



# US 231 SCOTTSVILLE ROAD SCOPING AND TRAFFIC OPERATIONS STUDY

From I-65 to Lovers Lane  
Warren County, Kentucky  
March 2015

Submitted To: Kentucky Transportation Cabinet, Division of Planning  
Prepared By: CDM Smith

Final Report

# US 231 Scottsville Road Scoping and Traffic Operations Study

## Executive Summary

Warren County, Kentucky

KYTC Item No. 3-8702.00

The Kentucky Transportation Cabinet (KYTC), in partnership with CDM Smith and its sub-consultant AEI, undertook a study for US 231, known locally as Scottsville Road, from the newly-constructed single-point interchange at I-65 to US 231 Business/KY 880 (Campbell Lane/Lovers Lane) in Bowling Green.

### Purpose & Need

The purpose of the proposed US 231 project is to improve safety and mobility along this route between KY 884 (Three Springs Road)/Ken Bale Boulevard and KY 880 (Campbell Lane)/Lovers Lane, while providing reasonable access along the corridor. Any improvements made should tie-in to the existing interchange. The need is expressed through above average crash rates, congested traffic operations, and close proximity to a frontage road system with numerous conflict points.

Other project goals include accommodating pedestrians and transit where appropriate, minimizing impacts to the human and natural environment, and ensuring any proposed improvement complements other planned projects or roadway improvements.

### Existing Conditions

US 231 is classified as an Urban Minor Arterial with a posted speed limit of 45 mph in the study area. It is a six-lane facility from the I-65 interchange, transitioning to a four-lane facility at Three Springs Road and continuing through Campbell Lane. US 231 has 12-foot lanes and 10-foot shoulders. Six signalized and three un-signalized intersections are located along the 1.4 mile-long corridor. A frontage road (24-26 feet wide) provides the primary

commercial driveway access on both sides of the corridor.

One bus route operated by GO bg Transit travels the corridor: Green Line (Route 3).



*The US 231 corridor and frontage road system near Cave Mill Road.*

Existing traffic volumes range from 29,300 to 31,600 vehicles per day, with the heavier volumes in the middle section between Cave Mill Road and Greenwood Square Shopping Center. Existing volume-to-capacity (V/C) ranges from 0.67 to 0.87, indicating busier sections are nearing their theoretical capacity. Spillback from downstream signals may exacerbate existing congestion, which is not reflected in V/C.

Level of Service (LOS), a qualitative measure of highway traffic conditions was calculated at major study intersections. Cross-street approaches at the six signalized intersections operate at an unacceptable LOS (E or F) during the PM peak hour.

Crashes are very prevalent along US 231, with 881 crashes occurring over a five year analysis period (November 1, 2008 through October 31, 2013), with 157 causing injury and two

resulting in fatalities. The entire corridor experiences a Critical Rate Factor (CRF) greater than 1.00, indicating that crashes may be occurring more often than can be attributed to random occurrence. CRFs range from 2.18 to 4.48, with higher crash concentrations located between Pascoe Boulevard and Three Springs Road. Rear end collisions accounted for 67% of all crashes, which is indicative of a congested roadway with many traffic signals. Ten 0.10-mile long spots along the route also exhibit above average crash rates, representing the majority of the corridor.



*Scottsville Road at Three Springs Road. The majority of the corridor does not adequately accommodate pedestrians; for example, the push button location pictured above without sidewalks or crosswalks.*

### Alternatives Considered

To improve safety and mobility, the project team considered a selection of potential alternatives:

- **No Build** Alternative;
- **Alternative 1**, which would widen US 231 to six lanes and integrate select intersection spot improvements;
- **Alternative 2**, which would maintain four lanes and convert select intersections to right-in/right-out with an additional left-in from US 231 while installing a 32-foot to 42-foot median;
- **Alternative 3**, which would widen US 231 to six lanes and convert select intersections to right-in/right-out with an additional left-in from US 231 while installing a 30-foot median;
- **Alternative 4**, which would widen US 231 to six lanes while installing a 59-foot to 69-foot median;
- **Alternative 5**, which would maintain four lanes and integrate intersection spot improvements.

Pedestrian improvements would be incorporated into all alternatives.

Throughout the study, the project team met with local officials and stakeholders to discuss alternatives and understand local perspectives on improvement concepts. During these discussions, Alternatives 2 and 4 were eliminated from consideration as they did not meet the purpose and need by failing to address future capacity.

### Alternative Analysis

The project team developed more detailed conceptual designs and planning-level cost estimates for Alternatives 1 and 3, and the short term improvements (initially evaluated as Alternative 5). Analysts examined future traffic in both the 2026 and 2040 years. In 2026, traffic along the corridor is forecasted to range from 33,400 to 36,000 vehicles per day, with V/C increasing to a maximum of 0.99, indicating additional capacity will be needed by 2026. Volumes in 2040 are forecasted to range from 38,400 to 41,400, which further increases the V/C ratio. The No Build, Spot Improvements, and Alternatives 1 and 3 were simulated using the micro-simulation software package VISSIM. Based on 2040 traffic, the simulation model showed heavy congestion in the No Build and Spot

Improvements scenarios, with improvement shown in Alternatives 1 and 3.

### Recommendation

To provide low-cost, short-term improvements while funding is secured for the long term recommendation, spot improvements are recommended. These show short-term benefits help address existing constraints along the corridor. The spot improvements were developed to complement the recommended long-term improvement. The spot improvements are noted below and shown in **Figure ES-1** through **Figure ES-3** (shown on the following pages):

- **Spot Improvement 1:** Add left turn lane at Greenwood Mall entrance (opposite Bryant Way) onto northbound US 231 (estimated construction cost = \$250,000)
- **Spot Improvement 2:** Widen median to 30 feet between Cave Mill Road and Pascoe Boulevard. Provide dual lefts from eastbound Cave Mill Road onto US 231. Replace signal at Greenwood Square Shopping Center, allow signalized left turn into Greenwood Square. Add a lane on Shive Lane between frontage road and US 231. Install bollards on Shive Lane to restrict left turns and through traffic from the frontage road. (estimated construction cost = \$820,000)
- **Spot Improvement 3:** Add an additional left turn lane on eastbound Pascoe Boulevard onto northbound US 231 (estimated construction cost = \$230,000)
- **Spot Improvement 4:** Extend US 231 southbound left turn lane at Ken Bale

Boulevard and close median access to Red Roof Inn/Motel Six (estimated construction cost = \$45,000)

In light of technical analyses and local input, the project team recommends that Alternative 3 be moved forward for future phases to address anticipated capacity constraints and existing safety concerns. Alternative 1 should only be considered if Alternative 3 is right-of-way constrained and low-cost elements of Alternative 3 can be incorporated into the design. Both an urban and rural typical section should be considered in the design phase. **Table ES-1** provides summary information about costs for Alternative 3. If spot improvements are implemented in advance, as described above, this estimate would be reduced. **Figure ES-4** through **Figure ES-6** shows the conceptual design for Alternative 3 and represents a rural typical section. **Figure ES-7** shows both the urban and rural typical sections for Alternative 3.

**Table ES-1: Alternative 3 Planning-Level Cost Estimates**

Project Phase	Cost (Millions)
<b>Design</b>	\$1.3
<b>Right-of-Way</b>	\$4.7
<b>Utilities</b>	\$9.9
<b>Construction</b>	\$12.9-\$13.0 <sup>1</sup>
<b>Total</b>	\$28.8-\$28.9 <sup>1</sup>

<sup>1</sup>Rural vs. Urban typical section.



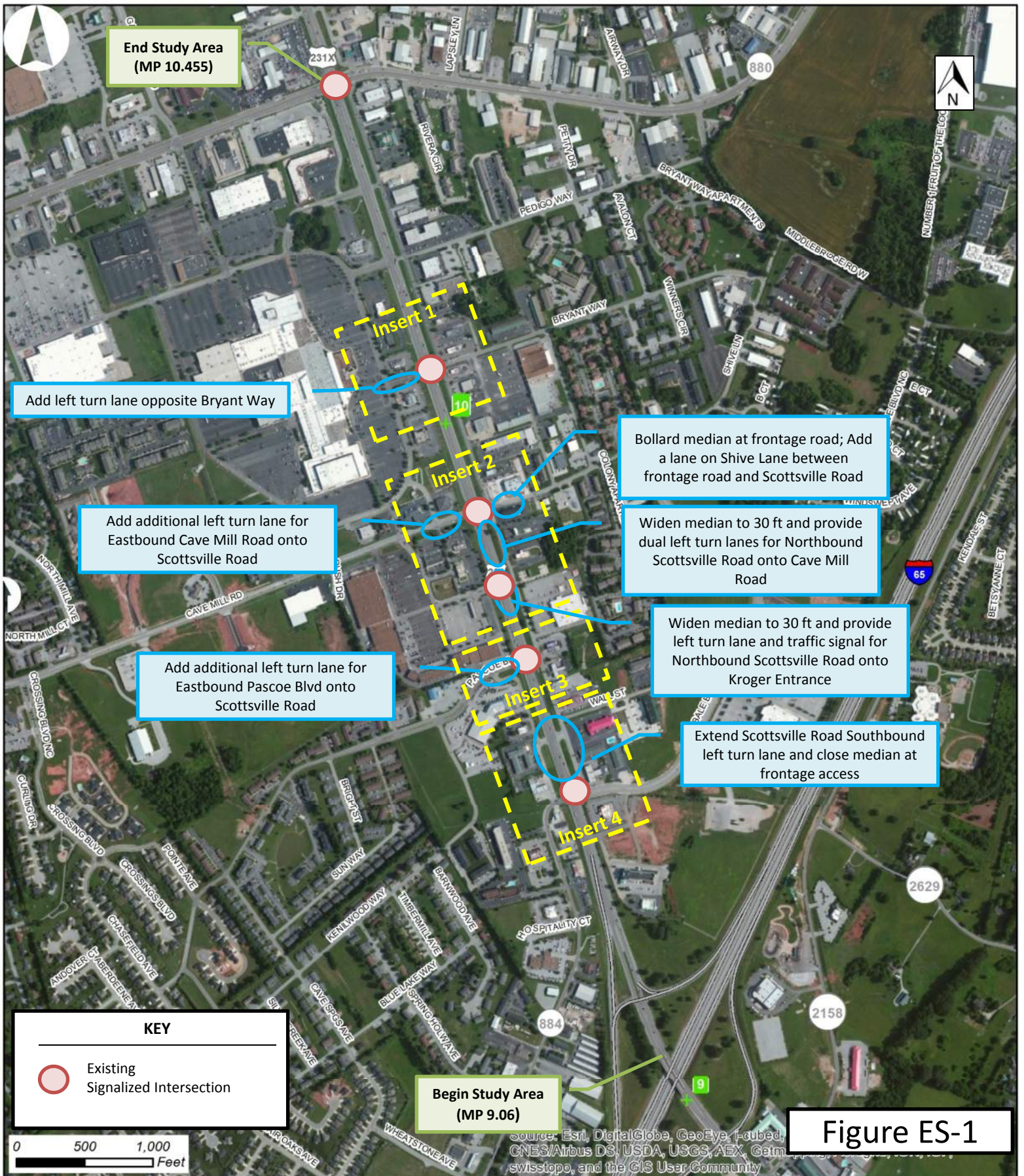
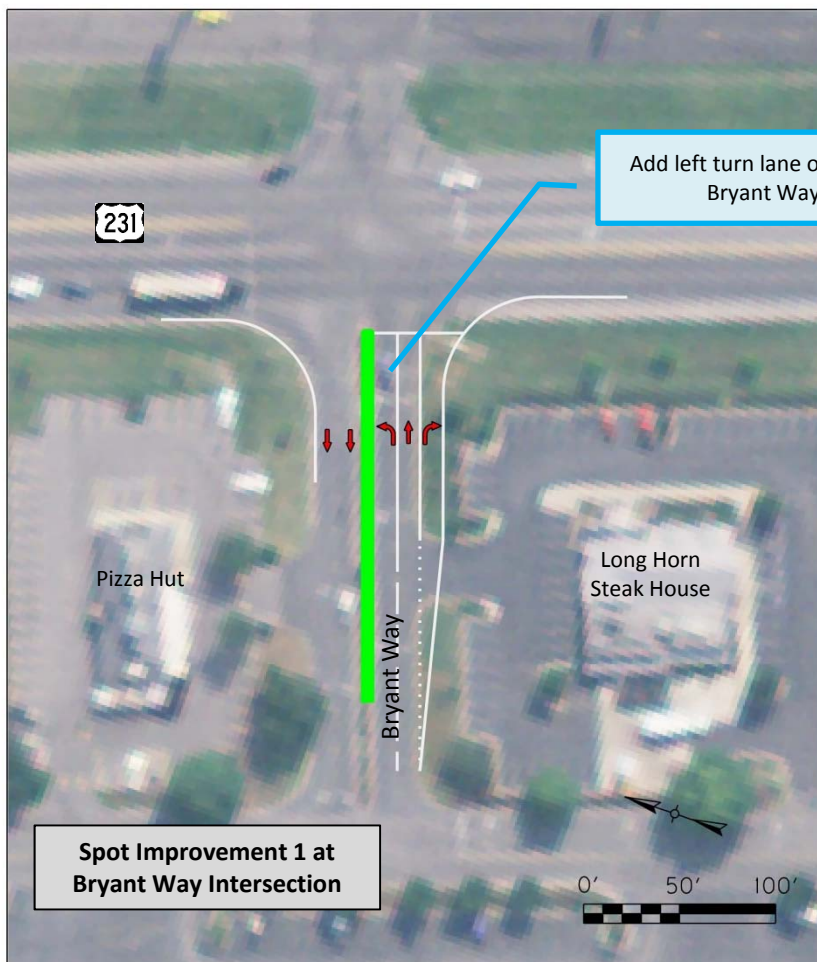
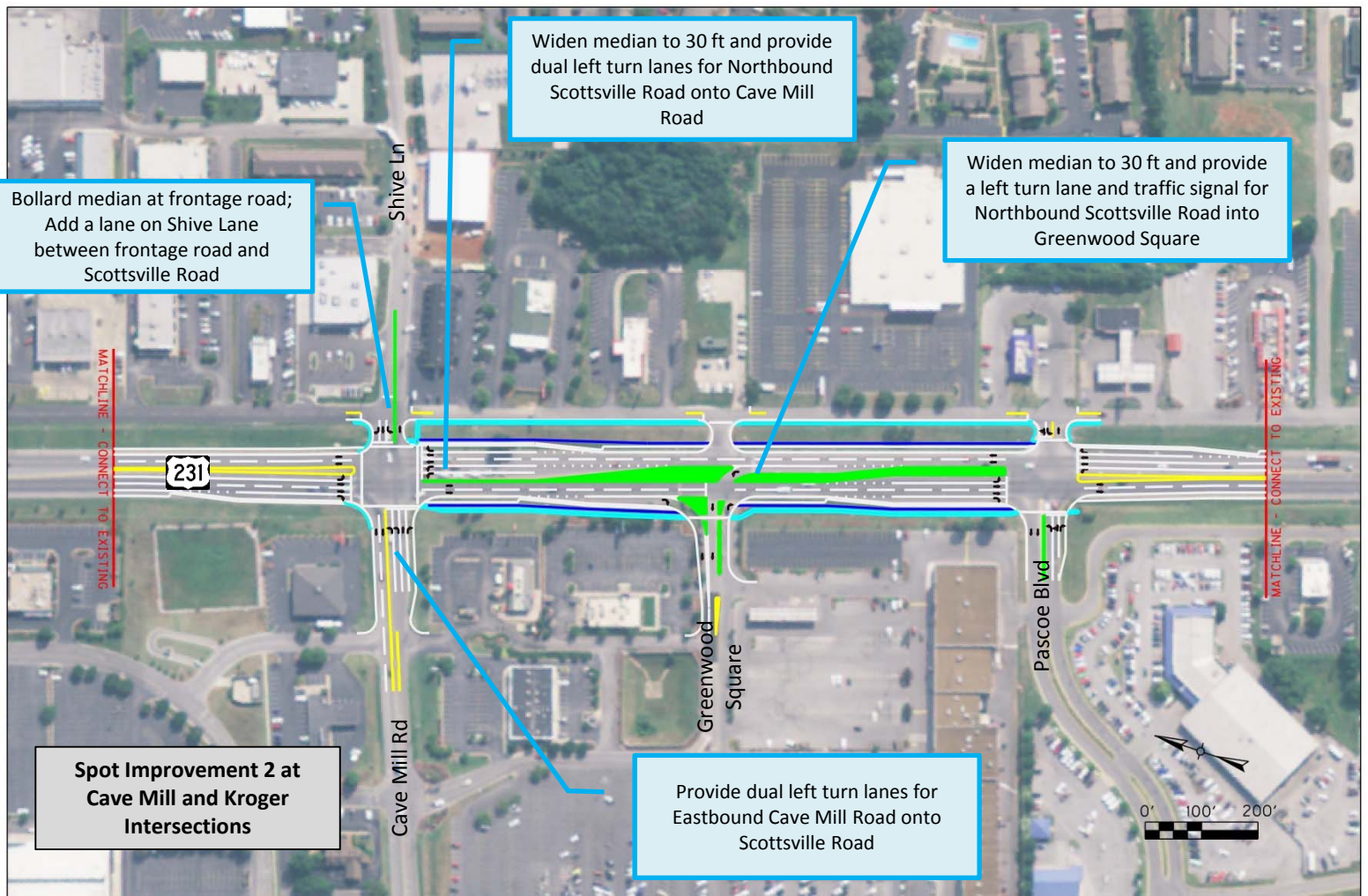


Figure ES-1

US 231 – Scottsville Rd  
 From I-65 to Lovers Lane  
 KYTC Item No 3-8702  
 Intersection Spot Improvements



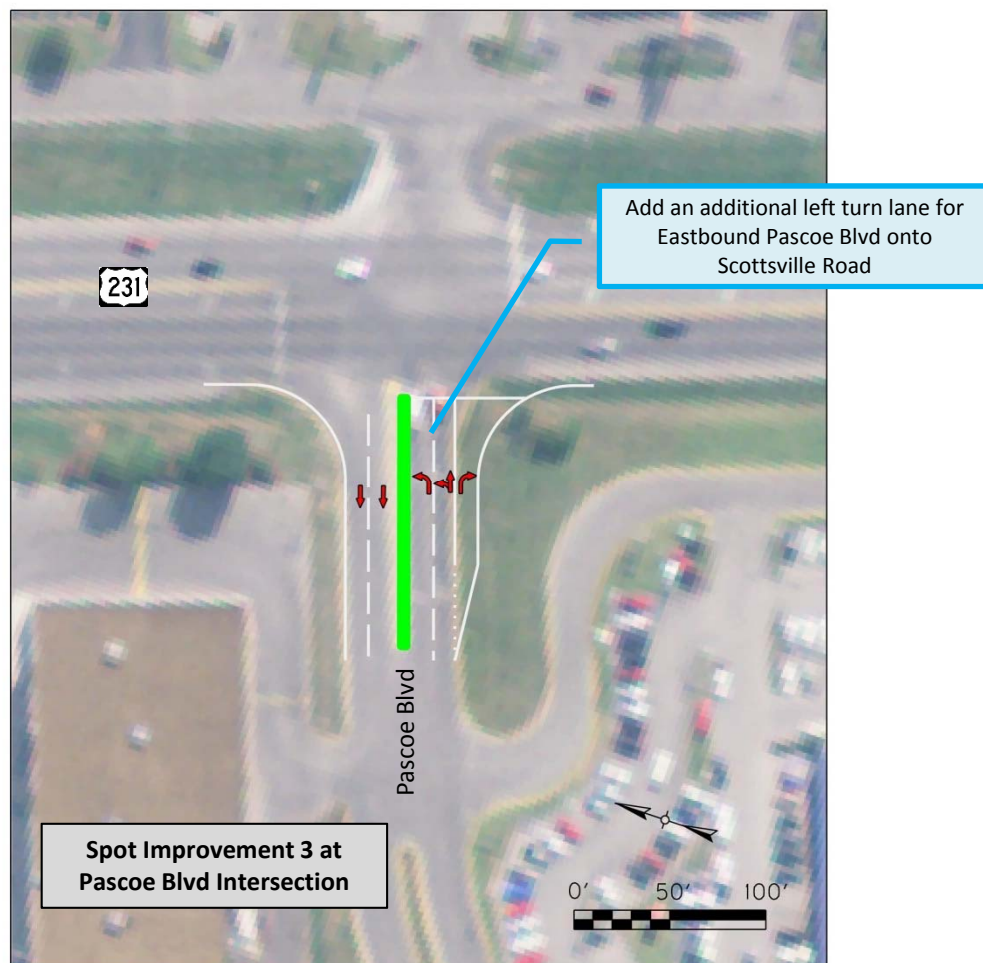
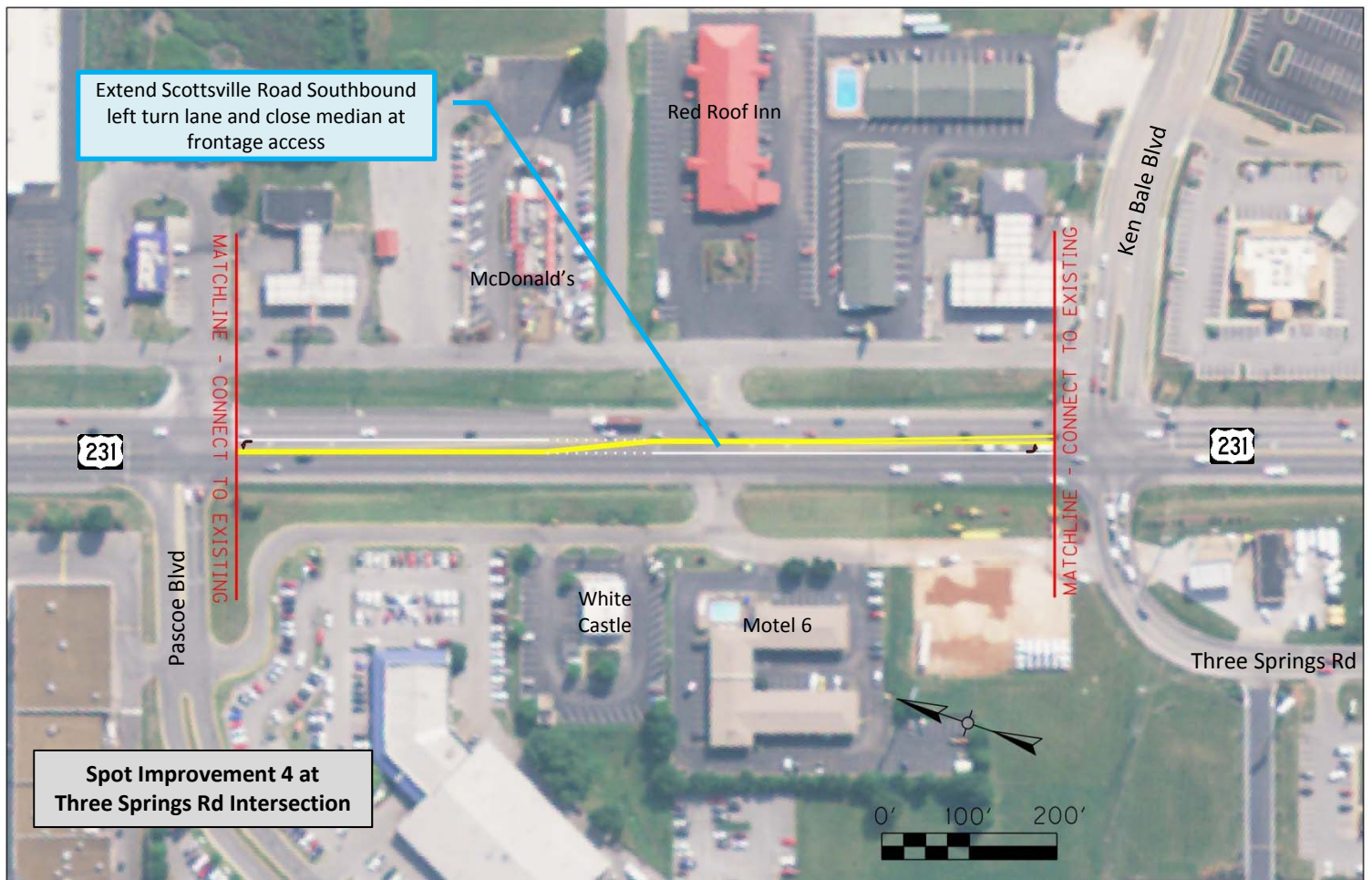




**Figure ES -2**

**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Spot Improvements 1 and 2**

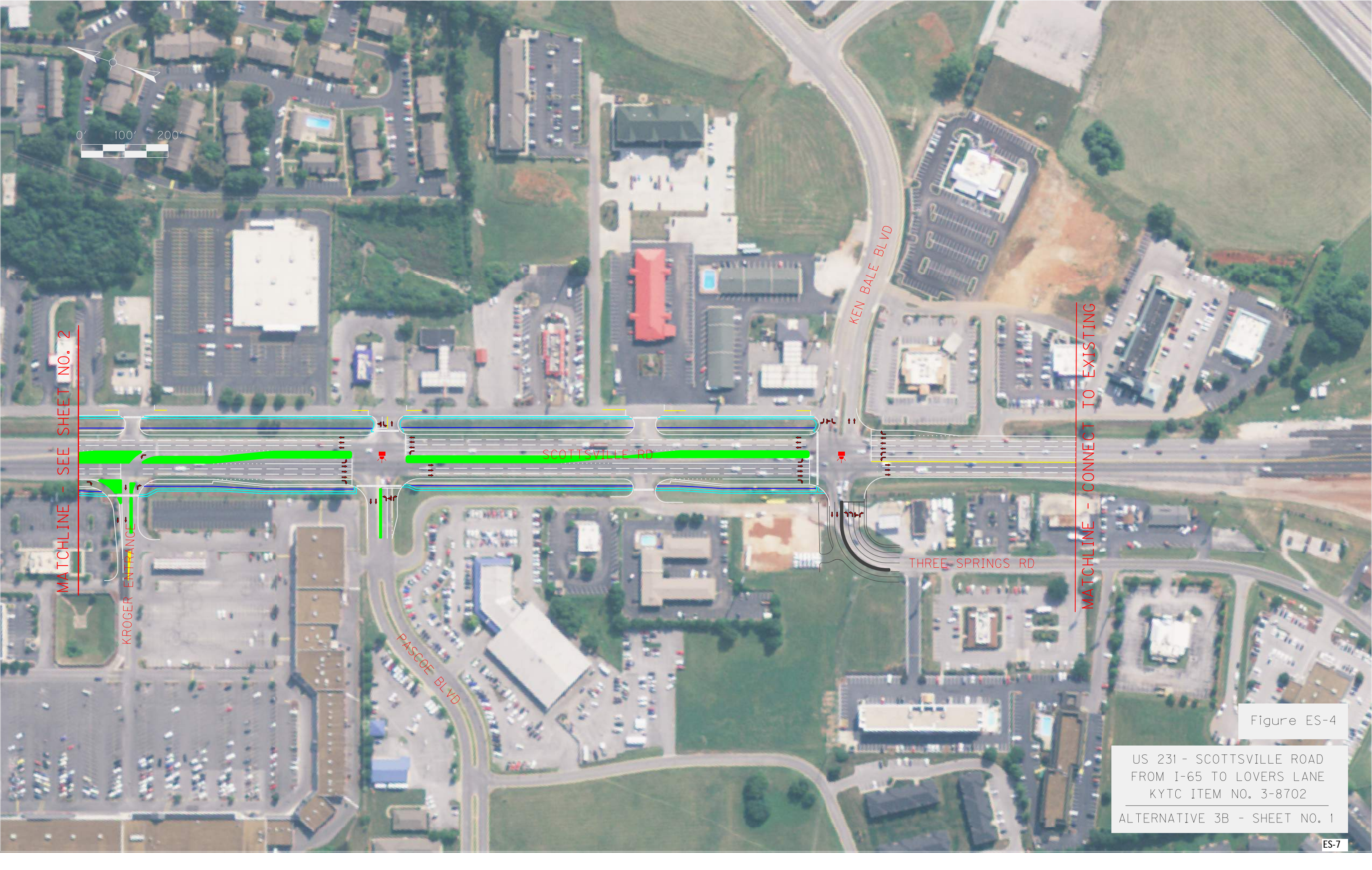




**Figure ES-3**

US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Spot Improvements 3 and 4





MATCHLINE - SEE SHEET NO. 2

KROGER ENTRANCE

SCOTTSDALE RD

PASCONE BLVD

KEN BAILE BLVD

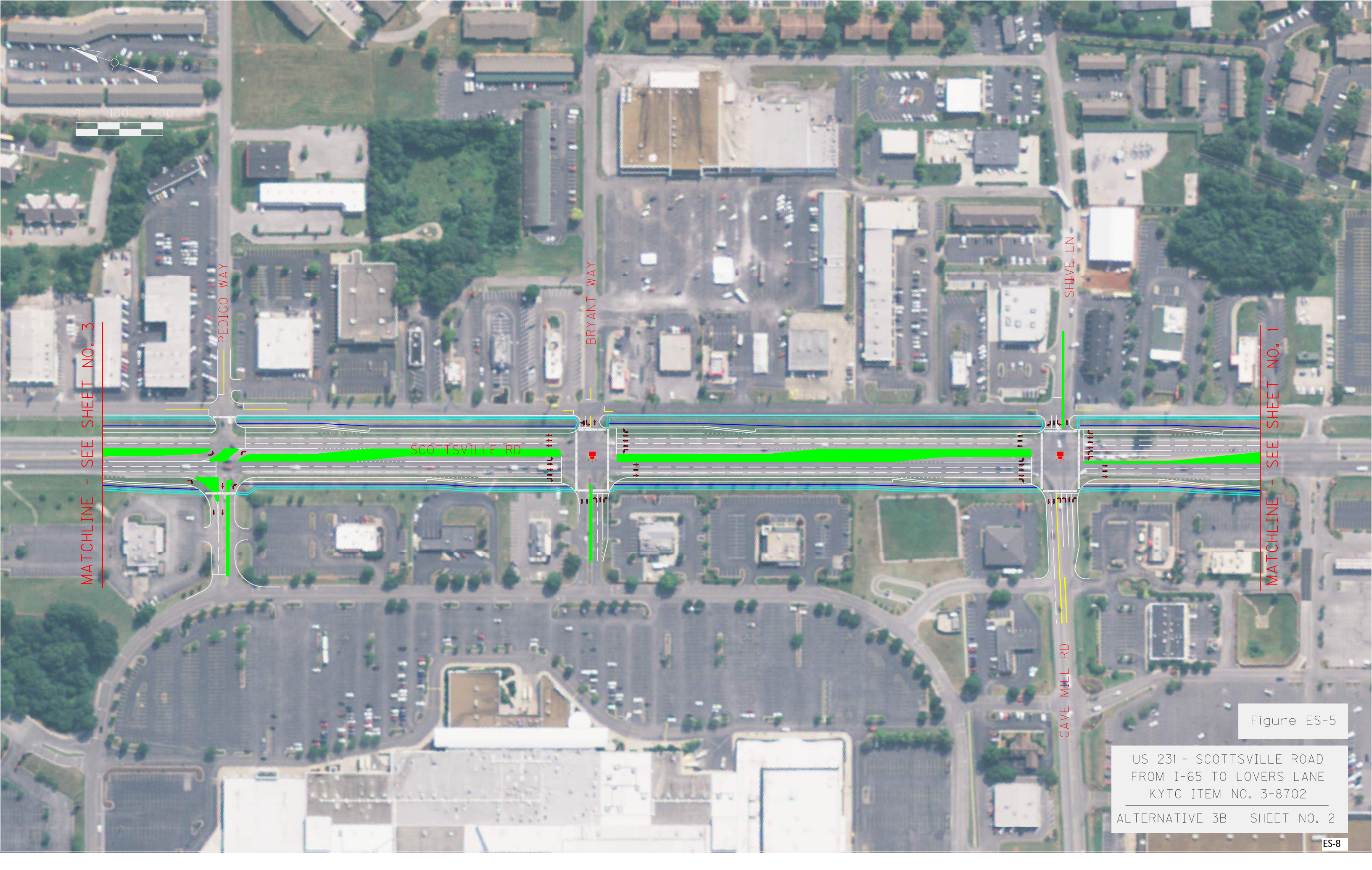
THREE SPRINGS RD

MATCHLINE - CONNECT TO EXISTING

Figure ES-4

US 231 - SCOTTSDALE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 1





MATCHLINE - SEE SHEET NO. 3

PEDIGO WAY

SCOTTSDALE RD

BRYANT WAY

SHIVE LN

CAVE MILL RD

MATCHLINE - SEE SHEET NO. 1

Figure ES-5

US 231 - SCOTTSDALE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 2



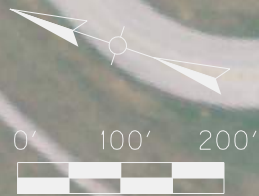
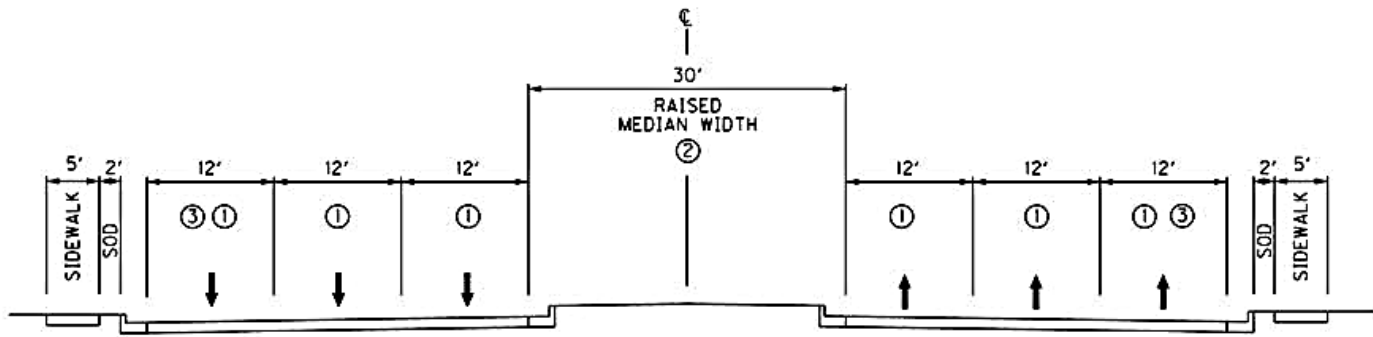


Figure ES-6

US 231 - SCOTTSVILLE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 3

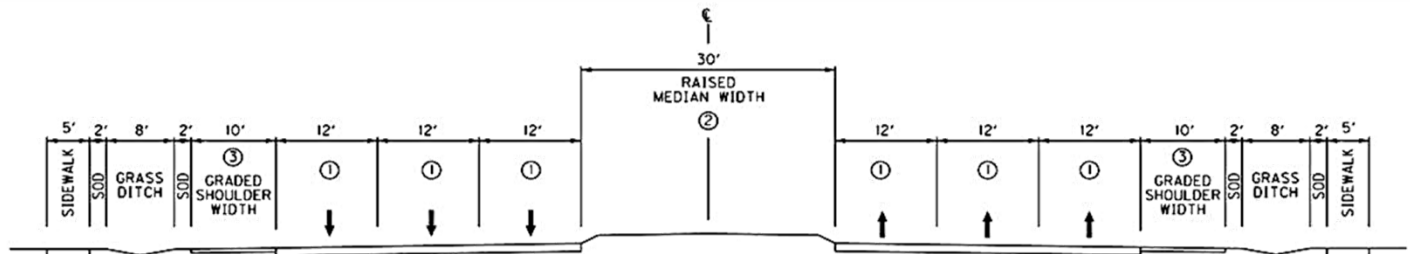


## Alternative 3 Urban Typical Section



- ① LANE WIDTHS MAY VARY BETWEEN 12 FEET AND 11 FEET.
- ② MEDIAN WIDTH ACCOMMODATES DUAL LEFT TURN LANES, U-TURNS FOR PASSENGER VEHICLES, AND CHANNELIZATION AT LEFT-IN RIGHT-IN RIGHT-OUT ONLY INTERSECTIONS.
- ③ RIGHT TURN LANES REQUIRE ADDITIONAL WIDTH

## Alternative 3 Rural Typical Section



- ① LANE WIDTHS MAY VARY BETWEEN 12 FEET AND 11 FEET.
- ② MEDIAN WIDTH ACCOMMODATES DUAL LEFT TURN LANES, U-TURNS FOR PASSENGER VEHICLES, AND CHANNELIZATION AT LEFT-IN RIGHT-IN RIGHT-OUT ONLY INTERSECTIONS.
- ③ SHOULDER WIDTHS VARY WHERE TURNING LANES EXIST.

**Figure ES-7**

US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Alternative 3 Typical Section

# **US 231 Scottsville Road Scoping and Traffic Operations Study**

**Final Report  
US 231 Scottsville Road  
From I-65 to Lovers Lane  
Warren County, Kentucky  
Item #3-8702.00**

**March 12, 2015**

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# Section 1

## Introduction

The Kentucky Transportation Cabinet (KYTC), in partnership with CDM Smith and its sub-consultant AEI, undertook a scoping and traffic operations study to examine US 231 (Scottsville Road) in Bowling Green, KY from the newly-constructed single-point urban interchange (SPUI) at I-65 to its intersection with KY 880/US 231 Business (Lovers Lane/Campbell Lane). A map showing the study area is shown on **Figure 1-1**. The objectives of this study are to:

- Identify and inventory known issues, concerns, and constraints; including safety, traffic, social, environmental, and geotechnical considerations;
- Develop the purpose, needs, and goals for the proposed project;
- Listen to and share information with local officials, government agencies, and other interested parties;
- Evaluate improvement concepts for the US 231 corridor based on project purpose and need;
- Develop improvement concepts into alternatives, including short-term “spot” improvements along the existing route and pedestrian accessibility enhancements; and
- Make project recommendations and provide phased cost estimates.

### A. Background

The project has been identified in the Barren River Area Development District’s (BRADD) transportation plan since 2001 and is the fifth-ranked overall priority project in the district. The project is KYTC Item Number 3-8702.00 as identified in Kentucky’s *FY 2014 – FY 2020 Highway Plan* dated May 2014. In the *Highway Plan*, the following is identified:

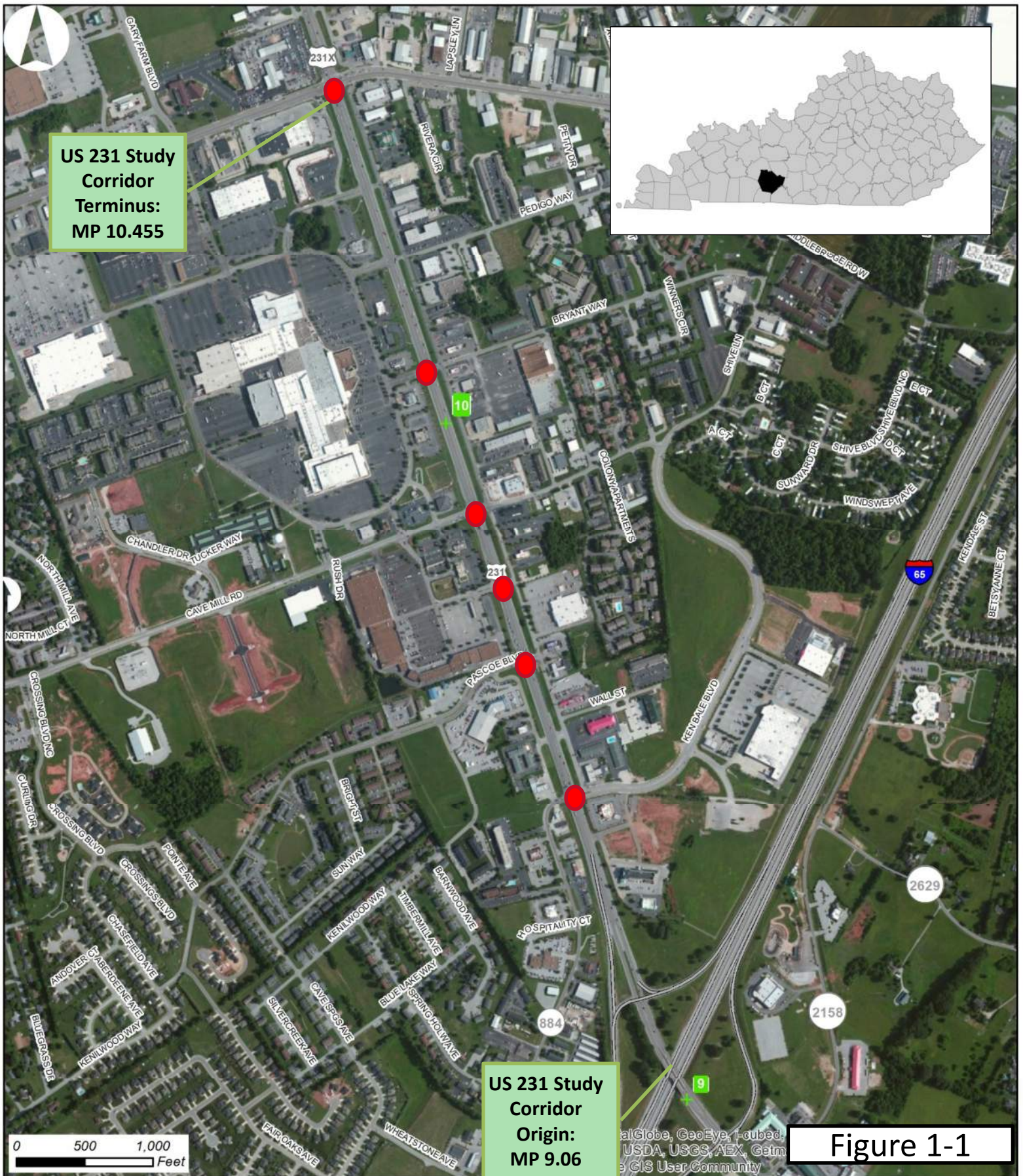
- Right-of-way phase “SPP” funding in year 2014 for \$1,600,000,
- Utility phase “SPP” funding in year 2015 for \$2,000,000, and
- Construction phase “SPP” funding is identified in year 2016 for \$5,000,000.

Design phase “SPP” funding in year 2013 for \$750,000 was previously allocated in Kentucky’s *FY 2012 – FY 2018 Highway Plan* dated May 2012. \$200,000 of the design phase money was reserved for this study. The corridor is frequently cited as one of the most congested roadways and the single-worst crash segment in District 3. Based on the cost estimates shown in **Section 7.D**, current programmed funds are insufficient for full major widening; however, funds could be used for recommended spot improvements.

### B. Project Location

This project is located in Warren County, Kentucky in the city of Bowling Green. The total project length is approximately 1.4 miles. Numerous businesses, shopping centers, and the Greenwood Mall have primary access points on US 231 or its frontage roads.







This primarily commercial corridor carries approximately 31,000 vehicles per day. It provides a link for vehicles traveling from Scottsville, the William H. Natcher Parkway, and I-65 to downtown Bowling Green and Western Kentucky University.

### C. Previous Studies

The need for an improved US 231 corridor has been identified in a number of previous planning documents.

The *2007 US 231/I-65 Interchange Study* by Wilbur Smith Associates (now CDM Smith) identified traffic management concepts and capacity improvements for US 231. The primary recommendations included the following:

- Widening US 231 to three lanes in each direction;
- Construction of a wide, non-mountable median with restricted openings at select intersections;
- Elimination of direct driveway access; and
- Consideration of backage road connections (which could involve local streets).

Improvements to the US 231 corridor are also identified in several other documents:

- The widening of US 231 with the installation of a non-mountable median is the subject of KYTC Project Identification Form (PIF) 03 114 B0231 58.00. As of 2011, the project was listed as the #5 overall priority project in District 3.
- The widening of US 231 from I-65 to Lovers Lane was listed as a “Priority Transportation Project” in the *2010-2035 Metropolitan Transportation Plan* prepared by the Barren River ADD for the Bowling Green – Warren County Metropolitan Planning Organization (MPO).
- Mobility enhancements along US 231 from KY 2158 (Cumberland Trace Road) to Ashley Circle, including widening and frontage road improvements were recommended as part of the *Bowling Green Transportation Plan 2000*.

## Section 2

### Existing Conditions

This section discusses the existing roadway conditions, traffic operations, and roadway safety.

#### A. Roadway Characteristics

US 231 is functionally classified as an Urban Minor Arterial with a 45 mph speed limit and 10-foot paved shoulders throughout the study area, although the cross-section varies as follows:

- From I-65 (MP 9.060) to just south of KY 884/Three Springs Road (MP 9.457), US 231 features three 12-foot travel lanes and 10-foot shoulders in each direction.
- The remainder of the study corridor to KY 880/Lovers Lane (MP 10.453) features two 12-foot travel lanes and 10-foot shoulders in each direction.
- An 8-foot non-traversable median has been installed from I-65 to the Red Roof Inn/Motel Six driveway (MP 9.541).



*US 231 looking north from Ken Bale Boulevard*

There are six (6) existing coordinated signalized intersections located along the study corridor:

- KY 884 (Three Springs Road/Ken Bale Boulevard)
- Pascoe Boulevard
- Greenwood Square Shopping Center (Kroger/K-Mart)
- Cave Mill Road/Shive Lane
- Bryant Way/Greenwood Mall Primary Entrance
- US 231 Business/KY 880 (Campbell Lane/Lovers Lane).

Signal timing sheets for the above signals were provided by KYTC.

There are also three (3) un-signalized intersections located along the study corridor:

- Motel Six/Red Roof Inn access (near Wall Street)
- Pedigo Way/Greenwood Mall Secondary Entrance
- Greenwood Mall Tertiary Entrance.

A frontage road (24-26 feet wide) provides the primary commercial driveway access along the entirety of the east side of US 231 between Three Springs Road and Lovers Lane. A less defined

frontage road system exists on the west side of US 231, providing access to the Greenwood Square Shopping Center and forming a loop around Greenwood Mall.

As part of this study, analysts studied the route in the field and reviewed roadway geometry data from Kentucky's Highway Information System (HIS). The existing conditions were then compared to current American Association of State Highway Transportation Officials (AASHTO) design standards to identify deficient elements. This analysis found zero deficiencies in roadway geometry along the study corridor.

## B. Other Modal Users

One bus route operated by *GO bg Transit* travels through the study portion of US 231. The Green Line operates hourly from 6:30 a.m. – 6:30 p.m Monday through Friday and generally uses US 231 near the top of each hour. The Green Line route and listed stops are shown in **Figure 2-1**.

- The Green Line (Route 3) enters Greenwood Mall from a rear entrance and stops in the parking lot.
- It travels along a frontage road to the Greenwood Square shopping center, stopping again in the parking lot.
- It utilizes US 231 directly for a brief time, before turning on Shive Lane and stopping on the far side of the frontage road intersection.
- After circling through local residential developments near Bryant Way, the route returns to the study corridor via Pedigo Way and turns north onto the frontage road, stopping opposite the Greenwood Mall Tertiary Entrance.
- Finally, the route returns to US 231 mainline, traveling north toward Bowling Green.

In addition to public transit service, school bus routes travel along and across US 231. Two schools, William Natcher Elementary School and Greenwood High School, are located in the vicinity of the project area.

There are no existing sidewalks along US 231 or its frontage road. Sidewalk connections exist at Ken Bale Boulevard/Three Springs Road and Lovers Lane/Campbell Lane (the only location where striped crosswalks exist along the corridor). Pedestrian signals and push-buttons are installed at every signalized intersection to cross US 231; however, the push-buttons are generally in inaccessible positions within ditches and are not adjacent to any pavement. An overview of pedestrian facilities can be found in **Figure 2-1**.

US 231 is not listed as a bicycle corridor as part of the Warren County Planning Commission's Greenways Project, nor in any other related bike plan.



*Scottsville Road at Three Springs Road shows the push button location does not include sidewalks or crosswalks.*



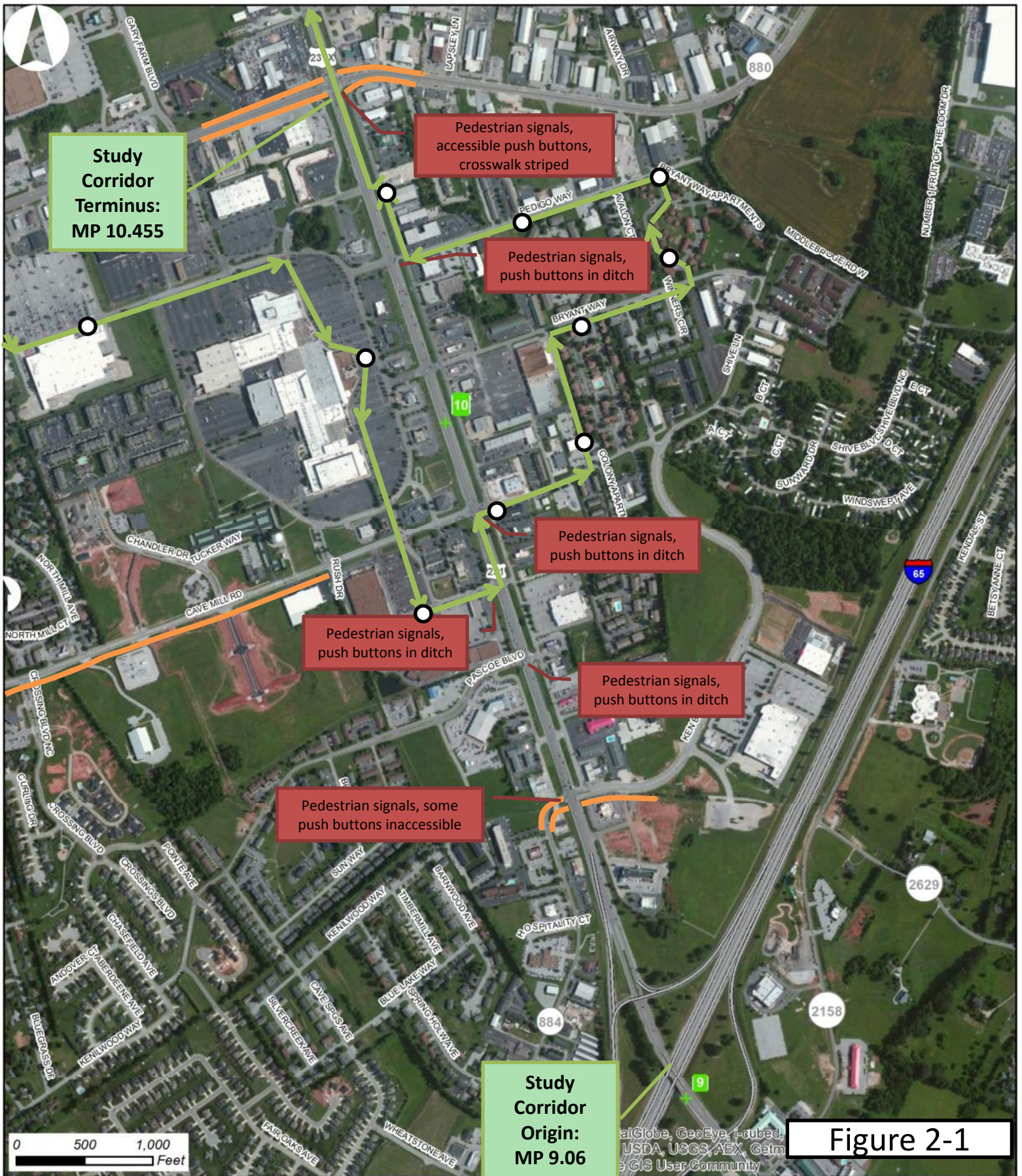


Figure 2-1

US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Multimodal Facilities





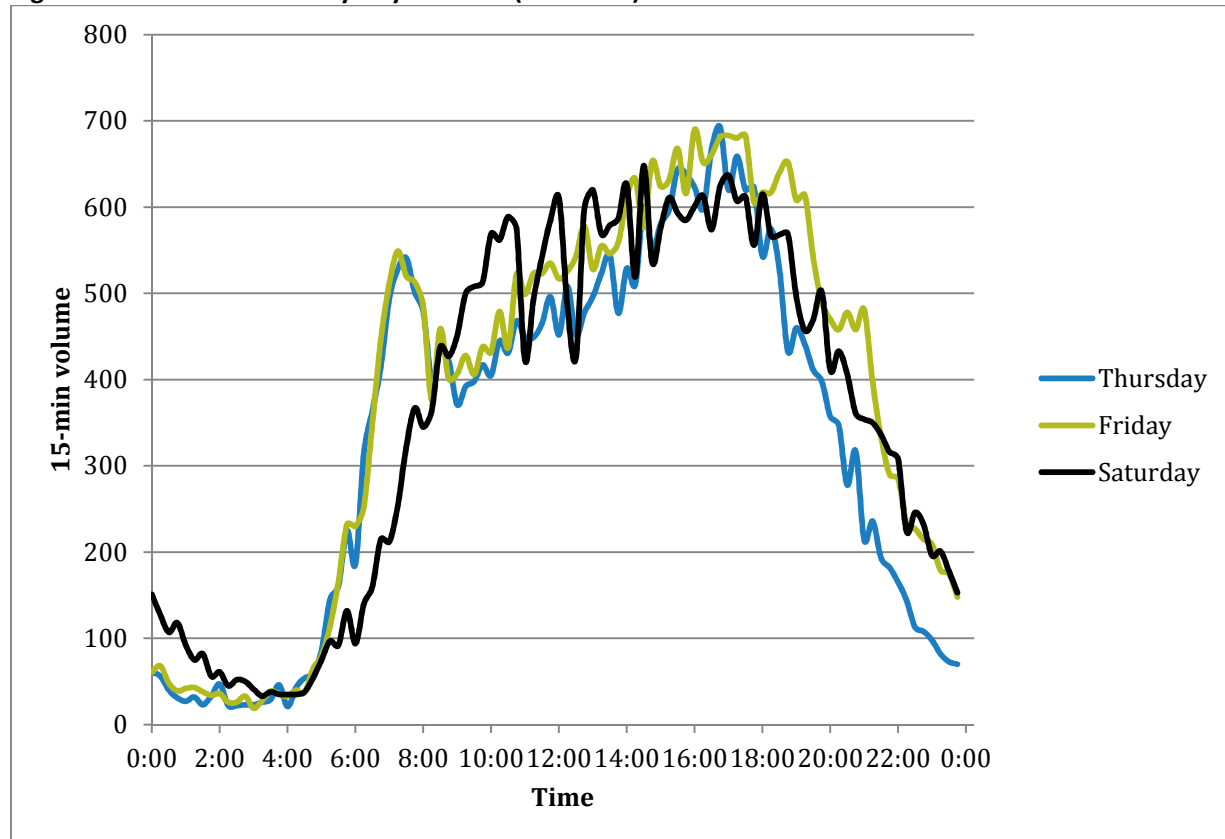
## C. Existing & Future Traffic Operations

This section details the existing (2013) and future (2040) corridor segment and intersection volumes, capacity analysis, intersection analysis, and micro-simulation results. An intermediate year (2026) capacity analysis is also discussed.

### Traffic Counts

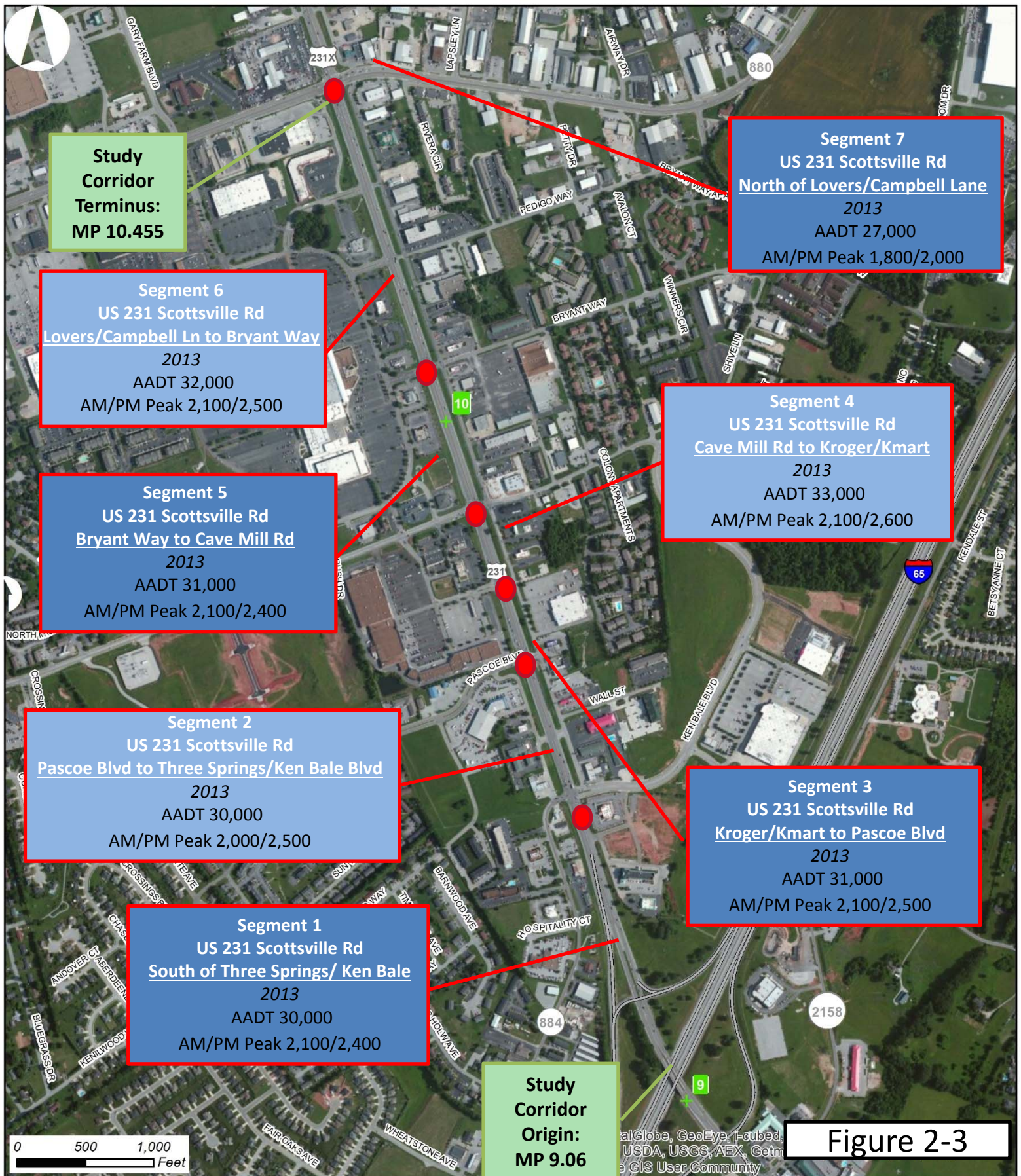
Existing (2013) traffic volumes for US 231 were collected in October 2013 using seven-day classification counts at each end of the corridor and 24-hour video counts at each signalized and unsignalized intersection. The latter were collected between Tuesday and Thursday representing a typical weekday. Due to the heavy presence of traffic visiting commercial establishments along the corridor, the seven-day count was examined to determine the differences in traffic between a typical weekday and the weekend. A chart showing traffic (in 15-minute increments) for a Thursday, Friday, and Saturday are shown in **Figure 2-2**.

**Figure 2-2: US 231 Volume by Day of Week (MP 10.35)**




While total volume is higher on Friday and Saturday due to sustained traffic, the peak period occurs on Thursday. The analysis presented in the following sections is for the peak period; therefore, the counts collected for the typical weekday were used in the evaluation.

Annual average daily traffic (AADT) volumes derived from the video counts range from 30,000 to 33,000 vehicles per day (vpd) within the study area. These volumes are shown in **Figure 2-3**. Passenger cars, motorcycles, and pickup trucks account for approximately 96% of the year 2013 daily traffic volume using the corridor, based upon the classification counts. Buses and commercial trucks make up the remaining 4% of the daily traffic volume.



**Figure 2-3**

Note: AADT is Average Adjusted Daily Traffic and is provided in Vehicles per Day.

 Signalized Intersections

**CDM Smith**



**US 231 – Scottsville Rd  
 From I-65 to Lovers Lane  
 KYTC Item No 3-8702  
 2013 Traffic Characteristics**



Intersection or “turning movement” counts along US 231 were collected in conjunction with the video counts during the afternoon peak traffic period. To better understand operations along the frontage road, three-hour manual counts were conducted at six select intersections along the frontage road and major side streets, with 30-minute spot counts at ten minor intersections. These volumes were used in conjunction with the micro-simulation effort described below. All turning movement counts were balanced with those along US 231 to create a cohesive network, which can be found in **Appendix A**. The turning movement volumes during the PM peak hour at the signalized intersections along US 231 are also presented in **Figure 2-4**.

### Micro-simulation Model

To better understand the operations and interactions of the frontage road system, the micro-simulation software package VISSIM was utilized in the analysis. VISSIM is a valuable tool to aid in analyzing traffic operations for the existing conditions and any future alternative options. VISSIM utilizes a link-connector system with individual routing decisions to model complex networks, with additional options for driver and vehicle behavior. A full report detailing the calibration effort, along with minutes from a calibration-only meeting with KYTC is available in **Appendix B**. VISSIM was used in combination with the software package Synchro for operational analysis for the entire corridor. The results from the effort are presented throughout this report.

### Operational Analysis

Level of Service (LOS) is a qualitative measure of highway traffic conditions, as identified in the 2010 *Highway Capacity Manual* (HCM). Individual levels of service characterize conditions in terms of speed, travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Six levels of service are defined and given letter designations from A to F, with LOS A representing free flow conditions, and LOS F representing severe congestion and/or time delays. Typically, a minimum LOS D is considered acceptable in urban areas and LOS C is considered acceptable in rural areas.

LOS was calculated for the signalized study intersections along the corridor, based on the existing lane configuration, traffic controls, and peak hour volumes. **Table 2-1** presents LOS for each intersection in the AM, Noon, and PM peak hours. Overall, all intersections operate at acceptable service levels. HCM 2000 Methodology was used due to HCM 2010’s inability to analyze intersections that have shared lanes such as a shared through and right.

**Table 2-1: Existing (2013) Peak Hour LOS**

Intersection	AM LOS	Noon LOS	PM LOS
Ken Bale Blvd / Three Springs Rd	C	C	D
Pascoe Blvd	C	B	B
Greenwood Square	A	B	B
Cave Mill Rd/Shive Ln	C	D	D
Bryant Way	B	C	C
Campbell Ln/Lovers Ln	D	D	D

As the PM peak hour contains both the highest volumes and has the worst LOS, a more detailed analysis by approach is presented in **Table 2-2** for the PM peak hour traffic. Several approaches were found to not operate at an acceptable level. Delay shown represents the additional travel time experienced by a driver, and is used as the threshold for LOS. The primary factors that influence delay are lane group volume, lane group capacity, cycle length, and effective green time.



**Table 2-2: Existing (2013) PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	40.3	D	Northbound US 231	38.8	D
			Southbound US 231	26.1	C
			Eastbound Three Springs Rd	62.5	<b>E</b>
			Westbound Ken Bale Blvd	70.1	<b>E</b>
Pascoe Blvd	16.1	B	Northbound US 231	10.2	B
			Southbound US 231	8.6	A
			Eastbound Pascoe Blvd	70.5	<b>E</b>
			Westbound Pascoe Blvd	73.6	<b>E</b>
Greenwood Square	12.3	B	Northbound US 231	7.6	A
			Southbound US 231	3.6	A
			Eastbound Greenwood Square Access	65.2	<b>E</b>
			Westbound Frontage Rd Access	62.7	<b>E</b>
Cave Mill Rd/Shive Ln	37.1	D	Northbound US 231	40.2	D
			Southbound US 231	18.5	B
			Eastbound Cave Mill Rd	45.5	D
			Westbound Shive Ln	65.5	<b>E</b>
Bryant Way	22.5	C	Northbound US 231	9.4	A
			Southbound US 231	14.8	B
			Eastbound Mall Access	62.2	<b>E</b>
			Westbound Bryant Way	70.7	<b>E</b>
Campbell Ln/Lovers Ln	50.1	D	Northbound US 231	36.9	D
			Southbound US 231	43.1	D
			Eastbound Campbell Ln	61.1	<b>E</b>
			Westbound Lovers Ln	66.8	<b>E</b>

Daily volumes for 2013 were derived from collected tube counts and video counts. These counts were then adjusted based on a seasonal adjustment factor, which converts the raw volumes into an average volume which is representative of the entire year. To transition between a daily and design hour forecast volume, analysts must apply two specific conversion factors. The K-factor describes what percentage of the weekday traffic volume is accounted for during the 30th highest hour during a typical year. The D-factor describes what percentage of the total traffic on a link is traveling in the peak direction.

- The percentage of PM Peak volume compared to daily volume for each segment varied from 7 to 9%. For the 30th highest hour, a K-factor of 9.8% was selected, which matches the statewide average rate for urban minor arterials (9.8%). It is typical for the K-factor to be higher than a typical day.
- Based on tube and video counts, the existing D-factor ranges from 53% - 58%. A factor of 56% was selected, which is similar to the statewide average for urban minor arterials. The peak flow during the PM Peak travels away from downtown Bowling Green (southbound along the study corridor).



To appropriately size roadways, the KYTC recommends evaluating the volume-to-capacity ratio (V/C). 2013 design hour volumes were compared to the road's theoretical capacity. A V/C ratio represents the number of vehicles using the road in a specific time period (i.e. design hour volume) compared to the number of vehicles the road was designed to be able to handle during that period. The target V/C ratio is no greater than 0.9 for rural areas and 1.0 for urban areas. A V/C greater than this indicates the road is congested, i.e. operating above its design capacity. For urban areas, such as the study area, signal timing is factored into the theoretical capacity to account for potential lost time at signals.

**Table 2-3** presents the V/C for each segment along the corridor based on an ideal directional capacity of 1,900 vehicles per hour per lane and the actual percent green time for US 231 movements approaching signalized intersections. Additional adjustments to the ideal capacity are made based on percent trucks, grade, and the peak hour factor. V/C ranges from 0.67 to 0.87 for individual segments of the study corridor. The segment between Bryant Way and Cave Mill Road/Shive Lane has a V/C of 0.87, indicating it is approaching capacity. Motorists consistently experience this capacity constraint along the entire US 231 corridor.

**Table 2-3: 2013 Peak Direction Volume-to-Capacity for Corridor Segments**

Segment Start	Segment End	AADT	Peak Hour Volume (Peak Direction)	V/C
North of Campbell Lane	Campbell Lane	26,500	1,454	0.72
Campbell Lane	Bryant Way	31,500	1,729	0.83
Bryant Way	Cave Mill Rd	30,600	1,679	0.87
Cave Mill Rd	Greenwood Square	31,600	1,734	0.69
Greenwood Square	Pascoe Blvd	30,600	1,679	0.67
Pascoe Blvd	Three Springs Rd	29,300	1,608	0.87

Given the number of closely-spaced signals on the corridor, spillback from downstream signals may not be accurately reflected in V/C calculations. Travel time through the study corridor is another metric which can be used not only in micro-simulation calibration, but to measure how well the corridor is operating. Existing travel time runs were conducted during October 2013, with additional runs completed in February 2014. To match the travel time output of VISSIM, measurements began when the vehicle crossed the stop bar at Three Springs Road or Campbell Lane for the northbound and southbound runs, respectively. Thus, the vehicle passed five signals per run. Typically, progression of the signals allowed motorists to travel through the majority of the signals without stopping. Stop conditions were found to frequently occur at the higher volume intersections: Campbell Lane/Lovers Lane, Three Springs Road/Ken Bale Boulevard, and Cave Mill Road. A summary of travel times is presented below in **Table 2-4**.

**Table 2-4: 2013 and 2014 PM Peak Hour Travel Times**

Direction	2013 Travel Time	2013 Average Speed	2014 Travel Time	2014 Travel Speed
US 231 Southbound	3 min 24 sec	17.7 mph	3 min 21 sec	17.9 mph
US 231 Northbound	3 min 13 sec	18.7 mph	3 min 18 sec	18.2 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.

## 2026 and 2040 Future No-Build Volumes

No-Build is a theoretical traffic scenario where volumes continue to increase but no changes are made to the transportation system. It serves as a baseline condition that potential alternatives can be compared to. 2040 was selected as the design year by KYTC, so any improvements designed must accommodate traffic in that year. As US 231 is not currently at capacity, as shown above, an intermediate year of 2026, representing 10 years beyond the construction year, was chosen to determine if improvements needed to be in place before then.

To project future traffic volumes along the study corridor, analysts examined a number of available sources:

- Historic traffic volumes along US 231;
- Previous transportation studies in the vicinity;
- Population and employment forecasts from the Kentucky State Data Center and Woods & Poole's 2012 *Complete Economic and Demographic Data Source*; and
- Bowling Green MPO Travel Demand Model.

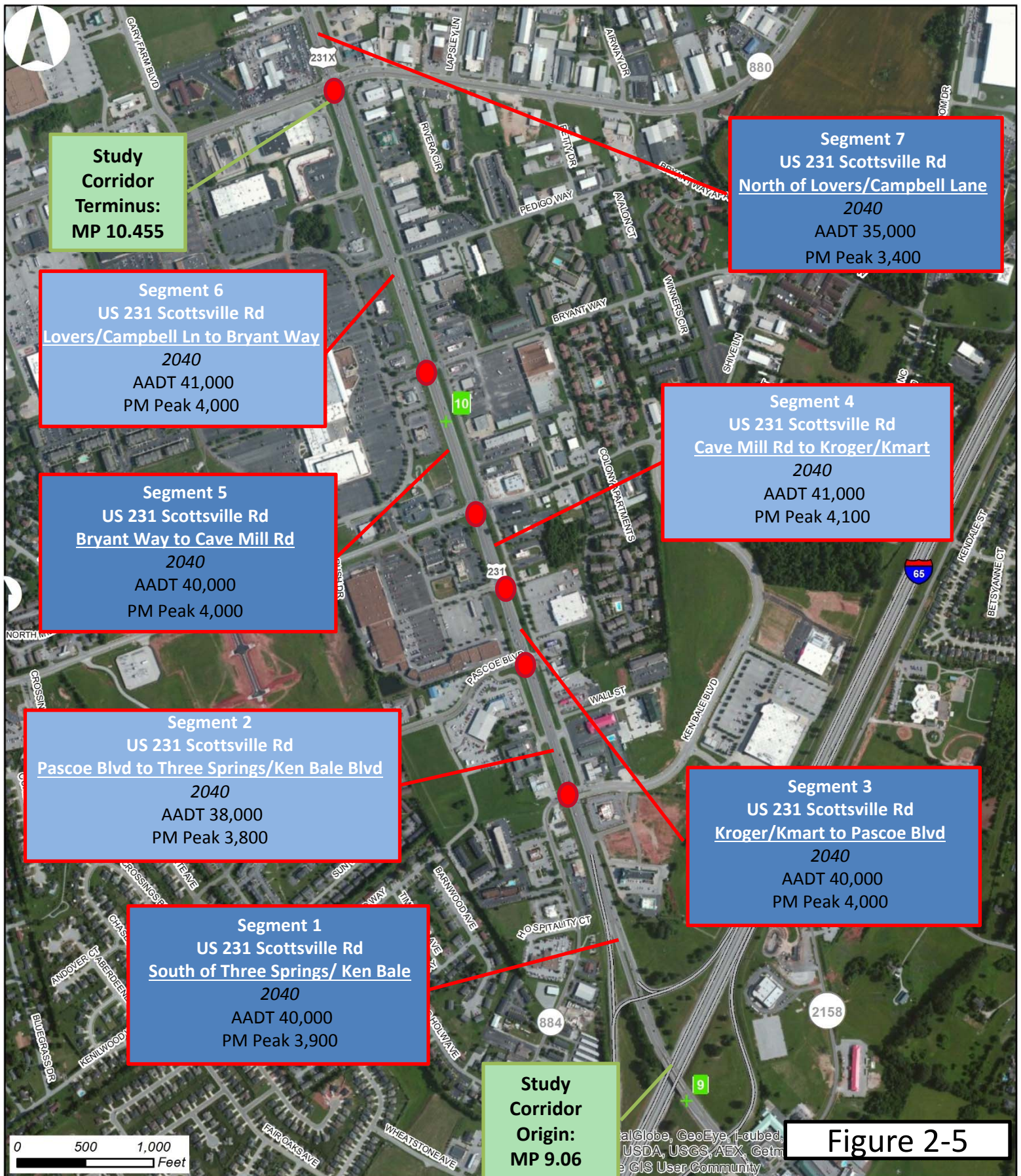
A variety of annual growth rates were identified, ranging from nearly stagnant linear annual traffic growth through 2.0% annual population growth. Accounting for all of these factors, an annual exponential growth rate of 1.0% was applied to forecast future traffic volumes. This growth rate accounts for background traffic growth (i.e. population forecasts, employment forecasts, etc.) and anticipated traffic growth associated with the development of US 231 south of I-65.

**Appendix C** includes the Traffic Forecast Report which provides additional detail on the traffic forecast assumptions and findings.


The growth rate (described above), K- and D-factors were applied to the 2013 AADT volumes to forecast future no build volumes for the analysis years 2026 and 2040. No Build 2040 AADT and turning movement volumes during the future PM peak hour are presented in **Figure 2-5** and **Figure 2-6**.

With the increase in traffic in 2040, traffic operations are expected to degrade during the peak hour. **Table 2-5** presents LOS for the 2040 No Build scenario. As shown, operations at Three Springs Road, Cave Mill Road, and Lovers Lane degrade to LOS F during the peak period. All of the minor cross street approaches throughout the corridor experience an unacceptable LOS E or F. **Table 2-6** presents V/C for each segment for the 2040 No Build scenario, which has also increased compared to the existing conditions. Each segment is either approaching or has exceeded its theoretical capacity. The section of US 231 between Bryant Way and Cave Mill Road is heavily congested with a V/C of 1.13. **Table 2-7** presents the 2040 average travel times in each direction during the PM peak hour as derived from the micro-simulation model.





Note: AADT is Average Adjusted Daily Traffic and is provided in Vehicles per Day.

 Signalized Intersections

**CDM Smith**



**US 231 – Scottsville Rd**  
**From I-65 to Lovers Lane**  
**KYTC Item No 3-8702**  
**2040 Traffic Characteristics**







**Table 2-5: No Build (2040) PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	97.5	<b>F</b>	Northbound US 231	86.7	<b>F</b>
			Southbound US 231	102.6	<b>F</b>
			Eastbound Three Springs Rd	64.0	<b>E</b>
			Westbound Ken Bale Blvd	144.6	<b>F</b>
Pascoe Blvd	21.8	C	Northbound US 231	10.7	B
			Southbound US 231	16.1	B
			Eastbound Pascoe Blvd	97.4	<b>F</b>
			Westbound Pascoe Blvd	143.8	<b>F</b>
Greenwood Square	15.5	B	Northbound US 231	11.0	B
			Southbound US 231	10.6	B
			Eastbound Greenwood Square Access	62.2	<b>E</b>
			Westbound Frontage Rd Access	60.5	<b>E</b>
Cave Mill Rd/Shive Ln	77.6	<b>E</b>	Northbound US 231	38.2	D
			Southbound US 231	80.3	<b>F</b>
			Eastbound Cave Mill Rd	113.9	<b>F</b>
			Westbound Shive Ln	140.3	<b>F</b>
Bryant Way	33.5	C	Northbound US 231	25.8	C
			Southbound US 231	23.4	C
			Eastbound Mall Access	74.6	<b>E</b>
			Westbound Bryant Way	96.9	<b>F</b>
Campbell Ln/Lovers Ln	79.5	<b>E</b>	Northbound US 231	38.0	D
			Southbound US 231	82.1	<b>F</b>
			Eastbound Campbell Ln	116.1	<b>F</b>
			Westbound Lovers Ln	109.7	<b>F</b>

**Table 2-6: 2040 No Build Peak Direction Volume-to-Capacity for Corridor Segments**

Segment Number	Segment Start	Segment End	AADT	Peak Hour Volume (Peak Direction)	V/C
1	Three Springs Rd	Pascoe Blvd	38,400	2,106	1.14
2	Pascoe Blvd	Greenwood Square	40,100	2,200	0.88
3	Greenwood Square	Cave Mill Road	41,400	2,272	0.91
4	Cave Mill Road	Bryant Way	40,100	2,200	1.13
5	Bryant Way	Campbell Lane	41,300	2,265	1.09
6	Campbell Lane	North of Campbell Lane	34,700	1,905	0.95

**Table 2-7: 2040 No Build PM Peak Hour Travel Times**

Direction	Travel Time	Average Speed
US 231 Southbound	10 min 3 sec	6.2 mph
US 231 Northbound	7 min 25 sec	8.4 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.

### Intermediate Year (2026) Volumes

To examine at what point the existing roadway would become over capacity, analysts derived segment volumes for an intermediate year, 2026. For reference, 2026 No Build AADT and PM peak hour volumes are shown in **Figure 2-7**. **Table 2-8** shows the V/C calculations for this intermediate year. As shown, the segment between Bryant Way and Cave Mill Road has reached its theoretical capacity, as has the segment between Pascoe Boulevard and Three Springs Road.

**Table 2-8: 2026 No Build Peak Direction Volume-to-Capacity for Corridor Segments**

Segment Number	Segment Start	Segment End	AADT	Peak Hour Volume (Peak Direction)	V/C
1	Three Springs Rd	Pascoe Blvd	33,400	1,831	0.99
2	Pascoe Blvd	Greenwood Square	34,800	1,912	0.76
3	Greenwood Square	Cave Mill Road	36,000	1,975	0.79
4	Cave Mill Road	Bryant Way	34,800	1,912	0.99
5	Bryant Way	Campbell Lane	35,900	1,969	0.95
6	Campbell Lane	North of Campbell Lane	30,200	1,656	0.83

### Traffic Summary

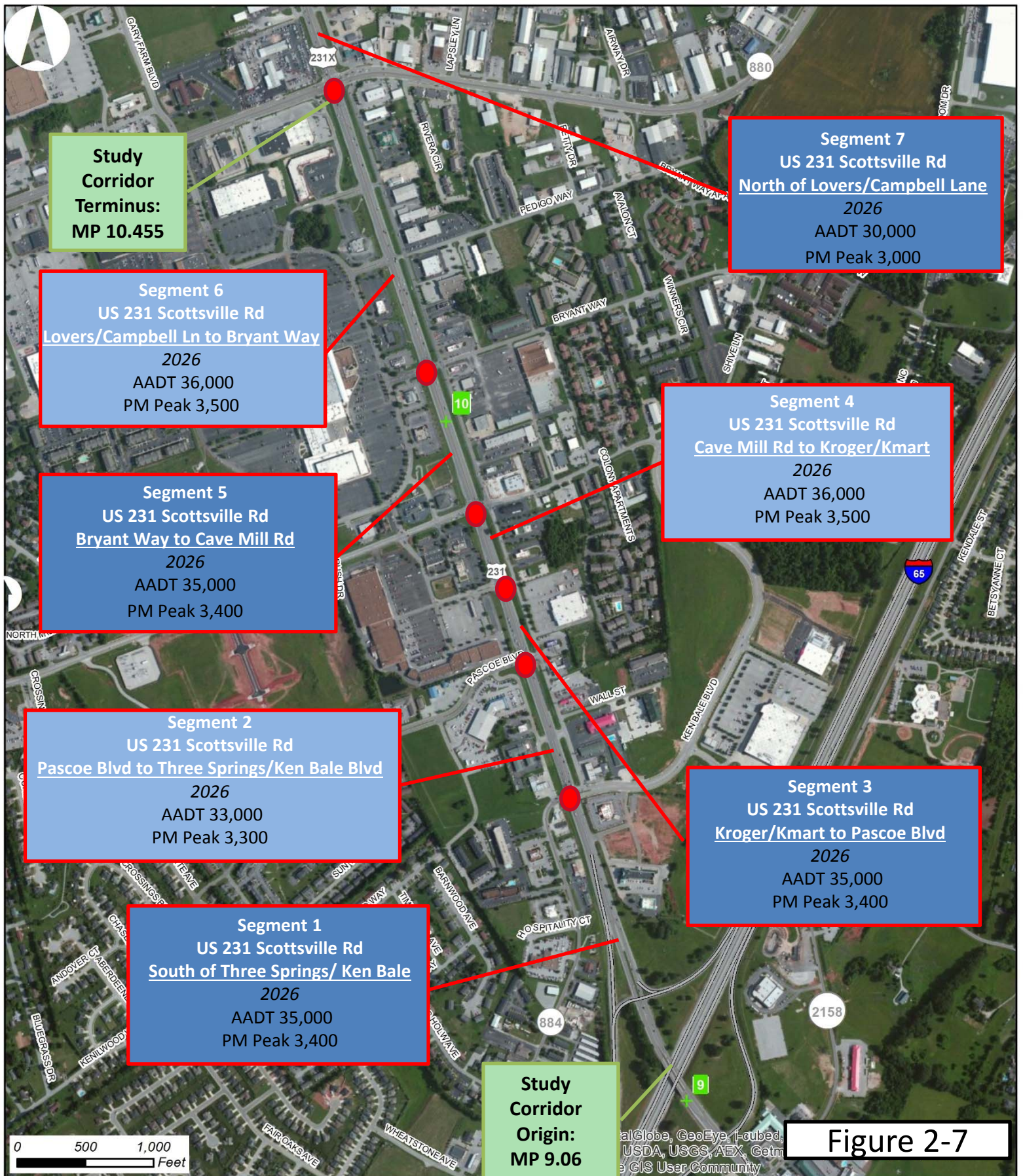
In summary,

- The LOS analysis by intersection approach shows there are several approaches that experience LOS E and F currently and conditions will continue to degrade if not mitigated. In 2040, each of the six signalized intersections has at least two approaches that experience LOS E or F. This illustrates the need for additional capacity at each intersection along the corridor.
- The V/C analysis shows the corridor is approaching capacity currently. By 2026, two segments will be at capacity and by 2040, three segments will be over capacity with the other three segments approaching capacity. This illustrates the need for capacity improvements along the corridor.
- The micro-simulation model shows a significant decrease in travel speed along the corridor between 2013/2014 and 2040 further supporting the need for capacity enhancements.


### D. Roadway Safety

To quantify safety concerns, a crash analysis was performed for US 231. Crash records were collected from KYTC for a five-year period (November 1, 2008 through October 31, 2013) and are shown in **Appendix D**. Crashes were geospatially referenced and compared to statewide data to identify locations experiencing above average crash rates. The methodology used is defined in the KYTC research report *Analysis of Traffic Crash Data in Kentucky* (Kentucky Transportation Center, 2013).





Note: AADT is Average Adjusted Daily Traffic and is provided in Vehicles per Day.

 Signalized Intersections

CDM  
Smith



**US 231 – Scottsville Rd**  
**From I-65 to Lovers Lane**  
**KYTC Item No 3-8702**  
**2026 Traffic Characteristics**

## Segment Analysis

As defined in the methodology report, segments vary in length and are divided along roadways where geometry or traffic volumes change. For each section, analysts looked at the number and severity of crashes to determine the critical rate factor (CRF). 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 average crash rate for roadways of the same highway type throughout the state. CRF also takes into account traffic volume, area type (rural/urban), and the number of lanes. If the CRF is 1.0 or greater, it may indicate that crashes are occurring due to circumstances that cannot be attributed to random occurrence. CRF calculations can be found in **Appendix B**.

**Figure 2-8** shows the result of the segment analysis with statistics on each segment. CRFs along the study corridor range from 2.18 to 4.48, indicating that crashes on US 231 cannot be attributed to random chance.

## General Crash Trends

Due to the number of crashes during the analysis periods, analysts examined the severity and type of incidents to identify general trends.

**Severity.** Of the 881 reported total crashes along the study route during the five-year analysis period, there were two crashes that resulted in fatalities. Both crashes involved a vehicle turning left across traffic; one at Three Springs Road and the other at Pascoe Boulevard. During the same period, there were 157 crashes that resulted in injuries (17.8%). The remaining 722 crashes (82.0%) resulted in property damage only.

**Type.** Analysts also considered the type of crashes to determine potential causation trends. Eight categories were represented: angle, backing, head on, opposing left turn, rear end, rear to rear, sideswipes, and single vehicle collisions. **Figure 2-9** shows the division by crash type of the 881 crashes on the study route during the five-year analysis period. The high propensity of rear end crashes is indicative of a congested roadway with many traffic signals. Angle crashes are often associated with multi-lane roadways and/or intersections.

## Frontage Road Crashes

Crashes along the US 231 Frontage Road system are illustrated on **Figure 2-8**. Eighty-five total crashes were identified throughout the study area. No clear patterns or clusters were identified with a couple of exceptions. Several crashes occurred at the side street intersection with the frontage road. Examples include the frontage road access opposite Pascoe Boulevard and the intersections of Shive Lane, Cave Mill Road, Bryant Way, Pedigo Way, and Lovers Lane. There is also a cluster of crashes that are occurring along the frontage road between Bryant Way and Pedigo Way.



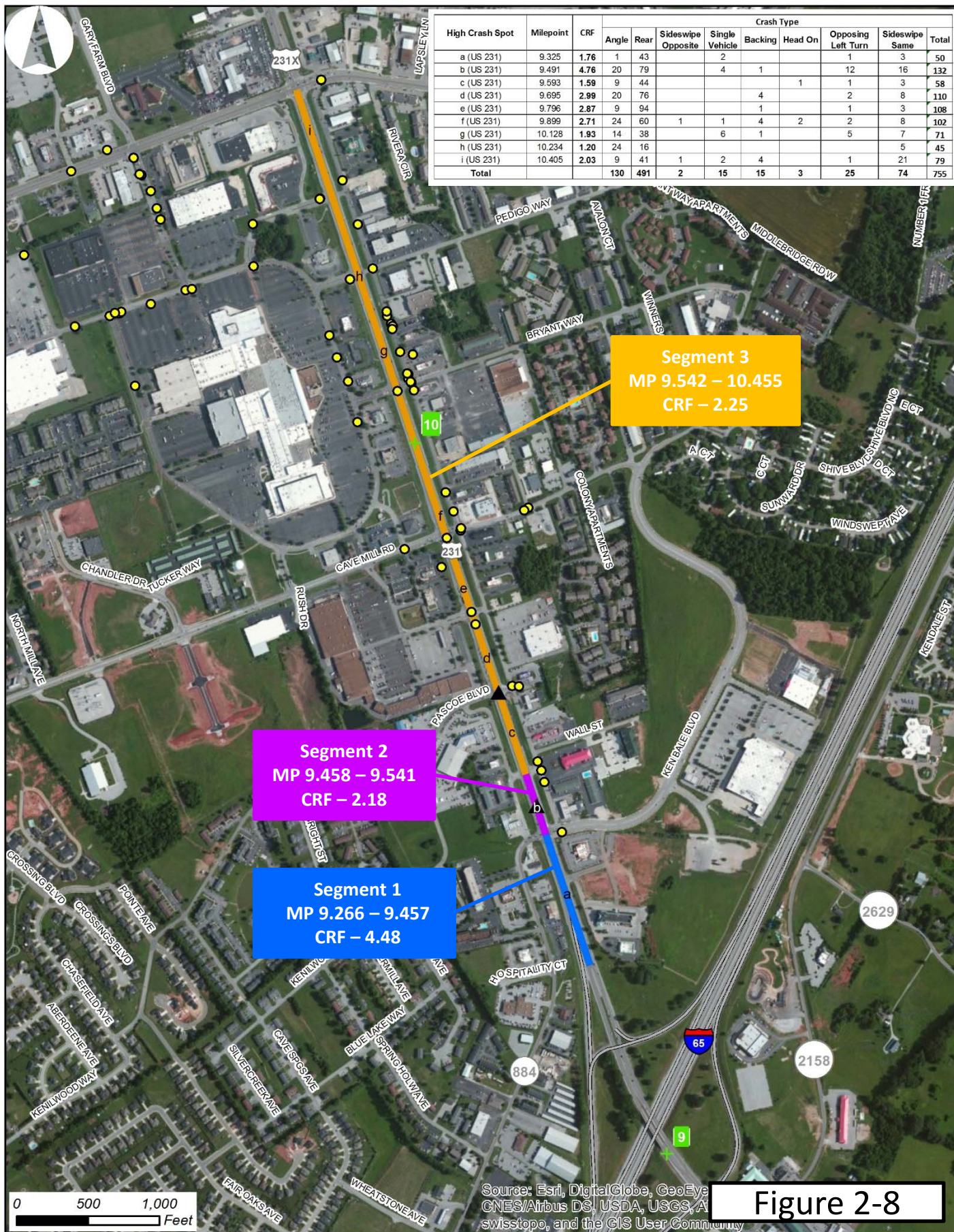


Figure 2-8

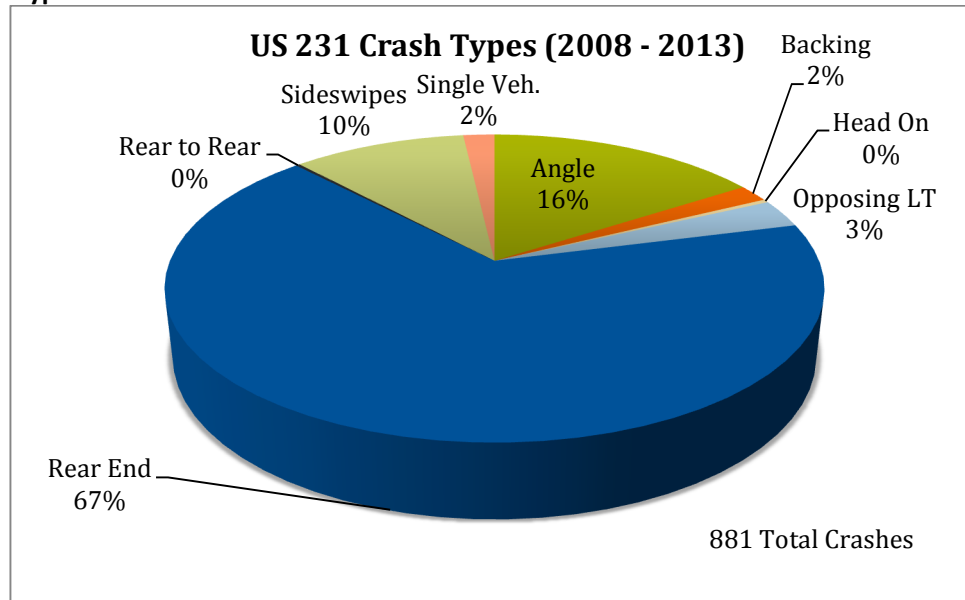
- High Crash Segments
- MP 9.266-9.457
  - MP 9.458-9.541
  - MP 9.542-10.455
- Frontage Road Crashes (85)
- Fatality Location
- a High Crash Spots

CDM Smith



US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Crash Analysis



**Figure 2-9: Type of Crashes on US 231**

### Spot Analysis

Analysts also conducted a “spot” crash analysis along the study route. Spots were defined by examining crash data to identify 0.10-mile sections where crashes were concentrated. Crashes were again geospatially referenced and compared to statewide data to identify spot locations experiencing above average crash rates. The methodology is defined in the KYTC research report *Analysis of Traffic Crash Data in Kentucky* (Kentucky Transportation Center, 2013).

Along the study corridor, nine spots were found to have a CRF greater than 1.00, as shown previously in **Figure 2-8**. For spots, CRFs ranged from 1.20 to 3.66. The highest CRF spot was between Red Roof Inn/Motel Six and Three Springs Road/Ken Bale Boulevard (132 crashes, CRF 3.66). Spot H at Pedigo Way had a high percentage of angle crashes (24 of 45). This intersection is un-signalized and is likely contributing to this higher percentage.



## Section 3

### Environmental Overview

The following sections provide an overview of the existing human and natural environment, based on information from readily available sources. Alternatives should be developed to minimize impacts to the environment, particularly resources such as schools, parks, and homes in the vicinity of the corridor.

#### A. Socioeconomic and Community Resources

The following sections summarize the community resources and socioeconomic characteristics of the study area.

##### Schools and Parks

There are no publicly-owned parks or recreation areas within the project study area. Two schools are located in the vicinity of the project area: Greenwood High School is located directly south of the project area on US 231 and William Natcher Elementary School is located west of the project area on Cave Mill Road. Western Kentucky University is located approximately four miles north of the project area.

##### Land Use

Within the study area, the land use adjacent to US 231 and its frontage road is commercial business. There are no anticipated business or residential relocations as part of the proposed project. In various areas behind the commercial businesses, there are numerous residential apartment complexes which should not be directly impacted by this proposed project.

##### Demographics

The Barren River Area Development District assembled an overview of select socioeconomic characteristics to determine the potential for the project to impact environmental justice populations, such as ethnic minorities and low-income individuals; the Environmental Justice Review is presented as **Appendix E** and summarized in this section. Census data was assembled for three block groups within two Census tracts containing the project, along with average statistics for Bowling Green, Warren County, the state of Kentucky, and the US, for comparison. It should be noted that the tracts, particularly Tract 107.1, cover a much larger area than the study area. The demographic data collected for the three block groups is summarized in **Table 3-1** and as follows:

- There does not appear to be a defined environmental justice community within Block Group 2 of Census Tract 107.2.
- Block Group 1 of Census Tract 107.1 shows an elevated percentage of disabled population located in this area compared to remainder of the city.
- Block Group 2 of Census Tract 107.1 shows elevated percentages of ethnic minorities, those of Hispanic or Latino origin, and persons below the poverty level compared to the remainder of the city.

**Table 3-1: Demographic Summary Data for Selected Geographies**

Geography	Minority Population <sup>1</sup>	Population Age 65 and over <sup>2</sup>	Population Below Poverty Level <sup>3</sup>	Disabled Population <sup>4</sup>
United States	25.8%	13.1%	15.0%	12.0%
Kentucky	11.9%	13.4%	18.4%	16.7%
Warren Co.	16.4%	10.9%	18.9%	14.0%
Bowling Green	24.2%	10.7%	27.7%	13.6%
Tract 107.1	23.2%	13.6%	26.8%	18.1%
Block Group 1	22.8%	10.6%	13.5%	23.1%
Block Group 2	31.0%	13.2%	42.8%	12.2%
Tract 107.2	18.7%	10.5%	8.1%	11.2%
Block Group 2	24.0%	9.5%	13.4%	12.1%

<sup>1</sup> Table D002 from 2008-2012 ACS estimates<sup>2</sup> Table DP03 from 2008-2012 ACS estimates<sup>3</sup> Table DP05 from 2008-2012 ACS estimates<sup>4</sup> US Census Bureau for Age data, 2008-2012

These areas should be noted in the future project planning and design phases, and, if necessary, field visits, discussions with local officials and/or other sources of information should be consulted. Pockets of environmental justice populations may be present that are not reflected at the block group or tract level.

## B. Aquatic & Terrestrial Resources

The corridor is in an urban setting with no suitable wildlife habitats or above-ground streams.

Coordination with the US Fish & Wildlife Service (USFWS) and Kentucky Department of Fish & Wildlife Resources (KDFWR) identified a list of federally endangered or threatened species that could occur in the vicinity. These species are presented in **Table 3-2**. Agency coordination letters are included as **Appendix F** to this report.

KDFWR records also identify a state-listed species in the vicinity: Rayed Bean Mussel (*Villosa fabalis*). Of the listed species there would be No Effect for all the mussels and plants as there is no suitable habitat located within the study area. The Kentucky cave shrimp is only found in the Green River karst drainage area to the north, while this project drains in the Barren River karst. However, karst connectivity between the two areas is likely and impacts could be possible. There are no above-ground streams suitable for mussel habitat. This project is “Not Likely to Adversely Affect” the bats species due to the lack of habitat within the project area.

This project is located in the Bowling Green Municipal Separate Storm Sewer System community. The entire project area is drained via karst drainage. There are no streams with a visible Ordinary High Water Mark (OHWM) or Defined Bed/Bank along the study corridor, therefore a 401/404 permit would not be required. The Kentucky Pollutant Discharge Elimination System Notice of Intent (NOI) for disturbing more than one acre of land would apply.



**Table 3-2: Federally Listed Species in Vicinity**

Group	Species	Common Name	Legal Status	Action Area Presence *
Mammals	<i>Myotis grisescens</i>	gray bat	Endangered	Potential
Mammals	<i>Myotis sodalist</i>	Indiana bat	Endangered	Potential
Mammals	<i>Myotis septentrionalis</i>	Nothorn long-eared bat	Proposed Threatened	Known
Mussels	<i>Epioblasma o. obliquata</i>	purple catspaw pearlymussel	Endangered	Potential
Mussels	<i>Pleurobema clava</i>	clubshell	Endangered	Potential
Mussels	<i>Cyprogenia stegaria</i>	fanshell	Endangered	Potential
Mussels	<i>Epioblasma torulosa rangiana</i>	Northern riffleshell	Endangered	Potential
Mussels	<i>Plethobasus cooperianus</i>	orangefoot pimpleback	Endangered	Potential
Mussels	<i>Lampsilis abrupta</i>	pink mucket	Endangered	Potential
Mussels	<i>Obovaria retusa</i>	ring pink	Endangered	Potential
Mussels	<i>Pleurobema plenum</i>	rough pigtoe	Endangered	Potential
Mussels	<i>Plethobasus cyphus</i>	sheepnose	Endangered	Potential
Mussels	<i>Quadrula cylindrica cylindrica</i>	rabbitsfoot	Threatened	Potential
Mussels	<i>Epioblasma triquetra</i>	snuffbox	Endangered	Potential
Mussels	<i>Cumberlandia monodonta</i>	spectaclecase	Endangered	Potential
Plants	<i>Apios priceana</i>	Price's potato-bean	Threatened	Potential
Crustaceans	<i>Palaemonias ganteri</i>	Kentucky cave shrimp	Threatened	Potential

\* These species are known to occur or have the potential to occur in the action area

## C. Air Quality

Pursuant to the Clean Air Act, the United States Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for seven principal transportation-related pollutants: carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), inhalable particulate matter (PM<sub>10</sub>), fine particulate matter (PM<sub>2.5</sub>), ozone (O<sub>3</sub>), sulfur dioxide (SO<sub>2</sub>), and lead. The study area is located within the incorporated city of Bowling Green within Warren County. Warren County is in attainment for all the above pollutants.

## D. Noise

This project is not a Type I project requiring a noise abatement study as designated in FHWA Regulation 23 CFR Part 772, as it does not require FHWA approval and is not using federal-aid highway funds.

## E. EPA Program Sites

GIS data from the US Environmental Protection Agency include a few permitted facilities/monitored sites along the corridor. These are shown in **Figure 3-1** and summarized below:

- **Airs/Afs** – These are facilities that release pollutants in the air. An example facility along the corridor is a dry cleaner.
- **Water Discharge** – These are facilities that discharge into the water system. Example facilities along the corridor include restaurants, hotels, car maintenance facilities, and other commercial businesses.
- **Hazardous Waste** – These are facilities that handle materials designated as hazardous waste, which has been deemed to pose a potential hazard to the environment or human health when not properly disposed of. Example facilities along the corridor include car maintenance facilities and restaurants where oil and grease need to be properly disposed of.

There do not appear to be any indications of hazardous materials on the surface. On past highway projects in Warren County water lines have been known to have asbestos-containing materials (ACM).

## F. Cultural & Historic Resources

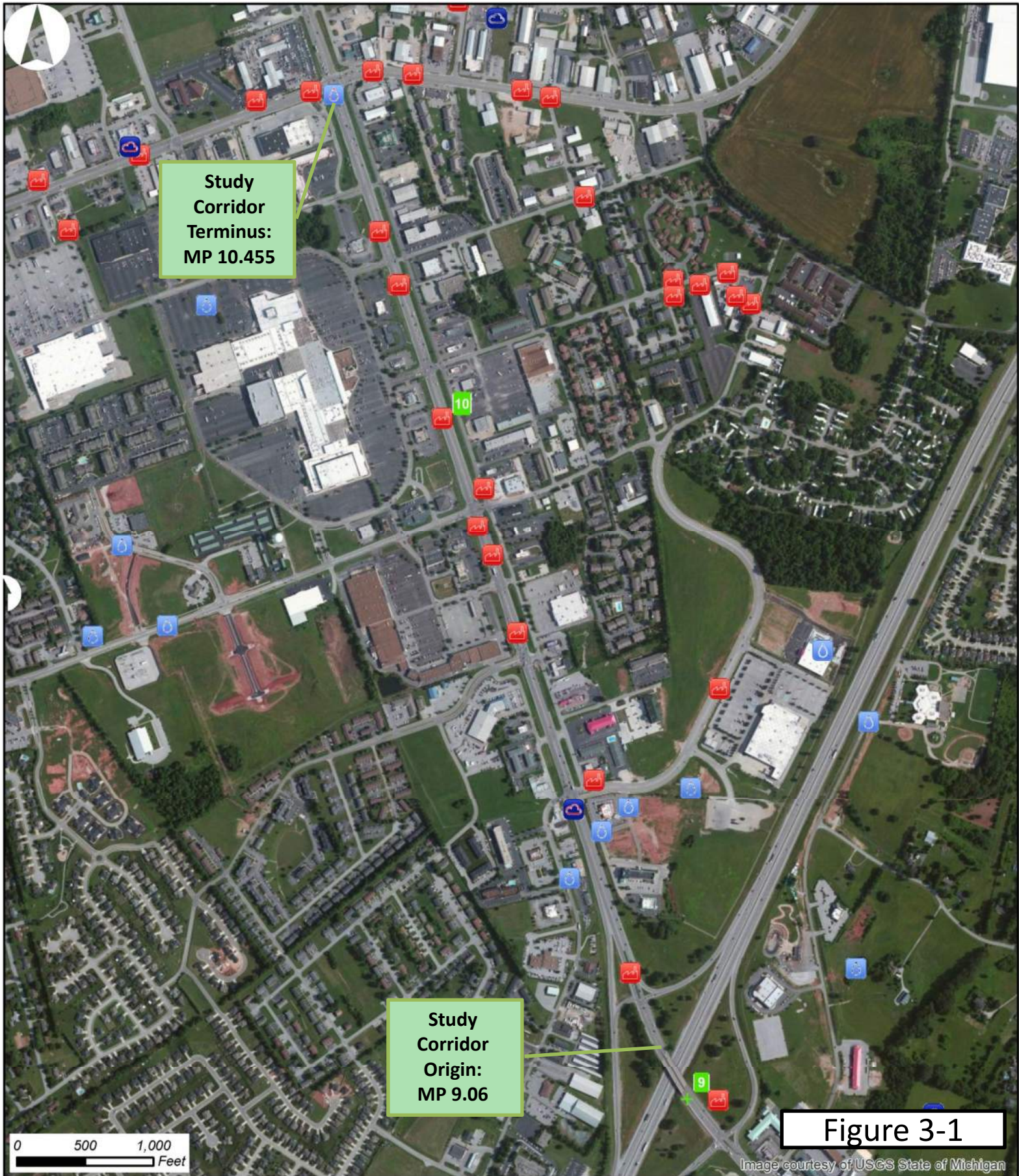
There are no publicly-owned parks or recreation areas within the proposed project study area. There are no listed or eligible historic sites on the National Register of Historic Places (NRHP) identified within the planning area. This area along US 231 was commercially developed in the 1970's, demolishing or disturbing historic and archeological resources. If a cave is discovered within the project limits during the construction phase, it must be investigated by a professional archaeologist.

## G. Geotechnical Overview

KYTC's Division of Geotechnical Engineering completed a preliminary geotechnical assessment of the study area, which is provided as **Appendix G** and summarized here. The study area is located in the Bowling Green South Geologic Quadrangle, which is the Mississippian Plateau or Pennyrile Physiographic Region. The study area is well known for its rolling terrain, red clay soils (residual material after the soluble elements of the bedrock have dissolved) and the Karst behavior of the underlying bedrock (Karst features may include sinkholes, caves and solution features in the bedrock). The available mapping shows that this area has numerous karst features (sinkholes).



Mapping also indicates bedrock in this area is relatively flat however large local variations in the bedrock surface should be anticipated due to the karst nature of the site. The limestone formations weather to moderately and highly plastic clay soils. Both the Ste. Genevieve Limestone and St. Louis Limestone present in the project area tend to leave small to large pieces of chert (large cobbles and boulders) in the weathered soil residue. Artificial fill should be anticipated due to the amount of development in the area.





**Figure 3-1**

**EPA Program Sites**

-  Airs/Afs
-  Water Discharge
-  Hazardous Waste



**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
EPA Program Sites**



From a construction perspective, site specific geotechnical investigations are critical in this region prior to design due to the karst potential of the area and the potential for problematic soils. Soils in the area are generally suitable for embankment construction. Soil cuts in the native soils have been historically problematic. Soil cuts over approximately 10 feet often require analyses to design proper sideslopes. Chemical modification of subgrade is sometimes used in the area; however, past projects have indicated chert in the soils which could make chemical modification problematic. Wet areas could require undercutting and/or rock stabilization for embankment construction. It is likely that subgrade beneath existing pavements could be very wet and might require some type of stabilization if pavements are removed.



## Section 4

### Purpose & Need Statement

The purpose and need statement establishes why KYTC is proposing to advance a transportation improvement and drives the process for the consideration, analysis, and selection of alternatives.

#### A. Purpose and Need

The purpose of the proposed project is to improve safety and mobility of US 231 (Scottsville Road) between Three Springs Road and Lovers Lane, while providing reasonable access along the corridor. The following needs have been identified:

##### Improve Safety

From November 1, 2008 through October 31, 2013, 881 total crashes were recorded by State Police along the study route. Of those, 157 crashes resulted in injuries and two resulted in fatalities.

Vehicle crashes occur more frequently along this route than on other similar type facilities. Crash analysis identified the entire study corridor as a “high crash segment” with a critical rate factor (CRF) of over 1.0, indicating crashes may occur more than can be attributed to random circumstances. “High crash segments” are any section of road with a CRF over 1.0. CRF compares the number of crashes along the road of interest to that of similar facilities in Kentucky.

The crash analysis also identified nine 0.10-mile long “high crash spots” along the corridor that exhibit a CRF greater than 1.0. The highest crash spot, near the Three Springs Road intersection, has a CRF of 3.66.

The existing congestion and signal spacing along US 231 compromise the safety and operational characteristics of the roadway. Several segments are nearing their theoretical capacity, and the close proximity of the frontage road system adds additional conflict points.

The most common types of crashes were rear end collisions (67%), which are common along high volume roadways that experience stop-and-go conditions. Additional information regarding crash types and statistics are discussed in **Section 2** and shown in **Figure 2-7** and **Figure 2-8**.

##### Improve Mobility

Based on 2013 traffic volumes, the corridor experiences congestion during the PM peak hour. As traffic volumes continue to increase in the future, operations are expected to deteriorate. For example, the segment between Bryant Way and Cave Mill Road exhibits a V/C ratio of 0.87, indicating it is approaching capacity. In this section, the V/C ratio rises to 0.99 in 2026, indicating that it has reached its theoretical capacity. By 2040, the V/C ratio for this segment is expected to increase to 1.13. Each of the other segments along the study corridor have similar capacity issues in the future.

US 231 is part of the Kentucky Primary Highway Network, providing access to I-65, downtown Bowling Green, many business and several schools – directly and indirectly. The study corridor provides direct access to Greenwood Mall, Greenwood Square Shopping Center and a number of other commercial establishments with driveways on the frontage road.

### Provide Reasonable Access

The close proximity of the frontage road presents additional safety and mobility concerns. Frontage road traffic has difficulty maneuvering between its intersections and US 231. Traffic attempting to turn left onto frontage roads can cause spillback onto US 231 if the frontage road intersection is not kept clear.

## B. Additional Goals

Beyond the project purpose, a number of secondary goals were identified. These include:

- **Minimize impacts to the human and natural environment.** Alternatives should be developed to minimize impacts to the environment, particularly considering drainage and utility impacts and impacts to numerous commercial businesses.
- **Accommodate pedestrians and transit where appropriate.** Mobility and safety for all modes of transportation are important considerations, including bicycles, pedestrians, and transit. According to the KYTC's Pedestrian and Bicycle Travel Policy (July 2002), accommodation of pedestrians and bicyclists will be considered on all new or reconstructed state-maintained roadways. The need to consider pedestrian facilities was emphasized at the April 2014 project meeting with stakeholders.
- **Ensure any improvement complements other planned projects or roadway improvements.** In the *2007 US 231/I-65 Interchange Study*, several backage roads were considered in conjunction with US 231 improvements. These types of connections continue to be explored including a connection between Pascoe Boulevard and Cave Mill Road. Ongoing coordination between KYTC and city officials should continue.



## Section 5

# Initial Alternative Development and Analysis

The following sections outline the process by which potential improvement alternatives were developed. Alternatives were developed based on the existing conditions analysis (traffic, crash, and environmental), previous studies, design guidelines, and input received from the project team and stakeholders/local officials.

### A. Potential Design Criteria and Considerations

This section addresses potential design criteria and assumptions for the proposed US 231 Corridor from I-65 to Campbell Lane/Lovers Lane, including typical section, alignment, access control, and multimodal considerations. These parameters were followed during the alternative development process, but specific geometric parameters should be further defined during future design phases of the project, as more detailed information becomes available.

Recommended minimal cross-sectional and alignment elements for a 45 mph urban arterial are presented in **Table 5-1** below.

**Table 5-1: Minimum Typical Section and Alignment Guidelines for US 231**

Element	Guideline
Lane Width	11-12 ft
Turn Lane Width	10-12 ft
Shoulder Width	2-8 ft
Sidewalk Width	4-8 ft min
Stopping Sight Distance	360 ft
Maximum Grade	6%
Maximum Superelevation	4-6%
Minimum Horizontal Radius	711 ft

#### Lane Width

The American Association of State Highway and Transportation Officials' (AASHTO) *A Policy on Geometric Design of Highways and Streets, 2011* (commonly referred to as the Green Book) recommends a 12-foot wide travel lane for urban arterials (AASHTO Green Book, Section 7.3.3). On roadways with interrupted-flow and speeds 45 mph or less, such as US 231, an 11-foot lane width is adequate. KYTC common practice, as described in the *Highway Design Manual's* Common Geometric Practices, suggests a 12-foot wide travel lane in free flow conditions and 11-foot in interrupted flow conditions (KYTC, exhibit 700-04).

KYTC common practice suggests a minimum 10-12 foot wide turn lane (KYTC, exhibit 700-04).

#### Shoulder Width

AASHTO recommends an 8-foot wide usable shoulder if sufficient right-of-way exists (AASHTO Green Book, Table 7-3) alongside the arterial. However, when a narrow section is needed to reduce construction impacts, the paved shoulder width may be a minimum of 2 feet provided that bicycle use is not intended to be accommodated on the shoulder.

In an urban setting on lower speed facilities, curbs and gutters should also be considered on a project-by-project basis. This decision should take into consideration right-of-way constraints, drainage, pedestrian activity, channelization needs, and access control, among other factors. KYTC common practice suggests vertical curbs of 6 inches or greater with a minimum offset of 1-foot. When a curb and gutter section is provided, the gutter pan width, normally 2 feet, should be used as the offset distance (KYTC, exhibit 700-04).

### **Sidewalks**

KYTC common geometric practices recommend a minimum sidewalk width of 4 feet, with 8 feet being preferred in residential and commercial areas (KYTC, exhibit 700-04).

### **Stopping Sight Distance**

Stopping sight distance for a 45 mph design speed arterial is 360 feet by AASHTO guidance (AASHTO Green Book, Table 7-1). Common practice guidelines for Kentucky concur with this criterion.

### **Maximum Grade**

According to the AASHTO design guidelines, the maximum grade for an urban arterial with a 45 mph posted speed limit over level terrain is 6% (AASHTO Green Book, Table 7-4). Common practice guidelines for Kentucky concur with this criterion.

### **Maximum Superelevation**

AASHTO recommends a maximum superelevation rate of 4% for urban conditions, due to safety considerations. But difficulties associated with drainage, ice formation, driveways, pedestrian crossings, and the effect on adjacent developed property should be evaluated when superelevation is considered for urban arterials (AASHTO Green Book, page 7-29). KYTC common geometric practices recommend a 4% to 6% maximum superelevation for urban arterials (KYTC, exhibit 700-04).

### **Minimum Horizontal Radius**

AASHTO recommends a minimum radius of 711 feet with a 4% superelevation rate (AASHTO Green Book, Table 3-8). KYTC references this guideline to determine radius requirements.

### **Minimum Intersection Corner Radius**

Each intersection corner radius should be designed individually to account for the design vehicle, number of receiving lanes, shoulder widths, pedestrian traffic, etc. AASHTO recommends a minimum design turning radius of 23.8 feet for a passenger car, 41.8 feet for a single unit truck, 41.6 feet for a city transit bus, and 44.8 feet for an interstate semi-trailer (AASHTO Green Book, Table 2-2b). Where practical, the corner radii along US 231 should be designed to accommodate an interstate semi-trailer (WB-67)

### **Minimum Taper Lengths**

For roads with a speed limit greater than or equal to 45 mph, KYTC recommends a minimum taper length for travel lanes equal to the width of roadway offset multiplied by the speed limit of the road (KYTC, HD-902 page 11). For left and right turn-lanes, a standard bay taper length for a 45 mph road is 100 feet (KYTC, HD-902 page 12).



## Access Control

US 231 is a partial access-controlled highway. Consideration should be given to further restrict the access-control for portions of the proposed improvement. The close proximity of the frontage road presents safety and mobility concerns. Restricting access to the frontage road will increase safety, pedestrian accessibility, and minimize interference with the free movement of traffic.

## Bicycle and Pedestrian Accommodations

Mobility and safety for all modes of transportation is an important consideration, including bicycles and pedestrians. According to the KYTC's Pedestrian and Bicycle Travel Policy (July 2002), accommodation of pedestrians and bicyclists will be considered on all new or reconstructed state-maintained roadways. Most arterial streets need to accommodate pedestrians; therefore the design should consider sidewalks and crosswalks. The major pedestrian-vehicular conflict usually occurs at intersections. On higher volume arterials like US 231, the interference between pedestrians and vehicles at intersections sometimes presents safety problems and can have an effect on the capacity of intersections. This can be reduced by shortening pedestrian crossing distances, restricting left or right turns, and separate pedestrian signal phases.

## B. Level 1 Alternative Development

Initially, six alternatives were considered as part of the Level 1 alternative development: No Build, and five Build Alternatives described below:

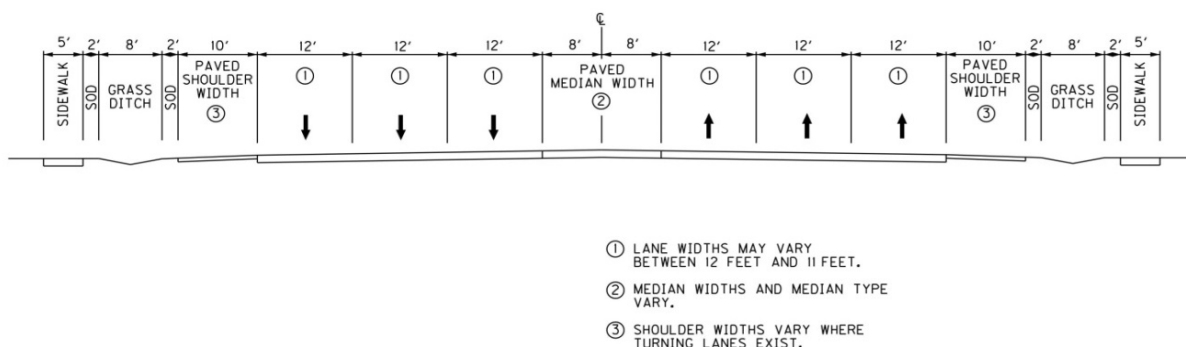
### No Build

The existing typical section for US 231 will be maintained and includes four 11-foot to 12-foot driving lanes, a 16-foot paved median with turn lane, and 10-foot paved shoulders.

### Alternative 1

Widen to six lanes and integrate select intersection spot improvements. The proposed typical section for US 231 includes six 12-foot driving lanes, a 16-foot paved median with turn lane, 10-foot paved shoulders, 12-foot ditches, and 5-foot sidewalks. The primary goal of Alternative 1 is to improve capacity and mobility along the corridor. The typical section and alternative details are illustrated in **Figure 5-1** and **Figure 5-2**. With the exception of the additional lane and the addition of sidewalks, the typical section would replicate the existing typical section present today. It should be noted that on February 3, 2014, an initial version of Alternative 1 was presented to Stakeholders and the Project Team without sidewalks. Likewise, spot improvements were added as part of the alternative later in the study process, discussed further in **Chapters 6** and **7**.

**Figure 5-1: Alternative 1 Typical Section**







**Figure 5-2**

**Alternative 1**  
**Widen Scottsville Rd to Six Lanes**

**CDM  
Smith**



**US 231 – Scottsville Rd**  
**From I-65 to Lovers Lane**  
**KYTC Item No 3-8702**

**Alternative Development – 1**



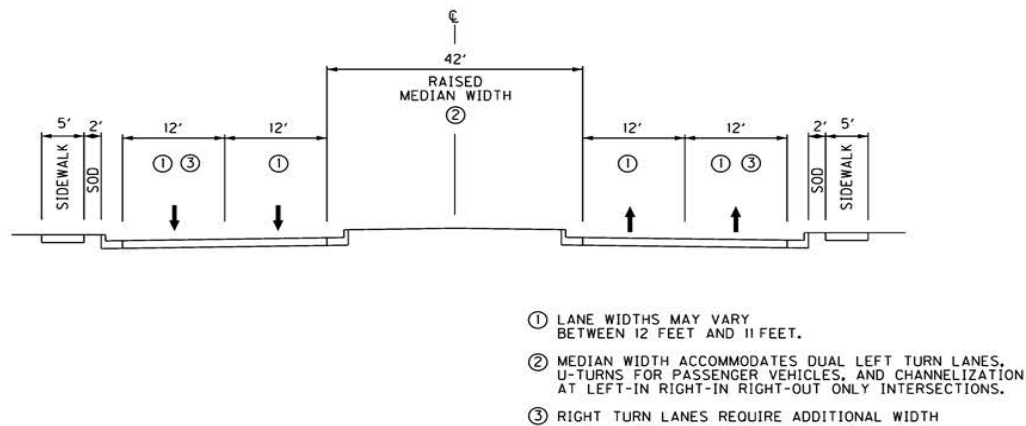
## Alternative 2

The primary goal of Alternative 2 is to improve safety by restricting side street left-turn movements at un-signalized intersections. The median would be wide enough to accommodate passenger vehicle U-turns, but not a larger commercial vehicle. Both a rural and urban typical section was considered and is described below.

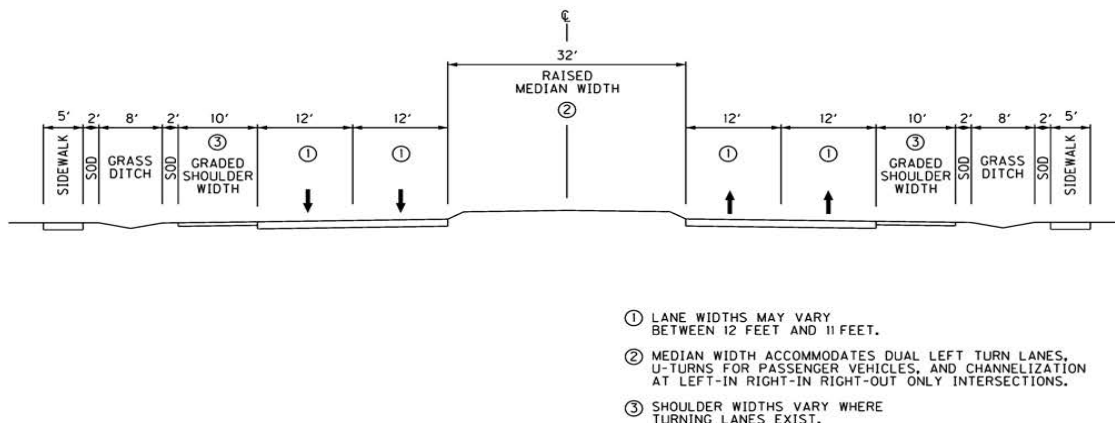
- Alternative 2A:** Maintain four lanes and convert select intersections to right-in/right-out with an additional left-in from US 231. The proposed urban typical section includes four 12-foot driving lanes, a 42-foot raised median, curb and gutter, and 5-foot sidewalks. The 42-foot median width accommodates dual left turn lanes, U-turns for passenger vehicles (AASHTO Green Book, Table 9-30), and channelization at right-in/right-out/left-in intersections. The typical section is illustrated in **Figure 5-3**.
- Alternative 2B:** Maintain four lanes and convert select intersections to right-in/right-out/left-in. The proposed rural typical section includes four 12-foot driving lanes, a 32-foot raised median, 10-foot paved shoulders, 12-foot ditches, and 5-foot sidewalks. The 32-foot median width accommodates dual left turn lanes, U-turns for passenger vehicles, and channelization at right-in/right-out/left-in intersections. Paved shoulder widths are reduced to 4 feet where there are right turn lanes. The typical section is illustrated in **Figure 5-4**.

The alternative is illustrated in **Figure 5-5**.

**Figure 5-3: Alternative 2A Typical Section**



**Figure 5-4: Alternative 2B Typical Section**







**Figure 5-5**

**Alternative 2  
Urban Four Lane Typical Section with  
42 ft Raised Median and Sidewalks**

**CDM  
Smith**



**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702**

**Alternative Development – 2**



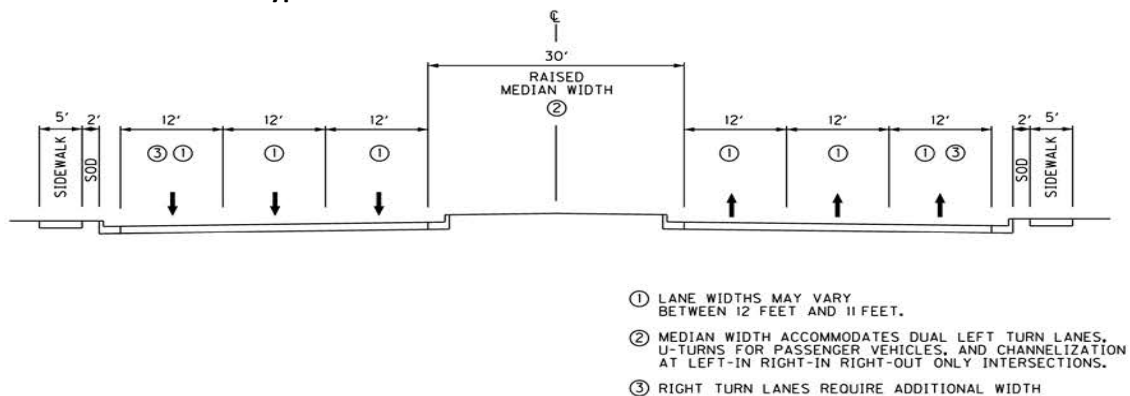
### Alternative 3

Similar to Alternative 2, the primary goal of Alternative 3 is to enhance safety; however, just as important for Alternative 3 is to improve mobility along the corridor with additional capacity. Alternative 3 includes both left turn restrictions and an additional lane in both directions. The median would accommodate a passenger vehicle U-turn, but would not be wide enough to accommodate U-turns for most commercial vehicles. Both an urban and rural typical section was considered and is described below.

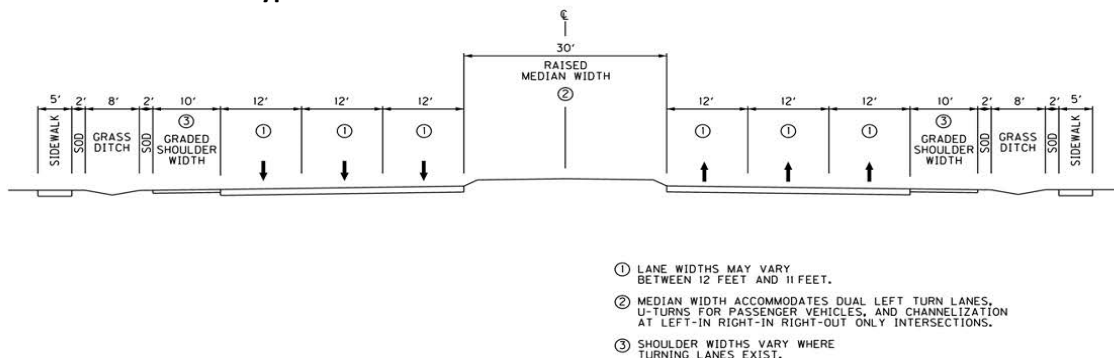
- **Alternative 3A:** Widen to six lanes and install a median; convert select intersections to right-in/right-out/left-in. The proposed urban typical section includes six 12-foot driving lanes, a 30-foot raised median, curb and gutter, and 5-foot sidewalks. The 30-foot median width accommodates dual left turn lanes, U-turns for passenger vehicles, and channelization at right-in/right-out/left-in intersections. The typical section is illustrated in **Figure 5-6**.
- **Alternative 3B:** Widen to six lanes and install a median; convert select intersections to right-in/right-out/left-in. The proposed rural typical section includes six 12-foot driving lanes, a 30-foot raised median, 10-foot paved shoulders, 12-foot ditches, and 5-foot sidewalks. The 30-foot median width accommodates dual left turn lanes, U-turns for passenger vehicles, and channelization at right-in/right-out/left-in intersections. Paved shoulder widths are reduced to 4 feet where there are right turn lanes. The typical section is illustrated in **Figure 5-7**.

The alternative is illustrated in **Figure 5-8**. In addition to the conceptual design shown for the Pedigo Way intersection, a “bulb-out,” or additional pavement to aid commercial vehicle U-turns, is shown at Campbell Lane.

**Figure 5-6: Alternative 3A Typical Section**



**Figure 5-7: Alternative 3B Typical Section**





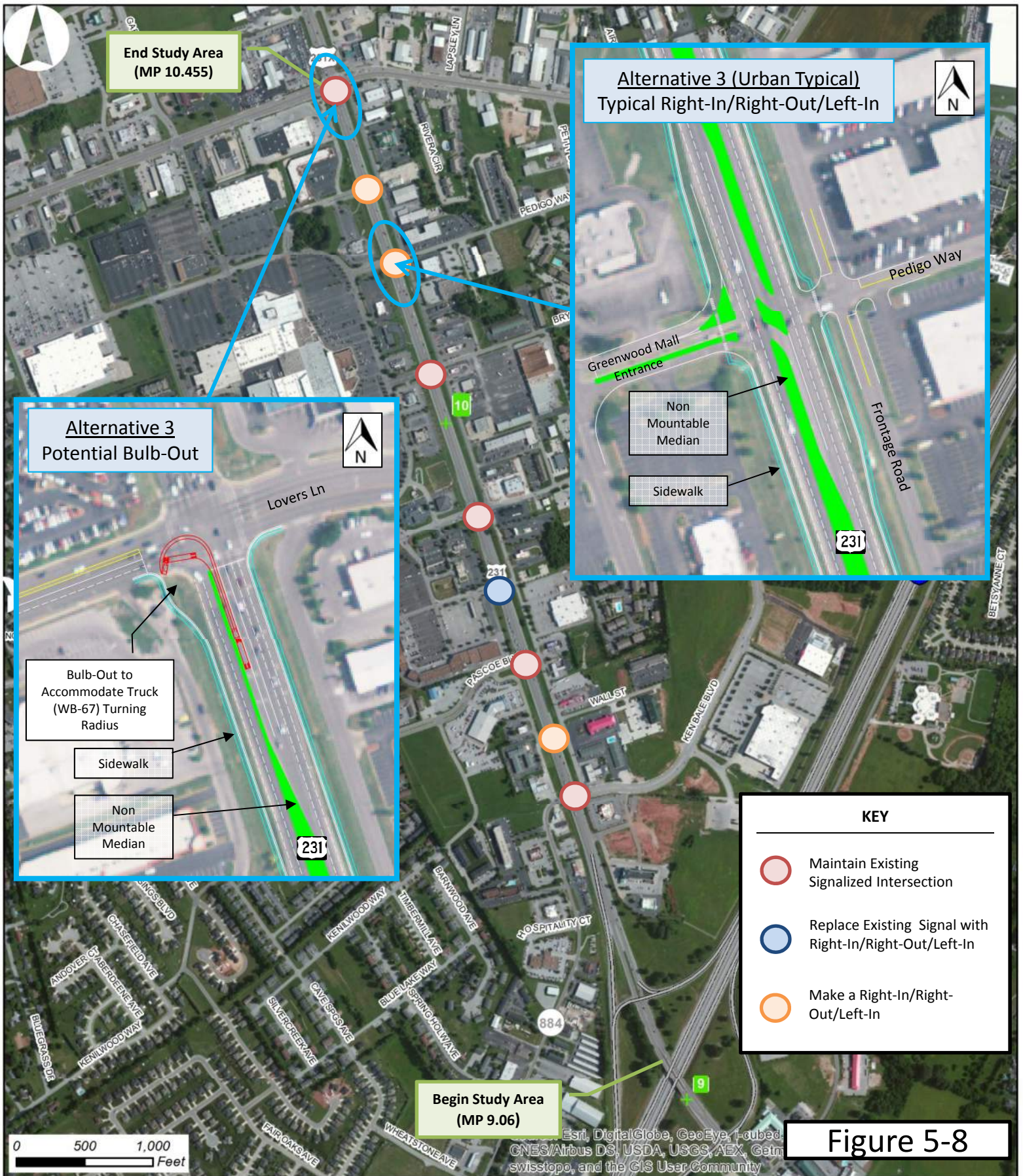


Figure 5-8

**Alternative 3  
Urban Six Lane Typical Section with  
30 ft Raised Median and Sidewalks**

**CDM  
Smith**



**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702**

**Alternative Development – 3**



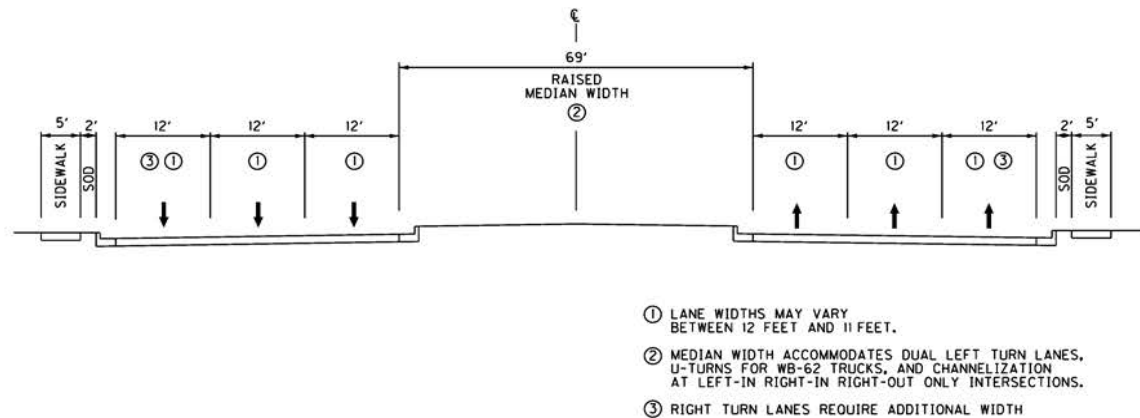
## Alternative 4

Alternative 4 is designed to accommodate both passenger and commercial vehicle U-turns. Alternative 4 includes both left turn restrictions and an additional lane in both directions. This alternative has the widest typical section and; therefore, would have the greatest potential to impact the frontage road system and a number of commercial properties. Both an urban and rural typical section was considered and is described below.

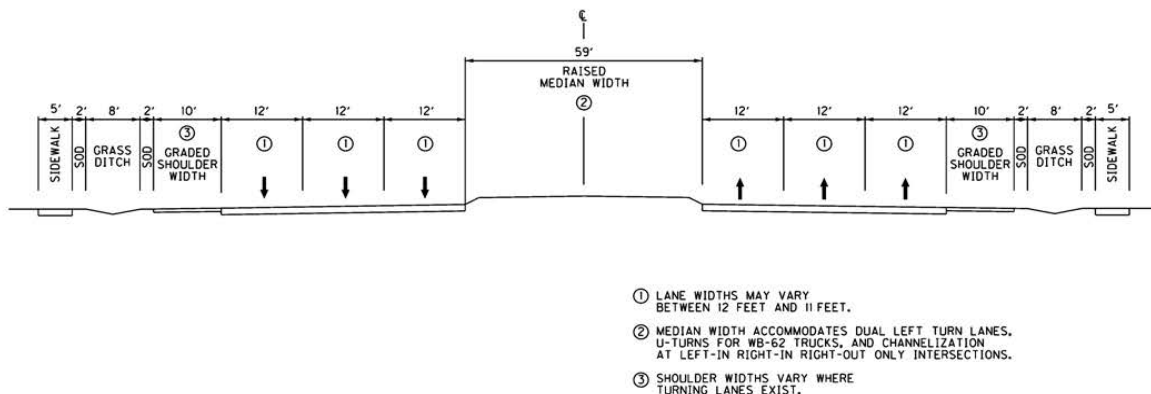
- Alternative 4A:** Widen to six lanes and install a wide median which allows for U-turns for all vehicles. The proposed urban typical section includes six 12-foot driving lanes, a 69-foot raised median, curb and gutter, and 5-foot sidewalks. The 69-foot median width accommodates dual left turn lanes, U-turns for WB-62 trucks, and channelization at right-in/right-out/left-in intersections. The typical section is illustrated in **Figure 5-9**.
- Alternative 4B:** Widen to six lanes and install a wide median which allows for U-turns for all vehicles. The proposed rural typical section includes six 12-foot driving lanes, a 59-foot raised median, 10-foot paved shoulders, 12-foot ditches, and 5-foot sidewalks. The 59-foot median width accommodates dual left turn lanes, U-turns for WB-62 trucks, and channelization at right-in/right-out/left-in intersections. Paved shoulder widths are reduced to 4 feet where there are right turn lanes. The typical section is illustrated in **Figure 5-10**.

The alternative is illustrated in **Figure 5-11**.

**Figure 5-9: Alternative 4A Typical Section**



**Figure 5-10: Alternative 4B Typical Section**







**Figure 5-11**

**Alternative 4**  
**Urban Six Lane Typical Section with**  
**69 ft Raised Median and Sidewalks**

**CDM**  
**Smith**



**US 231 – Scottsville Rd**  
**From I-65 to Lovers Lane**  
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**Alternative Development – 4**



## Alternative 5

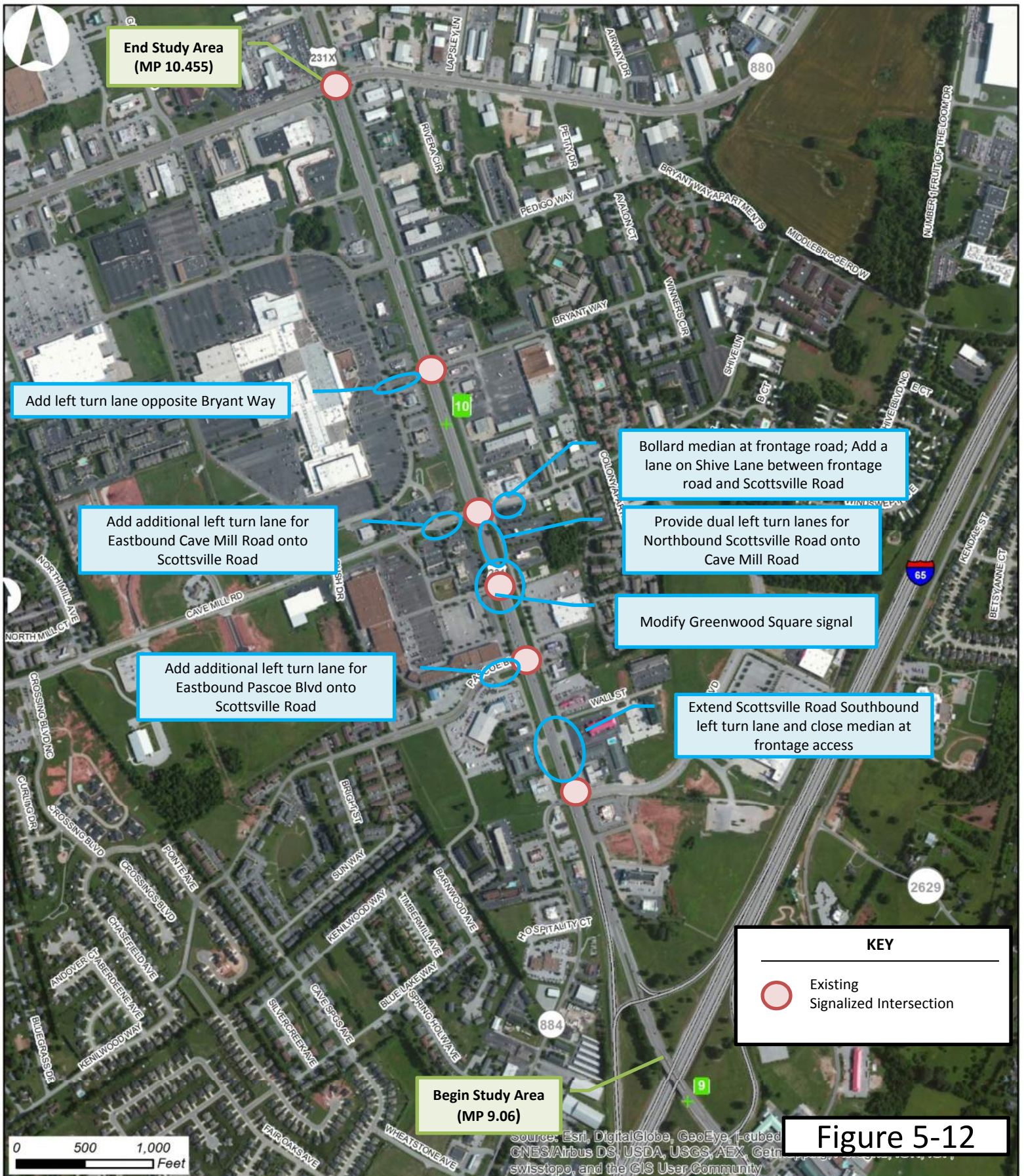
The goal of Alternative 5 is to maintain four lanes and implement intersection spot improvements to enhance localized safety and capacity, in comparison to a full length improvement. Where feasible, the median on US 231 will be widened to 30 feet to accommodate dual left turn lanes, U-turns for passenger vehicles, and channelization at right-in/right-out/left-in intersections. The spot improvement alternatives generally include relatively lower cost improvements that could be implemented individually as short-term solutions to address existing safety and congestion issues. It should be noted that Alternative 5 continued to evolve throughout the study; the initial improvements presented to the Project Team and Stakeholders on February 3, 2014 were refined based on this input to include four spot improvement projects, as discussed below and shown in **Figure 5-12**. Detailed views of each are presented in **Chapter 7**.

- Spot Improvement 1 - Add left turn lane at Greenwood Mall exit (opposite Bryant Way) onto northbound US 231.
- Spot Improvement 2 - Widen the median to 30 feet between Cave Mill Road and Pascoe Boulevard. Provide dual lefts from northbound US 231 to westbound Cave Mill Road. Provide dual lefts from eastbound Cave Mill Road to northbound US 231. Replace signal at Greenwood Square Shopping Center to allow for a signalized left turn from Northbound US 231 into the Greenwood Square Shopping Center.
- Spot Improvement 3 - Add an additional left turn lane for eastbound Pascoe Boulevard onto northbound US 231.
- Spot Improvement 4 - Extend US 231 southbound left turn lane at Ken Bale Boulevard; close median at access to Red Roof Inn/Motel Six.

## Additional Alternatives Considered

Other potential alternatives were discussed including removal or reconfiguration of the frontage roads. However, it was determined that the frontage road provides very important access – its removal would not satisfy the project purpose and need of providing safe, reasonable access to existing tenants. Each business would require its own driveway connection with US 231, adding numerous potential conflict points. In this scenario, the right-hand lane would become, in essence, a continuous acceleration and deceleration lane – which decreases mobility along the corridor, even with widening. A one-way operation was also considered, but it was agreed this option would make it more difficult to access businesses, particularly for heavy commercial vehicles. These alternatives were not developed further.





## Alternative 5 Intersection Spot Improvements

CDM  
Smith



US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Alternative Development – 5



## C. Level 1 Traffic Analysis

The spot improvements and five build alternatives were evaluated and presented to the project team and local officials for their input with the goal of narrowing the alternatives down to two for more detailed analysis. The initial traffic evaluation process consisted of two steps. First, micro-simulation was used to determine if Alternative 5 would result in a discernible improvement in the existing year (2013). Then, a V/C analysis was conducted to establish if each alternative would be viable in 2040. Signals were re-coordinated for each alternative using Synchro.

### 2013 Spot Improvements (Alternative 5)

Alternative 5 is comprised of intersection spot improvements as a short-term and potential long-term fix to aid safety and mobility. When all spot improvements are implemented, all intersections show acceptable levels of service (LOS), as shown in **Table 5-2**. Travel times, shown in **Table 5-3**, show an improvement of 24 seconds in the southbound, peak direction compared to existing conditions shown in **Table 2-4**.

**Table 5-2: 2013 Alternative 5, PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	34.8	C	Northbound US 231	38.2	D
			Southbound US 231	26.0	C
			Eastbound Three Springs Rd	41.5	D
			Westbound Ken Bale Blvd	46.5	D
Pascoe Blvd	14.0	B	Northbound US 231	5.5	A
			Southbound US 231	13.3	B
			Eastbound Pascoe Blvd	46.4	D
			Westbound Pascoe Blvd	53.8	D
Cave Mill Rd/Shive Ln	29.2	C	Northbound US 231	23.7	C
			Southbound US 231	15.9	B
			Eastbound Cave Mill Rd	43.7	D
			Westbound Shive Ln	52.5	D
Bryant Way	13.3	B	Northbound US 231	2.6	A
			Southbound US 231	10.0	B
			Eastbound Mall Access	45.2	D
			Westbound Bryant Way	38.9	D
Campbell Ln/Lovers Ln	44.7	D	Northbound US 231	50.2	D
			Southbound US 231	38.2	D
			Eastbound Campbell Ln	43.4	D
			Westbound Lovers Ln	49.7	D

**Table 5-3 2013 Alternative 5, PM Peak Hour Travel Times**

Direction	Travel Time	Average Speed
US 231 Southbound	3 min 0 sec	20.9 mph
US 231 Northbound	3 min 8 sec	20.0 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.

### Design Year (2040) Analysis

None of the proposed build alternatives are anticipated to increase traffic volumes along the corridor. Therefore, the future no build volumes described in **Section 2.C** apply to the future build scenarios as well. Diversion due to restricted turning movements in the alternatives applies only to turning movement counts, not to the traffic volumes along the corridor. The five alternatives were examined with 2040 volumes to determine if there was sufficient capacity for each. As shown in **Table 5-4**, Alternatives 2 and 5 will not have adequate capacity in select segments in 2040.

**Table 5-4: 2040 Alternative Comparison (V/C for Segment between Bryant Way and Cave Mill Road)**

Alternative	# of Lanes	Forecast AADT	Peak Hour Volume (Peak Direction)	V/C
Alternative 1	6	41,400	1,975	0.76
Alternative 2	4	41,400	1,975	1.13
Alternative 3	6	41,400	1,975	0.76
Alternative 4	6	41,400	1,975	0.76
Alternative 5	4	41,400	1,975	1.13



## Section 6

### Initial Project Team, Stakeholder, Local Officials, and Agency Coordination

Over the course of the study, the project team (consisting of KYTC District 3, KYTC Central Office, CDM Smith, and AEI) held three in-person meetings at the KYTC District 3 Office or BRADD Office to coordinate on key issues; meeting summaries are presented in **Appendix H**. In addition, the project team reached out to stakeholders/local officials, the public, and resources agencies. These efforts are described in the following sections and detailed summaries of each are presented in **Appendix I**.

The project team reached out to a number of local government representatives and other community groups early in the planning process. The following organizations were invited to participate as key stakeholders in the US 231 Scoping and Traffic Operations Study:

- County Judge Executive
- Bowling Green Mayor
- Kentucky Legislature
- Chamber of Commerce
- Barren River Area Development District
- Bowling Green MPO
- GO bg Transit
- Western Kentucky University
- Warren County Public Schools
- Local Government: Departments of Public Works, Police, Sheriff, & Emergency Management.

#### A. Project Team Meeting #1

The project team met for the first time on December 3, 2013. The purpose of the meeting was to discuss the project purpose and history, the scope of work, the preliminary data collected, and relevant project issues. The project team recommended the development of the five alternatives described in **Section 5.B**. Additionally, it was felt that pedestrian improvements such as sidewalks, crosswalks, and refuge islands should be considered; however, bicycle lanes were not recommended for this corridor.

#### B. Local Officials Meeting #1

The project team first met with key local officials on February 3, 2014. In addition to the project team, the local Kentucky State Senator and Representative attended along with representatives from the city of Bowling Green and Warren County. During the meeting, the project team shared existing conditions

information collected to date and solicited feedback on the five initial alternatives. Attendees were in favor of widening the corridor, citing concerns of existing congestion. Among other comments, attendees identified a number of spot improvements for consideration, including: the removal of the signal at the Greenwood Square Shopping Center (for progression issues), dual lefts at Cave Mill Road, and improvements at Pascoe Boulevard, which could help operations immediately and complement future widening.

### C. Project Team Meeting #2

The project team met for the second time on February 3, 2013. The purpose of the meeting was to discuss the proposed alternatives, solicit feedback from the project team, and discuss the feedback received following the first Local Officials Meeting. Due to Alternative 2 not having adequate capacity in 2040, it was recommended to not move forward to the Level 2 analysis. Additionally, the impacts of the wide median in Alternative 4 (both urban and rural typical) were deemed excessive by the project team, and also removed from consideration. The Project Team recommended that Alternatives 1 and 3 move forward for further study. It was further recommended that both the urban and rural typical section continue to be considered. Additionally, it was recommended that the spot improvements identified in Alternative 5 be incorporated into Alternatives 1 and 3 and also be considered as standalone short-term improvements.

### D. Agency Coordination

In addition to the coordination with stakeholders and local officials, the project team solicited feedback from interested public agencies. The project team sent letters to 74 federal, state, and local resource agencies/organizations and six elected officials on June 2, 2014. The letter, included as part of **Appendix F**, requested agency comments on the draft statement of purpose and need, the study limits, existing traffic information, environmental overview, and proposed improvement alternatives.

Twenty-four (24) written responses were received, which have been included in **Appendix F**. Specific comments have been incorporated throughout this report. Four agencies offered specific alternative preferences:

- Bowling Green/Warren County Emergency Management preferred Alternative 1. They do not want a situation where a median is installed (Alternative 3) and must be removed to install additional through lanes or turn lanes.
- Warren County Public Works preferred Alternative 1, and to reduce the median to 14 or 12 feet and curb and gutter be installed in lieu of paved shoulders so utility impacts can be reduced.
- Bowling Green Public Works preferred Alternative 3. Two additional suggestions included: 1) a new access road may be needed to connect Pascoe Boulevard and Cave Mill Road and 2) an additional right turn lane opposite Pascoe Boulevard to allow the dominant right turn movement to have their own lane.
- Western Kentucky Parking Services preferred Alternative 3 for its potential pedestrian benefits (safety island). Two additional suggestions could be incorporated into both alternatives: 1) the right turn lane on Cave Mill Road should be extended, and 2) access improvements at the third mall entrance should be considered.



## Section 7

# Level 2 Alternative Analysis

As a result of the input received from the project team, local officials, and stakeholders, Alternatives 1 and 3 were developed further as part of the Level 2 alternative development process.

### A. Alternative Conceptual Design

Three alternatives were considered as part of the Level 2 alternative development: No Build and two build alternatives: Alternatives 1 and 3. In addition, four spot improvements were considered as a short-term alternative, which could be implemented as standalone projects or collectively. Designs for Alternatives 1 and 3 incorporate each of the four spot improvement locations described on page 5-11, with minor modifications to account for specific median treatments. Alternatives 1 and 3 were presented in **Figure 5-2** and **Figure 5-8**, respectively. A more detailed conceptual design was developed for each and presented in **Figure 7-1** through **Figure 7-6**. For each alternative, the rural typical section is presented. In addition, more detailed conceptual designs for each spot improvement are presented in **Figure 7-7** through **Figure 7-9**.

Similar to the existing conditions, Alternative 1 would maintain three existing un-signalized intersections and additionally remove the signal at Greenwood Square Shopping Center. This would require left turning vehicles to turn across three lanes of traffic and presents some safety concerns. Furthermore, providing a left-turn lane opposite Greenwood Square Shopping Center reduces the length, and therefore capacity of the northbound left-turn lane at Cave Mill Road.

For Alternative 3, the four un-signalized intersections are converted to either right-in, right-out intersections or right-in, right-out, left-in intersections depending on location. This helps to reduce some of the safety concerns presented in Alternative 1, but requires additional right-of-way due to the wider median. The left-in turn movements could be signalized or un-signalized depending on both traffic and safety considerations. The northbound dual left turn lane at Cave Mill Road could be extended increasing capacity when compared to Alternative 1.

For Alternative 3, the detailed conceptual design presented in **Figure 7-4** through **Figure 7-6** illustrates the rural typical section (3B) because this represents the worst case scenario in terms of right-of-way impacts. For either the rural or urban typical section, U-turn movements for a passenger car could be accommodated, but with alternative connections available, it is expected that a minority of motorists will choose to make U-turns. For example, motorists leaving the Greenwood Square Shopping Center have access to signals at Cave Mill Road and Pascoe Boulevard. The northern intersections at Pedigo Way and Greenwood Mall have access to signals at Lovers Lane and Bryant Way.

When considering the turn restrictions presented in Alternative 3, commercial heavy vehicle movements were considered. Similar to passenger car movements, the project team felt all commercial vehicles could be accommodated with minor route changes. As future phases continue, coordination with local businesses should be conducted to ensure each alternative doesn't adversely impact their operations beyond an acceptable amount.





MATCHLINE - SEE SHEET NO. 2

KROGER ENTRANCE

SCOTTSDALE RD

PASCOTE BLVD

KEN BAILE BLVD

THREE SPRINGS RD

MATCHLINE - CONNECT TO EXISTING

Figure 7-1

US 231 - SCOTTSDALE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 1 - SHEET NO. 1





Figure 7-2

US 231 - SCOTTSVILLE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 1 - SHEET NO. 2

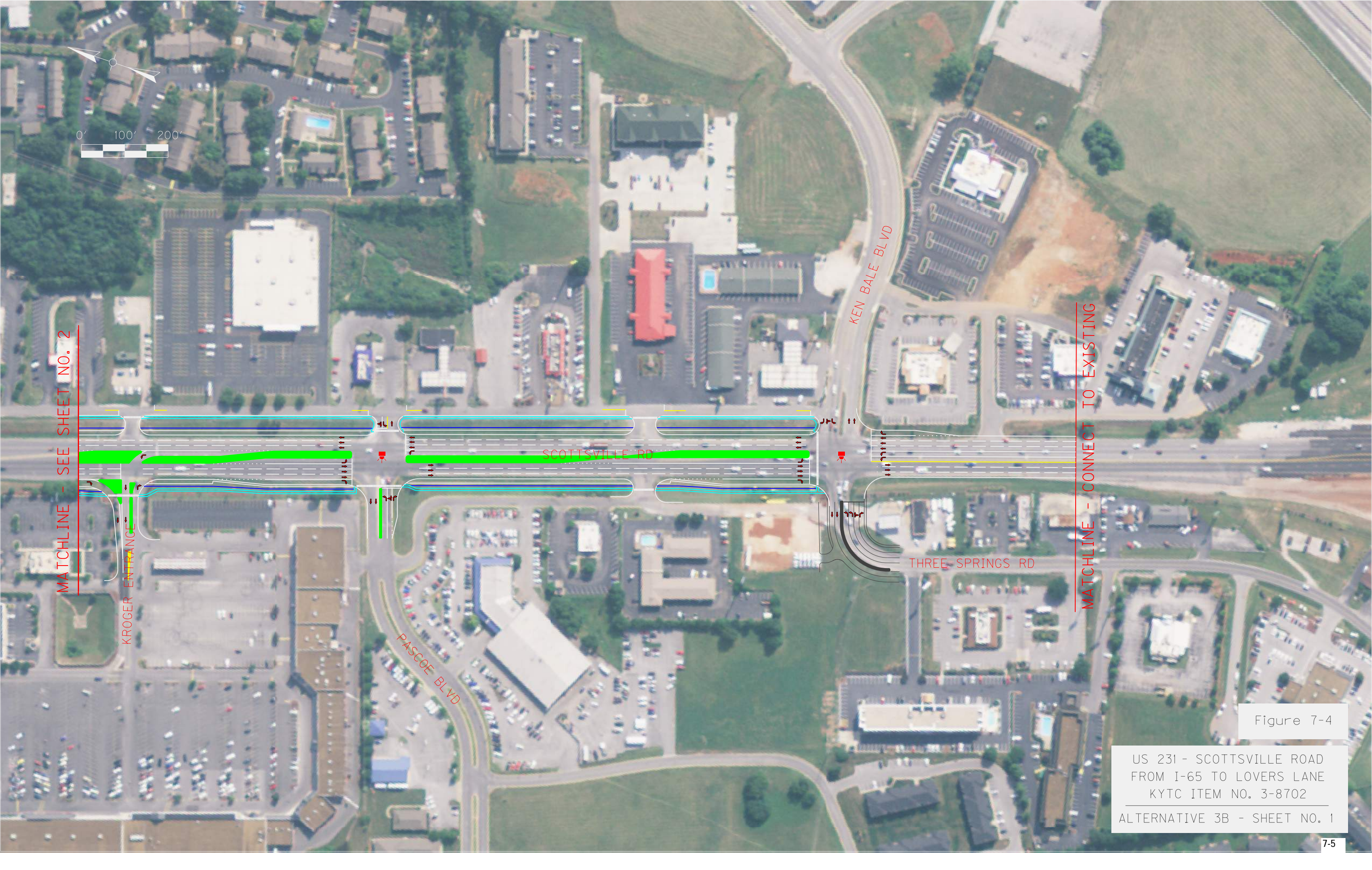




Figure 7-3

US 231 - SCOTTSVILLE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 1 - SHEET NO. 3





MATCHLINE - SEE SHEET NO. 2

KROGER ENTRANCE

PASCOTE BLVD

SCOTTSDALE RD

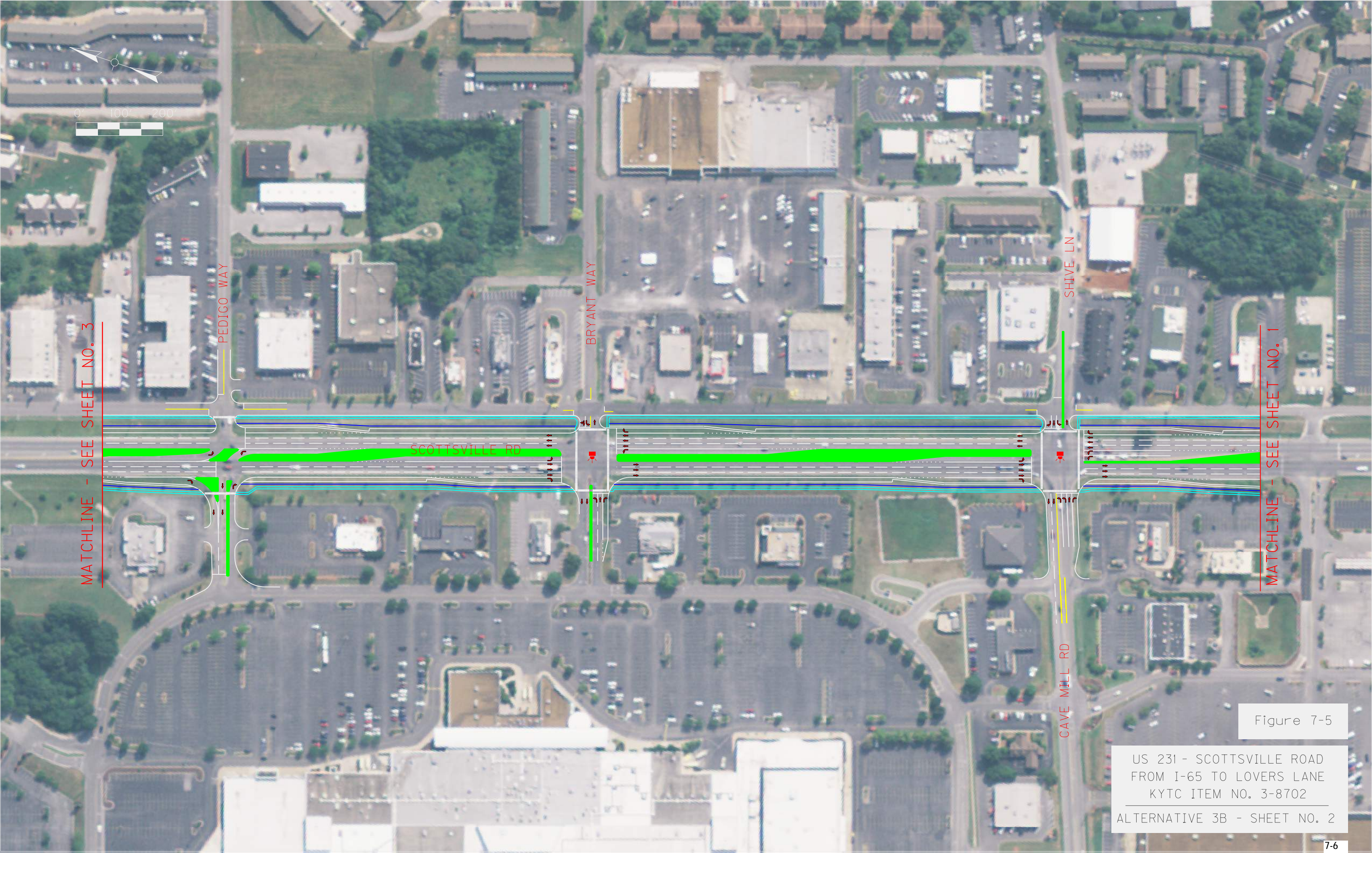
KEN BAILE BLVD

THREE SPRINGS RD

MATCHLINE - CONNECT TO EXISTING

Figure 7-4  
US 231 - SCOTTSDALE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 1





MATCHLINE - SEE SHEET NO. 3

PEDIGO WAY

BRYANT WAY

SHIVE LN

CAVE MILL RD

SCOTTSVILLE RD

MATCHLINE - SEE SHEET NO. 1

Figure 7-5

US 231 - SCOTTSVILLE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 2



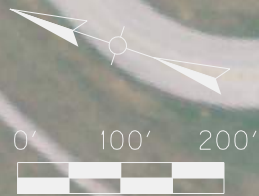


Figure 7-6

US 231 - SCOTTSVILLE ROAD  
FROM I-65 TO LOVERS LANE  
KYTC ITEM NO. 3-8702  
ALTERNATIVE 3B - SHEET NO. 3



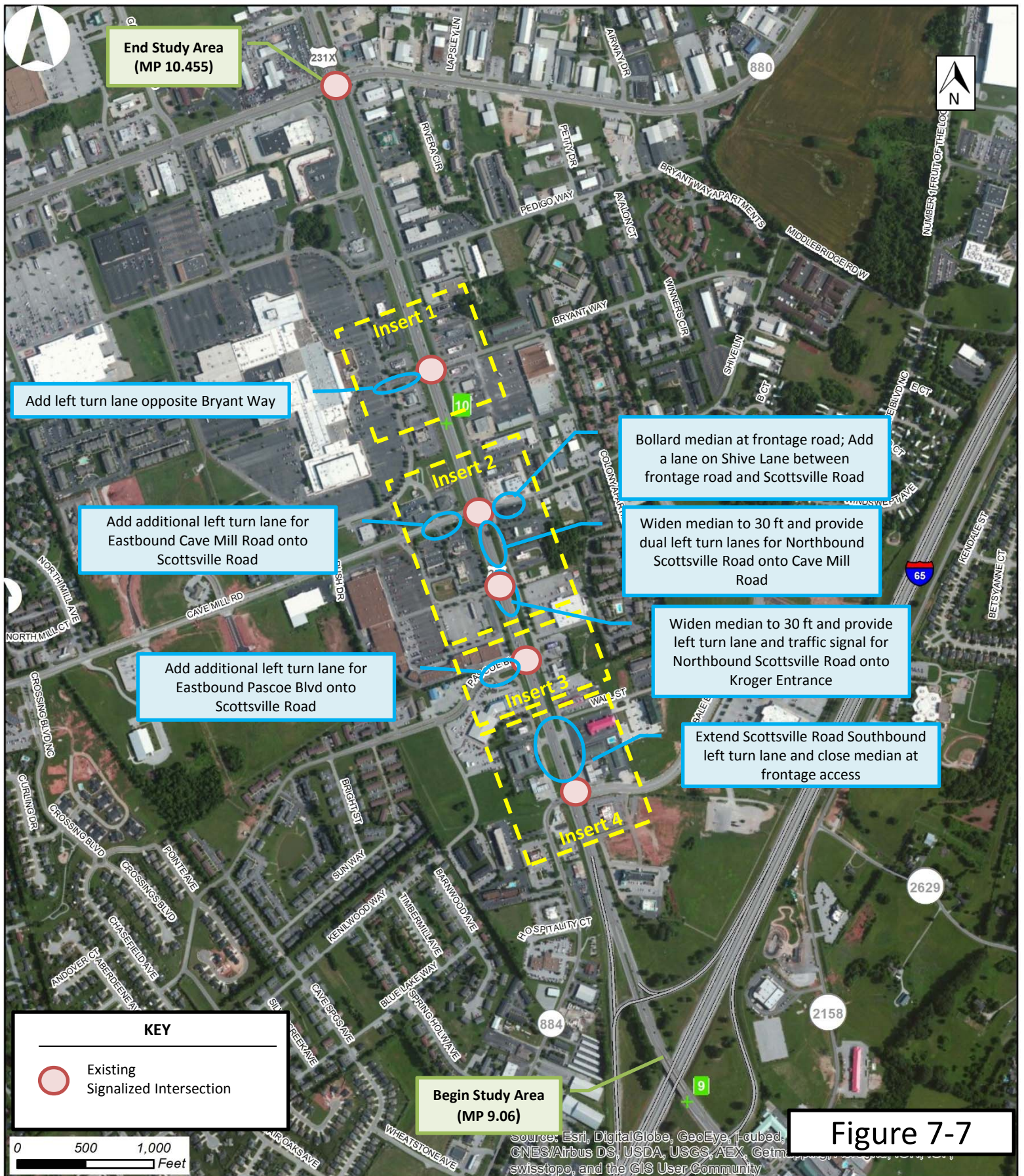
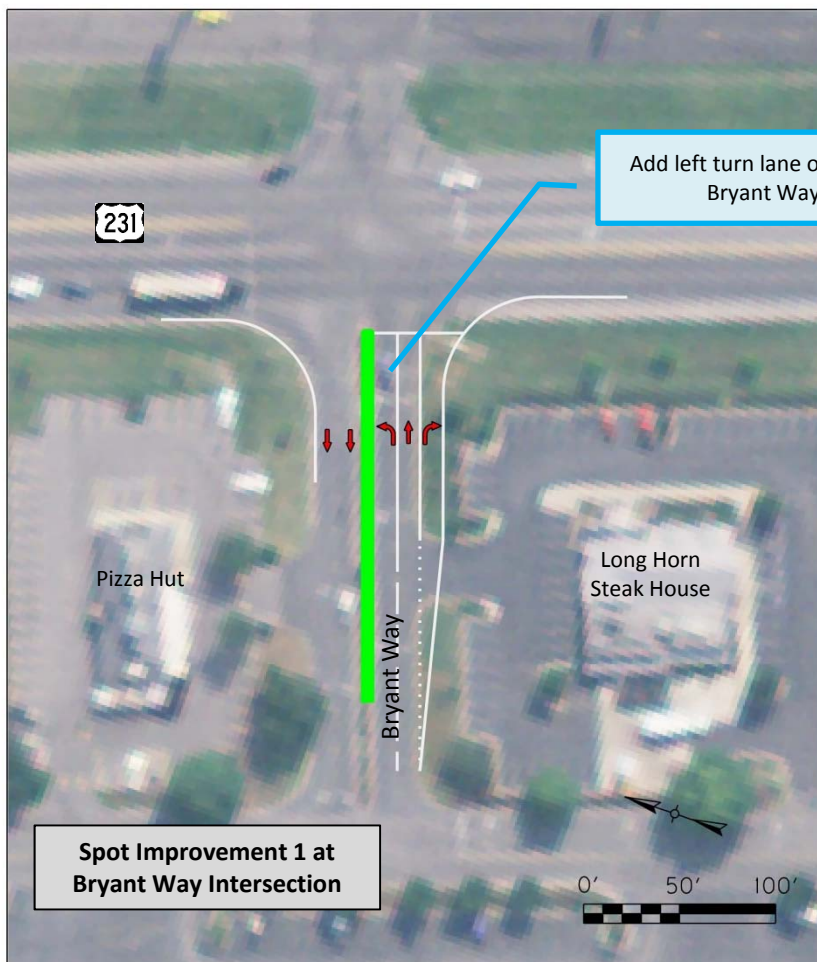
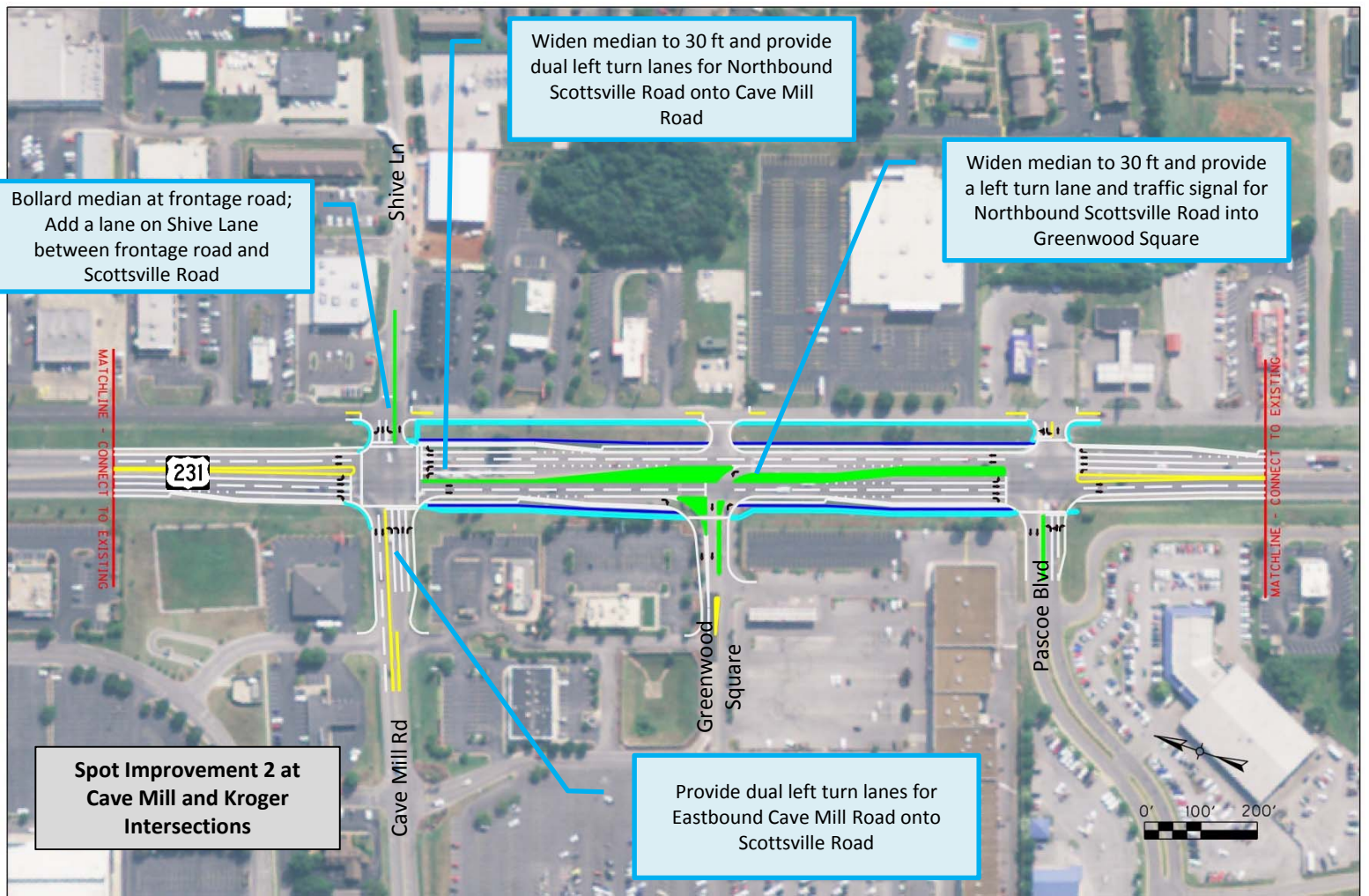


Figure 7-7

US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Intersection Spot Improvements

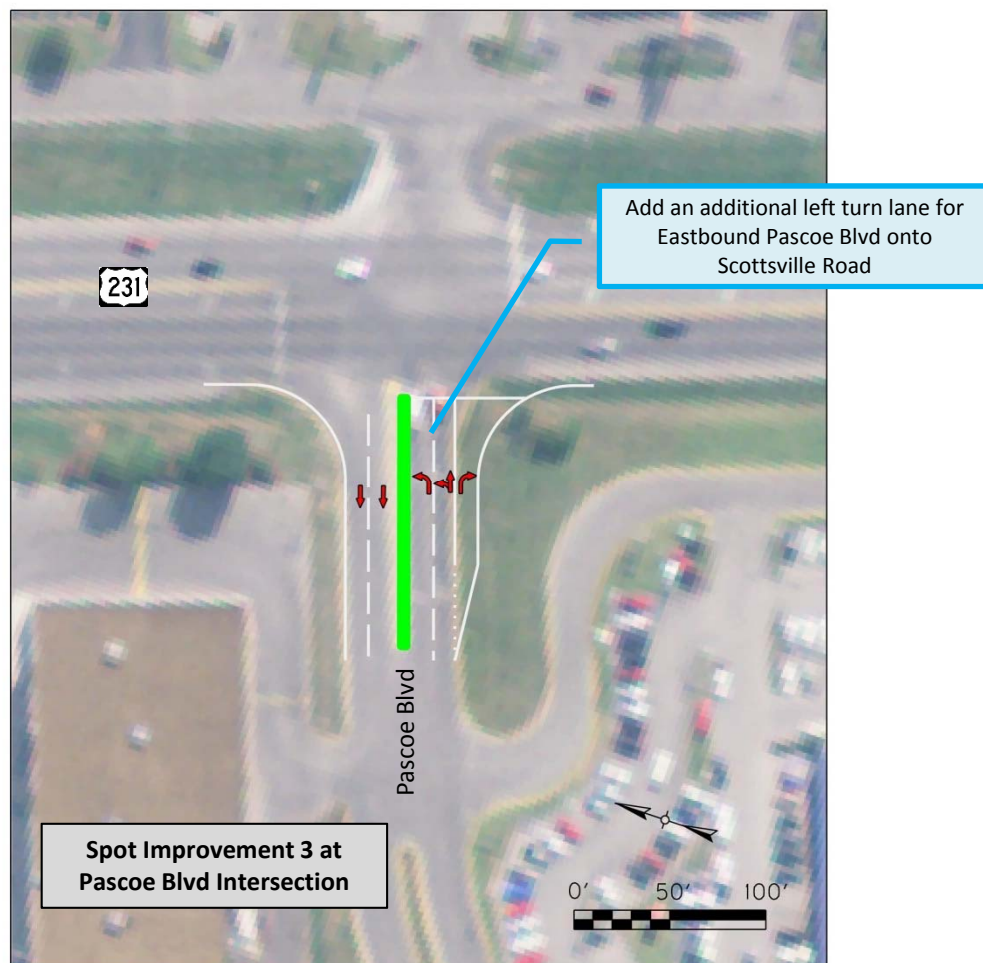
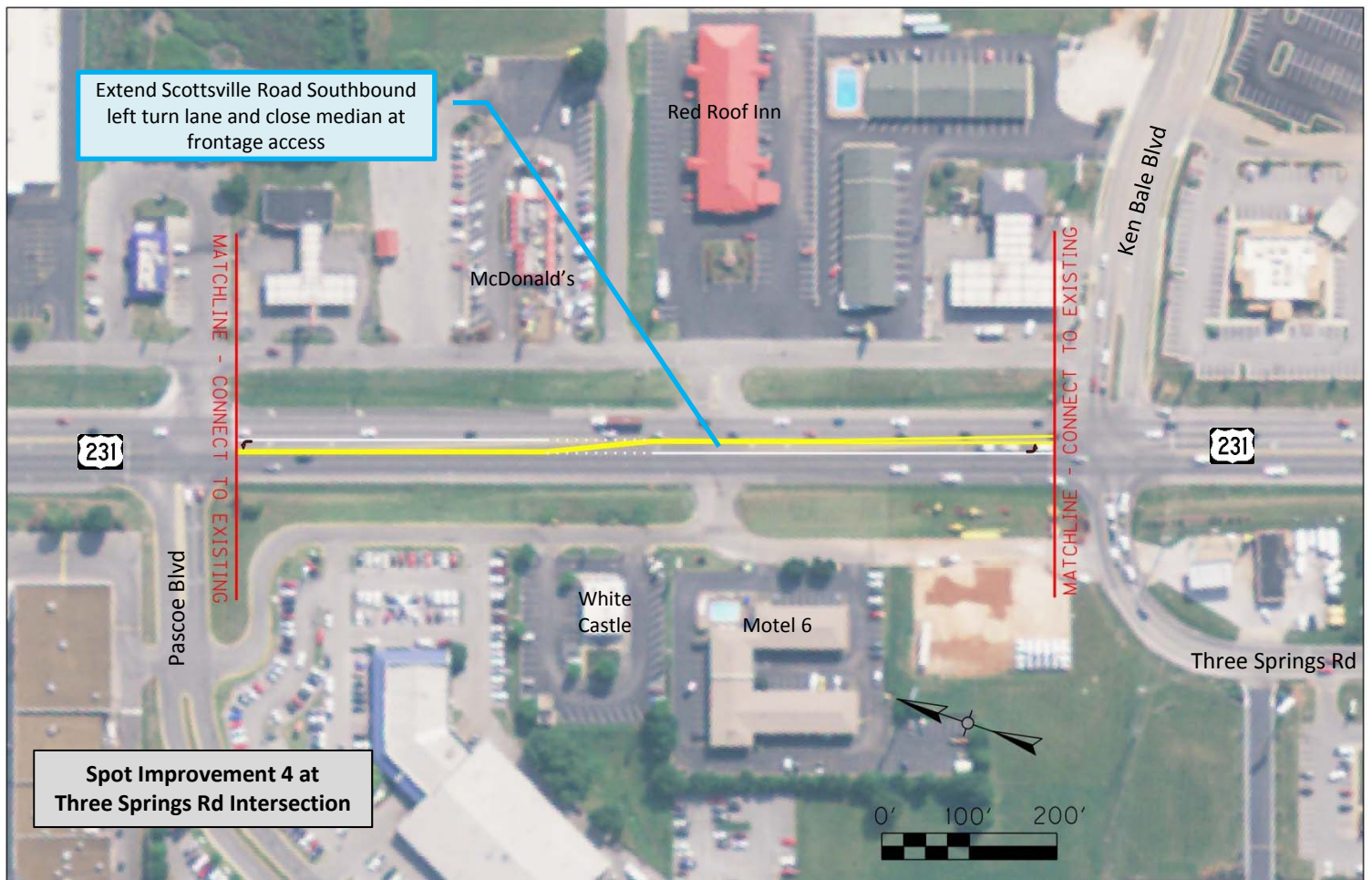




**Figure 7-8**

**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Spot Improvements 1 and 2**





**Figure 7-9**

**US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
Spot Improvements 3 and 4**



## B. Level 2 Traffic Analysis

Alternatives 1, 3, and 5 were modeled using the micro-simulation software package VISSIM. This allowed for direct comparison of the alternatives. Alternatives 1 and 3 were very similar in terms of traffic operations; the difference between them is mostly safety-related.

Although Alternative 5 does not meet capacity requirements, it was still modeled to see if the spot improvements had a discernible impact. Due to the saturated capacity of the corridor in this scenario, no benefit is realized, as can be seen in **Table 7-1** and **Table 7-2**. While spot improvements provide immediate benefits, this analysis shows they need to be combined with an alternative that provides additional capacity along the corridor in order to meet the long-term needs.

**Table 7-1: 2040 Alternative 5, PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	97.1	<b>F</b>	Northbound US 231	86.0	<b>F</b>
			Southbound US 231	106.2	<b>F</b>
			Eastbound Three Springs Rd	62.7	<b>E</b>
			Westbound Ken Bale Blvd	133.0	<b>F</b>
Pascoe Blvd	23.8	C	Northbound US 231	16.1	B
			Southbound US 231	12.5	B
			Eastbound Pascoe Blvd	78.0	<b>E</b>
			Westbound Pascoe Blvd	162.7	<b>F</b>
Cave Mill Rd/Shive Ln	60.6	<b>E</b>	Northbound US 231	35.2	D
			Southbound US 231	53.4	D
			Eastbound Cave Mill Rd	98.3	<b>F</b>
			Westbound Shive Ln	105.8	<b>F</b>
Bryant Way	28.1	C	Northbound US 231	19.4	B
			Southbound US 231	22.3	C
			Eastbound Mall Access	67.3	<b>E</b>
			Westbound Bryant Way	71.9	<b>E</b>
Campbell Ln/Lovers Ln	72.1	<b>E</b>	Northbound US 231	38.9	D
			Southbound US 231	80.6	<b>F</b>
			Eastbound Campbell Ln	85.0	<b>F</b>
			Westbound Lovers Ln	100.7	<b>F</b>

Note: Greenwood Square, Pedigo Way, Mall Rd are unsignalized.

**Table 7-2: 2040 Alternative 5, PM Peak Hour Travel Times**

Direction	Travel Time	Average Speed
US 231 Southbound	7 min 35 sec	8.3 mph
US 231 Northbound	5 min 31 sec	11.4 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.

Alternatives 1 and 3 were then simulated. There is no difference in traffic volumes or operations between Alternatives 3A and 3B; therefore, only one was modeled and represents both the urban and rural option from a traffic perspective. 2040 PM Peak Hour turning movement volumes for Alternative 1 are presented in **Figure 7-10**, while volumes for Alternative 3 are presented in **Figure 7-11**.

Traffic operations and travel times greatly improve over Alternative 5 and the No Build. All intersections operate at LOS D or better, although some movements operate at LOS E. The addition of a simple, two-phase signal at Greenwood Square and Pedigo Way in Alternative 3 appears to improve overall traffic operations, as some movements no longer need to divert to Cave Mill Road and Bryant Way. Traffic operations and travel times are shown in **Table 7-3** through **Table 7-6**.

**Table 7-3: 2040 Alternative 1, PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	49.2	D	Northbound US 231	51.0	D
			Southbound US 231	42.2	D
			Eastbound Three Springs Rd	51.0	D
			Westbound Ken Bale Blvd	67.5	E
Pascoe Blvd	17.1	B	Northbound US 231	10.5	B
			Southbound US 231	12.1	B
			Eastbound Pascoe Blvd	55.3	E
			Westbound Pascoe Blvd	79.9	E
Cave Mill Rd/Shive Ln	36.4	D	Northbound US 231	16.8	B
			Southbound US 231	33.3	C
			Eastbound Cave Mill Rd	63.0	E
			Westbound Shive Ln	70.8	E
Bryant Way	21.9	C	Northbound US 231	23.3	C
			Southbound US 231	10.1	B
			Eastbound Mall Access	53.7	D
			Westbound Bryant Way	54.2	D
Campbell Ln/Lovers Ln	44.6	D	Northbound US 231	20.3	C
			Southbound US 231	48.3	D
			Eastbound Campbell Ln	58.7	E
			Westbound Lovers Ln	67.0	E

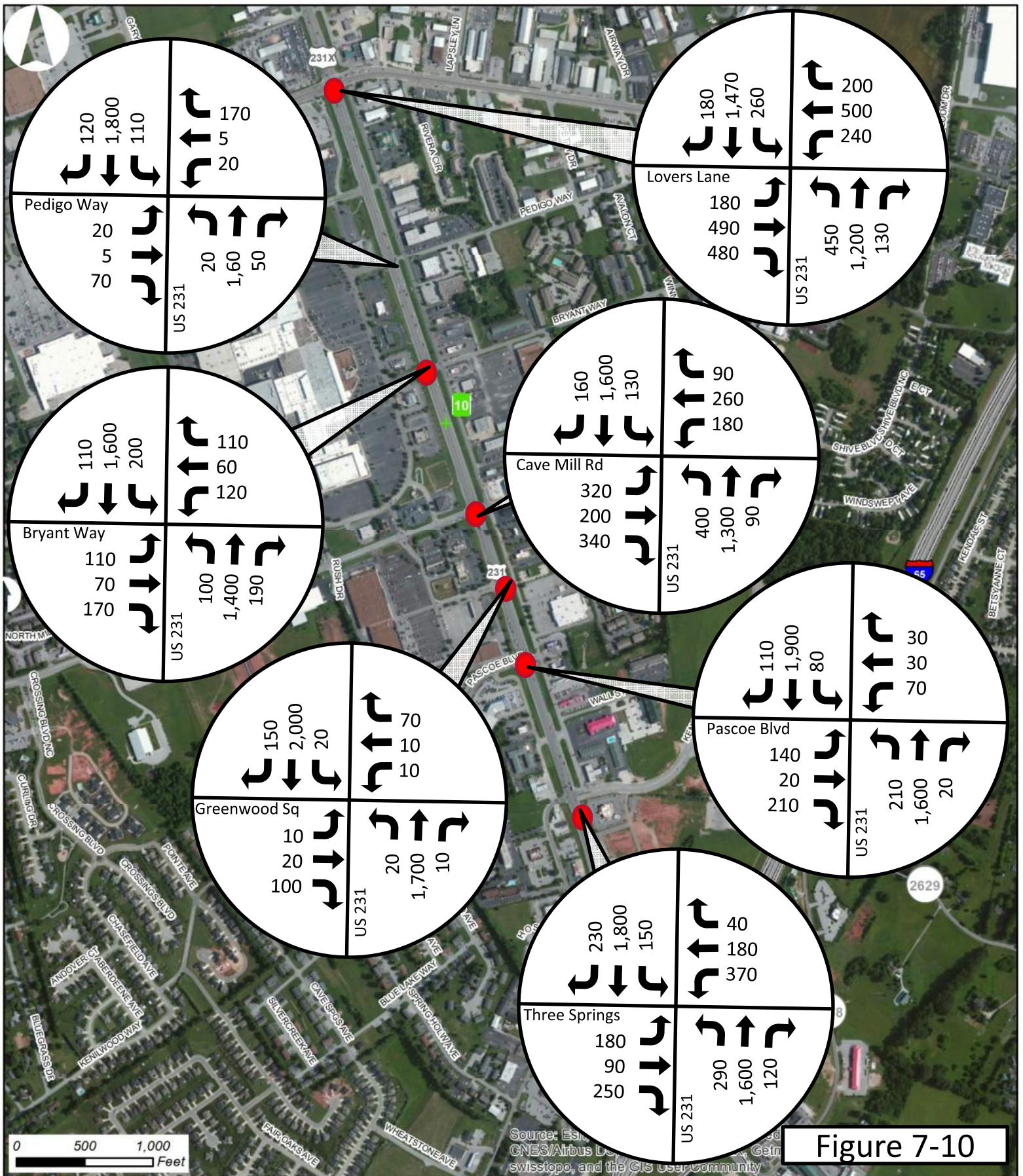
Note: Greenwood Square, Pedigo Way, Mall Rd are unsignalized.

**Table 7-4: 2040 Alternative 1, PM Peak Hour Travel Times**

Direction	Travel Time	Average Speed
US 231 Southbound	6 min 10 sec	10.2 mph
US 231 Northbound	3 min 14 sec	19.4 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.





Note: Turning Movements are for the PM Peak Hour only.

Signalized Intersections

CDM Smith




US 231 – Scottsville Rd  
From I-65 to Lovers Lane  
KYTC Item No 3-8702  
2040 Alternative 1 Volumes





Note: Turning Movements are for the PM Peak Hour only.

 Signalized Intersections

**CDM Smith**



**US 231 – Scottsville Rd**  
**From I-65 to Lovers Lane**  
**KYTC Item No 3-8702**  
**2040 Alternative 3 Volumes**



**Table 7-5: 2040 Alternative 3, PM Peak Hour Intersection LOS**

Intersection	Delay (s/veh)	LOS	Approach	Delay (s/veh)	LOS
Ken Bale Blvd / Three Springs Rd	47.5	D	Northbound US 231	51.0	D
			Southbound US 231	38.2	D
			Eastbound Three Springs Rd	51.0	D
			Westbound Ken Bale Blvd	67.5	<b>E</b>
Pascoe Blvd	20.8	C	Northbound US 231	10.7	B
			Southbound US 231	19.0	B
			Eastbound Pascoe Blvd	65.3	<b>F</b>
			Westbound Pascoe Blvd	82.8	<b>F</b>
Greenwood Square	6.1	A	Northbound US 231	4.2	A
			Southbound US 231	4.7	A
			Eastbound Greenwood Square Access	41.2	D
			Westbound Frontage Rd Access	--	--
Cave Mill Rd/Shive Ln	30.3	C	Northbound US 231	14.8	B
			Southbound US 231	19.4	B
			Eastbound Cave Mill Rd	57.8	<b>E</b>
			Westbound Shive Ln	70.7	<b>E</b>
Bryant Way	25.7	C	Northbound US 231	20.3	C
			Southbound US 231	21.9	C
			Eastbound Mall Access	48.9	D
			Westbound Bryant Way	52.2	D
Pedigo Way	5.3	A	Northbound US 231	4.3	A
			Southbound US 231	3.7	A
			Eastbound Pedigo Way	25.9	C
			Westbound Pedigo Way	26.3	C
Campbell Ln/Lovers Ln	51.0	D	Northbound US 231	39.2	D
			Southbound US 231	50.6	D
			Eastbound Campbell Ln	57.4	<b>E</b>
			Westbound Lovers Ln	66.4	<b>E</b>

Note: Mall Rd is un-signalized.

**Table 7-6: 2040 Alternative 3, PM Peak Hour Travel Times**

Direction	Travel Time	Average Speed
US 231 Southbound	5 min 36 sec	11.2 mph
US 231 Northbound	3 min 25 sec	18.3 mph

Note: Travel times taken from Campbell Lane/Lovers Lane to Three Springs Rd/Ken Bale Blvd.

As shown in the above tables, traffic operations for Alternatives 1 and 3 are very similar. Alternative 3 improved southbound travel time, but at the expense of the northbound direction and some side street delay.

If a corridor is congested in the simulation model, the forecasted volumes may not be able to enter the network. Analysts examined how much traffic volume passed through each particular intersection along the corridor in each alternative to determine if the model was accommodating all of the traffic.

**Table 7-7** shows the comparison between volume demand and simulated volume for each 2040 scenario. The No Build and Spot Improvements (Alternative 5) scenarios do not adequately meet demand in 2040, passing 76 and 83 percent, respectively. This is consistent with the results presented in previous sections. Alternatives 1 and 3 both satisfy 95% of the demand. Full demand is not met due to vehicles being present in the network but not completing their trip before the end of the simulation time period.

**Table 7-7: 2040 Traffic Simulation Volumes Through Intersections**

Intersection	No Build		Alternative 5 – Spot Improvements		Alternative 1		Alternative 3	
	VISSIM	Demand	VISSIM	Demand	VISSIM	Demand	VISSIM	Demand
Three Springs Rd/Ken Bale Blvd	4,261	5,321	4,413	5,321	5,301	5,321	5,277	5,321
Pascoe Blvd	3,431	4,361	3,687	4,405	4,345	4,405	4,371	4,413
Greenwood Square	3,258	4,308	3,420	4,094	3,844	4,094	4,148	4,131
Cave Mill Rd/Shive Ln	3,723	4,950	4,135	5,088	4,846	5,088	4,818	4,973
Bryant Way	3,258	4,215	3,420	4,276	3,844	4,276	4,211	4,301
Pedigo Way	2,872	3,994	3,297	3,994	3,886	3,994	3,892	3,959
Campbell Ln/Lovers Ln	4,198	5,785	5,091	5,785	5,377	5,785	5,588	5,786
Total	25,001	32,934	27,463	32,963	31,443	32,963	32,305	32,884

## C. Impacts

Below is a list of the potential impacts to be considered in the next phase of the project based on the Level 2 alternative development layouts.

- Widening US 231 reduces the length and turning radii of the frontage road which affects turning movements and the number of cars in storage between the two roads.
- Existing drainage basins may have to be enlarged and possibly new ones constructed. The entire watershed and drainage system needs to be studied to understand what impacts will be made. Impacts to the drainage basins may have utility implications as well. Storm sewer may be required across parking lots which will impact utilities as well.
- The sidewalk adjacent to the frontage road may require some power pole relocations.



- To reduce the impacts of widening, consider the following design elements: 1) 11-foot lanes, 2) 8-foot shoulders, 3) widening could occur to the right or left of the centerline instead of on the centerline, 4) use underground drainage system, and 5) only use 30-foot median where dual left turns are needed and a taper template where they are not needed.

The conceptual alternatives were developed in a 2D environment; therefore, it was not clear their full impact on the adjacent frontage road and adjoining businesses. As part of the study, seven critical locations were identified along the corridor and were surveyed. Typical cross-sections were developed that show additional detail on impacts. These are presented in **Appendix J**. They illustrate that with the use of some retaining walls, the typical section will work along the majority of the corridor. As shown, there will be minor impacts to some parking lots. As noted in previous sections, drainage calculations will need to be completed to determine if enough drainage area is provided. This could further impact the typical section.

## D. Cost Estimates

Based on the conceptual alignments, preliminary costs were developed for each alternative and are shown below in **Table 7-8**. Right-of-way and utility costs were developed by KYTC District 3 and can be viewed in detail in **Appendix K**. Right-of-way and utility costs were assumed to be equal across Alternatives 1, 3A and 3B due to the proximity of the utilities to the existing pavement and the current extent of existing right-of-way. Separate utility and right-of-way cost estimates were not developed for Alternative 5 (Spot Improvements), as future widening along the entire corridor was assumed. If Spot Improvements are constructed first, right-of-way purchased and utilities moved should accommodate future widening.

**Table 7-8: Preliminary Cost Estimates**

	Design	Right-of-Way	Utilities	Construction	Total
Alternative 1	\$1,093,000	\$4,675,000	\$9,885,000	\$10,939,000	\$26,592,000
Alternative 3A	\$1,304,000	\$4,675,000	\$9,885,000	\$13,044,000	\$28,908,000
Alternative 3B	\$1,289,000	\$4,675,000	\$9,885,000	\$12,889,000	\$28,738,000

The high cost of utilities can be attributed to the presence of several high-cost lines immediately adjacent along the corridor. For example, AT&T runs a fiber optic line that must be replaced manhole to manhole. Utility concerns such as these should be part of the future decision-making process, particularly in regards to project limits for Spot Improvements.

Detailed construction cost estimates for each of the above alternatives, including Alternative 5, are discussed below in **Tables 7-9** and **7-10**. The cost estimate for the long-term improvement options assumes spot improvements have not been constructed. If spot improvements are completed in advance of the long-term widening, then the alternative cost estimate should be reduced, but would depend on the extent of the improvement completed. **Table 7-11** identifies a potential pavement design and unit costs per layer.

**Table 7-9: Alternative 5 Construction Cost Estimates**

Component	SPOT 1	SPOT 2	SPOT 3	SPOT 4
Paving <sup>1</sup>	\$ 41,600	\$ 277,400	\$ 33,300	\$ 6,700
Roadway <sup>2</sup>	\$ 32,000	\$ 90,800	\$ 29,800	\$ 13,500
Drainage <sup>3</sup>	\$ 5,300	\$ -	\$ 3,000	\$ -
MOT	\$ 15,000	\$ 15,000	\$ 15,000	\$ 15,000
Signals	\$ 100,000	\$ 250,000	\$ 100,000	\$ -
Specials <sup>4</sup>	\$ -	\$ 10,000	\$ -	\$ -
Staking	\$ 2,900	\$ 9,600	\$ 2,700	\$ 500
Mobilization	\$ 5,800	\$ 19,300	\$ 5,400	\$ 1,100
Demobilization	\$ 2,900	\$ 9,600	\$ 2,700	\$ 500
Contingency	\$ 41,100	\$ 136,400	\$ 38,400	\$ 7,500
Total	\$ 246,600	\$ 818,100	\$ 230,300	\$ 44,800

<sup>1</sup> Assumptions: See pavement design below in **Table 7-11**. Shoulder excavated full depth, perforated edge drain mainline, widening of US 231 on both sides of Cave Mill Road for Spot Improvement 2.

<sup>2</sup> Earthwork: \$15.00/yd<sup>3</sup>, Fuel/Asphalt adjustment of \$300,000 (Alternatives only), 10' retaining wall at 350' length (Shive Ln) and 250' length (Best Buy) @ \$75/ft<sup>2</sup>, rock excavation not included, and signage not included.

<sup>3</sup> Assumptions: Alternative 3A – CBI calculation at 150' intervals for storm sewer, Alternative 3B – storm sewer included.

<sup>4</sup>\$400,000 contingency for drainage basin construction.

**Table 7-10: Long-Term Alternative Construction Cost Estimates**

Alternative	1	3A	3B
Paving <sup>1</sup>	\$ 4,932,000	\$ 4,684,000	\$ 6,073,000
Roadway <sup>2</sup>	\$ 2,133,000	\$ 2,764,000	\$ 2,525,000
Drainage <sup>3</sup>	\$ 135,000	\$ 1,406,000	\$ 135,000
MOT	\$ 500,000	\$ 500,000	\$ 500,000
Signals	\$ 500,000	\$ 500,000	\$ 500,000
Specials <sup>4</sup>	\$ 400,000	\$ 400,000	\$ 400,000
Staking	\$ 129,000	\$ 154,000	\$ 152,000
Mobilization	\$ 258,000	\$ 308,000	\$ 304,000
Demobilization	\$ 129,000	\$ 154,000	\$ 152,000
Contingency	\$ 1,823,000	\$ 2,174,000	\$ 2,148,000
Total	\$ 10,939,000	\$ 13,044,000	\$ 12,889,000

<sup>1</sup> Assumptions: See pavement design below in **Table 7-11**. Shoulder excavated full depth, perforated edge drain mainline, widening of US 231 on both sides of Cave Mill Road for Spot Improvement 2.

<sup>2</sup> Earthwork: \$15.00/yd<sup>3</sup>, Fuel/Asphalt adjustment of \$300,000 (Alternatives only), 10' retaining wall at 350' length (Shive Ln) and 250' length (Best Buy) @ \$75/ft<sup>2</sup>, rock excavation not included, and signage not included.

<sup>3</sup> Assumptions: Alternative 3A – CBI calculation at 150' intervals for storm sewer, Alternative 3B – storm sewer included.

<sup>4</sup>\$400,000 contingency for drainage basin construction.



**Table 7-11: Preliminary Pavement Design**

Location	Material	Cost per Ton
Traffic Lanes – Overall	1.5" CL4 ASPH SURF 0.50A PG76-22	\$95
	3.0" CL4 ASPH SURF 1.00D PG 76-22	\$90
Traffic Lanes - Widening	3.0" CL4 ASPH BASE 1.50D PG 64-22	\$80
	4.0" CL4 ASPH BASE 1.50D PG 64-22	\$80
	4.75" CL4 ASPH BASE 1.50 D PG 64-22	\$80
	4.0" DRAINAGE BLANKET – TYPE II ASPHALT	\$60
	4.0" DGA BASE	\$20
Shoulders	1.5" CL3 ASPH SURF 0.50A PG64-22	\$80
	3.0" CL3 ASPH SURF 1.00A PG64-22	\$60
	3.0" CL3 ASPH SURF 1.50A PG64-22	\$50
	4.0" CL3 ASPH SURF 1.50A PG64-22	\$50

## Section 8

# Conclusions & Recommendations

This chapter provides recommendations for improvements to US 231 (Scottsville Road) between I-65 and US 231X/KY 880 (Lovers Lane/Campbell Lane).

### A. Stakeholder/Local Officials Meeting #2

A second stakeholder/local officials meeting was held before the final project team meeting on Monday, May 12, 2014 at the Barren River ADD Office in Bowling Green. Eighteen stakeholders were able to attend in person. A copy of the meeting summary is included in **Appendix I**. The purpose of the meeting was to discuss the project findings and get input from the stakeholders on the recommendations for the study corridor. Key comments from attendees are summarized below; alternatives can be reviewed graphically in **Figure 7-1** through **Figure 7-9**:

- A phased construction schedule is desirable, where spot improvements are constructed with programmed funds that can tie into future widening. These spot improvements need not be constructed together, but all should be implemented as part of the project.
- The signals along Cave Mill Road should be coordinated with those on US 231.
- Concepts shown by the project team could be applied further north of this project's limits in future projects.
- 11' lanes are acceptable from a transit and pedestrian perspective – less time is required for pedestrians to be in the crosswalk.
- Physical barriers – whether they are bollards or a median – should be installed to force all traffic to oblige to movement restrictions.

### B. Project Team Meeting #3

The project team met for the final time on May 12, 2014 at the Barren River ADD Office. The purpose of the meeting was to review and analyze the initial alternatives, discuss feedback received in Stakeholder/Local Officials Meeting #2 held earlier that day, and review next steps. A detailed summary of the final project team meeting is included in **Appendix H**.

After detailed discussion, the following recommendation was solidified by the project team: Spot improvements should move forward immediately and as many spot improvements as programmed funding allows should be constructed. Alternative 3 is the preferred alternative to address long-term capacity needs. Alternative 1 may be considered if impacts caused by Alternative 3 are too great; however, safety improvement concepts from Alternative 3 should be incorporated into the Alternative 1 footprint (i.e.



*Example of bollards being used between lanes to restrict turn movements.*



bollards in place of a non-mountable median). An example is illustrated to the right.

## C. Recommended Improvements

In light of the input received and the analysis detailed in this report, the following improvement options are recommended to advance to future phases of project development.

### Spot Improvements

The spot improvements are proposed as lower cost intersection improvement options which show to have a noticeable short-term effect on mobility and should also address some of the safety concerns along the corridor. The four spot improvements are as follows:

- Spot Improvement 1 - Add a left turn lane opposite Bryant Way onto northbound US 231.
- Spot Improvement 2 - Widen median to 30 feet between Cave Mill Road and Pascoe Boulevard. Provide dual left turns from northbound US 231 to westbound Cave Mill Road. Provide dual left turns from eastbound Cave Mill Road to northbound US 231. Close the median at Shive Lane and the frontage road with the installation of bollards. Add a through/right turn lane on westbound Shive Lane. Remove the signal at Greenwood Square Shopping Center and convert intersection to a right-in/right-out/left-in. The left-in would be provided for the northbound direction only.
- Spot Improvement 3 - Add an additional left turn lane for eastbound Pascoe Boulevard onto northbound US 231.
- Spot Improvement 4 - Extend the US 231 southbound left turn lane at Ken Bale Boulevard; close the median at the access to Red Roof Inn/Motel Six.

The spot improvements are designed to complement the long-term solution in order to minimize future costs and impacts. Spot Improvements should proceed to the design phase following the completion of this report. They should be designed to tie-in to future widening along the corridor; preferably using the footprint of Alternative 3. If funding permits, it is recommended that sufficient right-of-way between Cave Mill Road and Pascoe Boulevard be purchased and utilities be moved to accommodate future tie-in to Alternative 3. This will minimize future impacts along this section.

### Alternative 3

In addition to spot improvements, Alternative 3 would widen US 231 to six lanes and install a 30-foot median. Additionally, some movements would be restricted at the following un-signalized intersections:

- Greenwood Square Shopping Center: Convert to right-in/right-out/left-in. Left-in would be provided for northbound direction only. A simple two-phase signal may be installed to allow unopposed left turning traffic into the shopping center. Note this is also included as a priority spot improvement. If the spot improvements are implemented first as recommended, this would not be required.
- Pedigo Way/Greenwood Mall Secondary Entrance: Convert to right-in/right-out/left-in. Left-in would be provided for both directions. A simple two-phase signal may be installed to allow unopposed left turning traffic into both Greenwood Mall and Pedigo Way.
- Greenwood Mall Tertiary Entrance: Close median, convert to right-in/right-out.

Alternative 3 meets the project purpose and need's call for mobility and addresses safety concerns. It also meets the secondary goal of providing reasonable access along the corridor, without the removal of the frontage road system.

Both the urban and rural typical section should be considered in the design phase. While the typical sections presented in the previous sections provide guidance as to the assumptions made in this study, it is recommended that the typical section be finalized in the next phase. This is due to the potential drainage impacts and the existing right-of-way constraints along the corridor. Although these impacts were looked at in more detail during the Level 2 alternative development process; a complete survey and detailed drainage analysis is needed to fully understand the disturb limits of the proposed alternative.

If in the design phase, Alternative 3 is found to have too great of an impact on the adjacent frontage road and commercial businesses, the narrower median presented in Alternative 1 could be considered. However, it should only be constructed if low-cost elements of Alternative 3 can be incorporated. These could include the installation of bollards in the median and the restriction of access at unsignalized locations via the construction of right-in/right-out traffic islands. While not as effective as those presented in Alternative 3, it would help mitigate the safety concerns associated with Alternative 1.

#### D. Construction and Environmental Considerations for Future Phases

Construction and environmental considerations identified throughout the study process are summarized here for further consideration in future project development phases:

- **Waste Management** – Solid wastes occurring as part of the construction process must be disposed of at a permitted facility. Underground storage tanks and other contaminants should be properly addressed as they are encountered.
- **Geotechnical Considerations** – Site specific geotechnical investigations are critical in this region prior to design, particularly as mining operations are likely to be encountered. There are likely numerous potentially unstable Talus areas in the study area. Soils in the area are generally suitable for embankment construction; suitable rock for embankment construction and rock roadbed is also readily available in this area of the state. Soils in the area are considered erodible.
- **Utilities** – Underground waterlines, gas lines and fiber optics lines as well as above ground power, cable, and telephone lines lie just off the existing road for portions of the corridor. It is recommended a SUE investigation be completed. Avoiding and/or relocating these utilities will be a concern during the design process and in future phases of project development.
- **Traffic Operations/Signal Timing** – Maintenance of traffic, frontage road access and commercial access should be preserved throughout the construction process. It is also important to review and update signal timing along the corridor once the construction is completed. New technology should be considered for use as signals warrant replacement. The Synchro and VISSIM models will be provided to the KYTC for their continued use.
- **Erosion and Sediment Control** – Measures should be utilized to control erosion and sedimentation during and after the commencement of earth-disturbing activities. Consideration should be given to erosion control methods; a Best Management Practices for Construction Activities guide is available from the Kentucky Division of Conservation.



- **Transit/Bus Access** – The corridor provides access to area school and GO bg Transit. Bus stop access and mobility should be addressed in future project phases.
- **Cultural & Historic Resources** - An archaeological and cultural historic survey of the project area should be conducted as part of future phases of the project development process to identify project-related impacts and to ensure compliance with Section 106 of the National Historic Preservation Act.
- **Hazardous Materials** – GIS data from the US Environmental Protection Agency include a few permitted facilities/monitored sites along the corridor. Solid wastes generated by any future construction activities must be disposed of at a permitted facility.