard so resources would not be wasted if Improvement Concept 2 were built first. The difference is Concept 4 replaces the CSX railroad bridge over Russellville Road in order to provide four travel lanes along with a sidewalk and a shared-use path.

The roundabout concepts were not recommended by the project team for the Russellville Road/University Boulevard intersection because the benefit-cost ratios, shown in **Table ES-1**, are better for the traditional intersection improvement concepts. Also, the utility impacts are considerably less, and the traffic analyses show that the roundabout alternatives have significantly increased delays on Creason Street, Morgantown Road, and Avenue of Champions. With the consistent stream of pedestrians coming to/from the Creason Parking Lot and vehicles coming from the major approaches, the minor approaches do not have sufficient gaps to enter the roundabouts. For these reasons, intersection improvements at Russellville Road/University Boulevard (Improvement Concepts 2 and 4) provide the best balance of traffic performance, multimodal accommodation, and reduced impacts. The traffic analyses also showed that in order to achieve a desirable LOS and delay during the 2040 PM peak, the widening of Russellville Road will eventually need to extend through Morgantown Road to the existing five-lane section at KY 880 (Campbell Lane), at which time a roundabout should be reconsidered for the Russellville Road/Morgantown

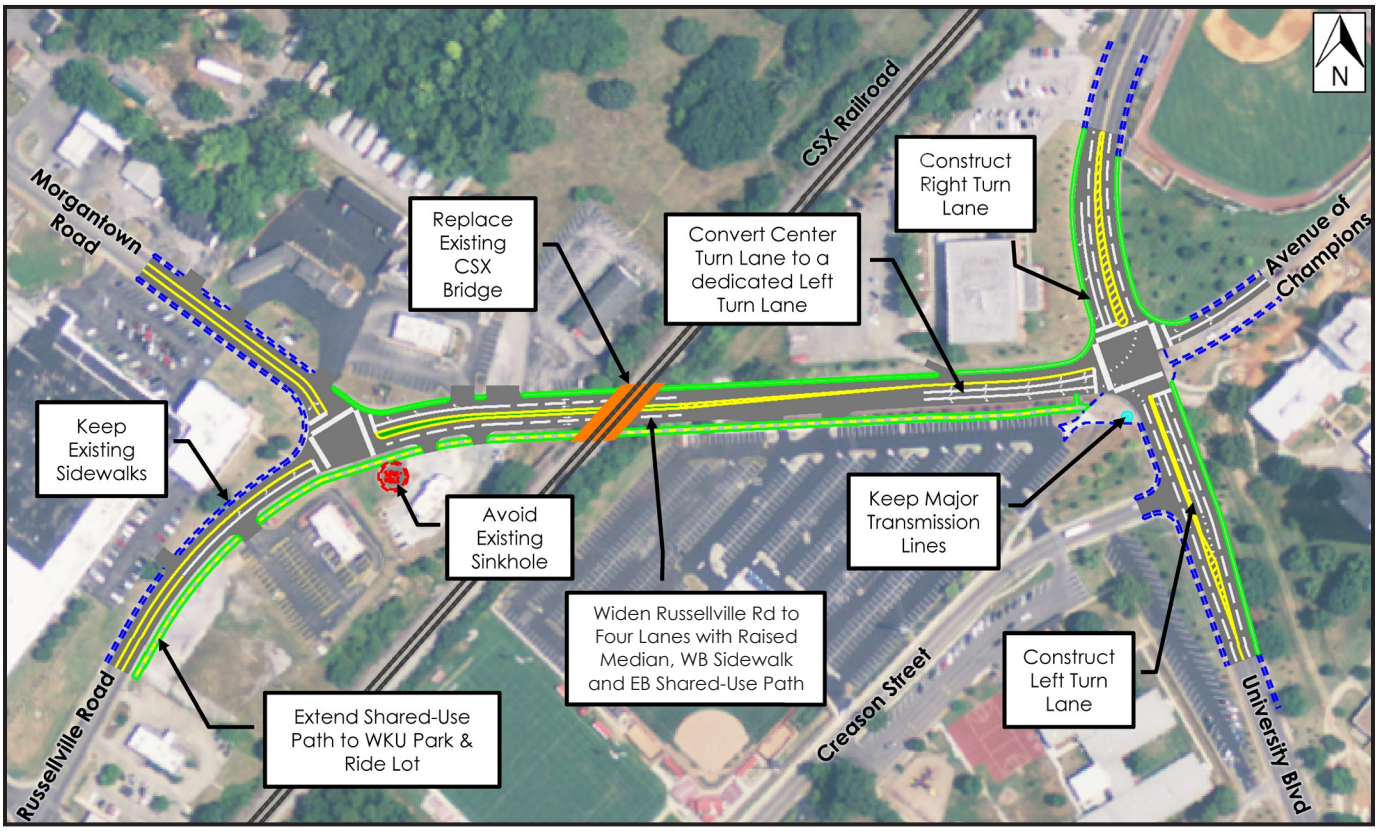

Figure ES-5*: Improvement Concept 4*

Road intersection. Widening Russellville Road to Campbell Lane was outside the scope of this study and is therefore not included in the cost estimates.

Future phases of the project should also explore prohibiting left turns from University Boulevard onto Creason Street. Stakeholder feedback indicated that this left turn is critical to WKU Topper Transit routes and some school buses accessing the W.R. McNeill Elementary School. The safety and traffic operation benefits of restricting this left turn merit further exploration in future project development phases if these buses can utilize alternate routes.

NEXT STEPS

The next phase for the Russellville Road (US 68X and US 231X) Planning Study would be Phase 1 Design (Preliminary Engineering and Environmental Analysis) for one or more of the recommended improvement concepts. Any improvement that includes the replacement of the existing CSX bridge will require the completion of TSL (type, size, and location) plans to be submitted to CSX for review and approval before continuing to the next design phase. Further funding will be necessary to advance an improvement to the design phase. Additional phases of the project are not funded in Kentucky's FY 2018 – FY 2024 Highway Plan. The next Highway Plan will be enacted in Spring 2020.

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Warren County
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KENTUCKY TRANSPORTATION CABINET

Kentucky Transportation Cabinet
Central Office, Division of Planning
Highway District 3, Bowling Green

In partnership with:

Stantec

November 2019

Table of Contents

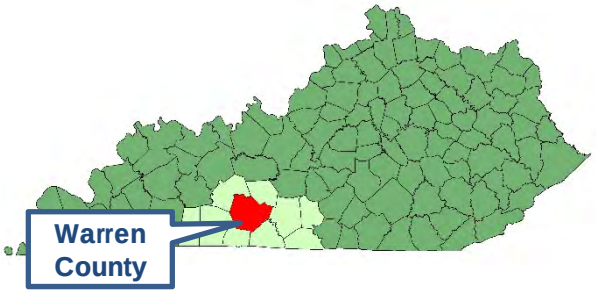
LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES (ON CD)

1.0 INTRODUCTION

The Russellville Road (US 68X and US 231X) Planning Study was initiated by the Kentucky Transportation Cabinet (KYTC) to evaluate the need for and impacts of transportation improvements along portions of Russellville Road and surrounding transportation facilities in Warren County. This project includes an examination of approximately 86 acres surrounding US 68X (Russellville Road/University Boulevard) and US 231X (University Boulevard/Morgantown Road) in central Bowling Green, Kentucky.



This planning study is funded with Federal Statewide Planning and Research (SPR) Chapter 7 funds. Future phases are not funded in *Kentucky's FY 2018 – FY 2024 Highway Plan*.

1.1 STUDY AREA

The study area includes US 68X (Russellville Road/University Boulevard) from south of Robinson Avenue (MP 1.000) to north of Avenue of Champions (MP 1.626) and US 231X (University Boulevard/Morgantown Road) from north of Normal Street (MP 2.300) to south of Holly Drive (MP 2.600) along with portions of Robinson Avenue and Creason Street. The Russellville Road intersections with Morgantown Road and University Boulevard are approximately 1,600 feet apart with major generators nearby, namely Western Kentucky University (WKU) and associated athletic venues (softball, baseball, and football stadiums) along with commuter parking as shown in **Figure 1**. With the study area's proximity to WKU and downtown Bowling Green, traffic is

Figure 1: Study Area

a mix of commuter travel to campus and local through traffic to downtown and the surrounding areas. To the west, Russellville Road provides access to I-165 (William H. Natcher Parkway), an important regional connector to Owensboro and the Western Kentucky Parkway. Improvements are being considered on US 68X and US 231X due to their centralized location and their importance to traffic flow in and out of Bowling Green.

1.2 PROJECT HISTORY

In 2005, two Project Identification Forms (PIFs) were created in the study area to reduce congestion and improve safety on US 68X and US 231X. These PIFs have been updated to the following Continuous Highway Analysis Framework (CHAF) projects:

- IP20070137: Reduce the congestion and improve safety on this section of US 68X from US 231/KY 880 to US 231X (University Boulevard) (MP 0.00 - MP 1.524).
- IP20060207: Improve mobility and accessibility, increase safety, and improve conditions of business on US 231X between US 68X and US 231/KY 880 (MP 2.507 - MP 3.899).

In 2015, two additional PIFs were created in the study area by the Bowling Green and Warren County Metropolitan Planning Organization (MPO). These PIFs have been updated to the following CHAF projects:

- IP20150070: Widen northbound US 231X to accommodate two through lanes and a left-turn lane.
- IP20150071: Widen southbound US 68X to accommodate two through lanes and a right-turn lane.

In the summer of 2016, news that CSX would be closing the at-grade railroad crossing at Robinson Avenue initiated a discussion to relocate the recreational biking and walking trail, the Greenway Trail, along Robinson Avenue to nearby Morgantown Road. There was also a desire by WKU to construct a roundabout at the University Boulevard intersection near campus. At that time, KYTC decided to apply for discretionary planning funds to complete a study to identify potential improvements for the two intersections that would also include pedestrian and bicycle accommodations. As a result, PIF 03 114 B0068X 2.00 and PIF 03 114 B0231X 2.00 were combined into a new PIF that was developed for this planning study and converted to the following CHAF project:

- IP20160011: Reconstruct the intersection of US 68X (MP 1.0-1.6) with US 231X (MP 2.3-2.6), including major widening of roadway extending through the CSX overpass on US 68X, to improve safety and congestion. Provide safe modes of travel for pedestrians and bicyclists, including a shared-use path and/or bike lane connecting WKU's campus to the existing greenway on Robinson Avenue (Planning = $200,000; Design = $2 Million; Right-of-Way = $4 Million; Utilities = $5 Million; Construction = $12 Million).

1.3 COMMITTED PROJECTS

There is one project in the immediate area listed in *Kentucky's FY 2018 – FY 2024 Highway Plan*:

- Item No. 3-8857.00: Major widening/reconstruction on US 31W from Campbell Lane (US

231) to University Boulevard (US 231X) (MP 10.561 – MP 11.688). This project ranks high in the District's Transportation Plan. Design began in 2017 and the 2018 Highway Plan includes $1,750,000 and $2,000,000 in State Construction High Priority Project (SPP) funds for the right-of-way and utility phase in fiscal year 2019. The 2018 Highway Plan also proposes $4,250,000 in SPP funds for construction in fiscal year 2022.

2.0 EXISTING CONDITIONS

Conditions of the existing transportation network are examined in the following section. The information compiled includes current roadway facilities and geometrics, crash history, and traffic volumes within the study area. Data for this section were collected from the KYTC Highway Information System (HIS) database, KYTC's Traffic Count Reporting System, aerial photography, as-built plans, and from field inspection.

2.1 ROADWAY SYSTEM

Functional classification is the grouping of roads, streets, and highways into integrated systems ranked by the level of mobility for through movements and access to adjoining land. This grouping acknowledges that roads serve multiple functions and it provides a basis for comparing roads. Functional classification can be used for, but is not limited to, the following purposes:

- Provide a framework for highways serving mobility and connecting regions and cities within a state.
- Provide a basis for assigning jurisdictional responsibility according to the roadway's importance.
- Provide a basis for development of minimum design standards according to function.
- Provide a basis for evaluating present and future needs.
- Provide a basis for allocation of limited financial resources.

Figure 2 shows the functional classification of roadways within the study area. Minor arterials (shown in blue) serve trips of moderate length to smaller geographic areas and provide connections between principal arterials. Collectors (shown in yellow) facilitate trips between local roads and the arterial network[1]. US 68X and 231X are both classified as Urban Minor Arterials with posted speed limits of 35 miles per hour (mph). Creason Street is classified as an Urban Minor Collector with posted speed limits ranging from 20 to 30 mph.

[1] *Highway Functional Classification Concepts, Criteria and Procedures*. U.S. Department of Transportation/Federal Highway Administration. https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section03.cfm#Toc336872985

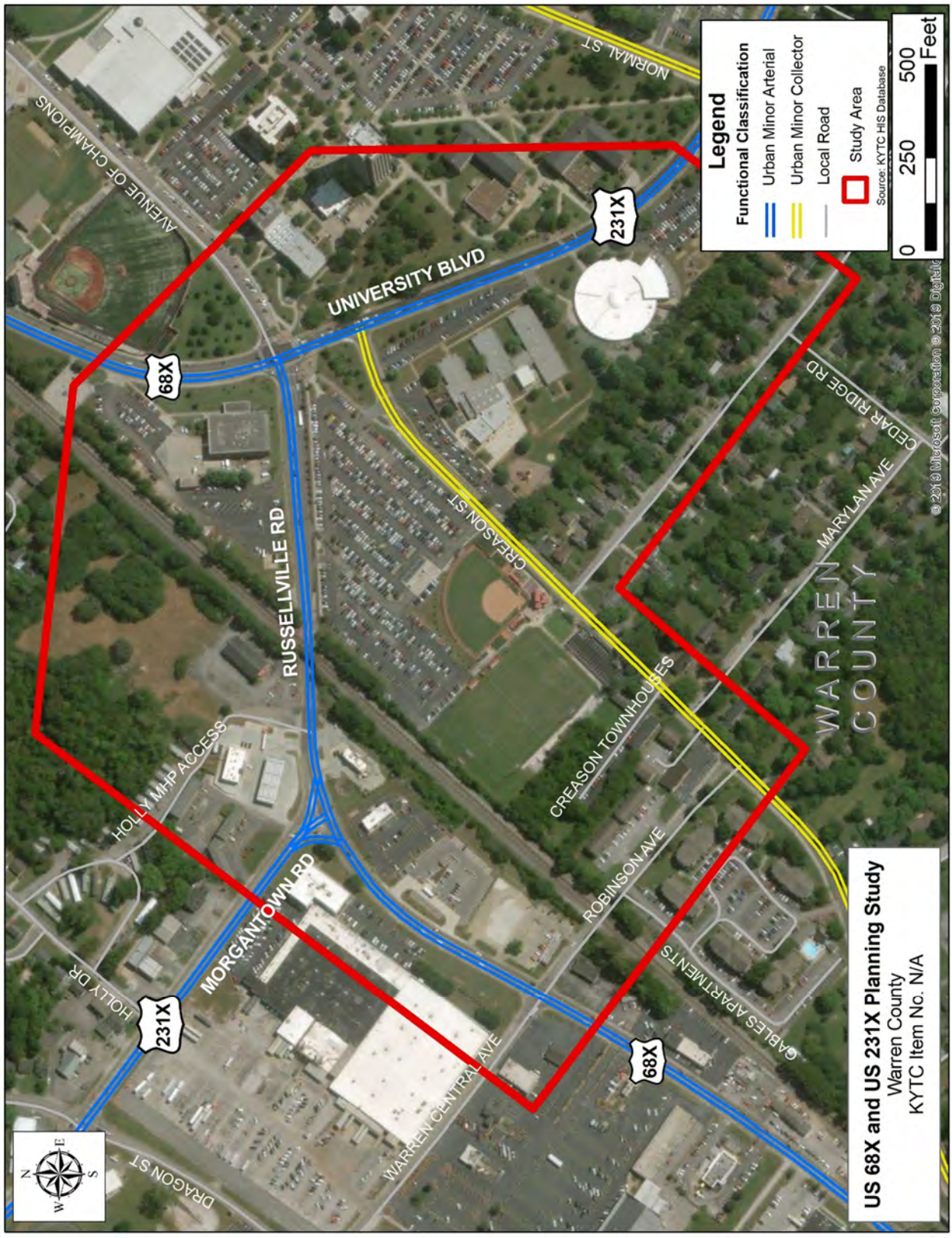


Figure 2: Functional Classification

2.2 ROADWAY GEOMETRIC CHARACTERISTICS

As part of the study effort, a review of existing geometrics along study area roadways was performed and compared against geometric guidelines in *AASHTO's A Policy on Geometric Design of Highways and Streets, 7th Edition, 2018*, commonly referred to as the "Green Book". Existing typical sections on study area roadways are shown in **Figure 3**.

2.2.1 Roadway Geometry

Russellville Road and University Boulevard have 12-foot-wide lanes except for the portion of University Boulevard south of the Russellville Road intersection, which has 10-foot lanes. Based on current Green Book design guidelines, lane widths under 12 feet are typically adequate under interrupted-flow operating conditions at lower speeds (45 mph or less). Morgantown Road north of the Russellville Road intersection and Russellville Road west of the Morgantown Road intersection have two-way left-turn lanes (TWLTL) while University Boulevard has a four-foot traversable median north of the Russellville Road intersection and no median to the south. There are crosswalks at the Russellville Road intersections with both Morgantown Road and University Boulevard. A signalized mid-block pedestrian crossing is also located on University Boulevard south of Russellville Road, just outside the study area.

Shoulder widths from KYTC's HIS database are also shown on **Figure 3**. Despite the advantages of having shoulders on arterial streets, their implementation is generally limited in urban areas by restricted right-of-way. In addition, curbs are often appropriate in heavily developed areas as a means of controlling access. When providing shoulders is not practical and curbs are used, they should be offset two feet from the edge of the traveled way (Green Book Section 7.3.3). Russellville Road and University Boulevard primarily have curb and gutter with a two-foot gutter pan.

Figure 4 presents the truck weight classifications on study area roadways. Both Russellville Road and University Boulevard are classified as 'AAA' and permit gross vehicle weights up to 80,000 pounds.

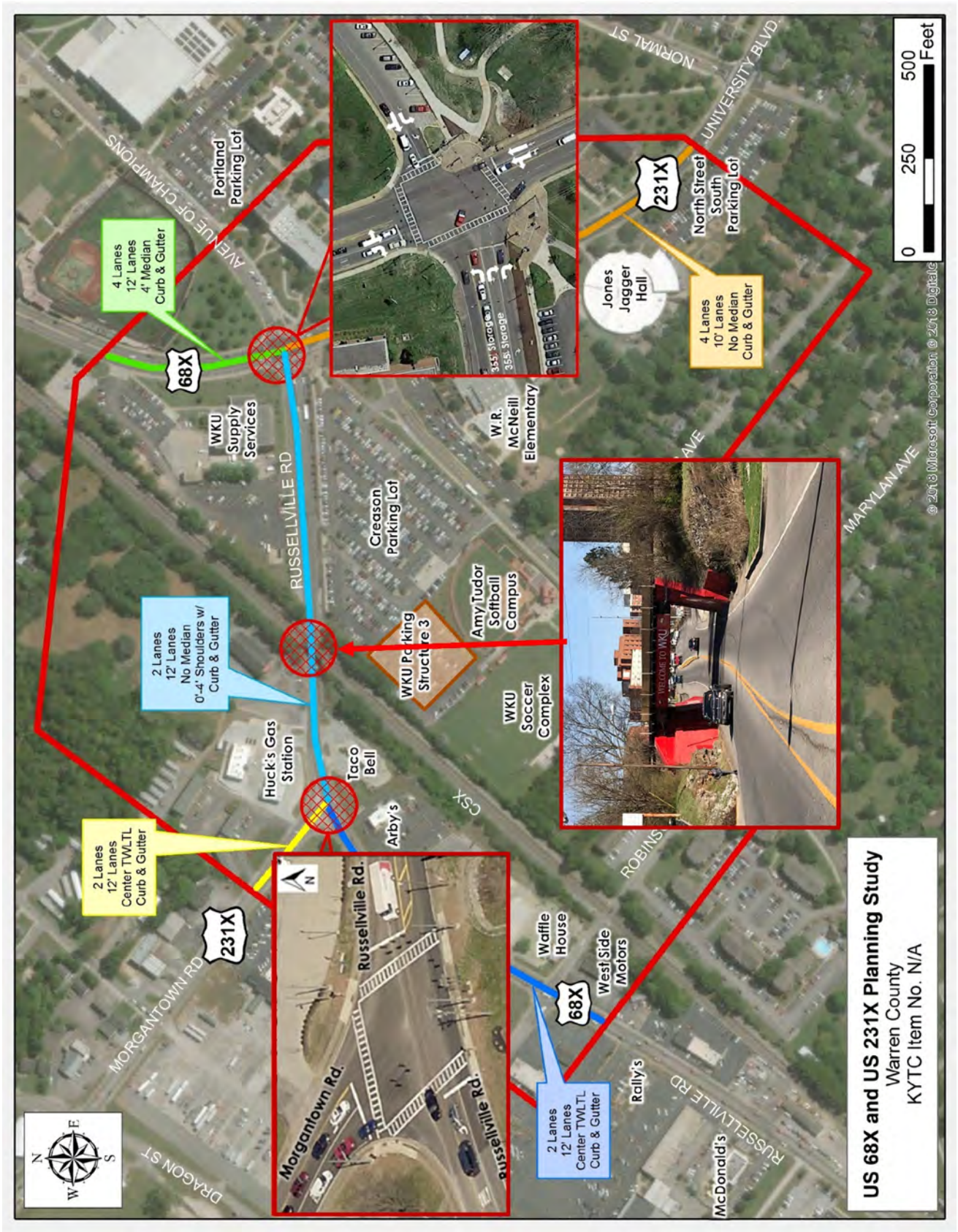


Figure 3: Typical Sections

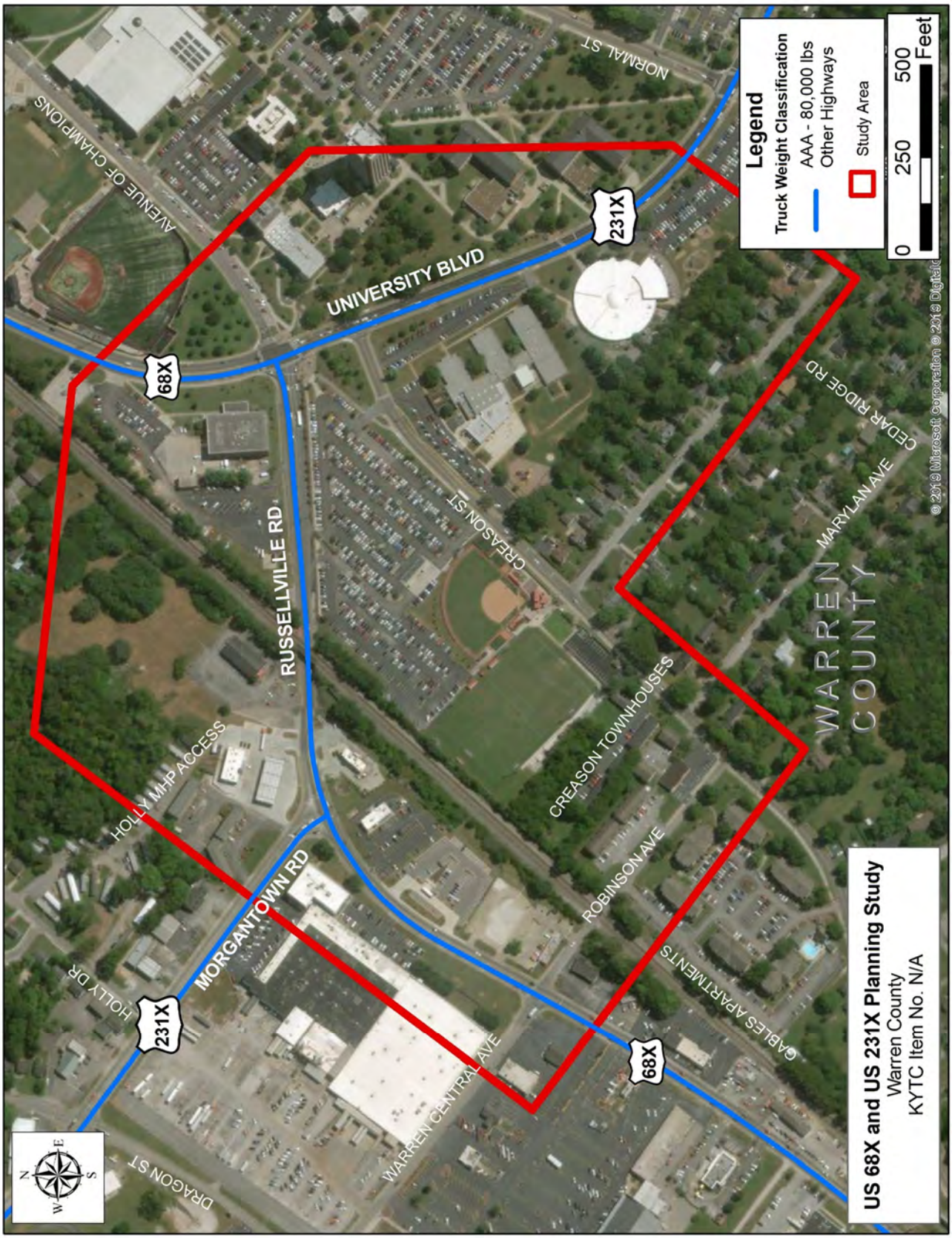


Figure 4: Truck Weight Classification

2.2.2 Intersection Geometry

The Russellville Road intersection with University Boulevard is a four-leg intersection with the following approaches:

- **Eastbound Russellville Road** – Two right-turn lanes and a left-turn lane
- **Northbound University Boulevard** – One shared through/left-turn lane and one dedicated through lane
- **Westbound Avenue of Champions** – One-way approach with one left-turn lane and one shared through/right-turn lane
- **Southbound University Boulevard** – One right-turn lane and one through lane

Russellville Road at University Boulevard

A repaving project to remove the channelized right-turn lanes and improve crosswalks at the Russellville Road intersection with Morgantown Road was completed by KYTC during this study. The current Russellville Road intersection with Morgantown Road is a three-leg intersection with the following approaches:

Russellville Road at Morgantown Road

- **Eastbound Russellville Road** – One left-turn lane and one through lane
- **Westbound Russellville Road** – One through lane and one right-turn lane
- **Southbound Morgantown Road** – One left-turn lane and one right-turn lane

2.3 STRUCTURES

There are two CSX railroad tracks in the study area, one mainline and one bypass track, as shown in **Figure 5**. There are also two crossings, the first of which is an at-grade crossing at Robinson Avenue, which is routinely blocked while trains allow each other to pass using the bypass track. This causes lengthy backups for vehicles seeking to access Creason Street from Russellville Road.

Robinson Avenue Crossing Blocked by Train

The second rail crossing is an overpass crossing over Russellville Road, which has approximately 30 feet of horizontal clearance and 14 feet of vertical clearance. Underneath the bridge, Russellville Road has one 12-foot lane in each direction with curb and gutter and no sidewalks. With heavy congestion during the peak periods and only one travel lane in each direction, the CSX overpass has become a bottleneck for traffic. However, there is not enough horizontal clearance to widen the roadway underneath the existing structure. Widening the roadway to add vehicle and/or bicycle lanes will require replacing the bridge.

CSX Railroad Over Russellville Road

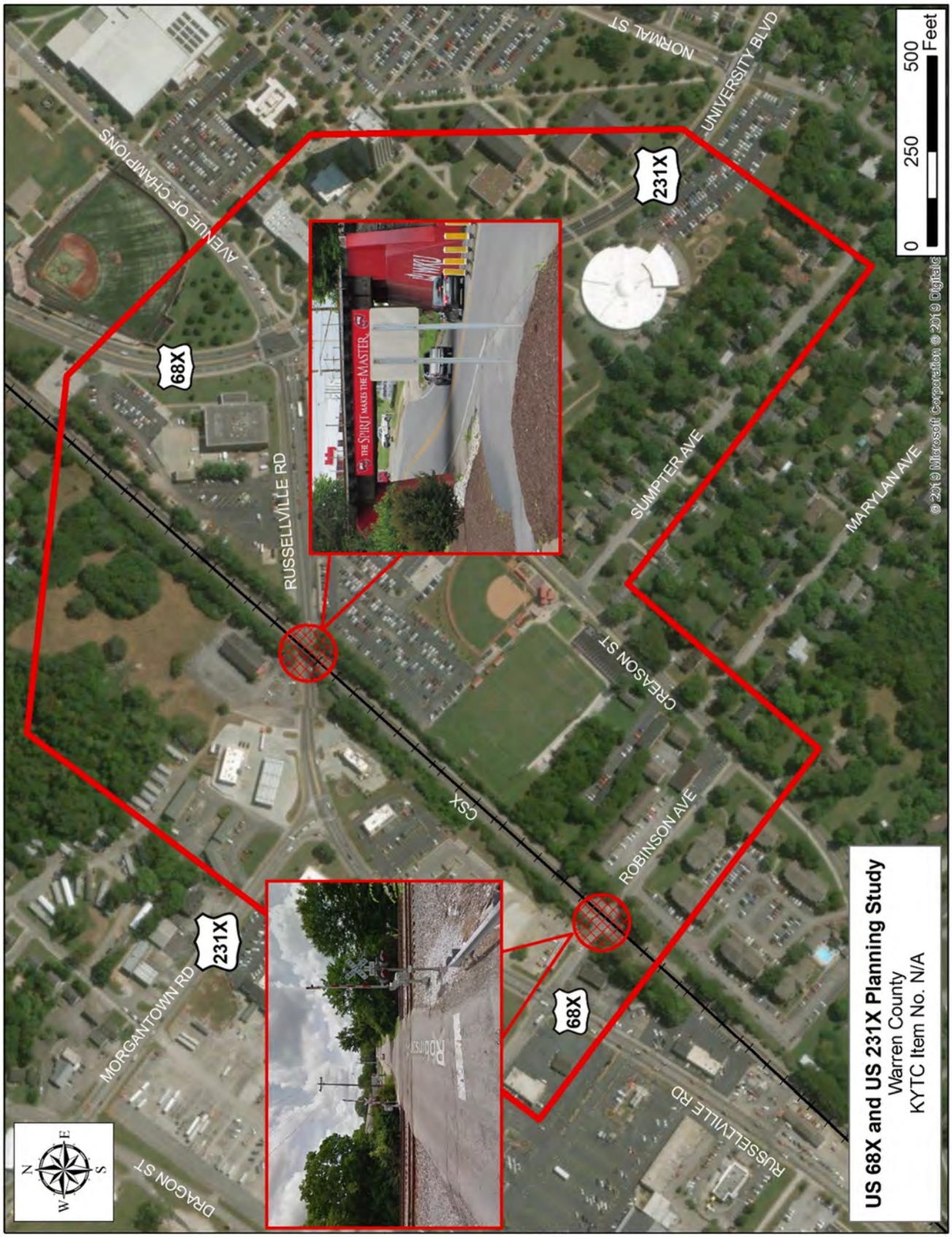


Figure 5: Existing Railroad Crossings

2.4 MULTIMODAL TRAVEL

Multimodal travel in the study area includes pedestrians, bicyclists, and buses. Each of these modes of travel are important in moving people through the study area.

With the proximity to WKU and commuter parking, there are high volumes of pedestrians and bicyclists in the central and eastern portions of the study area. The Creason Parking Lot and WKU Parking Structure No. 3 are located at the southwest quadrant of the Russellville Road intersection with University Boulevard. To access WKU's campus from this lot, commuters must either use the campus shuttles or cross University Boulevard. Based on counts taken on Tuesday, October 23, 2018, 30 pedestrians crossed northbound University Boulevard during the AM peak hour (7:30 AM – 8:30 AM), as shown in **Table 1**, and 145 people crossed during the PM peak hour (4:30 PM – 5:30 PM), as shown in **Table 2**. An emphasis was placed on accommodating these high volumes of WKU pedestrians at the Russellville Road intersection with University Boulevard during the concept development process.

Pedestrians walking along Russellville Road

Table 1: AM Pedestrian Crossings (NB University Approach)

Begin Time	End Time	Number of Pedestrians
6:00 AM	6:15 AM	2
6:15 AM	6:30 AM	1
6:30 AM	6:45 AM	5
6:45 AM	7:00 AM	3
7:00 AM	7:15 AM	6
7:15 AM	7:30 AM	4
7:30 AM	7:45 AM	11
7:45 AM	8:00 AM	8
8:00 AM	8:15 AM	7
8:15 AM	8:30 AM	4
8:30 AM	8:45 AM	6
8:45 AM	9:00 AM	7

Table 2: PM Pedestrian Crossings (NB University Approach)

Begin Time	End Time	Number of Pedestrians
3:00 PM	3:15 PM	31
3:15 PM	3:30 PM	14
3:30 PM	3:45 PM	29
3:45 PM	4:00 PM	29
4:00 PM	4:15 PM	24
4:15 PM	4:30 PM	40
4:30 PM	4:45 PM	52
4:45 PM	5:00 PM	34
5:00 PM	5:15 PM	31
5:15 PM	5:30 PM	28
5:30 PM	5:45 PM	27
5:45 PM	6:00 PM	45

Many students also utilize Topper Transit, WKU's free campus bus system. The fixed-day service routes (Hilltopper and Big Red Routes) operate Monday to Friday while WKU is in session. Both

lines travel through the study area with the Hilltopper Route stopping at the Creason Lot and the Big Red Route stopping at Parking Structure No. 3 and the Russellville Road West Lot. A third line, the Green Line, is an off-campus route used to transport passengers to and from area shopping, recreation, and housing centers. The Topper Transit Route Map can be found in **Appendix A.**

Community Action of Southern Kentucky operates the GO bg Transit system. The Purple Line and the Yellow Line both travel on Russellville Road and University Boulevard through the study area with the Purple Line also traveling on Creason Street. The GO bg Transit Route Map can also be found in **Appendix A**.

2.5 EXISTING TRAFFIC ANALYSIS

A review of the existing study area traffic revealed daily traffic volumes on Russellville Road ranging from 25,100 – 26,900 vehicles per day (VPD). A 2012 hourly count station on Russellville Road shows an even, albeit high, distribution of traffic between 7:00 AM and 5:00 PM, as shown in **Figure 6**. The even distribution of traffic can likely be attributed to student and commuter travel related to WKU. These hourly volumes are high for a two-lane roadway and are nearing capacity during the peak periods, as discussed in **Section 2.6.1**. Morgantown Road has 13,600 VPD while University Boulevard ranges from 19,000 VPD north of Russellville Road to 20,300 VPD to the south. The latest average daily traffic (ADT) volumes from KYTC's traffic count stations are shown on **Figure 7.**

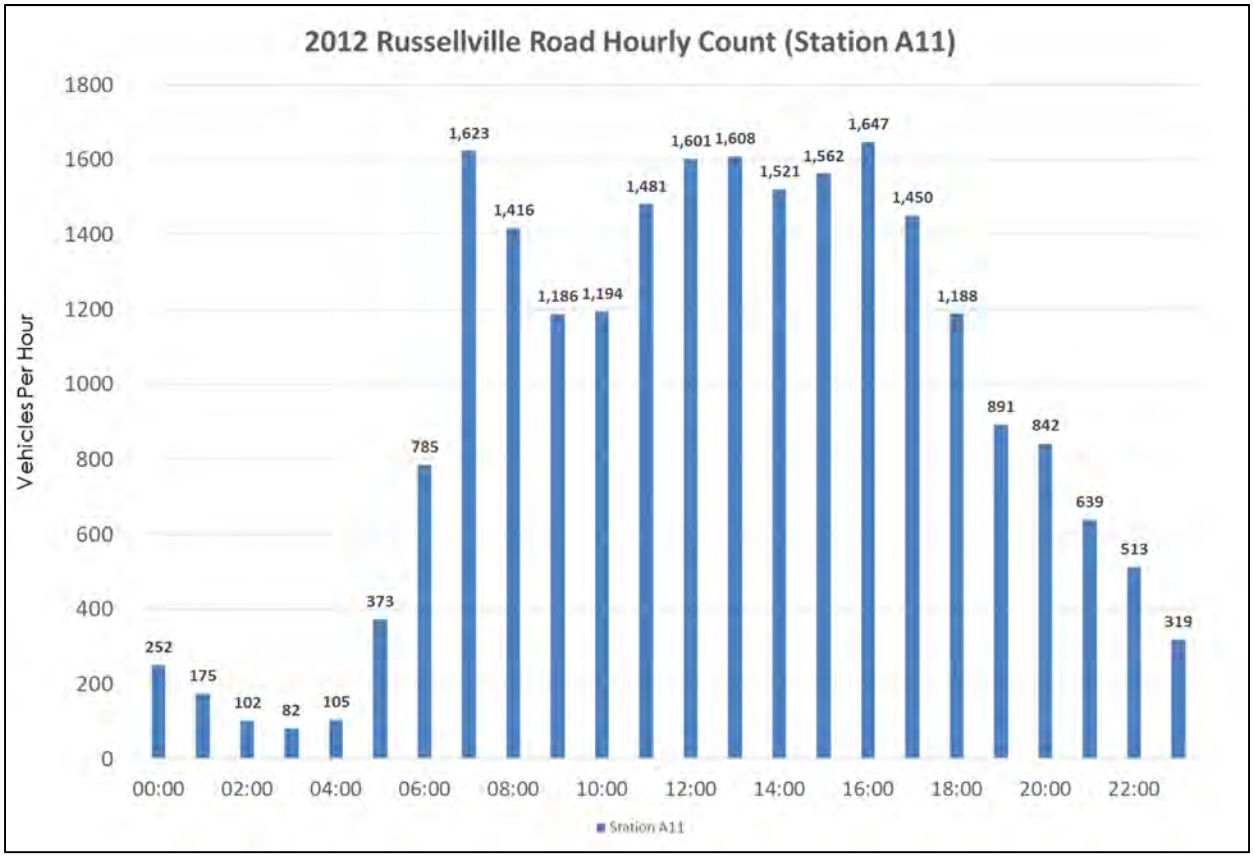


Figure 6: 2012 Russellville Road Hourly Traffic Volumes

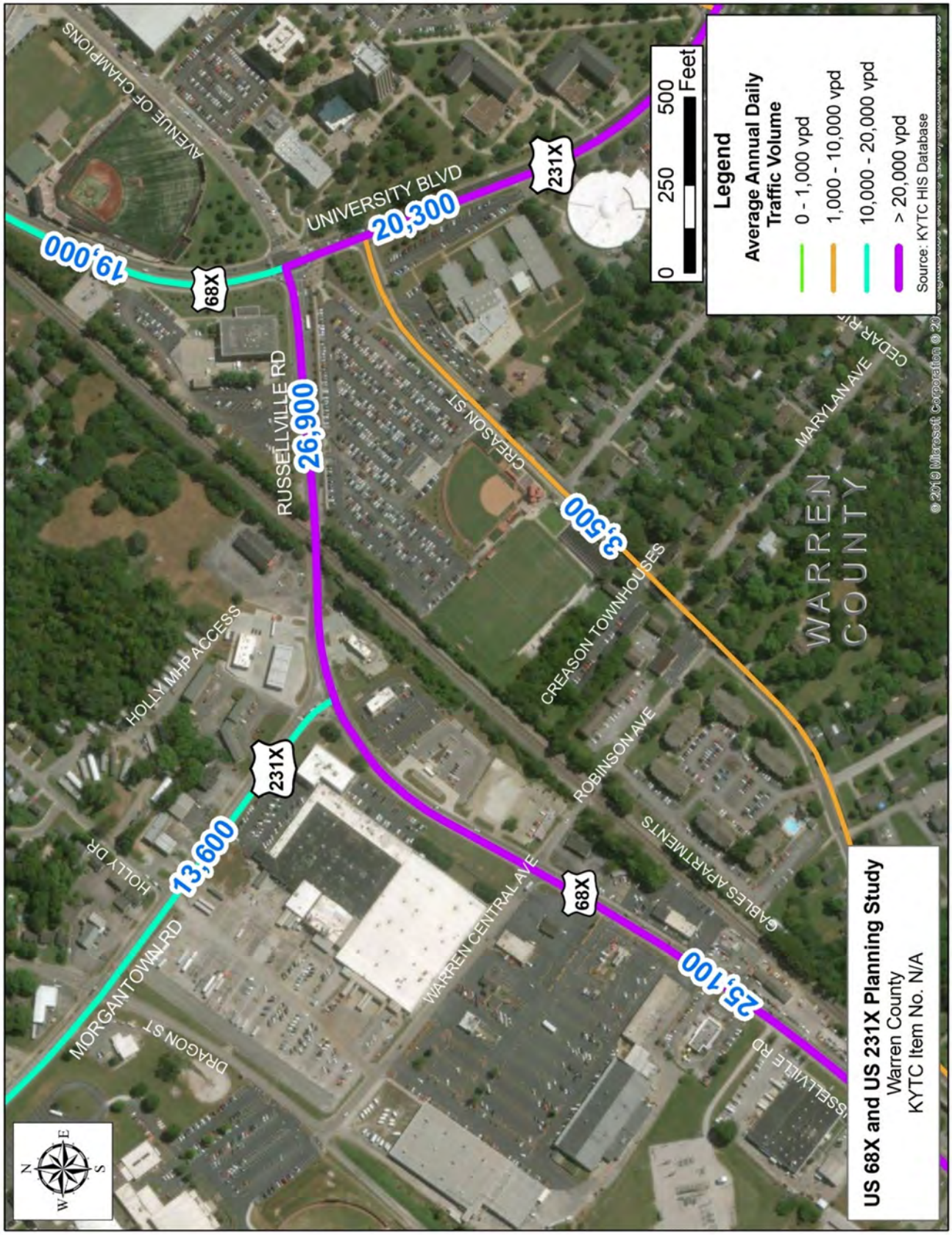


Figure 7: Average Daily Traffic (ADT) Volumes

Turning movement counts were conducted by KYTC at key intersections in the study area over a three-week period in February 2018 while WKU and Bowling Green public schools were in session. AM and PM intersection turning movement counts were conducted at the following intersections:

- Russellville Road at Robinson Avenue;
- Russellville Road at Morgantown Road;
- Russellville Road at University Boulevard;
- University Boulevard at Creason Street;
- University Boulevard at Normal Street;
- Creason Street at Sumpter Avenue; and
- Creason Street at Robinson Avenue.

Based on the traffic data at these locations, shown unbalanced in **Figure 8**, the AM peak hour was found to be 7:30 AM to 8:30 AM and the PM peak hour was found to be 4:30 PM to 5:30 PM. Additional spot counts were also collected at the following locations:

- Creason Parking Lot Entrance;
- Taco Bell Entrance;
- Huck's Gas Station Entrance;
- The at-grade railroad crossing at Robinson Avenue; and
- The pedestrian signal in front of Jones Jagger Hall on University Boulevard.

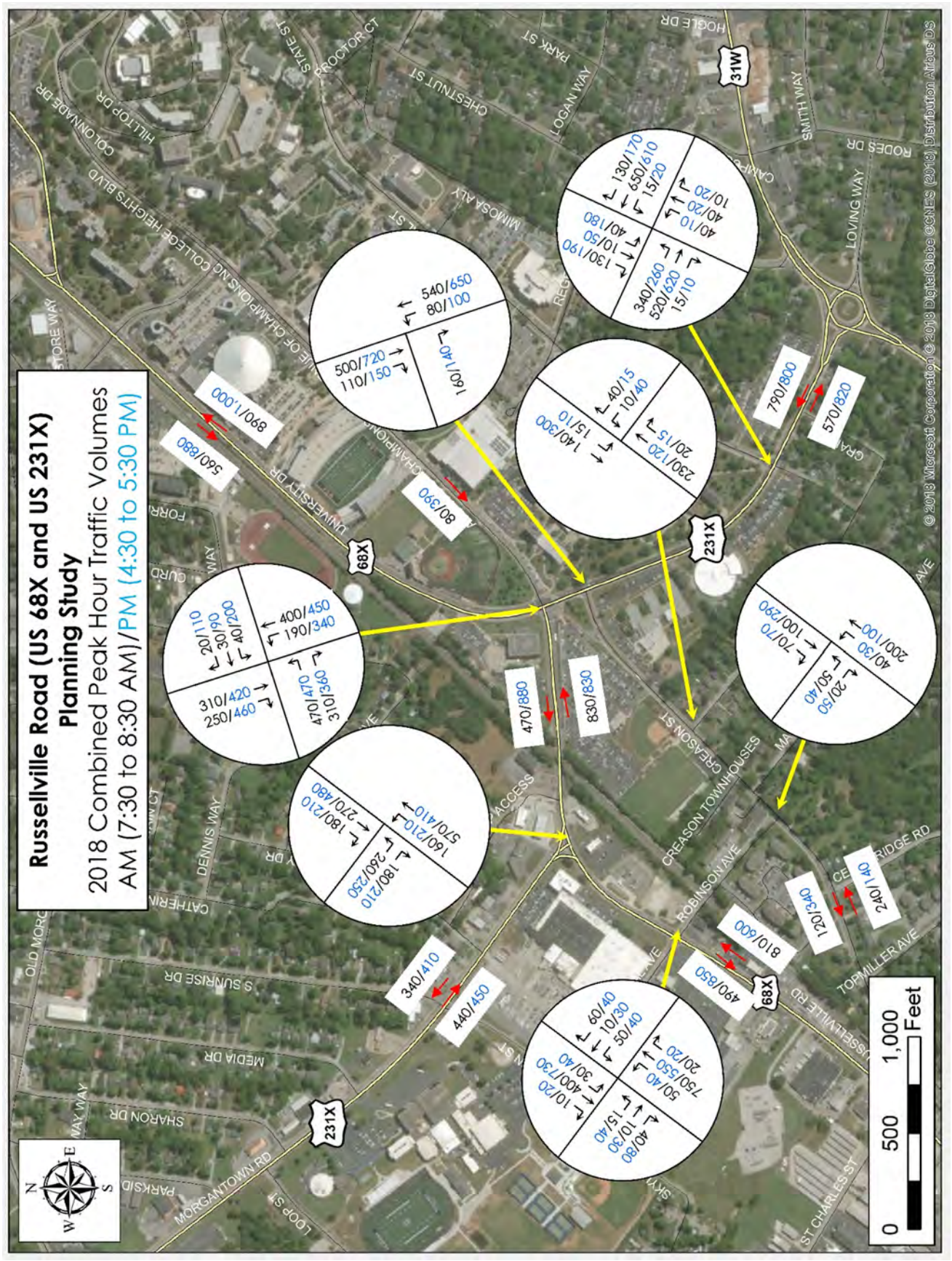


Figure 8: 2018 Peak Hour Traffic Counts

2.6 BASE YEAR (2018) SIMULATION MODEL

To analyze the existing traffic in the study area, a 2018 base year simulation model was developed depicting existing peak hour conditions using Caliper's TransModeler (version 5) simulation package. **Figure 9** presents the model simulation area, which focuses on the area surrounding the intersections of Russellville Road (US 68X) at Morgantown Road (US 231X) and Russellville Road (US 68X) at University Boulevard (US 68X/US 231X).

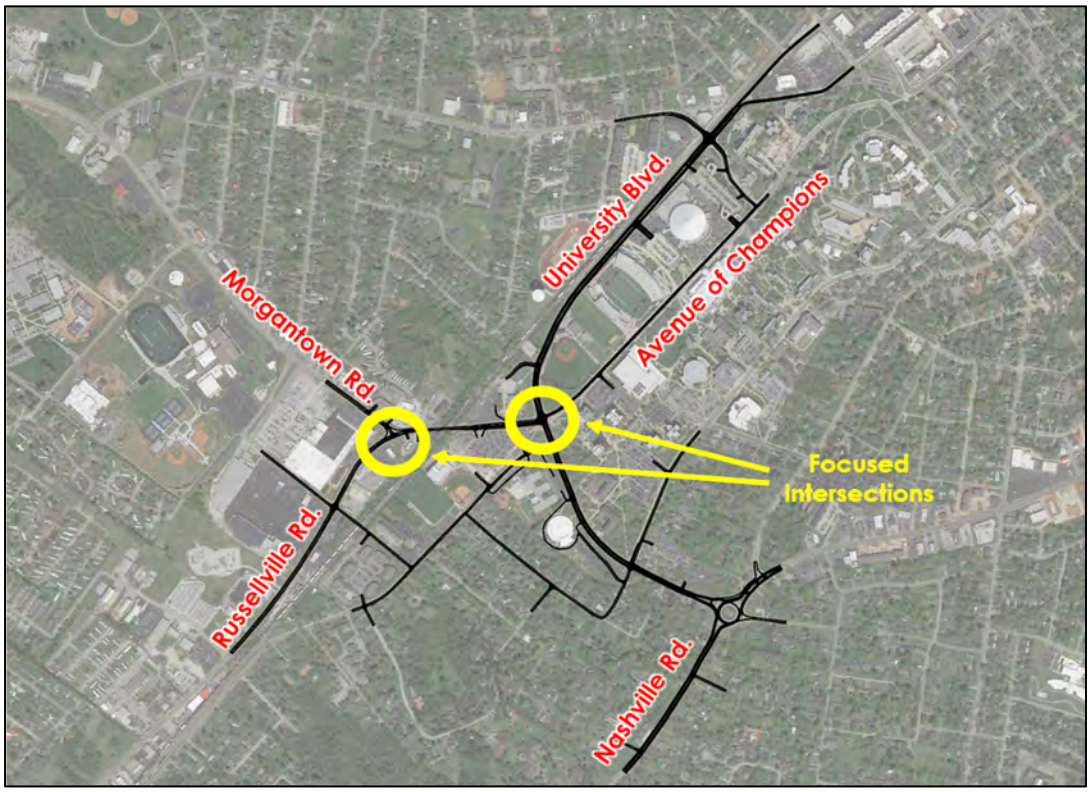


Figure 9: Simulation Model Study Area

The *Downtown Bowling Green Traffic Circulation* Study[2] Model (2014) was used as the initial source for the simulation model and network. Separate model scenarios were created for the AM (7:30 AM – 8:30 AM) and PM (4:30 – 5:30 PM) peak hours taken from the existing traffic analysis. 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. Signal timing plans provided by KYTC were programmed for the five signalized intersections and turning movement files were created for the seven intersections discussed in **Section 2.5**.

[2] https://www.warrenpc.org/wp-content/uploads/2018/04/Downtown%20Bowling%20Green%20Final%20Report%203-18-15%20.pdf

2.6.1 2018 No-Build

Delay is a measure, in seconds per vehicle, of the average time each vehicle spent waiting at the intersection. Level of Service (LOS) is a qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. For signalized intersections, LOS is determined by the average total vehicle delay. In urban areas, LOS D or better is desirable and in rural areas, LOS C or better is desirable. To achieve LOS D, average vehicle delay must be under 55 seconds per vehicle, as shown in **Table 3**. Volume-to-capacity (V/C) ratio represents the ability of an intersection approach to accommodate the vehicular demand. A V/C ratio approaching 1.0 indicates that the roadway capacity may not be adequate and traffic flow may become unstable.

Currently, the only intersection operating at an unacceptable LOS is the Russellville Road intersection with University Boulevard, operating at LOS E during the PM peak hour. The eastbound Russellville Road approach and the northbound University Boulevard have V/C ratios above 1. This intersection is also on the verge of LOS E during the AM peak, with the northbound University Boulevard approach having a V/C ratio over 1.0. **Table 4** presents a summary of the traffic operations for each intersection by approach for the 2018 No-Build scenario.

Table 3: Level of Service Criteria for Signalized Intersections

Delay (sec/veh)	LOS by V/C ratio	
	≤ 1.0	>1.0
≤ 10	A	F
10 - 20	B	F
20 - 35	C	F
35 - 55	D	F
55 - 80	E	F
> 80	F	F

Source: *2016 Highway Capacity Manual 6th Edition*

Table 4: 2018 No-Build Traffic Operations Summary

Intersection	Approach	AM		PM	
		LOS	V/C*	LOS	V/C*
Russellville/University	EB Russellville	D	0.9	E	1.3
	NB University	D	1.2	D	1.2
	SB University	D	0.5	E	0.6
	WB Ave of Champions	D	0.2	E	0.4
	Total	D	N/A	E	N/A
Russellville/Morgantown	EB Russellville	B	0.8	D	0.8
	WB Russellville	A	0.6	B	0.9
	SB Morgantown	C	0.8	D	0.9
	Total	C	N/A	C	N/A

*Demand-to-Capacity Ratio

A full discussion of the base year simulation model can be found in **Appendix B**.

2.7 CRASH HISTORY

To quantify safety concerns, a crash analysis was performed within the study area. Historical crash data were collected in the study area for a three-year period between January 1, 2014 and December 31, 2016. The crash records and locations are included in **Appendix C**.

2.7.1 Crash Severity

Over the analysis period, there were 315 reported crashes in the study area. Of these, zero crashes resulted in fatalities and 35 resulted in injuries. **Figure 10** demonstrates the distribution of crashes by severity.

The percentage of injury collisions along Russellville Road and University Boulevard is slightly below average when compared to similar roads in Kentucky; however, given the inherent variability in the smaller sample size of injury collisions, there is less confidence in presentation of simple averages. Based on the most recent statewide crash data from the Kentucky Transportation Center research report *Analysis of Traffic Crash Data in Kentucky (2013-2017)*[3], injury crashes along two- and four-lane urban highways generally compose 16 to 17 percent of total crashes. Along the study portion of Russellville Road and University Boulevard, injury crashes compose 11 percent of the total reported crashes.

[3]Green, Eric R., Kenneth R. Agent, and Jerry G. Pigman. "Analysis of Traffic Crash Data in Kentucky (2013-2017)." (2018).

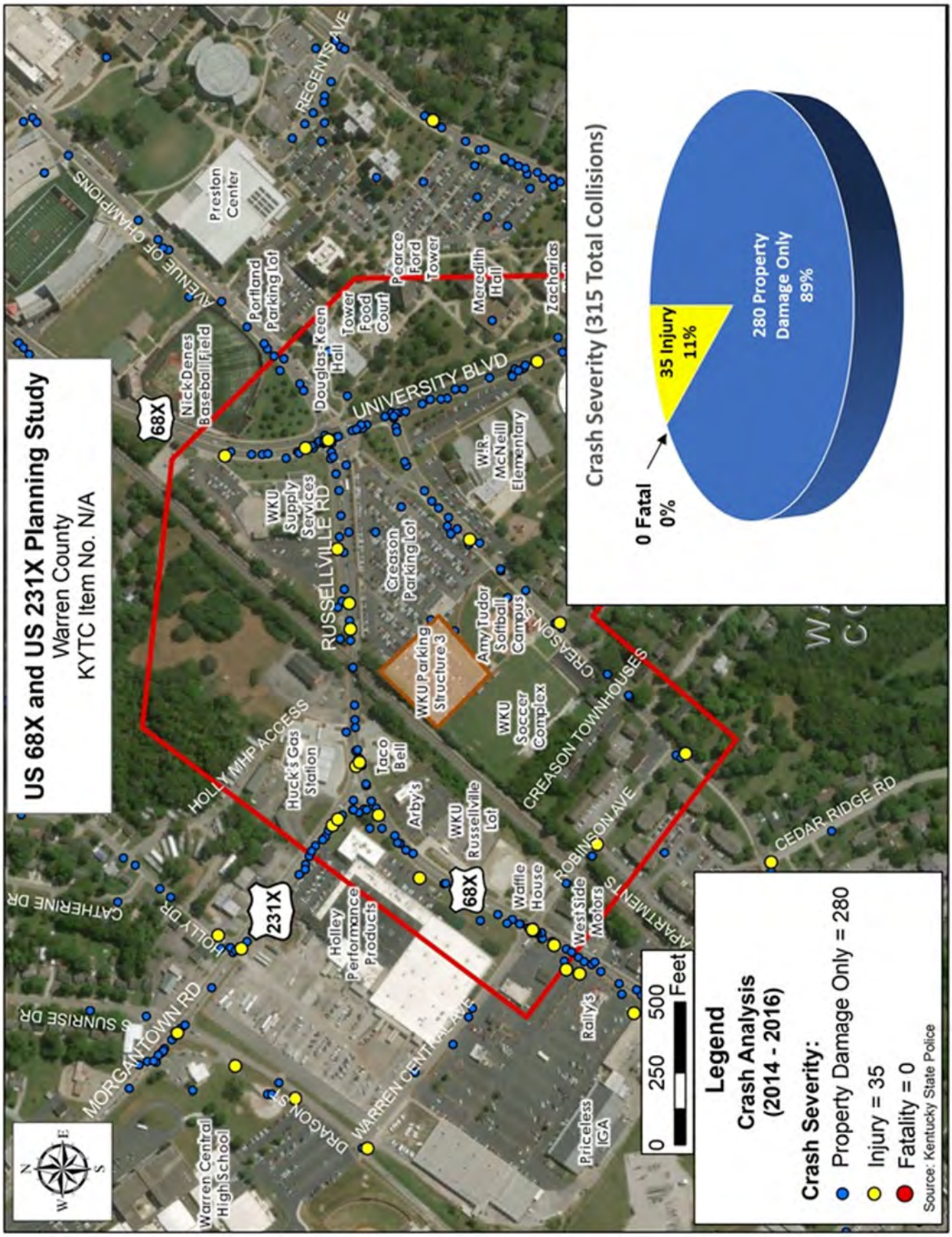


Figure 10: Distribution of Crash Severity by Location

2.7.2 Crash Type

Figure 11 presents the crashes by crash type. Rear end vehicle crashes were the most commonly reported crash type (114 crashes, 36 percent), followed by angle crashes (65 crashes, 21 percent), and sideswipe crashes (63 crashes, 20 percent).

Rear end collisions, angle collisions, and opposing left-turn collisions total 60 percent of all crashes along the study area portion of Russellville Road and University Boulevard. These types of crashes are often indicative of congested roadways and can be a symptom of poor access control.

2.7.3 Critical Crash Rate Factors

Crashes for the three-year period were geospatially referenced and compared to statewide data to identify locations experiencing above average crash rates. The methodology is defined in the Kentucky Transportation Center research report *Analysis of Traffic Crash Data in Kentucky (2013-2017)*. The critical rate factor is a measure of the safety, expressed as a ratio of the crash rate at the location compared to the critical crash rate for similar roadways throughout the state. A CRF of 1.0 or greater may indicate that crashes are occurring due to circumstances not attributed to random occurrence. **Table 5** shows the results of the segment analysis. One segment in the study area was found to have a CRF over 1.0, University Boulevard (US 68X) north of the Russellville Road intersection.

High Crash Spots

- CRF > 1.0 indicates crashes are likely not occurring at random
- 1 High Crash Segment & 8 High Crash Spots were identified with CRF > 1.0

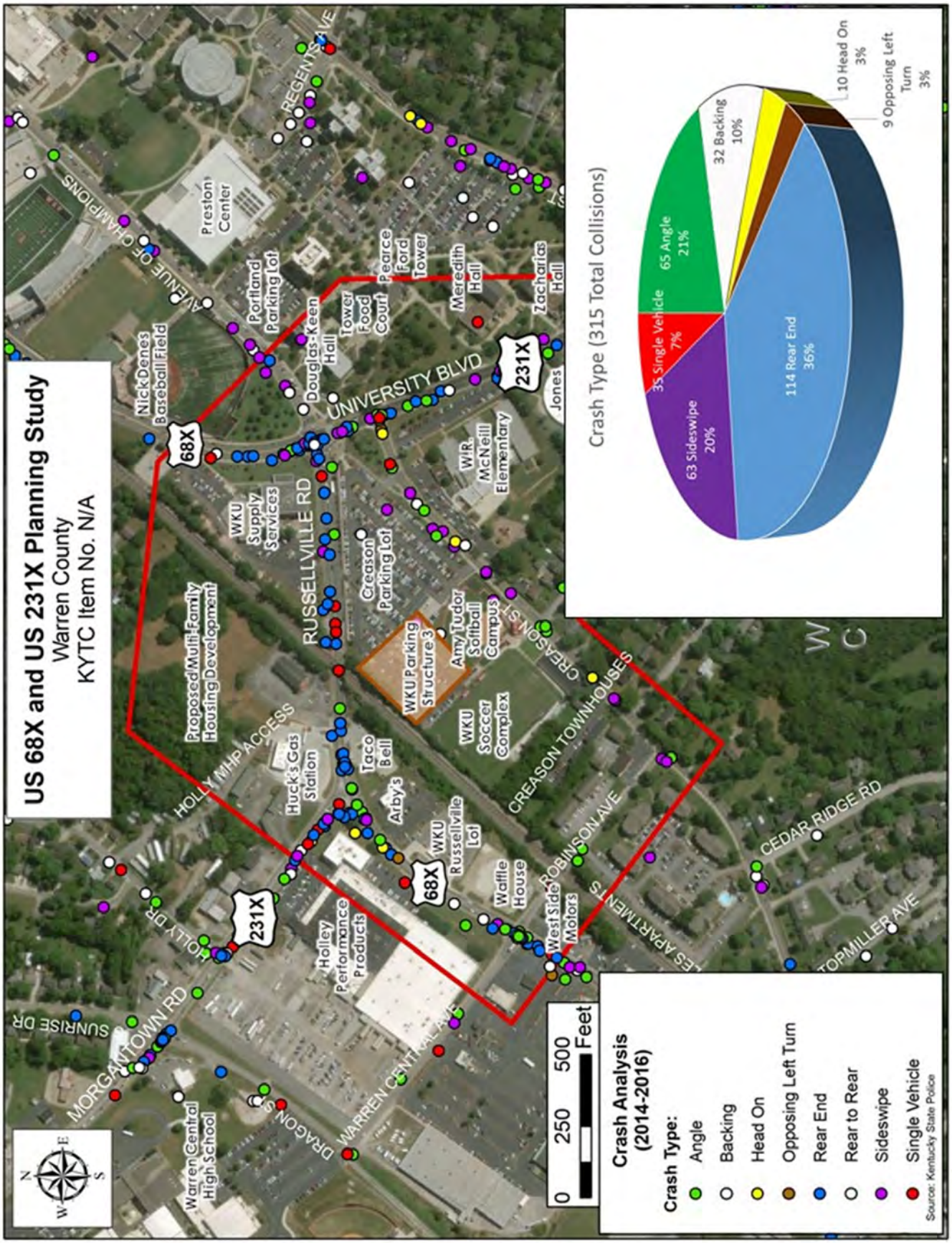


Figure 11: Distribution of Crash Type by Location

Table 5: High Crash Segment Analysis

Route	Beg. MP	End MP	Road Type	Crashes	ADT	CRF
Russellville Road (US 68X)	1.000	1.216	Urban 2-Lane	41	25,100	0.92
Russellville Road (US 68X)	1.216	1.407	Urban 2-Lane	17	26,900	0.40
Russellville Road (US 68X)	1.407	1.524	Urban 3-Lane	12	26,900	0.33
University Boulevard (US 68X)	1.524	1.626	Urban Divided 4-Lane	27	19,000	1.58
University Boulevard (US 231X)	2.300	2.526	Urban Undivided 4-Lane	36	16,500	0.98
Morgantown Road (US 231X)	2.526	2.600	Urban 2-Lane	9	13,600	0.74

* Source: KTC Analysis of Traffic Crash Data in Kentucky (2013-2017): Table 3 for Urban

A spot analysis was also conducted for the study area. Spots were defined by observing 0.1-mile sections where crashes were concentrated. Crashes were again geospatially referenced and compared to statewide data to identify locations experiencing above average crash rates. There were eight spots with a CRF greater than 1.0, as shown in **Table 6. Figure 12** presents the one high crash segment and the eight high crash spots.

Table 6: High Crash Spot Analysis

Route	Beg. MP	End MP	Road Type	Crashes	ADT	CRF
Russellville Road (US 68X)	1.000	1.100	Urban 2-Lane	25	25,100	5.17
Russellville Road (US 68X)	1.159	1.259	Urban 2-Lane	19	25,100	3.92
Russellville Road (US 68X)	1.300	1.400	Urban 2-Lane	8	26,900	1.59
Russellville Road (US 68X)	1.424	1.524	Urban 3-Lane	12	26,900	1.99
University Boulevard (US 68X)	1.524	1.624	Urban Divided 4-Lane	27	19,000	7.24
University Boulevard (US 231X)	2.300	2.400	Urban Undivided 4-Lane	12	16,500	2.90
University Boulevard (US 231X)	2.426	2.526	Urban Undivided 4-Lane	21	16,500	5.07
Morgantown Road (US 231X)	2.526	2.626	Urban 2-Lane	10	13,600	2.92

* Source: KTC Analysis of Traffic Crash Data in Kentucky (2013-2017): Table B-5 (The length of a spot is defined to be 0.1 mile.)

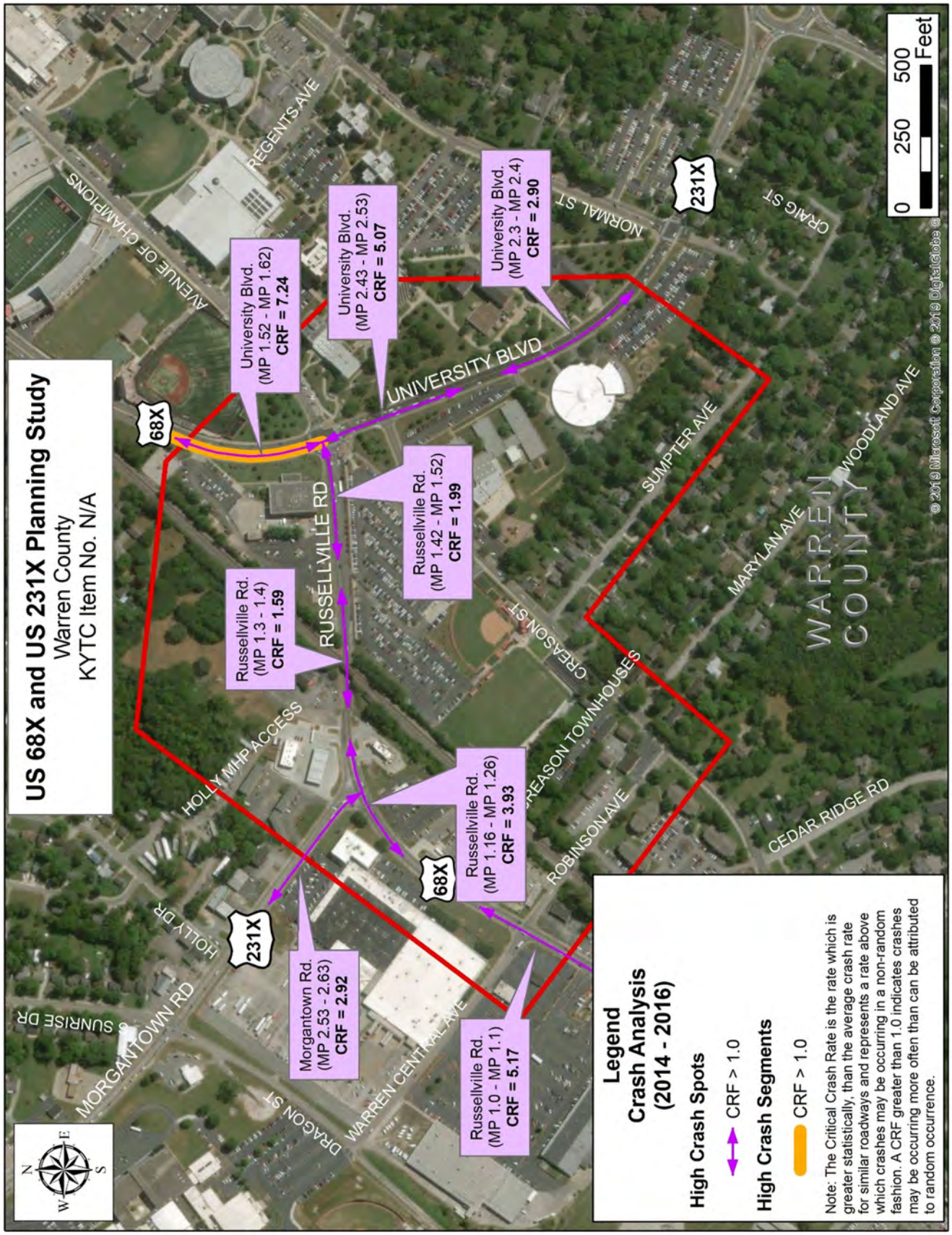


Figure 12: Critical Crash Rate Factors (CRF) Spots and

3.0 PURPOSE AND NEED

The purpose of the Russellville Road (US 68X and US 231X) study is to improve safety, reduce congestion, and better accommodate all modes of travel on US 68X (Russellville Road/University Boulevard) and US 231X (University Boulevard/Morgantown Road) in Bowling Green, Kentucky.

The Purpose and Need Statement supports the development of transportation improvements within the study area and encourages further development of improvement concepts, analysis, and recommendations. It was developed as a result of the existing conditions analysis, project team input, and local officials/stakeholder input. The following needs were identified over the course of the study. A more detailed discussion regarding these needs is found in **Chapter 2**.

3.1 IMPROVE SAFETY

A detailed discussion of the crash analysis in the study area is found in **Section 2.7**. Over the three-year period between January 1, 2014 and December 31, 2016, there were 315 crashes reported in the study area. This includes zero fatalities and 35 injury collisions.

Of the 315 reported crashes, 114 (36 percent) were rear end collisions with angle and sideswipe collisions the next most common. Critical crash rate factors[4] were calculated for the three-year study period between January 1, 2014 and December 31, 2016. There is one high crash segment (US 68X MP 2.524 – MP 2.626) and eight 0.1-mile-long high crash spots with CRF values greater than 1.0.

Purpose and Need

- Safety, congestion, and multimodal travel are the primary concerns in the study area.
- Multimodal travel in the area includes pedestrians, bicyclists, and buses.

3.2 REDUCE CONGESTION

A detailed discussion of the traffic analysis in the study area is found in **Sections 2.5** and **2.6**. With the study area's proximity to WKU, traffic demand includes a mix of commuter travel into campus and local through traffic to downtown Bowling Green and the surrounding areas. Russellville Road has the highest Annual Average Daily Traffic (AADT) volume in the study area with 25,000 – 27,000 VPD. University Boulevard (US 68X/US 231X) carries 16,500 – 19,000 VPD, and Morgantown Road (US 68X) carries 13,600 VPD. The high traffic volumes on the two-lane Russellville Road along with the proximity of the Morgantown Road and University Boulevard intersections cause major congestion issues during the AM and PM peak periods.

[4] The CRF is one measure of the safety of a road, expressed as a ratio of the crash rate at the location compared to the critical crash rate for similar roadways throughout the state. A CRF of 1.00 or greater may indicate that crashes are occurring due to circumstances not attributed to random occurrence.

3.3 ACCOMMODATE MULTIMODAL TRAVEL

A detailed discussion of multimodal travel in the study area is found in **Section 2.4**. Multimodal travel in the study area includes pedestrians, bicyclists, and buses. Each of these modes of travel move people and goods through and around Bowling Green.

Midblock Pedestrian Crossing on University Boulevard

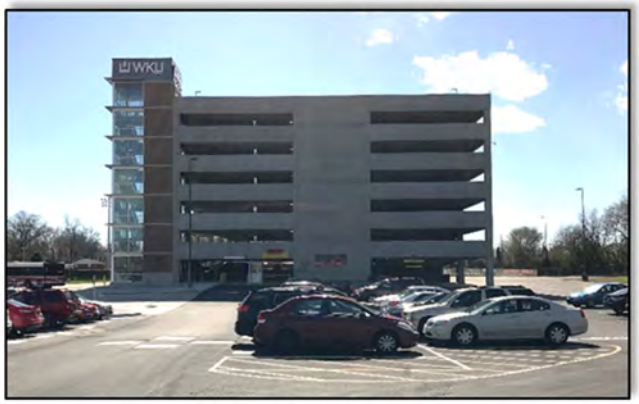
With the proximity to WKU and commuter parking, there are high volumes of pedestrians and bicyclists in the study area. This is especially true at the Russellville Road intersection with University Boulevard, where commuters using the Creason parking lot cross to access campus. Many students also utilize Topper Transit, which is WKU's campus bus system. The Red, White, and Green Lines all travel through the study area. A commuter/residential parking garage near the Creason Parking Lot (WKU Parking Structure No. 3) was opened in November 2017 and has increased pedestrian demand in the area.

4.0 FUTURE CONDITIONS

It is necessary to estimate future conditions to determine the need for and purpose of potential transportation improvement concepts. The following chapter summarizes the anticipated future conditions within the study area.

4.1.1 Traffic Forecast Development

2040 future year traffic forecasts were developed separately for local trips and through trips. Local trips are defined as any trip that begins or ends at a location inside the simulation model and through trips represent all trips that begin and end outside the model network and enter the network at its edges.



WKU Parking Structure 3

All trips with on-campus destinations have the uncommon restraint of limited and highly controlled parking. Except for the new garage, trips to and from on-campus zones were set at 10 percent above current level to allow for a marginal increase in the use of existing facilities, with the assumption of no substantial capacity increases. The zone with the new garage, which

increases the capacity of the existing surface parking, was set at 70 percent greater than the base year level of trips to reflect the additional capacity created by the construction of the garage. Off-campus zones, including W.R. McNeil Elementary School, that surround campus are built out and offer few opportunities for growth, suggesting a stable population. Therefore, the trip growth in these adjacent areas was set at five percent higher than the base year to reflect the same stability.

To develop the 2040 growth rates for through trips, the subarea model network used for the base year simulation model was applied to the 2040 future demand model. The high raw growth rates for many through trip pairs implied that the AM and PM period capacities of the demand model network did not reflect the true operational constraints of the simulation network, particularly at intersections. To address this over-assignment of regional through trips, a cap of 50 percent growth, or 1.8 percent annual growth, was placed on all trips to ensure that growth between trip pairs was realistically tempered by the operational constraints in the campus and downtown areas. This level of growth is in line with historic growth for the area and ultimately reflects a significant but regional amount of traffic growth over the 25-year time period between the base and future models. Warren County population projections from the Kentucky State Data Center are shown in **Figure 13**.

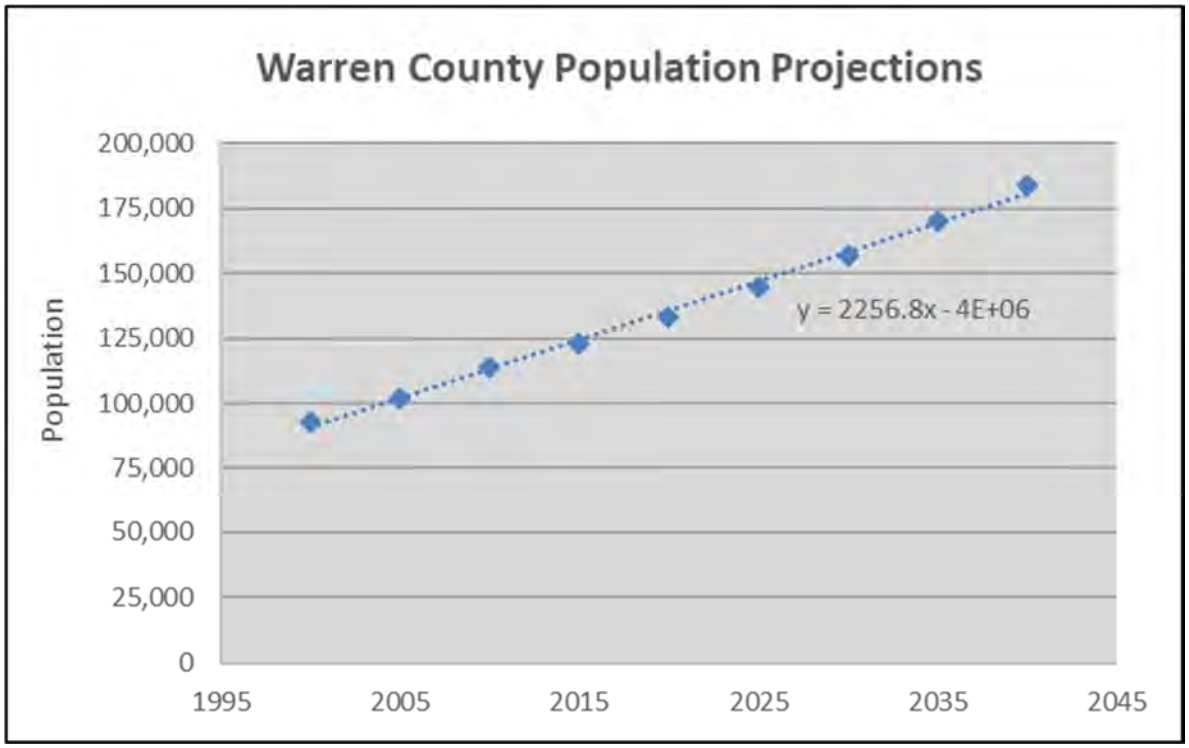


Figure 13: Warren County Population Projections (Source: KY State Data Center)

Overall, 2040 total trips in the AM peak period grew by 32 percent and by 26 percent in the PM peak period. **Table 7** presents a summary of the existing and forecasted simulation model trips for the AM and PM peak hours**.**

Table 7: Traffic Forecast Summary

	AM Peak (7:30 – 8:30)					
	2018		2040		Delta	
	To	From	To	From	To	From
On-campus	1,135	525	1,369	670	234	145
Off-campus	569	774	670	903	101	129
Through trips	3,587	3,992	5,084	5,549	1,497	1,557
Total	5,291		7,123		1,832	
	PM Peak (4:30 – 5:30)					
	2018 Trips		2040 Trips		Delta	
	To	From	To	From	To	From
On-campus	924	1,241	1,063	1,435	139	194
Off-campus	784	791	874	901	90	110
Through trips	4,805	4,481	6,297	5,898	1,492	1,417
Total	6,513		8,234		1,721	

4.1.2 2040 No-Build Simulation Model

To analyze future traffic operations in the study area, a 2040 future year simulation model was developed based on the calibrated 2018 base year model. The 2040 network included KYTC's Existing Plus Committed projects. In the study area, this included the major widening to four lanes on Nashville Road (US 31W) from Campbell Lane to University Boulevard. Due to the limited size of the simulation model, Nashville Road was widened from the southern extent of the model (just south of Lansdale Avenue) to the University Boulevard intersection.

Table 8 presents a summary of the 2040 No-Build traffic operations. With no further improvements, both intersections will operate at an acceptable LOS during the AM peak period; however, several approaches have V/C ratios nearing or above 1.0. Both intersections will operate at an undesirable LOS F during the PM peak period, with most of the approaches having V/C ratios above 1.0.

Table 8: 2040 No-Build Traffic Operations Summary

Intersection	Approach	AM		PM	
		LOS	V/C*	LOS	V/C*
Russellville/University	EB Russellville	E	1.3	F	2.3
	NB University	D	1.1	F	1.5
	SB University	D	0.6	F	0.6
	WB Ave of Champions	E	0.1	F	0.4
	Total	D	N/A	F	N/A
Russellville/Morgantown	EB Russellville	C	0.8	F	1.0
	WB Russellville	B	0.7	B	1.0
	SB Morgantown	F	0.9	F	1.2
	Total	D	N/A	F	N/A

*Demand-to-Capacity Ratio

A full discussion of the future year simulation model can be found in **Appendix D**.

5.0 ENVIRONMENTAL OVERVIEW

An Environmental Red Flag Summary was performed to identify environmental resources of significance, potential jurisdictional features, and other environmental areas of concern that should be considered during project development. Natural and human environmental resources within the study area were identified from a literature/database review, as well as a windshield survey. The complete document is included in **Appendix E**.

More detailed environmental studies may be required as individual projects are further developed. If a future project is federally funded, the National Environmental Policy Act (NEPA) requires that potential environmental impacts regarding jurisdictional wetlands, archaeological sites, cultural historic sites, and federally endangered species must be avoided if feasible and prudent. If not, then impact minimization efforts are required. Mitigation for unavoidable impacts may also be necessary.

5.1 NATURAL ENVIRONMENT

Natural environment resources include surface streams, floodplains, wetlands, ponds, groundwater, threatened, endangered, and special concern species and habitat, woodland and terrestrial areas, and parks. Through a literature/database review and field reconnaissance, potentially sensitive resources that affect the natural environment were identified in the study area and are discussed in the following sections and presented in **Figure 14**.

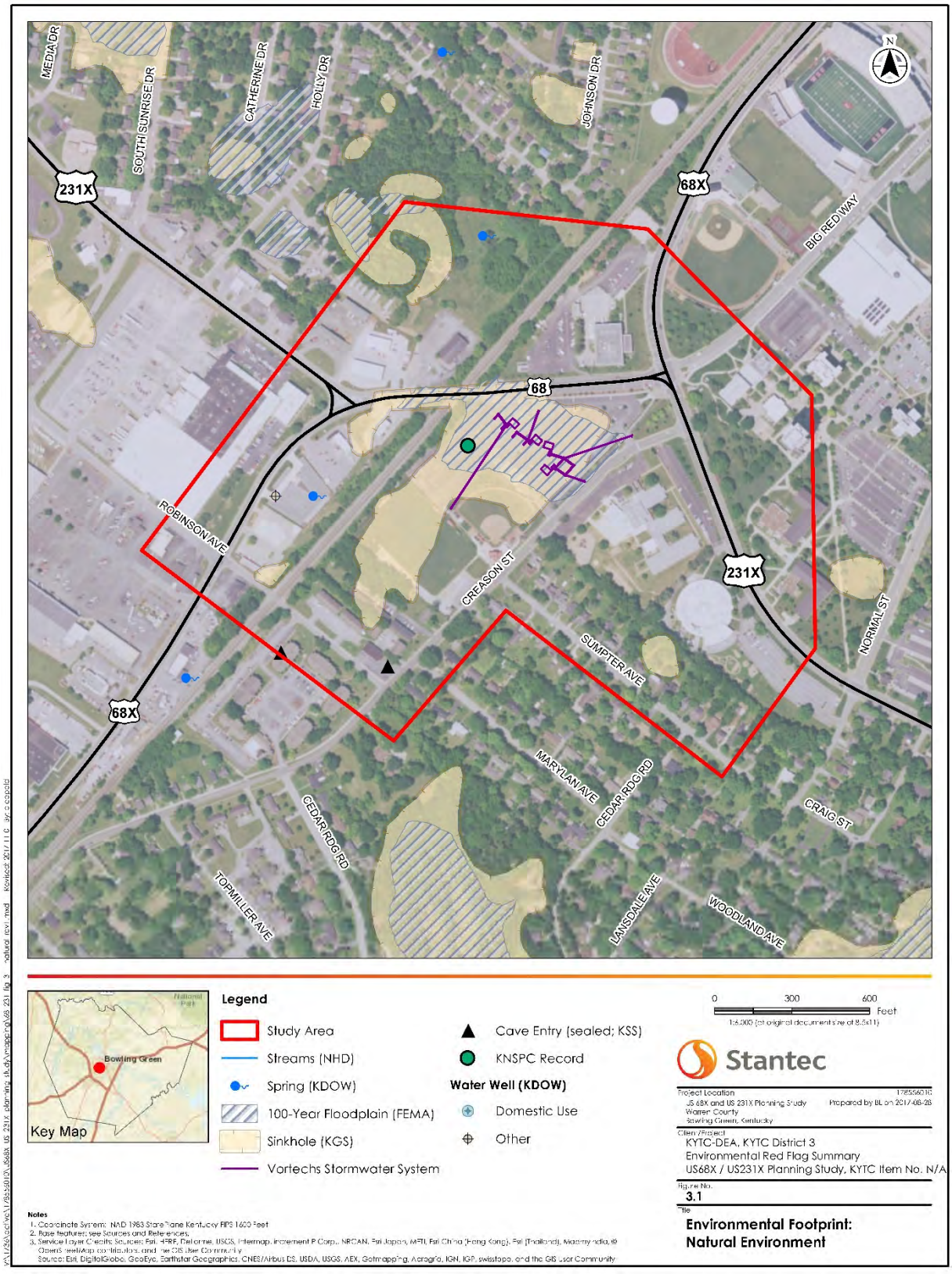


Figure 14: Natural Environment

5.1.1 USGS Streams

No United States Geological Survey (USGS) streams are mapped within the study area. The karst nature of the landscape results in very few surface stream features in the study area vicinity.

5.1.2 Other Streams

Multiple underground streams are mapped within the study area, all part of the Lost River system that underlies Bowling Green.

No surface streams are evident on aerial photography or were observed during field review of the study area. Surface runoff in the project area is accommodated by vegetated swales and a storm sewer system.

5.1.3 Watersheds

The study area lies within the Jennings Creek Subwatershed of the Barren River Sub-basin.

No Kentucky Division of Water (KDOW) designated Priority Watersheds are located in or adjacent to the study area. The study area does not occur within a Source Water Assessment and Protection Program (SWAPP) area.

5.1.4 Wetlands

No National Wetlands Inventory (NWI) mapped wetlands are located in the study area, and no hydric soils are mapped.

5.1.5 Ponds

No ponds are mapped within the study area and no standing water features were observed during field review activities.

5.1.6 USFWS Species List

Seventeen federally listed species are known or have the potential to occur in the study area, including:

- Indiana bat, gray bat, and northern long-eared bat are known to occur in Warren County;
- Twelve endangered or threatened mussels (clubshell, fanshell, northern riffleshell, orangefoot pimpleback, pink mucket, purple cat's paw, ring pink, rough pigtoe, sheepnose, snuffbox, rabbitsfoot, and spectaclecase) are listed as being potentially affected by activities in the study area; and

- The Kentucky cave shrimp and Price's potato-bean may be affected by activities in the area.

The study area lies within a Known Summer 1 Habitat designated area for northern long-eared bats. Limited potential summer roost and foraging habitat for Indiana bat and northern long-eared bat is present in a small woodlot located in the northwest corner of the study area.

Habitat for gray bat is not likely to be present because known cave entrances in the study area have been sealed. None of the mussel species listed above have suitable habitat present because there are no streams in the study area. Although cave shrimp are listed as potentially affected, this project is not located within their critical habitat.

Habitat for Price's potato-bean may be present in the limited extent of open woodland having a powerline clearing located in the northwest portion of the study area.

Potential Bat Habitat in Northwest Corner of Study Area

5.1.7 KDFWR Species List

The Kentucky Department of Fish and Wildlife Resources (KDFWR) lists 43 additional State-threatened, Endangered, and Special Concern Species as occurring in the Bowling Green South USGS quadrangle that covers the study area. These include:

- Thirteen state-endangered species (eight birds, three fish, two mussels);
- Thirteen state-threatened species (10 birds, two mussels, one snail); and
- Seventeen state-special concern species (12 birds, two fish, one mussel, one insect, one crustacean).

5.1.8 KSNPC Species Database

The Kentucky State Nature Preserves Commission (KSNPC) provided records for 44 federal or state-endangered, threatened, or special concern listed species within 10 miles of the study area. These include:

- One amphibian;
- Twelve birds;
- Two crustaceans;
- Four fish;
- Thirteen mussels;
- One insect;
- Five mammals;
- One snail; and
- Five plants.

Two occurrences are known within the study area, for two plant species in one location. Four bat species have known hibernacula within five miles of the study area.

5.1.9 Groundwater

Three water wells are mapped within the study area. All are plugged and present at a former gas station as part of the Underground Storage Tank (UST) regulatory program. No wellhead protection areas are mapped within the study area.

Two springs are mapped within the study area, neither of which are used as a source water supply. One spring is located on the same property as the plugged water wells along Russellville Road. The second spring is located in an undeveloped field in the northwest corner of the study area.

Underground drainage conduits exist in the study area and vicinity, part of the Lost River system that flows under the study area.

5.1.10 Karst

The project area is underlain by bedrock with high potential for karst, in addition to having karst geology. Four sinkholes are mapped underlying the study area, accounting for approximately 13 percent of the area. Large sinkholes are located between Russellville Road and Creason Street, and north of Holly Drive.

Two cave entrances are known within the study area, leading to separate caves (Creason Cave and Robinson Cave). Both entrances are non-natural (drilled shaft or dug well) and are currently sealed.

KYTC has a policy for use of specific drainage designs (grass swales and detention basins) in roadway improvement projects in known karst areas.

Stormwater drains in Creason Parking Lot

5.1.11 Floodplain

Based on review of Flood Emergency Management Agency (FEMA) National Flood Hazard Layer, FEMA 100-Year floodplains are present at two locations within the study area, both associated with the larger sinkholes present and represent closed depressions isolated from surface features. The floodplain area present in the middle of the Study Area currently has four Vortechs® stormwater treatment and flood control devices installed under the parking lot. This system is sized to accommodate existing runoff and flow volume and conditions.

5.1.12 Floodway

No FEMA designated floodway occurs in the study area or vicinity.

5.1.13 Farmland

No soils identified as Prime Farmland are mapped within the study area. No active farmland is present within the study area.

5.1.14 Hazardous Materials

A database records review summary found nine sites of potential concern within or immediately adjacent to the study area. These include four United States Environmental Protection Agency (USEPA)-Envirofacts Sites and six UST sites (one active). No Superfund, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), National Priorities List (NPL), or Brownfields sites are located within one mile of the study area.

A field survey indicated two additional potential hazardous materials concern sites: The WKU Supply-Services out-building that posted a "Hazardous Waste" placard and an electrical substation, along with two automotive service businesses.

5.1.15 Oil and Gas Wells

No oil or gas wells are mapped within or near the study area. The nearest producing oil/gas well is approximately 1.2 miles northwest of the study area.

5.1.16 Section 4(f)

No Section 4(f) resources were identified in the study area through secondary source information or during field survey. There are no public use recreational facilities in the study area, as all are for restricted use by WKU or McNeill Elementary School.

5.1.17 Section 6(f)

Based on current Land and Water Conservation Fund (LWCF) records, there are no Section 6(f) resources in the study area.

5.1.18 Air Quality

The study area is not located in a Nonattainment Area for eight-hour ozone, or a Maintenance area for PM2.5 for the transportation-related criteria pollutants for which the Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for Transportation Criteria Pollutants.

Two USEPA permitted air emissions facilities are located within or immediately adjacent to the study area, both on Russellville Road at Robinson Avenue. One facility is a manufacturing plant and the other is a vacant dry-cleaning business.

5.1.19 Noise

Noise-sensitive land use areas are present throughout the eastern and southern portions of the study area, consisting of the following:

Activity Category "B" land use:

- Four student residence halls;
- Three apartment complexes; and
- One residential neighborhood.

Activity Category "C" land use (exterior):

- Three WKU sports facilities and
- Two outdoor playgrounds.

Apartment Complex on Robinson Avenue

Activity Category "D" land use (interior):

- One public institutional structure (Jones Jagger Hall and Child Care Center) and
- W.R. McNeill Elementary School.

5.2 HUMAN ENVIRONMENT

Human environment is defined as what we live in and around and what we have built. Through review of secondary source information and field reconnaissance, potentially sensitive resources that affect the human environment were identified in the study area, are discussed in the following sections, and shown on **Figure 15**.

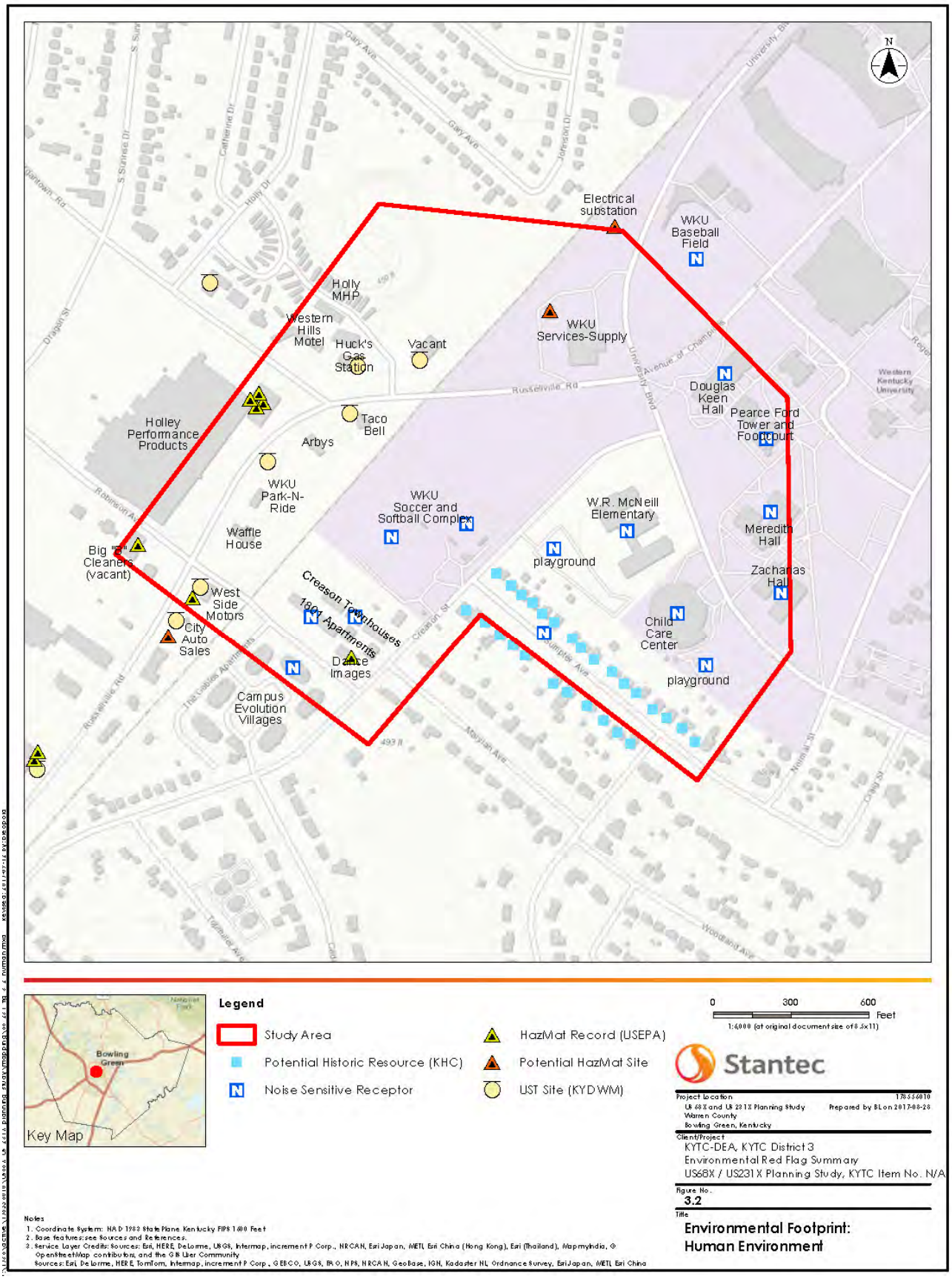


Figure 15: Human Environment

5.2.1 Socioeconomic Report

The Barren River Area Development District (BRADD) performed a review of socioeconomic conditions in the study area based on 2012 – 2016 American Community Survey (ACS) statistics. The complete document is included in **Appendix F**. The following were conclusions of the study:

- The study area includes five Census Tract Block Groups.
- Minority populations (42.15 percent) in Block Group 3 Census Tract 103 and (36.05 percent) In Block Group 5 of Census Tract 109 are double that of the region and county (9.62 percent and 14.71 percent).
- Persons age 65 and older (18.33 percent) in Block Group 4 Census Tract 109 and (24.19 percent) in Block Group 5 Census Tract 109 are more than the county, region, state, and nation.
- The populations below the poverty level in three of the five Block Groups in the study area are considerably higher than that of the county, region, state, and nation.
- Block Group 4 Census Tract 109 persons with a disability (4.99 percent) is considerably lower than that of the remaining four Block Groups, county, region, state, and nation.
- Block Group 5 of Census Tract 109 and Block Group of Census Tract 110.01 are the two areas with a slightly higher limited English proficiency in the study area, county, region, and state. The two Block Groups are still lower than nation.

5.2.2 Cultural – Archaeology

Based on a review of the National Register of Historic Places (NRHP) and the Kentucky Office of State Archaeology (OSA) Preliminary Site Check response, no archaeological sites are known in or near the study area.

5.2.3 Cultural – Historic

Based on a review of the Kentucky Heritage Council (KHC) Site Check response, there are 27 houses with undetermined NRHP status in the study area. These houses are listed as KHC Historic Resources. Additional cultural historic investigations are recommended for any proposed project activities.

5.2.4 Houses of Worship

Based on a review of topographical maps and a field survey, no houses of worship (church, mosque, synagogue, etc.) were identified in the study area.

5.2.5 Schools

WKU encompasses approximately 40 percent (36 acres) of the study area, comprised primarily of residential housing and athletic and support facilities. One elementary school (W.R. McNeill Elementary) is also present.

5.2.6 Residences and Businesses

Residential land use in the study area includes single-family homes along Sumpter Avenue and Creason Street, and multi-family apartment complexes along Creason Street and Robinson Avenue.

Commercial businesses are concentrated along US 68X and US 231X west of the railroad tracks, with one additional business at the corner of Robinson Avenue and Creason Street.

5.2.7 Cemeteries

No cemeteries are located within or near the study area.

5.2.8 Public Services

Public service and utility facilities located within the study area include:

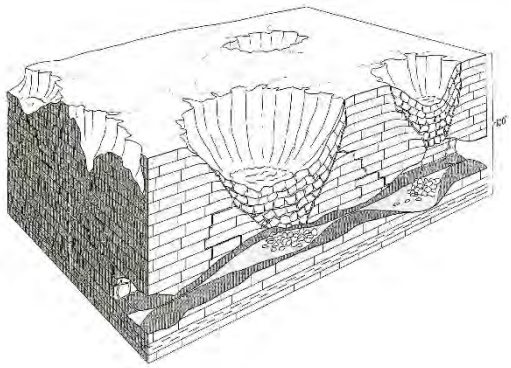
- CSX Railroad bridge over Russellville Road;
- CSX Railroad at-grade crossing at Robinson Avenue; and
- Electrical substation on University Boulevard at the north end of the study area.

CSX Railroad in Study Area

5.3 GEOTECHNICAL OVERVIEW

A geotechnical overview of the study area was completed based upon research of available published data and experience with highway design and construction within the region. The purpose of the overview was to provide a general summary of the bedrock, soil, and geomorphic features likely to be encountered in the study area and to identify geotechnical features that may have an adverse impact on the project alignment. The complete document is included in **Appendix G**. The overview, shown on **Figure 16**, included:

- Karst topography/sinkholes and basins are located within the study area. Sinkholes or solution cavities identified within the vicinity of proposed improvements that are not accepting drainage should be filled and/or capped. Any sinkholes utilized for drainage purposes for roadway construction should incorporate adequate measures to minimize water infiltration into the subgrade and erosion control measures to minimize siltation of open sinkholes. The design team should inventory the sinkholes and other karst features and note whether the sinkhole accepts drainage. Reportedly, the drainage basins in WKU's parking area have reduced flooding in the immediate area. Any improvements should avoid these drainage features.



Typical Karst Activity Underlain by Limestone

- Two caves (Robinson and Creason Caves) are present beneath the study area. New route alignments and widenings should be positioned outside the limits of the caves. If this is not possible, any new alignments should cross the cave system in a perpendicular manner. In no case should new construction cross a large room within the cave system. Geotechnical drilling may need to be supplemented with geophysical techniques in immediate areas of known sinkholes/karst activity.
- Geotechnical drilling will be critical in this region for new, replacement or widened culverts, bridges, retaining walls, and design due to the karst potential. It is anticipated that conventional spread footing and/or pile foundation systems can be utilized for structures. However, if voids/caves are present, additional costs associated with karst mitigation should be anticipated.
- Because portions of projects may be widening projects, information on pavement structure should be obtained to assist the team on pavement structure and California Bearing Ratio (CBR) information. Other projects in the vicinity have utilized mechanical or chemical stabilization and generally yielded CBR values of approximately six or less.
- Once alignment and sections are identified, the open-faced logging of exposed cuts and/or drilling should be performed. Sampling of foundation soils should be performed for embankment situations of sufficient height to evaluate stability.

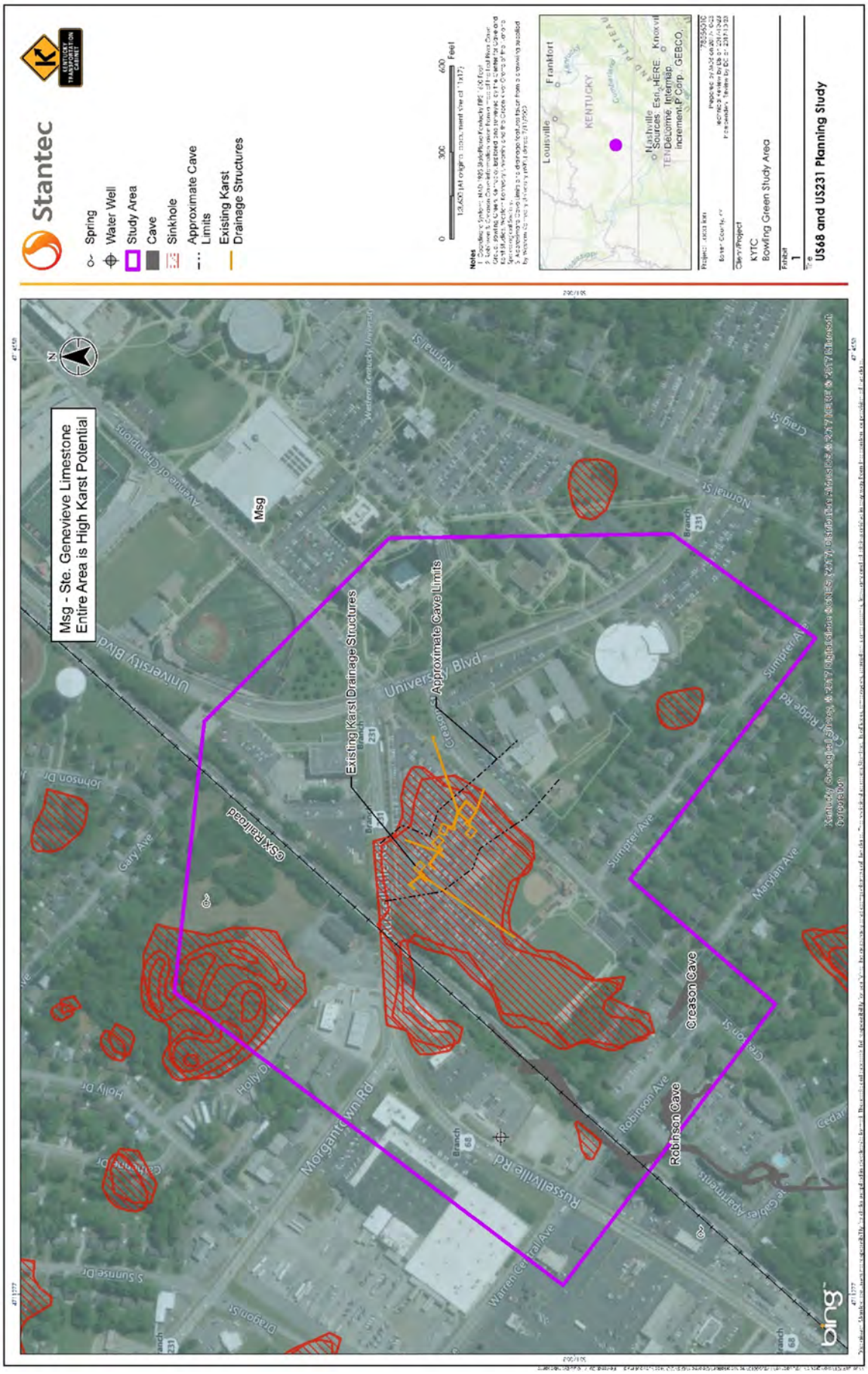


Figure 16: Geotechnical Overview

6.0 INITIAL PROJECT TEAM AND STAKEHOLDERS COORDINATION

Over the course of the study, the project team held three in-person meetings to coordinate on key issues. The project team consisted of representatives from KYTC Central Office, KYTC District 3, the Bowing Green – Warren County MPO, WKU, and the consultant Stantec. The project team also reached out to stakeholders and local officials for input. Detailed summaries of each meeting are presented in **Appendix H**.

6.1 PROJECT TEAM MEETING NO. 1

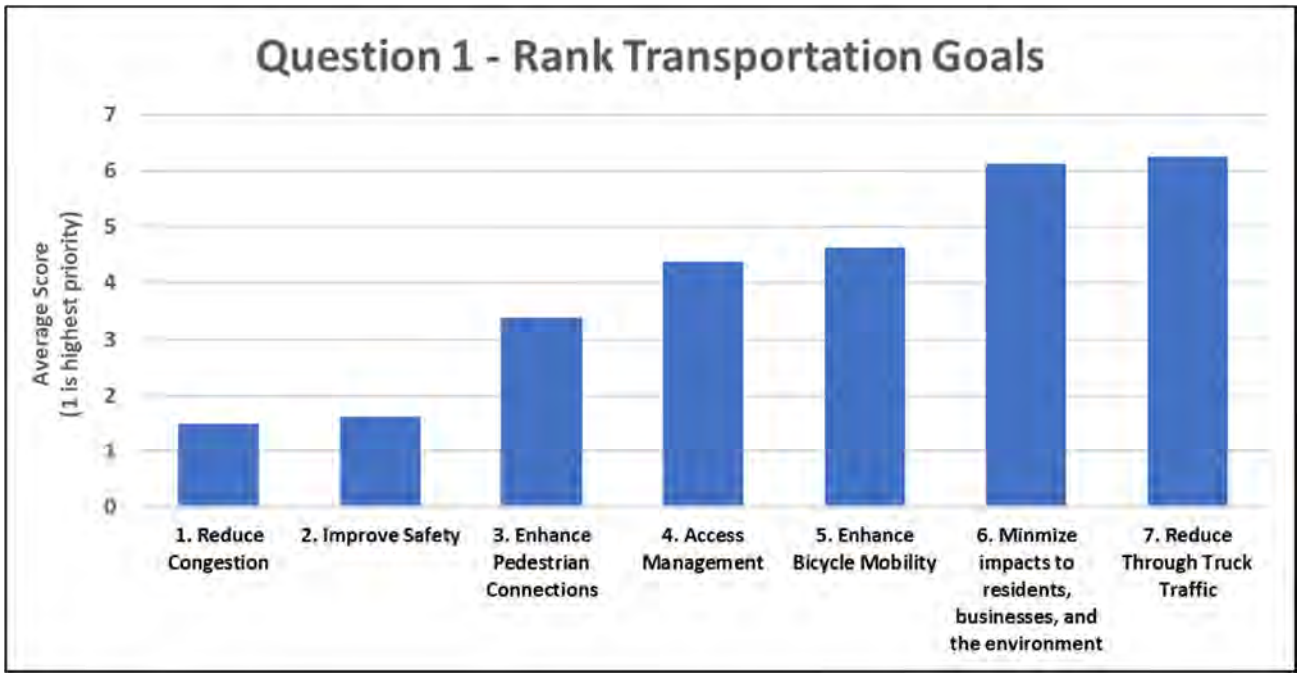
The project team first met at the KYTC District 3 Office in Bowling Green, Kentucky on June 22, 2018. The purpose of the meeting was to present the results of the existing conditions analysis and to get feedback from the project team on potential improvement concepts. Key discussion items included the following:

- This study ranked 6th out of 42 planning projects submitted by highway districts across the state and scored through SHIFT metrics. Two PIFs were combined in the development of this planning study.
- An upcoming repaving project was planned to remove the channelized right-turn lanes and improve the crosswalks at the Russellville Road/Morgantown Road intersection. Construction was complete in the summer of 2018.
- A new parking garage near the Creason Parking Lot (WKU Parking Structure 3) was opened in November 2017. The garage is currently underutilized but is expected to be full at the start of the Fall 2018 semester. Trips for the new parking garage were estimated using the parking space allocation information from WKU (number of commuter and residential parking passes) and the trip distribution factors from the ITE Trip Generation Manual. These additional trips from the new parking garage were added to the existing turning movement counts that were collected by KYTC in February 2018.
- There is a proposed student apartment complex development in the study area near the Russellville Road intersection with Morgantown Road. There are expected to be 228 units with 378 beds. Access points will be located at Russellville Road, Holly Drive, and Gary Avenue. The estimated traffic to be generated from this development was included in the No-Build (2040) simulation model.
- In addition to the No-Build, the project team will study several improvements: existing intersection improvements; a roundabout at the Morgantown Road/Russellville Road intersection; a roundabout at the University Boulevard/Russellville Road intersection; widening Russellville Road and adding bicycle lanes and sidewalks; and other low-cost improvements such as signal optimization and driveway consolidation.

6.2 LOCAL OFFICIALS/STAKEHOLDERS MEETING NO. 1

The project team reached out to local government representatives and other community groups early in the planning process. The first local officials/stakeholders meeting was held the morning of June 22, 2018, immediately after the first project team meeting. In addition to the project team, representatives from the Bowling Green Chamber of Commerce, the City of Bowling Green, the City Council Planning Commission, and Warren County were in attendance. The purpose of the meeting was to discuss the project purpose and history, the results of the existing conditions analysis, design considerations, and to solicit input on the need for improvement concepts. Attendees were asked to provide input on transportation goals and interest in concepts.

- Respondents were asked to rank transportation goals from 1-7, where 1 is the highest priority and 7 is the lowest. The transportation goals are shown below in order of lowest average ranking by the eight Local Officials/Stakeholders:



- Respondents were asked to rank the improvement concepts presented at the meeting from 1-5, where 1 is the highest priority and 5 is the lowest. The concepts are shown below in order of best average ranking by the eight Local Officials/Stakeholders:
    - Reconstruct University Boulevard/Russellville Road Intersection (Average Score = 2.4)
    - Widen Russellville Road to Four Lanes with Bike/Ped Facilities. This concept includes replacing the railroad bridge. (Average Score = 2.5)

  - Access Management/Driveway Consolidation. (Average Score = 3.3)
  - Reconstruct Morgantown Road/Russellville Road Intersection. (Average Score 3.4)
  - Add sidewalks on existing Russellville Road and do not replace the existing railroad bridge. (Average Score = 3.5)

- There was a suggestion for an improvement concept to create a pedestrian bridge over the railroad to connect the proposed apartment development with WKU's campus. This is outside the scope of this project, but bicycle and pedestrian connections will be considered along Russellville Road.

7.0 INITIAL CONCEPT DEVELOPMENT

Improvement concepts were developed based on a combination of input from stakeholders and the project team, a review of existing conditions, simulation model traffic analyses, and field reconnaissance. Over the course of the study, the project team worked to determine which improvement concepts proved to be the most cost effective. These concepts were carried forward for future evaluation. Traffic operations for the improvement concepts were analyzed using the traffic simulation model. Along with the No-Build, this study examined several other types of improvements discussed below. The KYTC repaving project to remove the channelized right-turn lanes and improve crosswalks at the Russellville Road/Morgantown Road intersection was completed during this study and is included in all improvement concepts.

Improvements Concepts

- No-Build
- Intersection Improvements
- Roundabouts
- Widen Russellville Road
- Pedestrian Tunnel
- Flyover

No-Build: This option would make no transportation improvements. The No-Build serves as a baseline for comparison of improvement concepts.

7.1 IMPROVEMENT CONCEPT 1

Improvement Concept 1 is a short-term option to improve the University Boulevard intersection and provide better connections between pedestrian facilities. It includes the following:

- Convert the existing center right-turn lane on eastbound Russellville Road at the University Boulevard intersection to a shared left/right-turn lane.
- Construct a sidewalk on eastbound Russellville Road under the CSX bridge.

Converting the existing center right-turn lane to a shared left/right-turn lane required the removal of the overlap phase at the signal, which increased congestion. It was, therefore, not evaluated further.

Proposed sidewalk under CSX bridge

7.2 IMPROVEMENT CONCEPT 2

Improvement Concept 2 is a long-term option to improve the University Boulevard intersection and provide better connections between pedestrian facilities. It includes the following:

- Convert the existing center right-turn lane on eastbound Russellville Road at the University Boulevard intersection to a shared left/right-turn lane.
- Construct a dedicated left-turn lane on northbound University Boulevard at the Russellville Road intersection to allow for two dedicated through lanes.
- Construct a right-turn lane on southbound University Boulevard at the Russellville Road intersection to allow for two dedicated through lanes.
- Construct a sidewalk on eastbound Russellville Road under the CSX bridge. The proposed sidewalk is assumed to be on eastbound Russellville Road in order to connect with the existing sidewalks along the Creason Parking Lot.

7.3 IMPROVEMENT CONCEPT 3

Improvement Concept 3 is a long-term option to reconstruct the University Boulevard intersection and provide better connections between pedestrian facilities. There are three variations of this improvement concept: 3a, 3b, and 3c. All three improvement concepts include the following improvements:

- Construct a roundabout at the Russellville Road intersection with University Boulevard.
- Construct a sidewalk on EB Russellville Road under the CSX Bridge.

Improvement Concept 3b also includes a right-turn bypass lane for the Avenue of Champions approach at the roundabout. Improvement Concept 3c includes the right-turn bypass lane and only allows access on Avenue of Champions by permit.

Through discussions with WKU, it was determined that limiting access on Avenue of Champions is not feasible. Improvement Concept 3c was not further evaluated.

Without limiting access on Avenue of Champions, a bypass lane at the roundabout is necessary. Improvement Concept 3a was, therefore, not evaluated further.

7.4 IMPROVEMENT CONCEPT 4

Improvement Concept 4 is a long-term option to improve the University Boulevard intersection, widen Russellville Road, and provide better connections between pedestrian facilities. It includes the following:

- Convert the existing center right-turn lane on eastbound Russellville Road at the University Boulevard intersection to a shared left/right-turn lane.
- Construct a dedicated left-turn lane on northbound University Boulevard at the Russellville Road intersection to allow for two dedicated through lanes.
- Construct a right-turn lane on southbound University Boulevard at the Russellville Road intersection to allow for two dedicated through lanes.
- Widen Russellville Road to four lanes through the study area including adding bicycle and pedestrian facilities (requires replacing the CSX bridge).

7.5 IMPROVEMENT CONCEPT 5

Improvement Concept 5 is a long-term option to reconstruct the University Boulevard intersection and widen Russellville Road. It includes the following:

- Construct a roundabout at the Russellville Road intersection with University Boulevard with a right-turn bypass lane from Avenue of Champions.
- Widen Russellville Road to four lanes through the study area including adding bicycle and pedestrian facilities (requires replacing the CSX bridge).

7.6 IMPROVEMENT CONCEPT 6

Improvement Concept 6 is a long-term option to reconstruct both the University Boulevard and Morgantown Road intersections and widen Russellville Road. It includes the following:

- Construct a roundabout at the Russellville Road intersection with University Boulevard with a bypass lane from Avenue of Champions.

- Construct a roundabout at the Russellville Road intersection with Morgantown Road.
- Widen Russellville Road to four lanes through the study area including adding bicycle and pedestrian facilities (requires replacing the CSX bridge).

7.7 IMPROVEMENT CONCEPT 7

Improvement Concept 7 is a long-term option to improve the University Boulevard intersection and provide better pedestrian facilities. It includes the following:

- Convert the existing center right-turn lane on eastbound Russellville Road at the University Boulevard intersection to a shared left/right-turn lane.
- Construct a bike/ped tunnel under University Boulevard from the Creason Parking Lot.
- Allow the eastbound Russellville Road approach to turn right on red at the University Boulevard intersection.

Example bike/ped tunnel

It was determined that the congestion relief provided by Improvement Concept 7 does not sufficiently satisfy the purpose and need of this study. It was, therefore, not evaluated further.

7.8 IMPROVEMENT CONCEPT 8

Improvement Concept 8 involves constructing an overpass to take Russellville Road over the existing CSX railroad bridge. However, there is not enough distance between the overpass and the Morgantown Road (700 feet) and University Boulevard (400 feet) intersections. The grades would be too steep for an overpass to tie into these existing intersections while providing adequate clearance. This concept was not evaluated further.

8.0 SECOND PROJECT TEAM AND STAKEHOLDERS MEETINGS

Following the development of the initial improvement concepts, the project team met with local officials and stakeholders. During the meeting, improvement concepts were presented, and attendees were asked to provide feedback regarding their concerns and priorities. Summaries for all meetings are found in **Appendix H**.

8.1 PROJECT TEAM MEETING NO. 2

The project team met at the KYTC District 3 Office in Bowling Green, Kentucky on August 30, 2018. The purpose of the meeting was to discuss the initial improvement concepts and get feedback from the project team on changes that should be considered. Key discussion items included the following:

- Several preliminary improvement concepts were presented. Five were moved forward for more detailed analysis:
    - Improvement Concept 2
    - Improvement Concept 3
    - Improvement Concept 4
    - Improvement Concept 5
    - Improvement Concept 6
- Improvement Concept 7, the shared-use path tunnel concept was discussed. The path would travel under University Boulevard from the Creason Parking Lot, eliminating pedestrian conflicts at the Russellville Road/University Boulevard intersection and allowing right turns on red from Russellville Road. While this concept allows pedestrians to cross unimpeded, it does not significantly improve congestion. The project team decided that resources may be more wisely allocated to improvement concepts that both alleviate congestion and improve pedestrian safety for the entire study area.
- There was an open discussion about public involvement. An online survey will be created to find out what "type" of improvements the public would like to see rather than voting on which concept they prefer. WKU agreed to assist in this effort by sending a campus-wide email with information on the project and a link to the survey. Local homes and businesses will be mailed postcards with a link to the survey.

8.2 LOCAL OFFICIALS/STAKEHOLDERS MEETING NO. 2

The project team met with key stakeholders and local officials for a second time on November 19, 2018. The purpose of the meeting was to present the conceptual improvement concepts and solicit feedback from local officials and stakeholders. Stakeholders were also asked to fill out a questionnaire to help the project team evaluate improvement concepts. Eight surveys were returned. The results are summarized in **Table 9**.

Table 9: Local Officials Meeting No. 2 Survey Results

Question 1 Are improvements needed at the Russellville/University intersection?	**Question 2** Which concept do you prefer?	**Question 3** Are the recent improvements at the Russellville/Morgantown intersection adequate?	**Question 4** Which improvement do you prefer at the Russellville/Morgantown intersection?	**Question 5** With lengthy road closures (up to 1 year) should Russellville Rd. be widened?	**Question 6** Which concept do you prefer?
Yes 100% (8 responses) **No** 0% (0 responses)	**Roundabout** 75% (6 responses) **Additional lanes** 25% (2 responses)	**Yes** 14% (1 response) **No** 72% (5 responses) **Not enough time to know** 14 % (1 response)	**Roundabout** 60% (3 responses) **Additional lanes** 40% (2 responses)	**Yes** 100% (8 responses) **No** 0% (0 responses)	**Additional lanes/sidewalks** 0% (0 responses) **Roundabout at University** 0% (0 responses) **Russellville widening & roundabout at University** 0% (0 responses) **Russellville widening & roundabouts at University and Morgantown** 75% (6 responses) **Other - Widen Russellville and provide intersection improvements** 25% (2 responses)

There was considerable discussion concerning the roundabout concepts, particularly related to accommodating pedestrians. Some considerations for enhancing pedestrian safety were discussed, including proper design of the approaches and crosswalks, implementation of rapid rectangular flashing beacons (RRFB) at the crosswalks, and the possibility of signalized mid-block pedestrian crossings.

9.0 REVISED IMPROVEMENT CONCEPTS

After the second round of coordination, the initial improvement concepts were revised based on feedback received. The revised improvement concepts were analyzed to determine the safety, congestion, and multi-modal benefits in the study area.

9.1 REVISED IMPROVEMENT CONCEPTS

Based on feedback received at the second round of meetings, it was determined that Improvement Concepts 1, 7, and 8 did not satisfy the project purpose and need and were eliminated. The remaining improvement concepts all improve safety, reduce congestion, and better accommodate all modes of travel in the study area. Due to concerns over pedestrian safety, signalized midblock crossings were added for the roundabout concepts at the University Boulevard intersection. The five revised improvement concepts include:

Improvement Concept 2 – Additional turn lanes at the University Boulevard intersection and provide a sidewalk on Russellville Road, as shown in **Figure 17**.

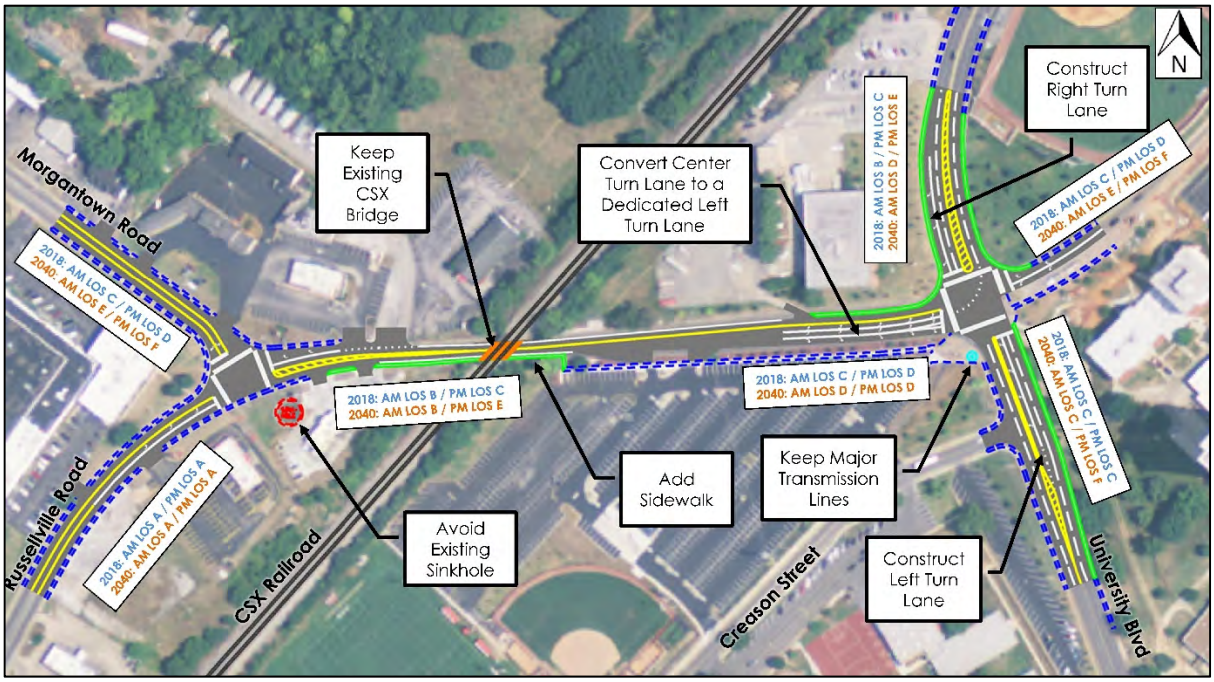


Figure 17: Improvement Concept 2

Improvement Concept 3 – Construct a dual lane roundabout at the University Boulevard intersection with a right-turn bypass lane for the Avenue of Champions approach and a signalized midblock pedestrian crossing and provide a sidewalk on Russellville Road. Due to the high number of pedestrians crossing University Boulevard at this location and since roundabouts allow vehicles to flow continuously, the midblock pedestrian crossing is signalized to provide gaps for pedestrians to cross safely, as shown in **Figure 18**.

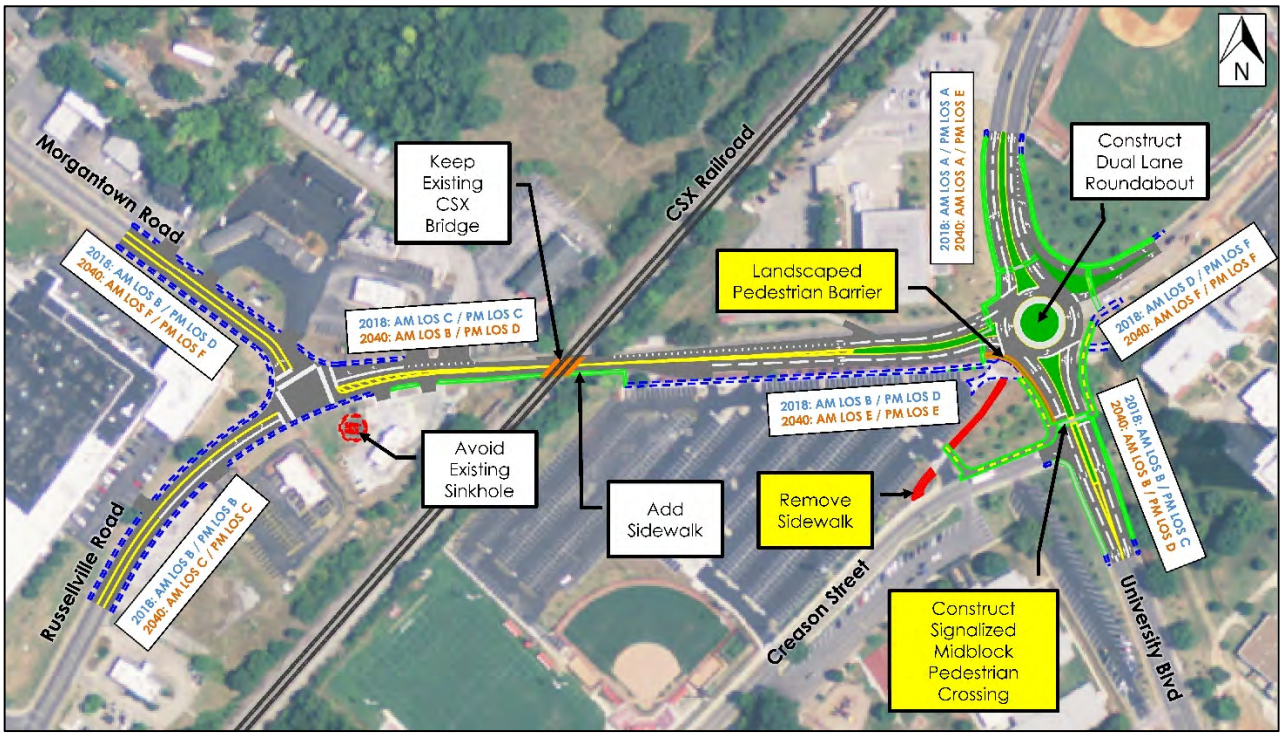


Figure 18. Improvement Concept 3

Improvement Concept 4 – Added turn lanes at the University Boulevard intersection and widen Russellville Road to four lanes including adding bicycle and pedestrian facilities.

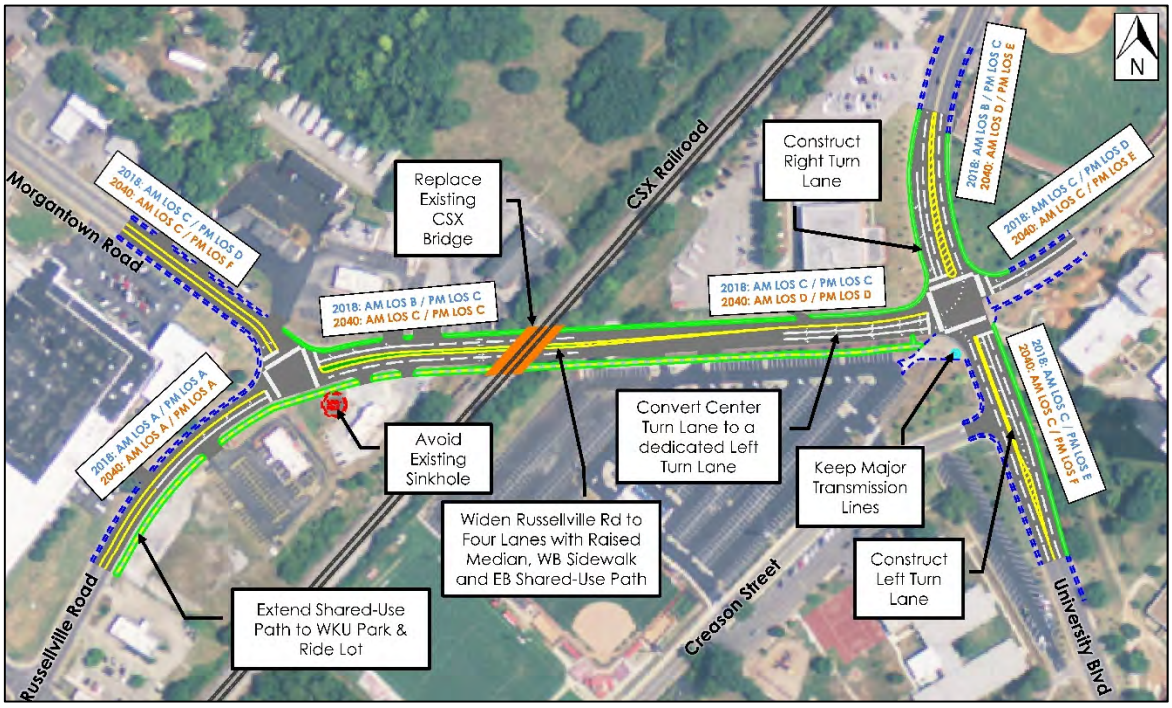


Figure 19: Improvement Concept 4

Improvement Concept 5 – Construct a roundabout at the University Boulevard intersection with a signalized midblock pedestrian crossing and widen Russellville Road to four lanes including adding bicycle and pedestrian facilities.

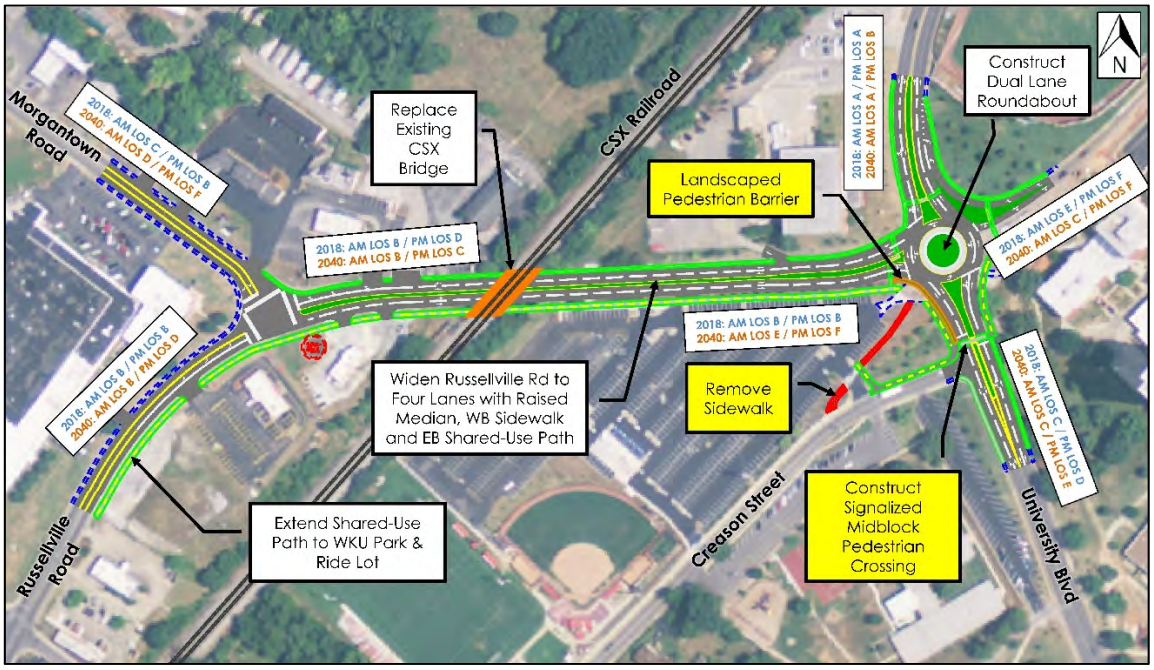


Figure 20: Improvement Concept 5

Improvement Concept 6 – Construct a roundabout at the University Boulevard intersection with a signalized midblock pedestrian crossing, construct a roundabout at the Morgantown Road intersection, and widen Russellville Road to four lanes including adding bicycle and pedestrian facilities.

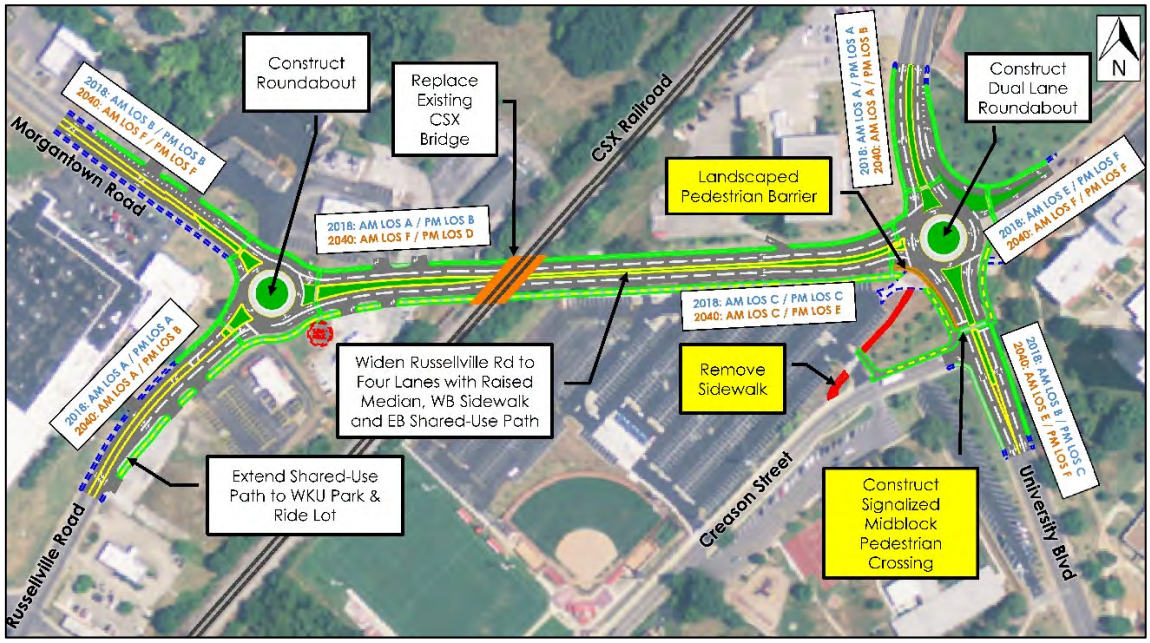


Figure 21: Improvement Concept 6

9.2 SIMULATION MODEL RESULTS

The 2018 and 2040 No-Build traffic simulation model scenarios, as discussed in Chapters 3 and 4, were used to develop scenarios for the revised improvement concepts. **Table 10** presents the AM and PM peak hour LOS and intersection delay (in seconds) for each of the concepts. The results indicate that the Russellville Road/University Boulevard intersection currently has an undesirable LOS in the PM peak hour and that both the Russellville Road/University Boulevard intersection and the Russellville Road/Morgantown Road intersection will have an undesirable LOS for the AM and PM peak hours in 2040. The traffic simulation model shows that while the roundabout concepts perform best at the Russellville Road/University Boulevard intersection, there are increased delays on Creason Street, Morgantown Road, and Avenue of Champions. With the consistent stream of vehicles coming from the major approaches, the minor approaches do not have sufficient gaps to enter the roundabouts. Looking at the entire study area, intersection improvements at Russellville Road/University Boulevard (Improvement Concepts 2 and 4) perform best.

Table 10: Simulation Model LOS and Delay

Improvement Concept	Intersection	2018				2040			
		AM LOS	AM Delay (sec/ veh)	PM LOS	PM Delay (sec/ veh)	AM LOS	AM Delay (sec/ veh)	PM LOS	PM Delay (sec/ veh)
No-Build	University at Russellville	D	52	**E**	**76**	D	55	**F**	**117**
	Morgantown at Russellville	C	28	C	33	D	49	**F**	**85**
Improvement Concept 2	University at Russellville	C	25	D	36	D	43	**F**	**74**
	Morgantown at Russellville	B	11	C	22	C	23	**E**	**68**
Improvement Concept 3	University at Russellville	C	17	C	25	D	30	**E**	**50**
	Morgantown at Russellville	B	15	C	25	D	47	**E**	**78**
Improvement Concept 4	University at Russellville	C	23	D	36	C	32	**E**	**68**
	Morgantown at Russellville	B	11	B	20	B	16	**E**	**58**
Improvement Concept 5	University at Russellville	C	17	D	27	D	30	**E**	**40**
	Morgantown at Russellville	B	15	C	23	C	25	D	52
Improvement Concept 6	University at Russellville	C	18	C	19	D	32	**E**	**43**
	Morgantown at Russellville	A	8	B	13	D	33	**E**	**43**

Figure 22 and **Figure 23** present the AM and PM peak hour delay. It is evident from these graphs that although the improvement concepts still operate at an unacceptable LOS during the 2040 PM peak, the average intersection delay drastically decreases from the No-Build. In order to achieve a desirable LOS and delay during the 2040 PM peak, the widening of Russellville Road will eventually need to extend through Morgantown Road to the existing five-lane section at Campbell Lane.

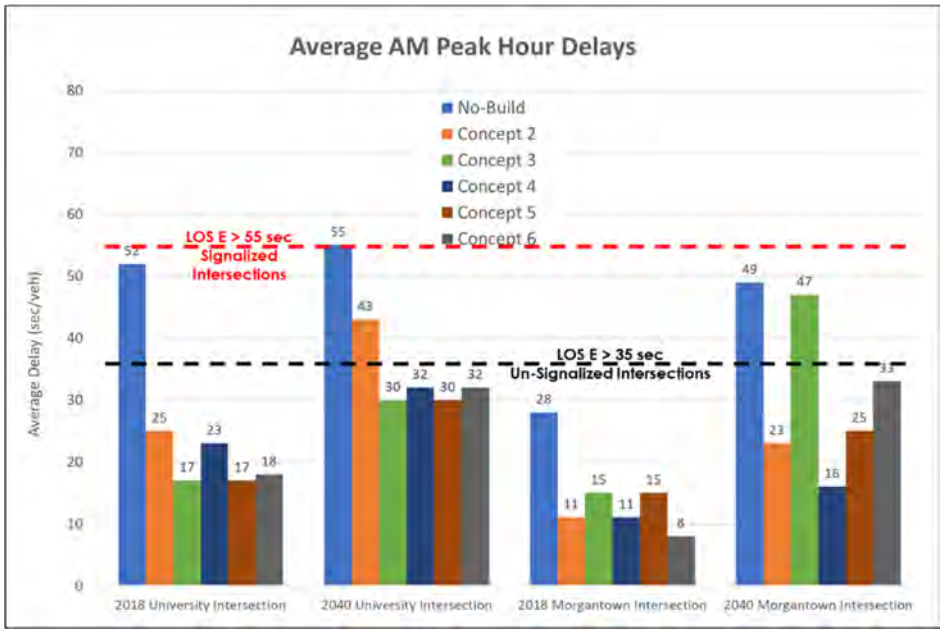


Figure 22: Average AM Peak Hour Delays

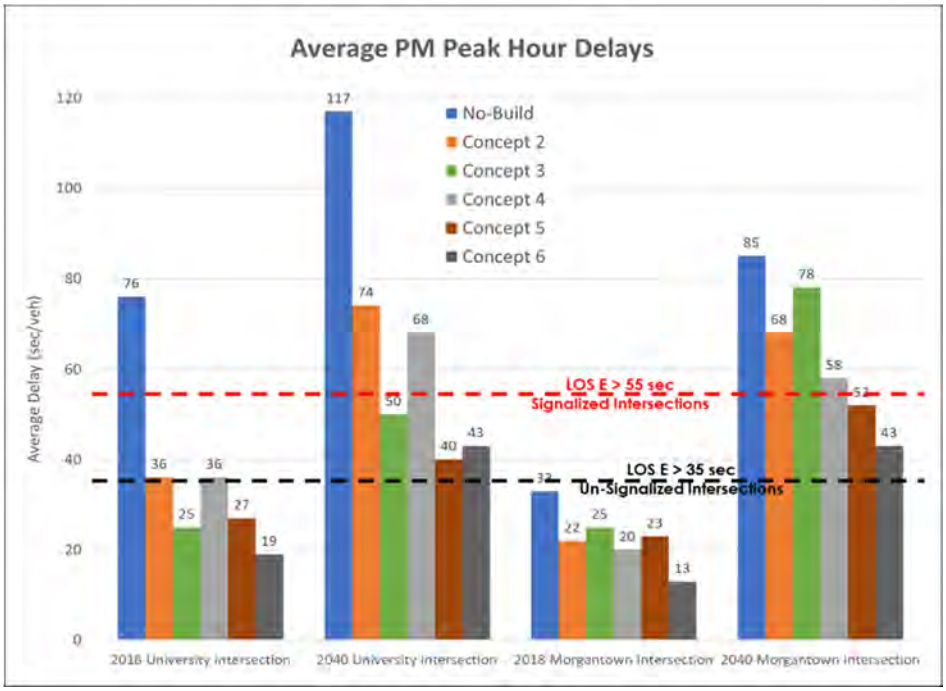


Figure 23: Average PM Peak Hour Delays

9.3 CSX BRIDGE

The CSX bridge over Russellville Road has approximately 30 feet of horizontal clearance and approximately 14 feet of vertical clearance. The long-term improvement concepts for this study includes the widening of Russellville Road, which in turn requires the replacement of the existing

CSX bridge. As part of this study, two bridge replacement techniques were analyzed, as described below:

- Roll-In Bridge Replacement: This method would build the new bridge next to the existing bridge, not disturbing the existing track until the old bridge is removed and the new bridge is rolled into place. This would require an approximate two-day closure of the track. Total construction time would likely be two construction seasons and Russellville Road would have lengthy, intermittent closures during that time.

- In-Place Replacement with Temporary Bypass (Shoofly): This option utilizes a temporary railroad alignment (shoofly) and a temporary bridge for bypass track(s) while the existing bridge is being replaced. This would be a similar construction technique to what was used to widen the CSX overpass at Veterans Memorial Lane 1.8 miles away. This technique would minimize the closures on the railroad track and on Russellville Road but would cost more than the roll-In bridge replacement option.

To better understand the pros and cons of each bridge replacement option, the project team held a meeting and a site visit with CSX's engineering representative, Benesch, on April 16, 2019. At this meeting, several items were noted:

- This is a 'blue line' track, a high traffic, priority track, which carries approximately 17 trains per day.

- CSX prefers track closures be limited to four hours on 'blue line' tracks.

- CSX is not opposed to the roll-in bridge replacement technique as long as they have one track active at all times. However, the second track should not be out of service for more than 24-48 hours.

- The shoofly that was developed at the Veterans Memorial Lane crossing utilized a 30-mph design speed. That is the track speed at that location.

- The track speed at the Russellville Road crossing is 60 mph.

- CSX prefers the design of the shoofly to match existing conditions.

- CSX requires TSL (type, size, and location) plans to be submitted during the preliminary review before continuing to the next design phase. AREMA Design Standards should be followed.

- CSX records indicate that Qwest is the owner of the fiber optic line that runs along the west side of the tracks.

Due to the amount of railroad track closure time required for the roll-in bridge technique, this alternative may not be acceptable to CSX. This combined with the desire to minimize closures of Russellville Road during construction, the project team decided to remove this option from further consideration. Instead, layouts were developed for a 30-mph and 60-mph shoofly to help

identify constraints, quantify potential impacts, and develop planning-level cost estimates to help design makers and facilitate future design efforts. The planning level cost estimates are summarized in **Table 11**. The layout for the 60-mph shoofly is shown in **Figure 24** and the layout for the 30-mph shoofly is shown in **Figure 25**.

Table 11: Bridge Replacement Cost Estimates

Bridge Replacement Options	2019 Bridge Replacement Cost Estimates				
	Design*	ROW	Utility	Construction	Total
30 mph Shoofly	$700,000	$300,000	$1,100,000	$4,700,000	$6,800,000
60 mph Shoofly	$900,000	$500,000	$1,600,000	$5,700,000	$9,000,000

** Design assumed to be 15 percent of the construction cost estimate.*

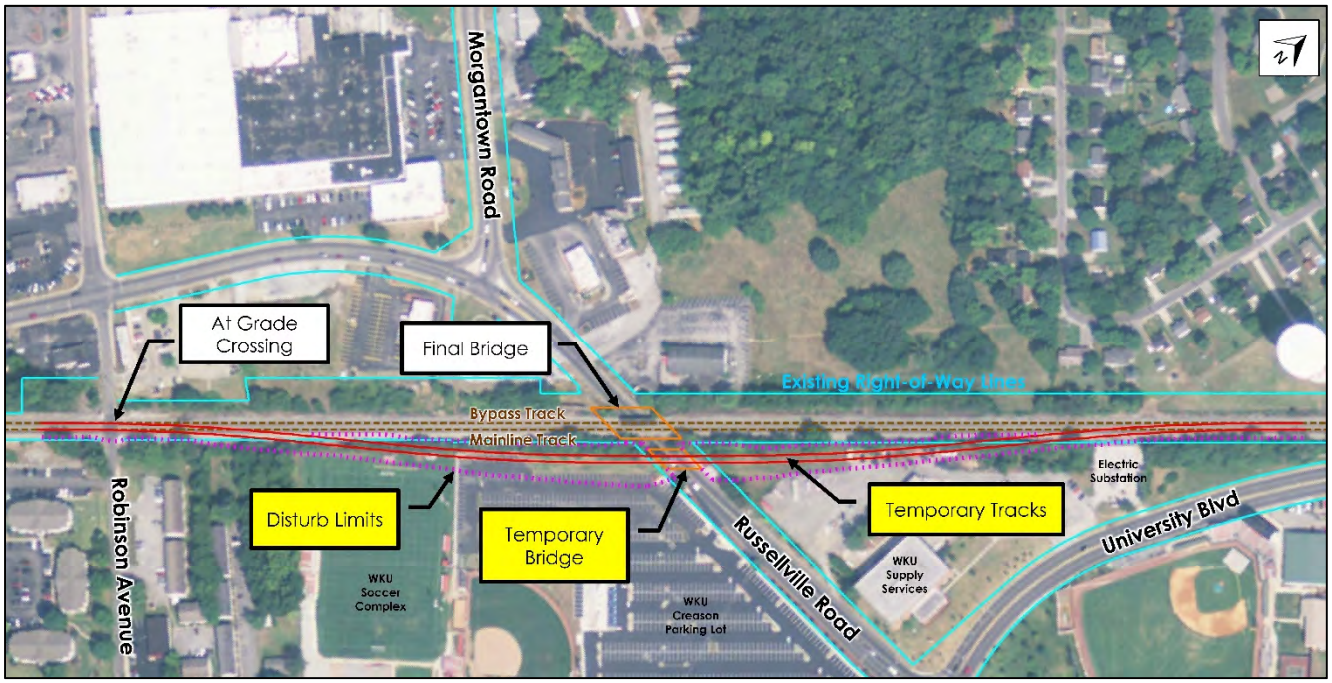


Figure 24: 60-mph Shoofly

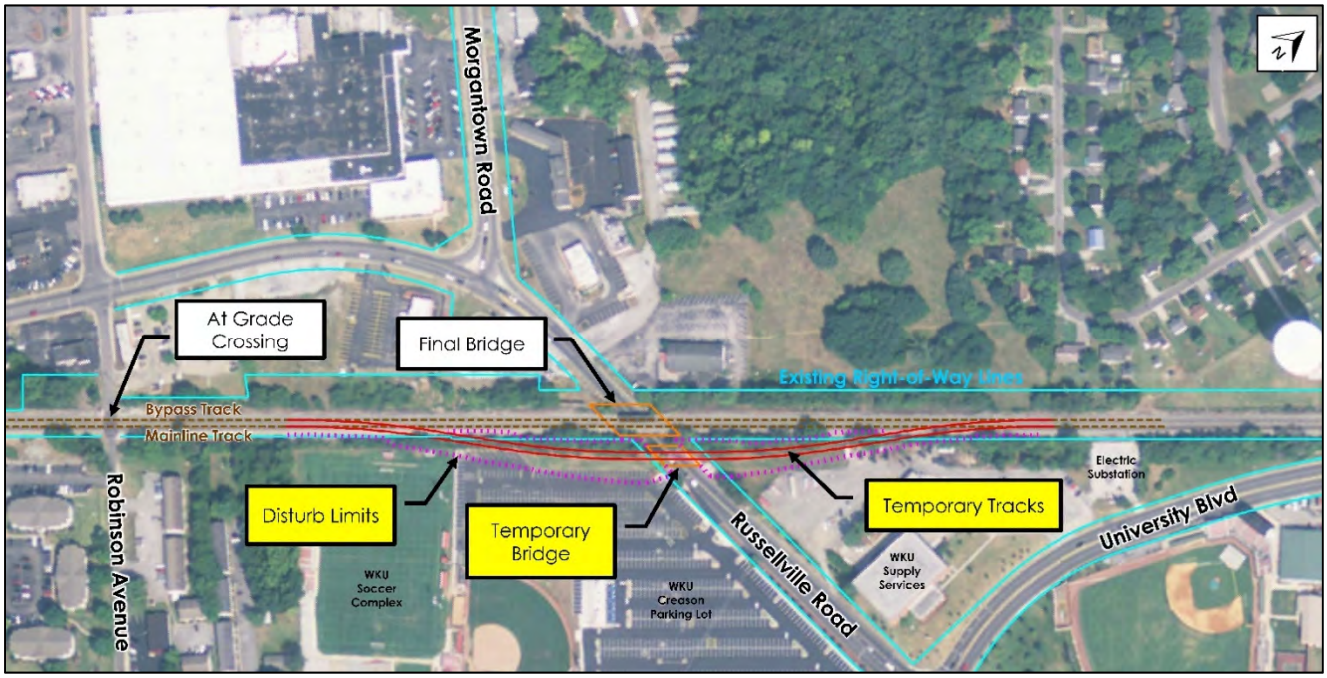


Figure 25: 30-mph Shoofly

The high cost of the 60-mph shoofly and its potential impacts to the at-grade railroad crossing on Robinson Avenue, WKU's Soccer Complex, WKU's Creason Parking Lot, WKU's Supply Services, and the electrical substation would likely make such an undertaking infeasible. The project team decided this alternative was not a viable improvement concept and as a result decided to use the 30-mph shoofly for improvement concepts that widen Russellville Road.

9.4 COST ESTIMATES

Planning level cost estimates were prepared for each improvement concept, shown in **Table 12**, based on average KYTC unit costs plus additional costs for special features such as culverts and traffic signals. Improvement Concepts 4, 5, and 6 include costs for the 30-mph shoofly discussed in **Section 9.3**. KYTC District 3 assisted in this effort by providing approximate right-of-way and utility cost estimates. Construction cost estimate calculations are included in **Appendix I**.

Table 12: 2019 Cost Estimates

Improvement Concept	Design	Right-of-Way	Utility	Construction	Total
No-Build	$0	$0	$0	$0	$0
Improvement Concept 2	$200,000	$2,000,000	$500,000	$1,000,000	$3,700,000
Improvement Concept 3	$300,000	$2,400,000	$1,900,000	$2,500,000	$7,100,000
Improvement Concept 4	$1,000,000	$2,700,000	$4,400,000	$8,600,000	$16,700,000
Improvement Concept 5	$1,100,000	$2,700,000	$4,400,000	$9,600,000	$17,800,000
Improvement Concept 6	$1,300,000	$2,900,000	$5,400,000	$11,000,000	$20,600,000

9.5 BENEFIT-TO-COST ANALYSIS

To assist in prioritizing improvement concepts, the project team conducted a benefit-to-cost analysis. This analysis provided a means for determining which improvements have the greatest benefit and are the most economical. The benefit-to-cost analysis was conducted based on both crash reduction and congestion relief.

9.5.1 Benefit Related to Crash Reduction

Crash modification factors (CMFs) from the Crash Modification Clearinghouse[5] were applied to historical crash data for the associated crash types and severities to determine the crash reduction for each improvement type. This crash reduction was then multiplied by the crash cost from the *2017 Kentucky Traffic Collision Facts* Report[6] for fatal, injury, and property damage only (PDO) collisions to determine the crash reduction benefit for each improvement concept. **Tables 13 – 17** present the 10-year crash reduction benefit for each improvement concept.

Table 13: Benefits Related to Crash Reduction - Improvement Concept 2

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. Intersection	New left-turn lane	0.76	0	3	49	52	$10,080,000	$274,905	$8,500	$297,900
	New right-turn lane	0.92	0	2	19	21	$10,080,000	$274,905	$8,500	$56,900
Russellville Rd.	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
										$717,700

[5] Crash Modification Factors Clearinghouse – http://www.cmfclearinghouse.org/

[6] University of Kentucky and Kentucky State Police, "Kentucky Traffic Collision Facts 2017" (2018). *Kentucky Transportation Center Research Report*. 1614.
https://uknowledge.uky.edu/ktc_researchreports/1614

Table 14: Benefits Related to Crash Reduction - Improvement Concept 3

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. intersection	Convert signalized intersection	0.52	0	17	192	209	$10,080,000	$274,905	$8,500	$3,026,600
Russellville Rd.	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
										$3,389,500

Table 15: Benefits Related to Crash Reduction - Improvement Concept 4

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. Intersection	New left-turn lane	0.76	0	3	49	52	$10,080,000	$274,905	$8,500	$297,900
	New right-turn lane	0.92	0	2	19	21	$10,080,000	$274,905	$8,500	$56,900
Russellville Road	Convert 2 lane roadway to 4 lane divided roadway	0.236	0	17	89	106	$10,080,000	$274,905	$8,500	$4,148,400
	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
	Install bike lanes	0.86	0	0	0	0	$10,080,000	$274,905	$8,500	$0
										$4,866,100

Table 16: Benefits Related to Crash Reduction - Improvement Concept 5

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. intersection	Convert signalized intersection	0.52	0	17	192	209	$10,080,000	$274,905	$8,500	$3,026,600
Russellville Road	Convert 2 lane roadway to 4 lane divided roadway	0.236	0	17	89	106	$10,080,000	$274,905	$8,500	$4,148,400
	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
	Install bike lanes	0.86	0	0	0	0	$10,080,000	$274,905	$8,500	$0
										$7,537,900

Table 17: Benefits Related to Crash Reduction - Improvement Concept 6

Location	Improvement	CMF	Crashes (2008-2017)				Cost per Crash			10-Yr Benefit
			Fatal	Injury	PDO	Total	Fatal	Injury	PDO	
University Blvd. intersection	Convert signalized intersection	0.52	0	17	192	209	$10,080,000	$274,905	$8,500	$3,026,600
Morgantown Rd. intersection	Convert signalized intersection	0.52	0	18	134	152	$10,080,000	$274,905	$8,500	$2,921,900
Russellville Rd.	Convert 2 lane roadway to 4 lane divided roadway	0.236	0	17	89	106	$10,080,000	$274,905	$8,500	$4,148,400
	Install sidewalk (to avoid walking along roadway)	0.35	0	2	1	3	$10,080,000	$274,905	$8,500	$362,900
	Install bike lanes	0.86	0	0	0	0	$10,080,000	$274,905	$8,500	$0
										$10,459,800

9.5.2 Benefit Related to Congestion Relief

Results from the traffic simulation model were used along with the 2017 Bowling Green average hourly wage of $19.09 (according to the Bureau of Labor Statistics) to determine the congestion relief benefits for each improvement concept. The AM and PM peak hour delays for each improvement concept were subtracted from the No-Build peak period delays to find total delay

savings. This 2018 delay savings was multiplied by the Bowling Green average hourly wage, then extended to 2028 to find a 10-year wage savings, as shown in **Table 18**.

Table 18: Benefits Related to Congestion Relief

	Concept 2		Concept 3		Concept 4		Concept 5		Concept 6	
	Delay Savings (hours)	Wage Savings	Delay Savings (hours)	Wage Savings	Delay Savings (hours)	Wage Savings	Delay Savings (hours)	Wage Savings	Delay Savings (hours)	Wage Savings
10-Yr Savings	578,000	$11,034,014	392,016	$7,483,576	579,510	$11,062,855	478,425	$9,133,133	513,486	$9,802,455

9.6 EVALUATION MATRIX

The improvement concepts were reviewed for potential "red flags" to help with the evaluation process and provide KYTC with information that will be used to make final recommendations regarding concept(s) to be carried forward for future development.

A summary of the complete evaluation matrix is shown in **Table 19**.

Table 19: Evaluation Matrix

Evaluation Matrix and Cost Estimates														
Improvement Concepts	Traffic at Russellville Rd/University Blvd Intersection				Bike/Ped Facilities on Russellville Road		2018 Cost Estimates (millions)					10-Year Benefit-Cost Ratio (BCR)		
	Year 2018 PM Peak Hour		Year 2040 PM Peak Hour											
	Intersection Delay (sec)	Intersection LOS[1]	Intersection Delay (sec)	Intersection LOS[1]	Pedestrian Accomodations	Bicycle Accomodations	Design	Right-of Way	Utility	Construction	Total	Crash Reduction (millions)	Congestion Relief[2] (millions)	BCR
No-Build	76	E	117	F	No	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Improvement Concept 2 Intersection Improvements at University Boulevard and Sidewalk on Russellville Road	36	D	74	F	Yes	No	$0.2	$2.0	$0.5	$1.0	$3.7	0.7	11.0	3.16
Improvement Concept 3 Roundabout at University Boulevard with Signalized Midblock Pedestrian Crossing and Sidewalk on Russellville Road	27	D	50	E	Yes	No	$0.3	$2.4	$1.9	$2.5	$7.1	3.4	7.5	1.54
Improvement Concept 4 Widen Russellville Road with intersection improvements at University Boulevard	36	D	68	E	Yes	Yes	$1.0	$2.7	$4.4	$8.6	$16.7	4.9	11.1	0.96
Improvement Concept 5 Widen Russellville Road with Roundabout at University Boulevard and Signalized Midblock Pedestrian Crossing	27	D	40	E	Yes	Yes	$1.1	$2.7	$4.4	$9.6	$17.8	7.5	9.1	0.93
Improvement Concept 6 Widen Russellville Road and Roundabout at University Boulevard with Signalized Midblock Pedestrian Crossing and Roundabout at Morgantown Road	19	C	43	E	Yes	Yes	$1.3	$2.9	$5.4	$11.0	$20.6	10.5	9.8	0.99

[1] In urban areas a LOS D or better is desirable.
[2] Based on reduction in average delay from AM and PM peak hours between 2018 and 2028 and average hourly rate of $19.09 per hour (source: Bureau of Labor Statistics)

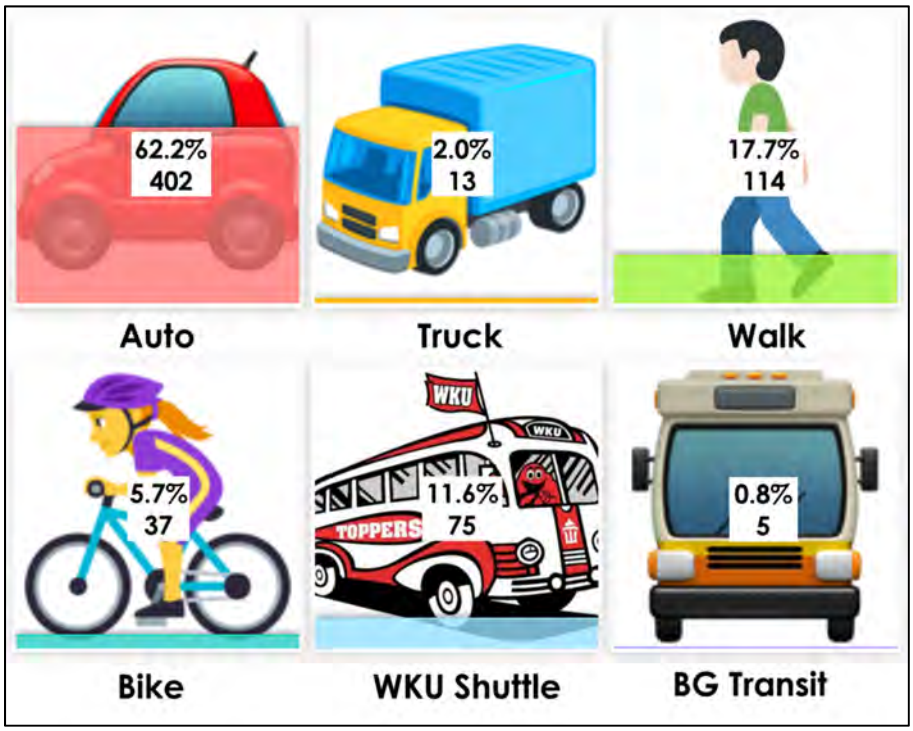
9.7 FINAL PROJECT TEAM MEETING

Following the development of the revised improvement concepts, the project team met for the final time on January 31, 2019. The purpose of the meeting was to discuss the survey results from the public, review the refined simulation model results, review the benefit-to-cost analysis, and discuss project team recommendations. A detailed summary of the final project team meeting is included in **Appendix H**.

Approximately 3,200 survey postcards, as shown in **Figure 26**, were mailed to addresses in and around the study area to solicit input on study goals and improvement concepts. WKU also assisted in this effort by sending a campus-wide email with information on the project and a link to the survey.

Of the 421 responses, approximately 36 percent were WKU faculty/staff, 32 percent were Bowling Green residents, and 29 percent were WKU students. The majority (84 percent) of the respondents travel the study area at least two to three times per week, with 58 percent living in the study area. The results are as follows:

- When asked how they travel the study area, the majority of respondents (62.2 percent) indicated they travel by auto, with walking (17.7 percent) being the second most common form of travel.



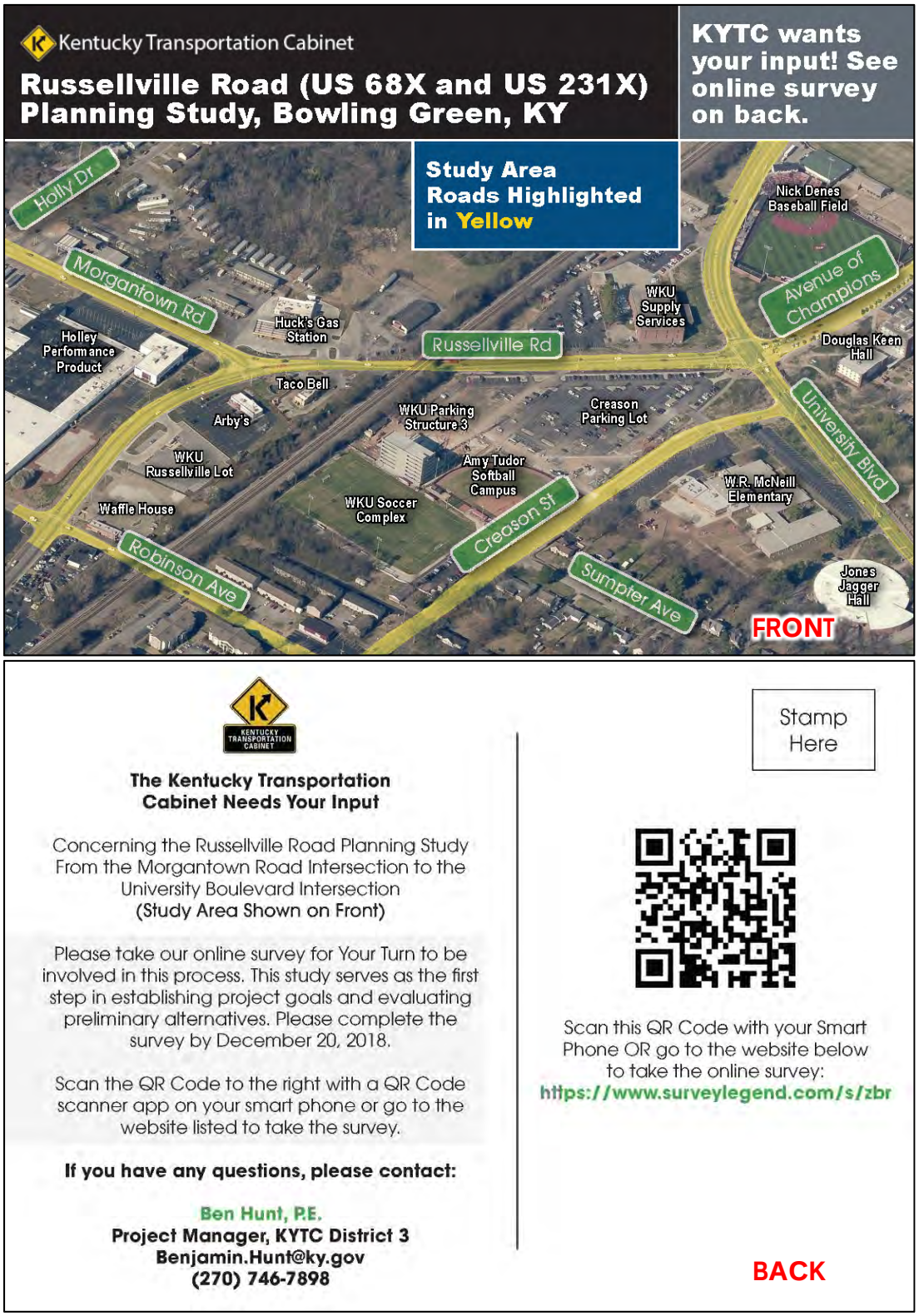
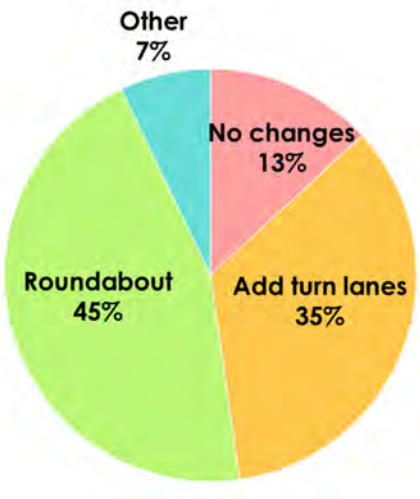


Figure 26: Public Survey Postcard

- Respondents were asked to rank transportation issues in the study area with six points rewarded to the 1st priority, five points to the 2nd, four points to the 3rd, three points to the 4th, two points to the 5th, and one point to the 6th. Congestion was found to be the most important, with safety and not having enough sidewalks next important.
    1) Congestion (2,097 points)
    2) Safety (1,701 points)
    3) Not enough sidewalks (1,607 points)
    4) Too many driveways (1,216 points)
    5) Not enough bike facilities (900 points)
    6) Not enough bus stops (640 points)
- When asked if improvements are needed in the study area, 95 percent of respondents indicated that yes, improvements are needed.
- When asked which improvements are most important, respondents indicated that widening Russellville Road and improving the University intersection were most important.
    1) Widen Russellville Road (1,671 points)
    2) University intersection (1,639 points)
    3) Morgantown intersection (1,403 points)
    4) Russellville road sidewalk (1,314 points)
    5) Driveways (990 points)
    6) Robinson Avenue (799 points)
- When asked which improvement is preferred at the Russellville Road intersection with University Boulevard, 45 percent chose a roundabout and 35 percent preferred additional turn lanes.



- Respondents were then asked, understanding the lengthy road closures needed to replace the railroad bridge on Russellville Road (up to one year), should Russellville Road be widened to improve traffic flow and provide dedicated bicycle and pedestrian facilities? 79 percent of respondents indicated that Russellville Road should be widened even if lengthy road closures are needed.
- When asked for additional improvements, respondents mentioned a focus on pedestrian safety, improved roadway capacity, and the need to prohibit left turns from University Boulevard onto Creason Street.

It was noted that the WKU Topper Transit routes use the left-turn lane from University Boulevard onto Creason Street.

Due to the recent opening of the WKU Parking Structure 3 in the Creason Parking Lot, additional pedestrian counts were taken at the Russellville Road/University Boulevard intersection in October 2018. These counts were significantly higher than the original counts and were used in the traffic simulation model results presented in **Section 9.2**.

It was also noted that WKU's campus is serviced by the Bowling Green Fire Department Station 4 on Morgantown Road. In an emergency event, they will drive the wrong way on Avenue of Champions to gain access to campus. In the event of any road closure, an alternate route would have to be taken, which would increase response times.

10.0 RECOMMENDATIONS

This section provides recommendations for the Russellville Road (US 68X and US 231X) Planning Study. Prioritization was accomplished through examination of technical analyses, stakeholder input, and engineering judgement.

10.1 RECOMMENDATIONS

This study was undertaken to seek feasible strategies to improve safety, reduce congestion, and better accommodate all modes of travel on US 68X and US 231X in Bowling Green. Considering the technical data, comments from local officials/stakeholders, results from the public outreach survey, and results from the benefit-to-cost analysis, the project team decided to recommend a short-term project and a long-term project. Improvement Concept 2, improving the University Boulevard intersection and providing a sidewalk on Russellville Road is the recommended short-term improvement. Improvement Concept 4, improving the University Boulevard intersection and widening Russellville Road to four lanes including bicycle and pedestrian facilities, is the recommended long-term improvement. Improvement Concept 4 utilizes the same intersection improvement at Russellville Road and University Boulevard so resources would not be wasted if Improvement Concept 2 were built first.

Although the roundabout concepts were supported by the local officials and the public, they are not recommended by the project team at the Russellville Road and University Boulevard intersection. The local officials and public were not shown the benefit-cost ratios, shown in **Table 19** in **Section 9.6,** which are higher for the intersection improvement concepts. Also, the traffic operation results shown to the local officials did not include the higher pedestrian volumes, which creates more delay for the roundabout concepts. The traffic analyses show that the roundabout concepts have significantly increased delays on Creason Street, Morgantown Road, and Avenue of Champions. With the consistent stream of pedestrians coming to/from the Creason Parking Lot and vehicles coming from the major approaches, the minor approaches do not have sufficient gaps to enter the roundabouts. Looking at the entire study area, intersection improvements at Russellville Road/University Boulevard (Improvement Concepts 2 and 4) perform best. The traffic analyses also showed that in order to achieve a desirable LOS and delay during the 2040 PM peak, the widening of Russellville Road will eventually need to extend through Morgantown Road to the existing five-lane section at Campbell Lane. Widening Russellville Road to Campbell Lane was outside the scope of this study and is, therefore, not included in the cost estimates.

Future phases of the project should also explore prohibiting left turns from University Boulevard onto Creason Street. Stakeholder feedback indicated that this left turn is critical to WKU Topper Transit routes and some school buses accessing the W.R. McNeill Elementary School. The safety and traffic operation benefits of restricting this left turn are worth exploring further if these buses can utilize alternate routes.

10.2 NEXT STEPS

The next phase for the Russellville Road (US 68X and US 231X) Planning Study would be Phase 1 Design (Preliminary Engineering and Environmental Analysis) for one or more of the recommended improvement concepts. Any improvement that includes the replacement of the existing CSX bridge will require the completion of TSL (type, size, and location) plans to be submitted to CSX for review and approval before continuing to the next design phase. Further funding will be necessary to advance an improvement to the design phase as additional phases of the project are not funded in *Kentucky's FY 2018 – FY 2024 Highway Plan*.

11.0 CONTACTS/ADDITIONAL INFORMATION

Written requests for additional information should be sent to Amanda Spencer, Director, KYTC Division of Planning, 200 Mero Street, Frankfort, KY 40622. Additional information regarding this study can also be obtained from the KYTC District 3 Project Manager, Ben Hunt, at (270) 746-7898 (email at Benjamin.Hunt@ky.gov).