

FINAL Smallhouse Road Study

In Partnership with:



Bowling Green-Warren County Metropolitan Planning Organization
HMB Professional Engineers, Inc.

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Chapter 1 – Introduction

The Smallhouse Road corridor between US 231 (Campbell Lane) and KY 884 (Three Springs Road) is in the heart of everything in Bowling Green / Warren County. Smallhouse Road provides connections to schools, churches, parks, and homes and serves as an alternate travel route to the more congested US 31W and US 231 routes. There is an opportunity to expand the user base from vehicular traffic to incorporate bicyclists and pedestrians. Often overlooked, due to the residential nature of portions of this corridor, mobility and access can be affected by service vehicles such as mail delivery and garbage trucks. Considering the current context and demographics of users, the Bowling Green-Warren County Metropolitan Planning Organization (BG-WC MPO) has contracted with a consulting firm, HMB Professional Engineers, Inc. to provide recommendations on how to transform the corridor to a safer, more user-friendly roadway. As part of the study, considerations are given to safety, capacity, access management, and bicycle / pedestrian improvements along the corridor to determine future short- and long-term solutions.

Additional participating agencies include the City-County Planning Commission of Warren County (CCPC), Kentucky Transportation Cabinet (KYTC), City of Bowling Green, and Warren County Public Works. These agencies, along with the BG-WC MPO, form the Steering Committee for the study.

1.1 Study Area

The study area encompasses Smallhouse Road from the intersection with US 231 (Campbell Lane) to KY 884 (Three Springs Road). Additional emphasis is placed on major intersections along this portion of Smallhouse Road including Campbell Lane, Cave Mill Road, Grider Pond Road, Elrod Road, and Three Springs Road. The full extent of the study area is included as **Figure 1**.

1.2 Study Purpose and Goals

The purpose of this study is to evaluate safety and capacity and assess access management and bicycle / pedestrian improvements along Smallhouse Road from US 231 (Campbell Lane) to KY 884 (Three Springs Road). The results of the evaluation will help determine future short-term and long-term solutions.

Study goals include the following:



Provide necessary safety, capacity, access management, and bicycle / pedestrian improvements for all users into the future.

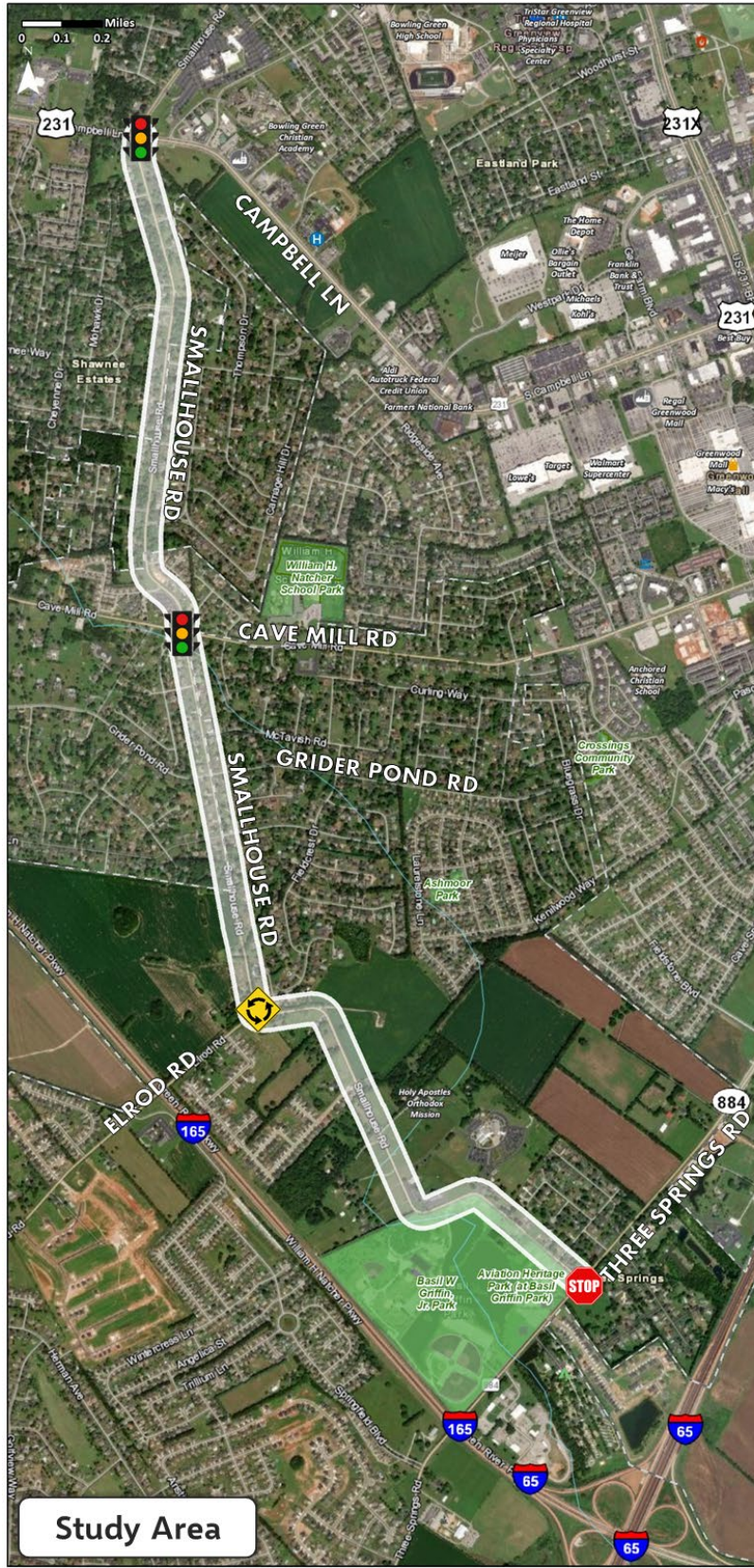


Recommendations for major intersections along the corridor including, but not limited to, US 231 (Campbell Lane), Cave Mill Road, Grider Pond Road, Elrod Road, and KY 884 (Three Springs Road).



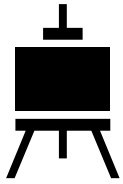
Have minimal right-of-way impacts.

Figure 1. Study Area



1.3 Study Process

The process of this study is described in detail in the following nine chapters. Additional resource / reference materials are included in the appendices.



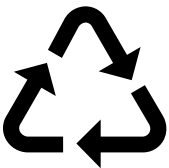
Chapter 1 – Introduction

The first chapter provides background introductory information about the study and provides the framework for the remainder of the report.



Chapter 2 – Existing Conditions

The second chapter encompasses collected data including geometrics, speeds, existing traffic volumes and operations, safety analysis and bicycle and pedestrian accommodations.



Chapter 3 – Environmental Overview

This chapter is devoted to a summary of the natural, human, and socioeconomic resources within the study area.



Chapter 4 – Geotechnical Overview

This chapter includes a high-level review based on available online resources identifying geotechnical features in the vicinity of the study area.



Chapter 5 – Public Outreach

This chapter is devoted to a summary of outreach efforts which includes coordination with the Steering Committee, a community survey, and a public meeting.



Chapter 6 – Future Year (2045) Traffic Forecast

The process of determining traffic volumes for the future year of analysis (2045) is presented in this chapter.



Chapter 7 – Intersection / Spot Improvement Concepts

Chapter seven presents the process by which intersections / spot locations were identified along with the development of corresponding improvement concepts.



Chapter 8 – Corridor Improvement Concepts

In this chapter, the focus is on the identification and evaluation of improvements to the corridor (between intersections and spots).



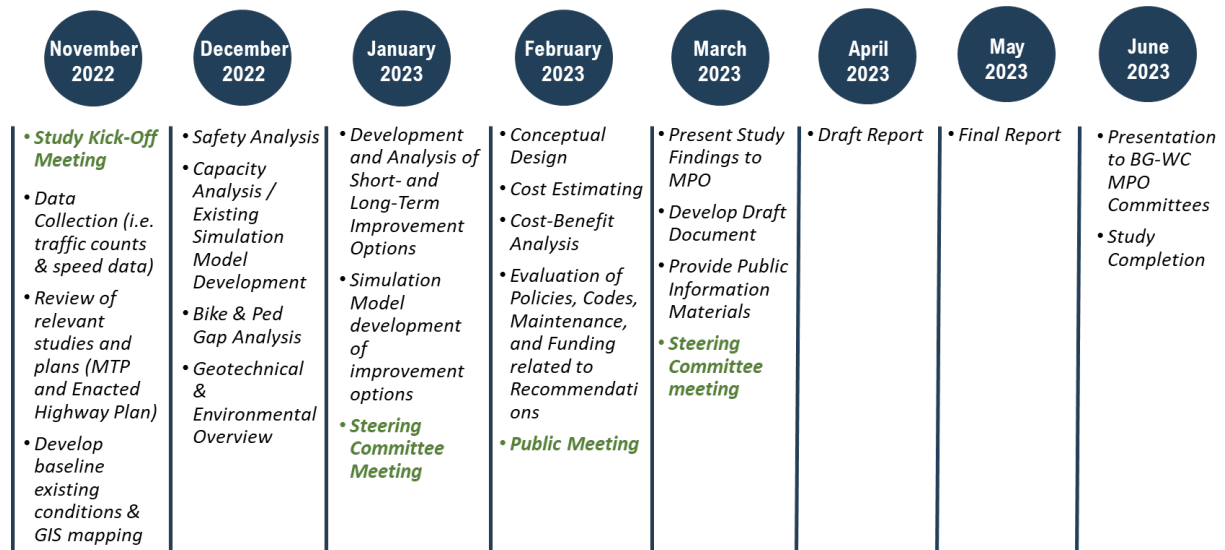
Chapter 9 – Study Outcomes

The final chapter presents the outcomes of the study as a prioritized list of locations and improvement concepts.

1.4 Study Schedule

The study began in November 2022 with an initial meeting held with the Steering Committee. Following the study process, the study concluded in March 2023 with the final meeting. The following illustration (Figure 2) shows the timeline of events throughout the study.

Figure 2. Study Schedule



1.5 Previous Studies, State and Local Plan Projects

A review of programming documents was performed to identify projects in / near the study area that could impact Smallhouse Road in the future. These documents include:

- KYTC Enacted Highway Plan (2022 – 2028)
- KYTC Identified 2022 SHIFT Projects
- BG-WC MPO Unified Planning Work Program (Fiscal Year 2023)
- BG-WC MPO Metropolitan Transportation Plan (2045)
- Bicycle and Pedestrian Master Plan, 2022
- BG-WC Comprehensive Plan Focus 2030

KYTC Identified and Highway Plan Projects

Identified projects are transportation projects that have been identified as a need and have been entered in the Continuous Highway Analysis Framework (CHAF) database. The database provides a means to track and analyze projects as well as a way to sponsor, score, and rank projects as part of the Strategic Highway Investment Formula for Tomorrow (SHIFT) prioritization process. One project was identified that would have an impact on future improvements to Smallhouse Road – Item No. 3-8707.00. The project description is “construct a new interchange on the Natcher Parkway at Elrod Road in Bowling Green (MP 3.4 to MP 4.0)”. The total cost provided in the database is \$40,420,700. A study for this project was completed in May 2009 (Item No. 3-130.00). A preliminary conceptual layout was developed that utilized more of existing Elrod Road; however, no additional study has been conducted and there are no funds associated with the project for further development at this time. A new interchange at I-165 and Elrod Road would change connectivity in this portion of the county, directly impacting traffic flow on Smallhouse Road north and south of the existing roundabout at Elrod Road. As a result, future year traffic scenarios are developed for this study with consideration of this potential project. More detail is provided in the traffic forecasting section and appendix of this document.

The KYTC Enacted Highway Plan projects are those that have been prioritized through SHIFT and have been included in Kentucky's Highway Plan. The enacted plan at the time of this study is *FY 2022 - 2028*. It includes two relevant projects. **Figure 3** and **Table 1** provides a summary of relevant CHAF and Highway Plan projects.

Table 1. KYTC Enacted Highway Plan (2022 - 2028) and CHAF Projects

Map ID	Item #	Project Type	Description	Main Route	Begin Mile Point	End Mile Point	Length	Work Type	Fund Type	Phase Cost				Phase Total
										Design (D)	Right of Way (R)	Utilities (U)	Construction (C)	
1	3-8707.00	CHAF	Construct a new interchange on the Natcher Parkway at Elrod Road in Bowling Green.	I-165	3.400	4.000	0.600	New Interchange	N/A	\$940,000	\$8,369,500	\$7,958,400	\$23,152,800	\$40,420,700
2	3-80201.00 3-80212.00	Highway Plan	Reduce congestion and increase safety on Cave Mill Road / Dishman Lane from the end of the three-lane section near Raintree Drive (MP 0.570) just east of Grider Pond Road.	CS-1432 CR-1704- X CS-2281	1.036 0.000 0.570	1.541 0.879 0.943	1.757	Congestion Mitigation	SPP	\$1,860,000 (2023)	\$6,500,000 (2025)	\$6,200,000 (2025)	\$12,400,000 (2027)	\$26,960,000
3	3-8818.00	Highway Plan	Three Springs Road Extension from Flealand to the Natcher Parkway including bridge over parkway.	KY 884	7.302	8.622	1.320	Minor Widening	SPP	-	\$2,310,000 (2022)	\$4,900,000 (2024)	\$9,520,000 (2025)	\$16,730,000

Planning documents for the MPO were also reviewed. In the BG-WC MPO Fiscal Year 2023 Unified Planning Work Program, a corridor improvement study for Smallhouse Road and Cave Mill Road was included using discretionary funds. Subsequently, the City of Bowling Green began a design project for Cave Mill Road Corridor Improvements. As a result of the City focusing on improvements to Cave Mill Road, the funds for this study were dedicated solely to the study of improvements to Smallhouse Road.

In the 2045 BG-WC MPO Metropolitan Transportation Plan (MTP), improvements to Cave Mill Road and Three Springs Road were also noted (MTP ID 32 and 45 in the Long-Range Plan). These are the same projects that are listed in the KYTC Enacted Highway Plan.

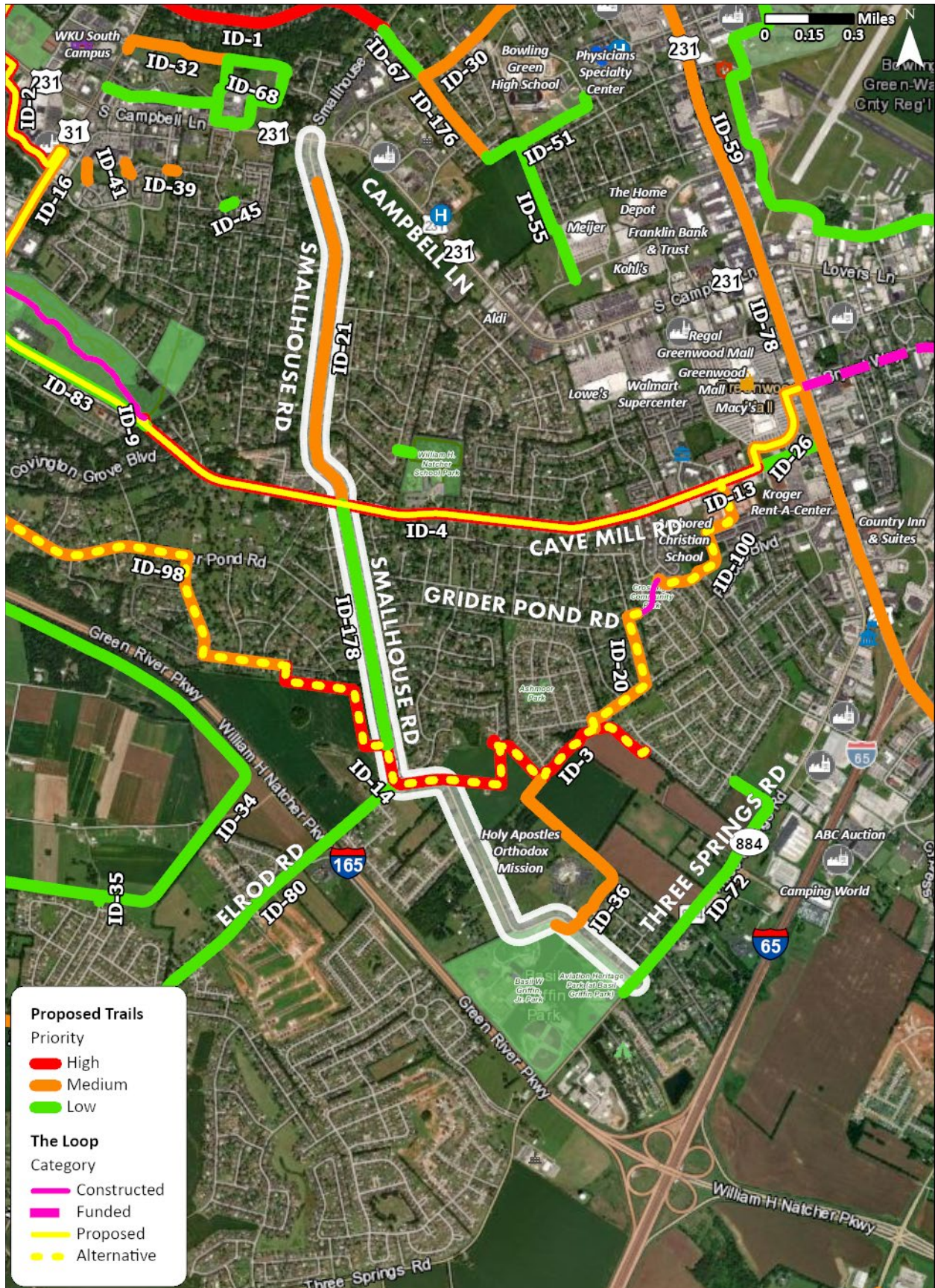
An additional project recently completed by the City of Bowling Green is the construction of a multi-use path on Smallhouse Road from US 231 (Campbell Lane) to Scottsville Road / Broadway Avenue. This project is an eight-foot multi-use path constructed on the east / south side of Smallhouse Road.

BikeWalk BG is a focus effort by the MPO for bicycle and pedestrian encouragement and planning efforts in the Bowling Green area. Proposed project priorities can be found in the 2022 Bicycle and Pedestrian Master Plan as well as online through the [MPO's BikeWalk BG website](#). Projects that are identified along or connecting to the study area include the following:

- **Trail ID-4, High Priority:** Construct an 8-10' shared use path along Cave Mill Road to improve bike/ped safety and access for residential areas, Natcher Elementary, and retail businesses.
- **Trail ID-14, High Priority:** Construct greenway to extend connection from Ashmoor Parke to Lois Lane, providing a south option for a safe greenway loop alternative.
- **Trail ID-21, Medium Priority:** Shared use path south of Campbell Lane to Cave Mill Road.
- **Trail ID-36, Medium Priority:** Construct a ten-foot shared use path connecting the Grider Pond area (Ashmoor Parke, Fieldstone Farms, Fieldcrest Drive) to Basil Griffin Park.
- **Trail ID-72, Low Priority:** Shared use path along Three Springs Road as part of the current KYTC project.
- **Trail ID-178, Low Priority:** Shared use path or bike lanes between Cave Mill Road and Elrod Road to connect to other proposed greenways, connecting to Basil Griffin Park.
- **Trail ID-80, Low Priority:** Shared use path along Elrod Road.
- **The Loop:** a contiguous greenway loop around the City of Bowling Green utilizing either ID-4 (Cave Mill Road) or as an alternative, ID-14 (Ashmoor Parke to Lois Lane).

The locations and priorities for these proposed projects are shown in **Figure 4**.

Figure 4. BikeWalk BG Bicycle and Pedestrian Priorities



Chapter 2 – Existing Transportation Conditions

In this chapter, the existing transportation conditions are presented. This includes information on the following:

- Roadway Facility and Geometrics
- Vehicular Speeds
- Existing Traffic Volumes and Operations
- Safety Analysis
- Bicycle and Pedestrian Accommodations

Transit systems and opportunities is another area of consideration for studies. A fixed route transit service “GO BG Transit” provides services in Bowling Green and surrounding areas. There is no service along Smallhouse Road in the study area. The nearest bus service is on Campbell Lane (US 231). With no plans to expand the transit system to Smallhouse Road, concept improvements along the corridor do not include accommodations for transit operations. However, any modifications to the Campbell Lane / Smallhouse Road intersection should include accommodations for the through transit route along Campbell Lane.

Data for this chapter was collected from KYTC’s Highway Information System (HIS) database, KYTC Traffic Count Reporting System, and MPO / City of Bowling Green / Warren County GIS Mapping. Field reviews were performed for additional data collection and verification.

At the end of this chapter (Section 2.6), summaries are provided for reference of collected data for each study intersection (Campbell Lane, Cave Mill Road, Grider Pond Road, Elrod Road, and Three Springs Road) and the corridor.

2.1 Roadway Facility and Geometrics

Functional Class

Functional classification is the process of grouping streets and highways by character of travel service and access to adjacent land uses. According to the HIS database, the entirety of Smallhouse Road in the study area is classified as an Urban Major Collector. An Urban Major Collector is a roadway that provides a connection between local roads and higher functional arterials, and typically serves shorter trips.

Typical Section

Smallhouse Road consists of two travel lanes (no median) that range from ten to twelve feet. There is minimal to no shoulder width (zero to one foot).

Maintenance

The City of Bowling Green and Warren County both maintain portions of Smallhouse Road. **Figure 5** shows the division of responsible agencies for reference.

Figure 5. Ownership / Maintenance of Smallhouse Road



Horizontal and Vertical Curves

Information was extracted from the KYTC HIS database to determine whether the horizontal and vertical curves meet current design standards according to *A Policy on Geometric Design of Highways and Streets, 7th Edition (2018)*.

The following locations have horizontal curves graded at E (14.0 – 27.9 degrees) or F (28.0 degrees or more). Curves graded at D or lower typically would benefit from improvements.

- Curve just north of Cave Mill Road
- Curve at Elrod Road Roundabout
- Curve just east of Elrod Road Roundabout
- Curve by Lakeview Fellowship Church and Basil Griffin Park exit
- Curve by Holy Spirit Catholic Church and Basil Griffin Park access

All vertical curves have a grade of 4.4% or less, which meets design criteria for 30-35 mph urban sections. **Figures 6** and **7** display the horizontal and vertical curvature grading respectively.

Figure 6. Horizontal Curvature

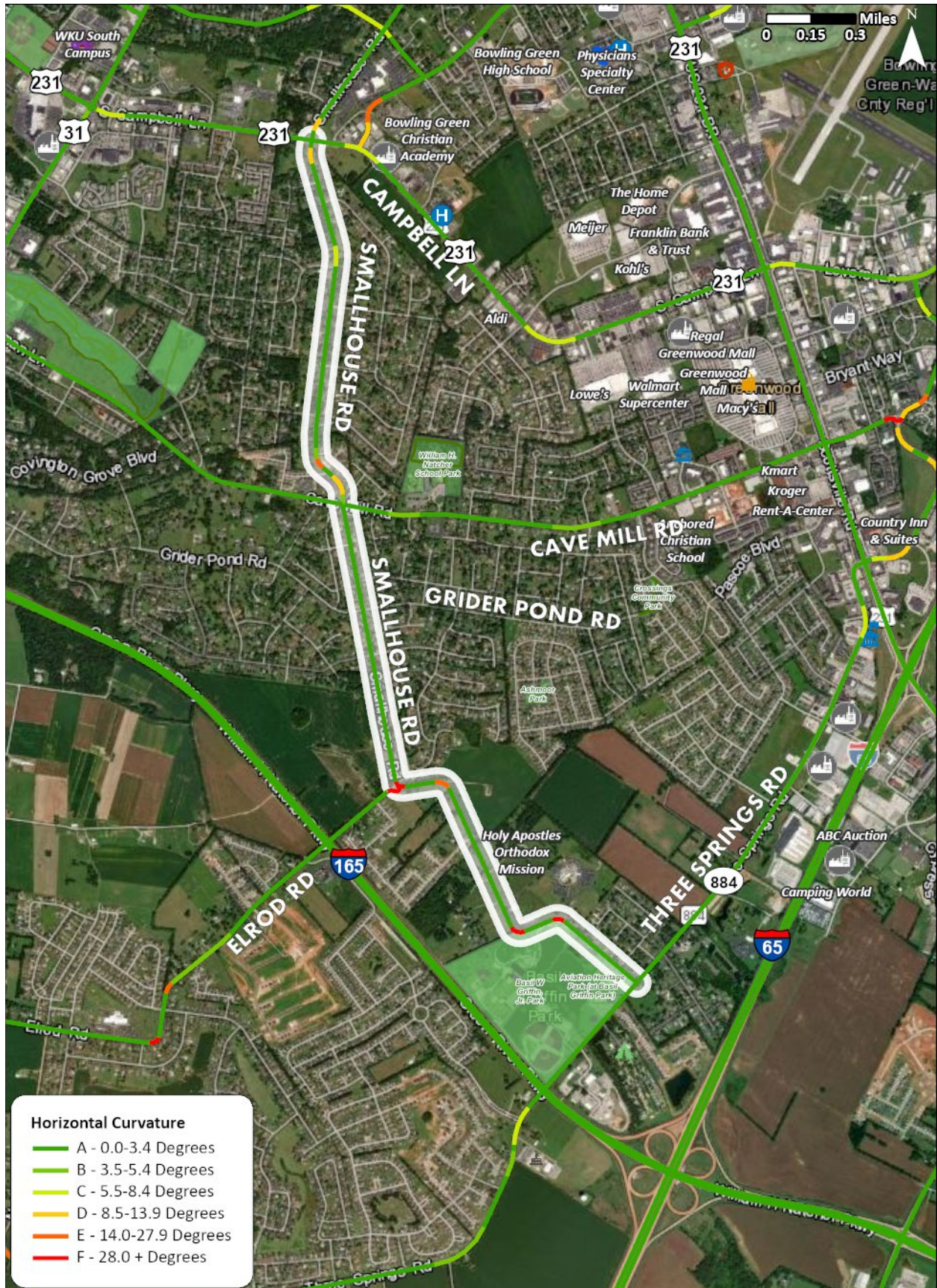
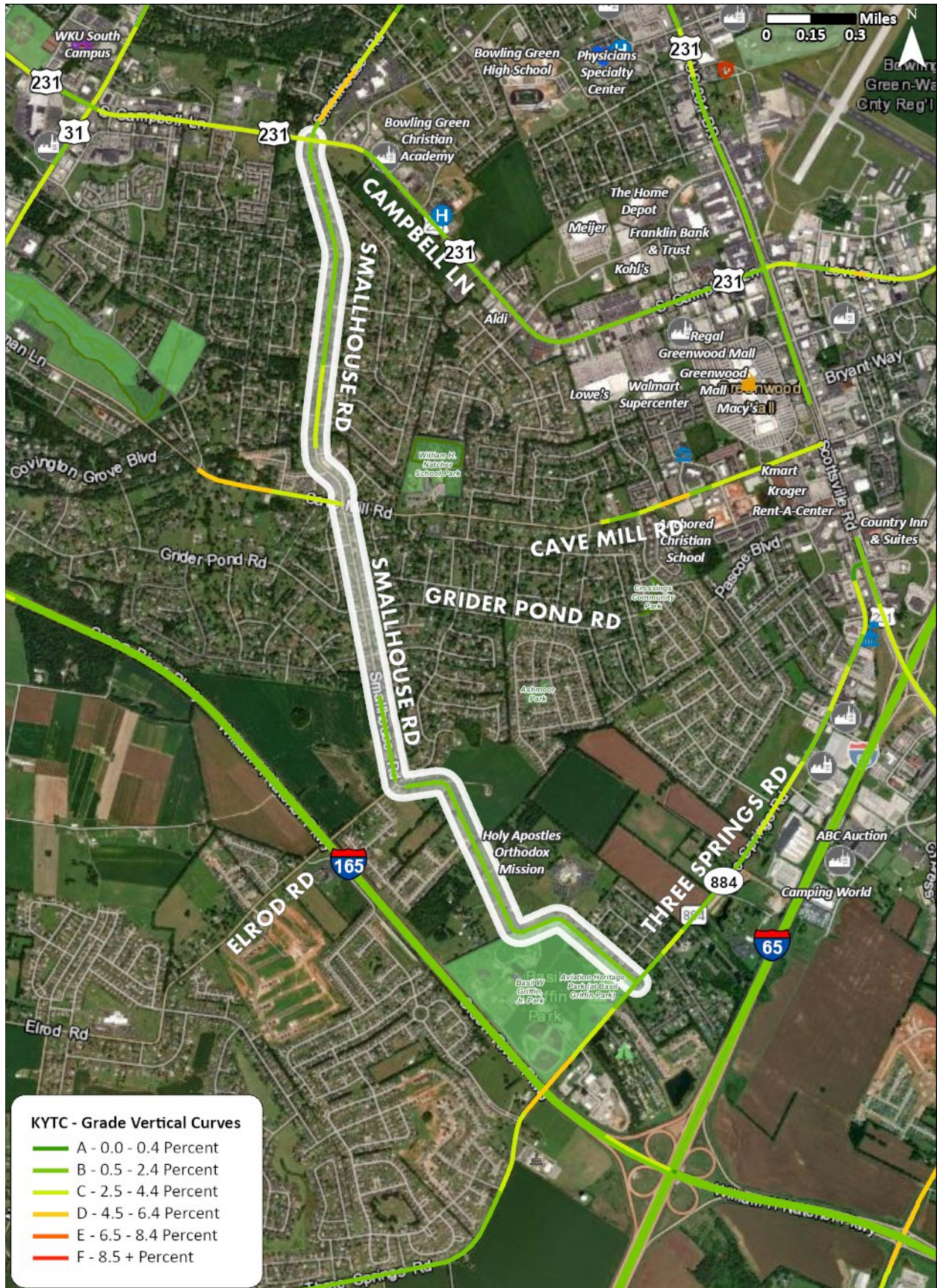


Figure 7. Vertical Curvature



2.2 Vehicular Speeds

Vehicular traffic uses Smallhouse Road for local access and as a through route connecting the southern portion of the county to retail / shopping / downtown. As a result, speeds have been noted as an issue to be examined in this study. The speed limit varies along the route within the study area – between 30 and 35 mph, and 25 mph for the roundabout at Elrod Road. **Figure 8** displays the changes in speed limits along the corridor.

To determine the actual, free-flow travel speed distributions within the study area, speed data was collected using MUTCD methodologies using a radar gun in each speed zone during off-peak hours with a minimum of 100 observations for each location. **Figure 8** also shows the locations the radar gun was used to measure the speed of drivers in the study area. Data was collected on Wednesday, November 16, 2022. Both directions were observed for a 35 mph zone and a 30 mph zone. The first data set was collected in the 30 mph zone between 10:25 AM and 11:05 AM (CST) near Walnut Way. The second data set was collected in the 35 mph zone between Basil Griffin Park and Elrod Road between 11:45 AM and 12:15 PM (CST). The weather varied between partly cloudy and sunny.

The data was analyzed to determine metrics for if / what modifications may be appropriate to the posted speed limits. The results of the speed study are shown in **Table 2** and **Table 3**.

Table 2. 30 mph Section Speed Study Data

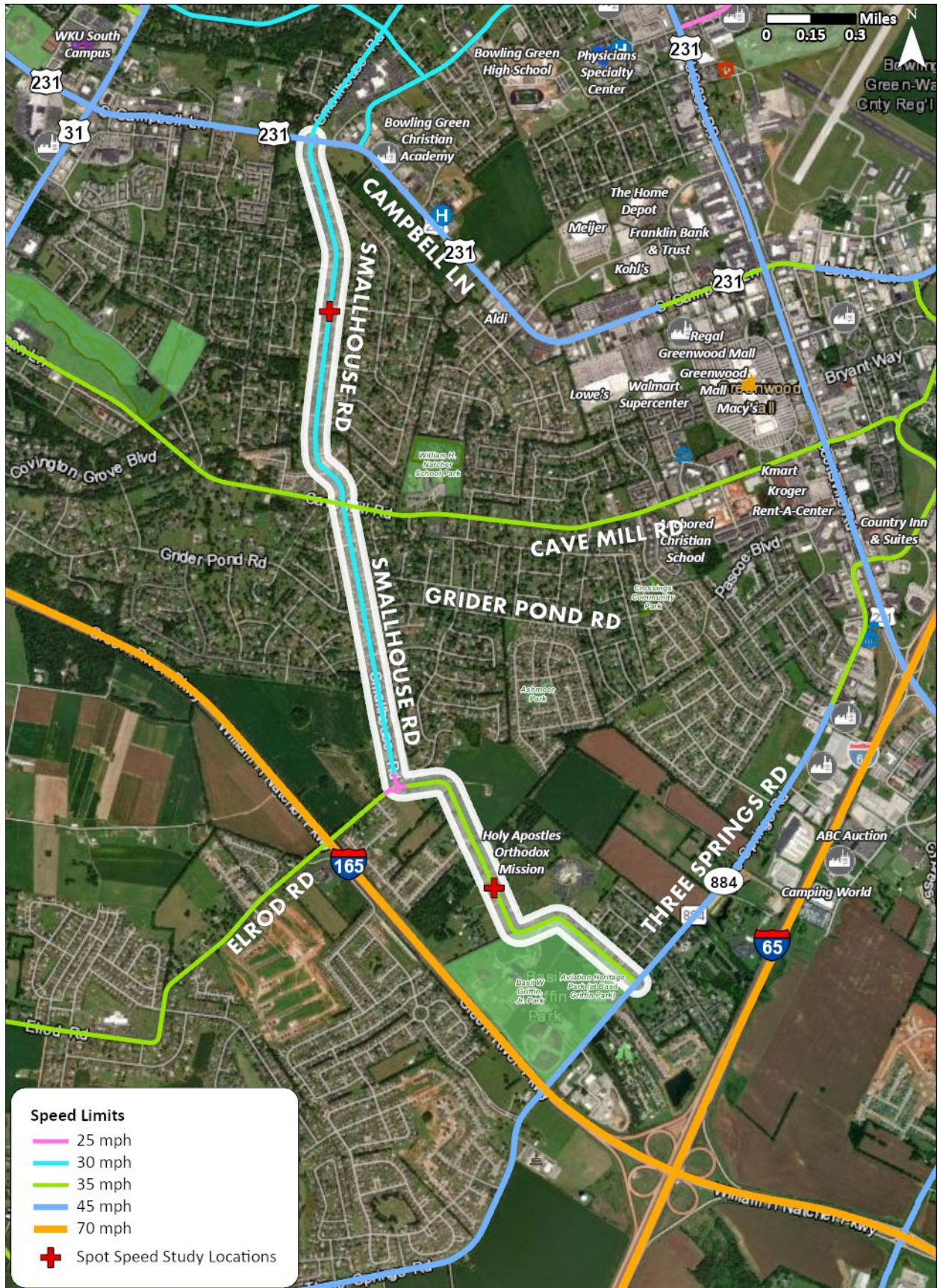
Category	Direction		
	SB	NB	Both
Average Speed (mph)	31	38	-
10-mph Pace (mph)	42-52	38-48	38-48
85 th Percentile Speed	49	47	47
85 th Percentile Vehicle	46	57	103

Table 3. 35 mph Section Speed Study Data

Category	Direction		
	SB	NB	Both
Average Speed (mph)	25	40	-
10-mph Pace (mph)	36-46	36-46	36-46
85 th Percentile Speed	47	47	47
85 th Percentile Vehicle	37	60	97

The data shows vehicles driving at speeds higher than the posted speed limits. The 85th Percentile speed has traditionally been the measure used to establish a speed limit. Based on this data, the 85th Percentile speed ranges from 47-49 mph in both locations, which is significantly higher than 30 and 35 mph. As a result of the identified excessive speeds, options for reducing speeds / traffic calming will be explored as potential improvement options.

Figure 8. Speed Data



2.3 Existing Traffic Volumes and Operations

Existing year (2022) Annual Average Daily Traffic (AADT) volumes for Smallhouse Road between Campbell Lane and Three Springs Road are based on the most recent counts at the following KYTC count stations:

- Station 114D12 between KY 884 (Three Springs Road) and Elrod Road: 3,612 AADT in 2019
- Station 114C62 between Elrod Road and Cave Mill Road: 8,233 AADT in 2019
- Station 114C09 between Cave Mill Road and US 231 (Campbell Lane): 7,930 AADT in 2020

The location of the count stations and corresponding volumes are shown in **Figure 9**.

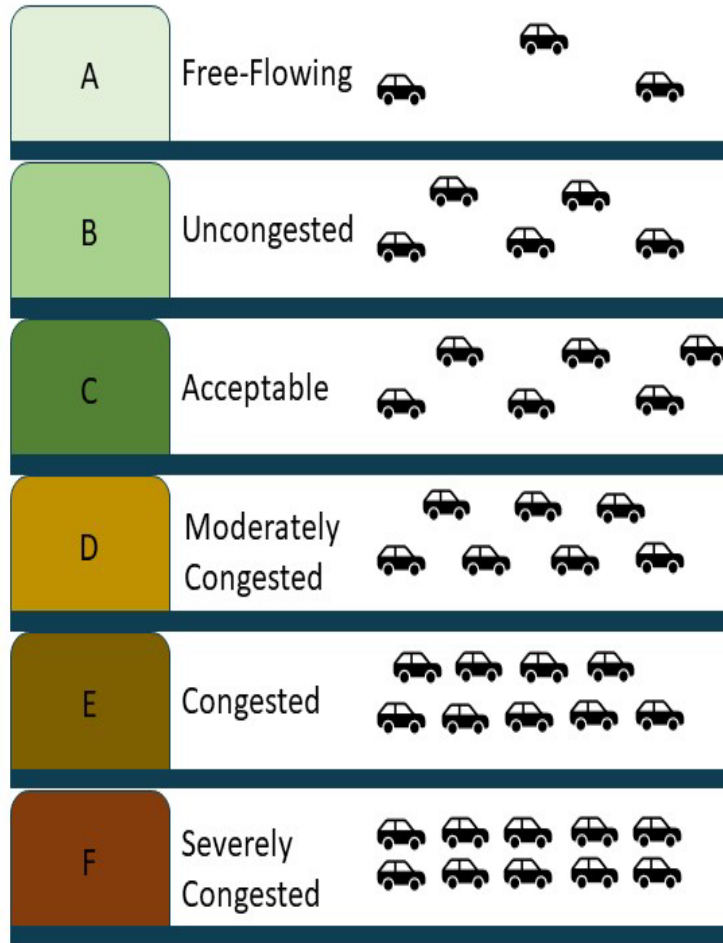
For the study intersections (Campbell Lane, Cave Mill Road, Grider Pond Road, and Elrod Road) turning movement counts were conducted during the AM peak (7:00 AM to 9:00 AM) and PM peak (2:00 PM to 6:00 PM) periods (Central Time) on Tuesday, November 15, 2022. The PM peak hour was extended to encompass dismissal times from nearby schools. KYTC recently conducted a turning movement count at Three Springs Road on August 25/26th, 2021 which was provided for use in this study. Peak hour volumes are shown on the summary sheets at the end of this chapter. Count data is included in **Appendix A** for reference.

Figure 9. Smallhouse Road Existing Corridor AADT Volumes



A level of service (LOS) analysis was performed to assess traffic operations for the corridor and intersections using *Synchro 11 based on the HCM 6th Edition*. LOS is a qualitative measure of determining the operational characteristics of a roadway facility. It is used to define the quality of traffic operations based on measures such as vehicle speed, travel time, comfort and convenience, maneuverability, congestion, and delay. There are six levels of service for each type of facility. The levels are designated by letters, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Acceptable operations for roadways in urban areas is LOS D or better. **Figure 10** presents a graphical depiction of LOS for reference.

Figure 10. Level of Service (LOS) Designations



In addition to providing the range of traffic flow according to letter grade, another reported performance measure is seconds of delay. These are provided to illustrate the range in operation within each letter category. Finally, queue lengths are recorded to compare to existing available storage lengths. This allows a comparison to determine if existing turn lane lengths are adequate to capture queues without backing up into travel lanes.

Table 4 illustrates the results of the traffic operations analysis (LOS, delay, and queue length) by intersection. This information is also provided in the summary figures at the end of this chapter.

Additional operational data was collected to calibrate the Synchro traffic analysis model. This included travel time runs conducted during during peak hours (AM and PM) in January 2023 and queue lengths at the intersections of Campbell Lane, Cave Mill Road, Grider Pond Road, Elrod Road, and Three Springs Road.

Cells that are highlighted in red on **Table 4** indicate that the queue length exceeds the existing available storage. Cells that are highlighted in yellow indicate that the queue length is approaching the existing available storage.

Table 4. Existing (2022) Intersection Operations

Campbell Lane (Signalized)

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)	95th Percentile Queue Length (ft)		
				Left	Thru	Right
AM	Eastbound (Campbell)	C (33.8)	C (23.3)	120	408	50
	Westbound (Campbell)		C (21.4)	43	205	38
	Northbound (Smallhouse)		D (52.2)	195	548	335
	Southbound (Smallhouse)		D (45.9)	68	195	183
PM	Eastbound (Campbell)	D (42.4)	C (29.6)	113	585	168
	Westbound (Campbell)		C (27.6)	218	653	110
	Northbound (Smallhouse)		E (68.4)	180	355	258
	Southbound (Smallhouse)		F (83.1)	50	748	380

Cave Mill Road (Signalized)

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)	95th Percentile Queue Length (ft)		
				Left	Thru	Right
AM	Eastbound (Cave Mill)	C (22.4)	C (20.6)	55	193	30
	Westbound (Cave Mill)		C (22.3)	28	178	128
	Northbound (Smallhouse)		C (24.8)	68	273	90
	Southbound (Smallhouse)		B (19.7)	68	63	20
PM	Eastbound (Cave Mill)	D (22.0)	C (23.4)	33	260	70
	Westbound (Cave Mill)		B (19.7)	93	233	78
	Northbound (Smallhouse)		C (20.8)	35	103	55
	Southbound (Smallhouse)		C (24.1)	45	243	123

Grider Pond Road (Two-Way Stop Controlled)

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)	95th Percentile Queue Length (ft)		
				Left	Thru	Right
AM	Eastbound (Grider Pond)	N/A	C (17.2)	-	2.5	-
	Westbound (Grider Pond)		C (18.7)	-	22.5	-
	Northbound (Smallhouse)		A (7.6)	0	-	-
	Southbound (Smallhouse)		A (9.1)	2.5	-	-
PM	Eastbound (Grider Pond)	N/A	C (21.4)	-	10	-
	Westbound (Grider Pond)		C (18.7)	-	15	-
	Northbound (Smallhouse)		A (8.9)	0	-	-
	Southbound (Smallhouse)		A (8.1)	5	-	-

Elrod Road (Roundabout)

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)	95th Percentile Queue Length (ft)	
				Left/Thru/Right	
AM	Eastbound (Elrod)	A (6.6)	A (7.5)	50	
	Westbound (Elrod)		A (6.9)	25	
	Southbound (Smallhouse)		A (4.2)	25	
PM	Eastbound (Elrod)	A (7.1)	A (6.1)	25	
	Westbound (Elrod)		A (5.1)	25	
	Southbound (Smallhouse)		A (8.2)	75	

Three Springs Road (Two-Way Stop Controlled)

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)	95th Percentile Queue Length (ft)	
				Left	Right
AM	Eastbound (Three Springs)	N/A	A (1.1)	7.5	-
	Westbound (Three Springs)		A (0.0)	-	-
	Southbound (Smallhouse)		C (17.3)	20	6
PM	Eastbound (Three Springs)	N/A	A (2.0)	12.5	-
	Westbound (Three Springs)		A (0.0)	-	-
	Southbound (Smallhouse)		D (33.3)	60	17.5

2.4 Safety Analysis

As part of this study, historical crash data was analyzed to identify locations along the portion of Smallhouse Road in the study area that could be considered high crash locations. Historical crash records were extracted from the Kentucky State Police's (KSP) *Collision Database* for a five-year period (September 1, 2017 – August 31, 2022). Analysis is based on this time period with the exception of the intersection of Smallhouse Road and Elrod Road. A roundabout was constructed here and opened in October 2020. As a result of the new configuration, data was evaluated before and after opening. Injury crashes went from fourteen percent (29 total / 4 injury) to zero percent (9 total).

Trends in crash locations, severity and manner of collision were examined with summaries shown in **Figures 11 – 13**. Crash severities are classified based on the Modal Minimum Uniform Crash Criteria (MMUCC), 4th Edition.

- **K – Fatal Injury:** indicates the person was killed as a result of the collision and died within 30 days of the collision.
- **A – Suspected Serious Injury:** any non-fatal injury which prevents the person from walking, driving, or normally continuing the activities he / she could perform prior to the collision and does require medical attention. Includes severe lacerations, broken limbs, skull fracture, internal injuries, unconsciousness when leaving the scene, or inability to leave scene without assistance.
- **B – Suspected Minor Injury:** evident to observers at the collision scene such as minor lacerations, bruises, and abrasions.
- **C – Possible Injury:** claim of injury and / or pain that is not evident to the eye. Includes momentary unconsciousness, limping, nausea, and hysteria.
- **O – No Apparent Injury:** property damage only.

Statistical analysis was performed based on methods that compare existing crash rates with crash rates of similar types of facilities. Excess Expected Crashes (EEC) is a statistical model to calculate crash distributions based on AASHTO Highway Safety Manual (HSM) procedures. This method allows for the ability to estimate the frequency of crashes based on differences in roadway characteristics such as geometry, lane/shoulder/median configurations, AADT, length, functional classification, and traffic control. A positive EEC value indicates more crashes are occurring than expected in a segment. A negative EEC value indicates fewer crashes are occurring than expected in a segment. Once established, EEC values can be categorized by Level of Service of Safety (LOSS). LOSS ranges from LOSS 1 to LOSS 4. LOSS 1 indicates a substantially better safety performance and a low potential for crash reduction. LOSS 4 indicates a substantially worse than expected safety performance and a high potential for crash reduction. **Figure 14** displays LOSS categories 3 and 4 for KAB crash types. There are numerous segments between Campbell Lane and Cave Mill Road that fall into the LOSS 3 category. An additional segment at LOSS 3 is found near Lois Lane.

Figure 11. Heat Map - All Crashes

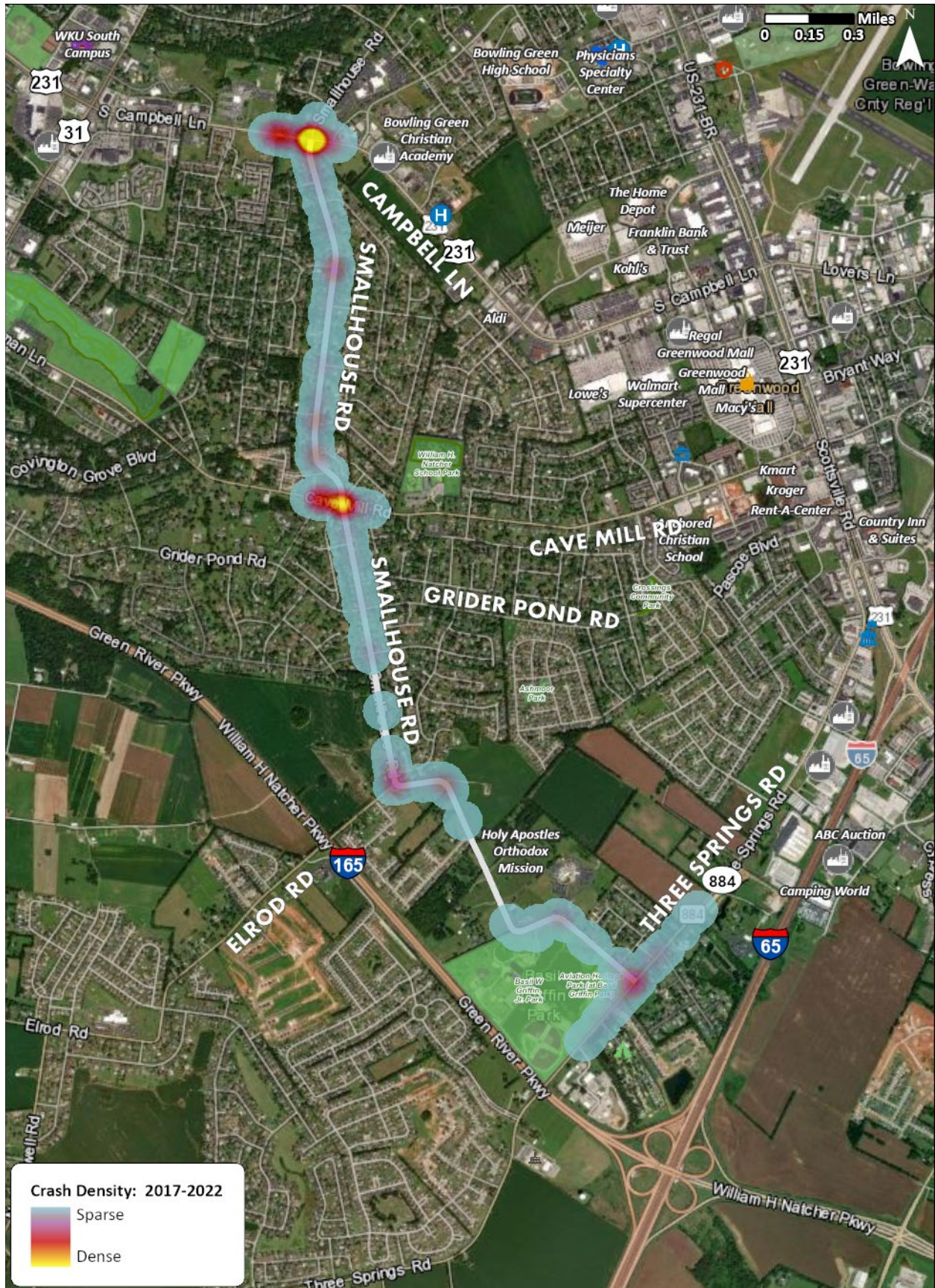


Figure 12. Manner of Collision Crash Clusters

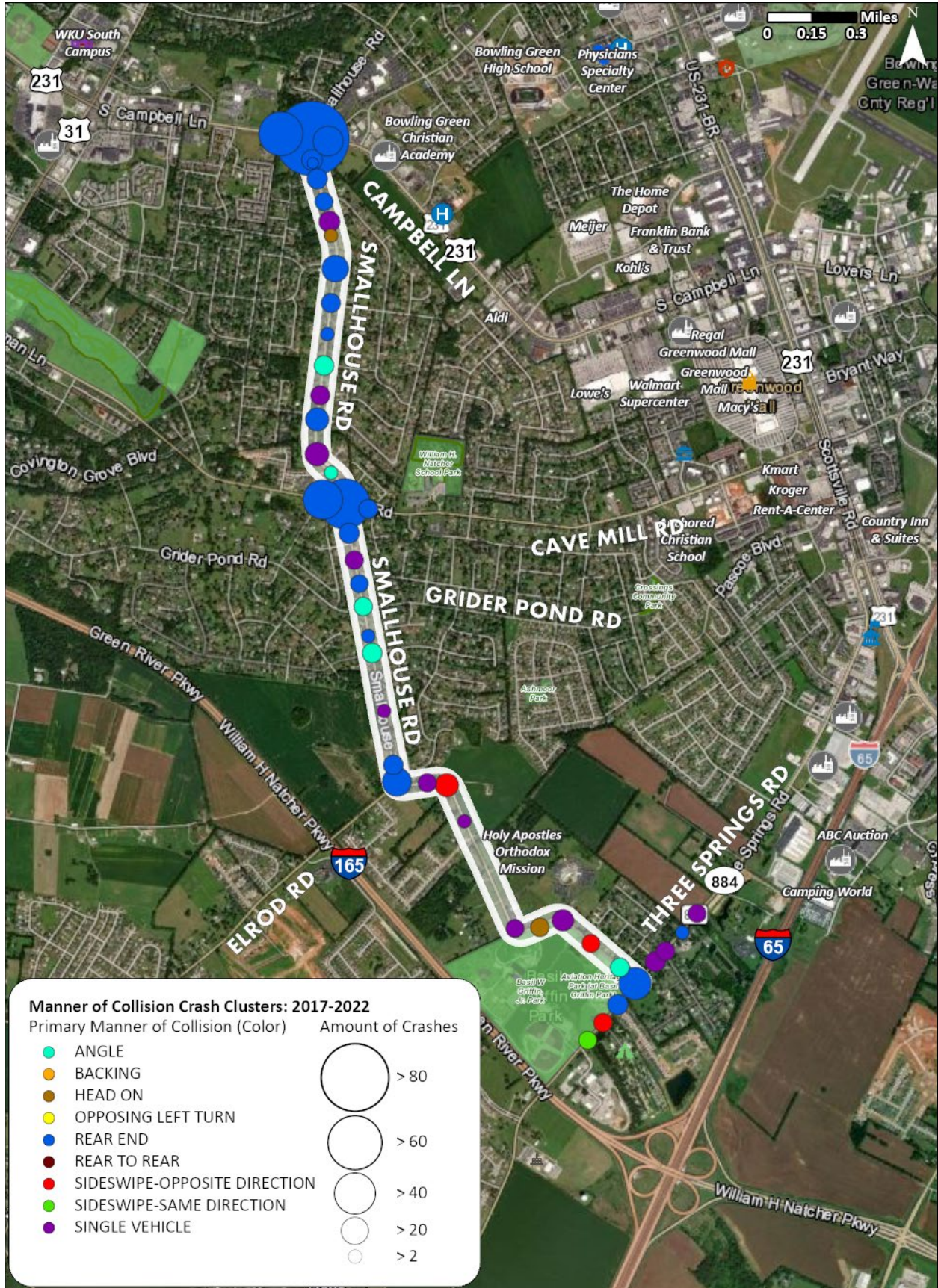


Figure 13. Detailed Manner of Collision and Injury Type

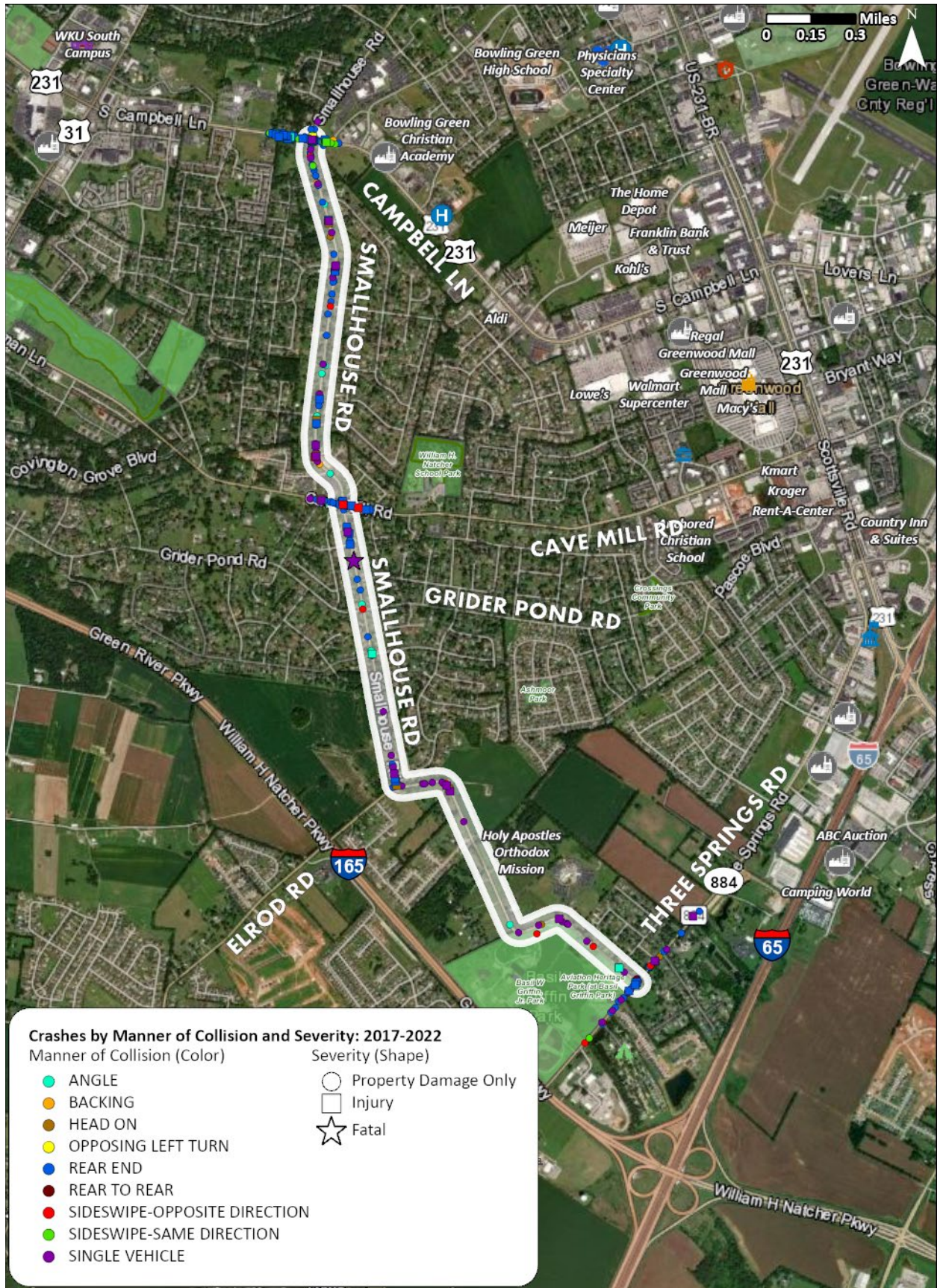
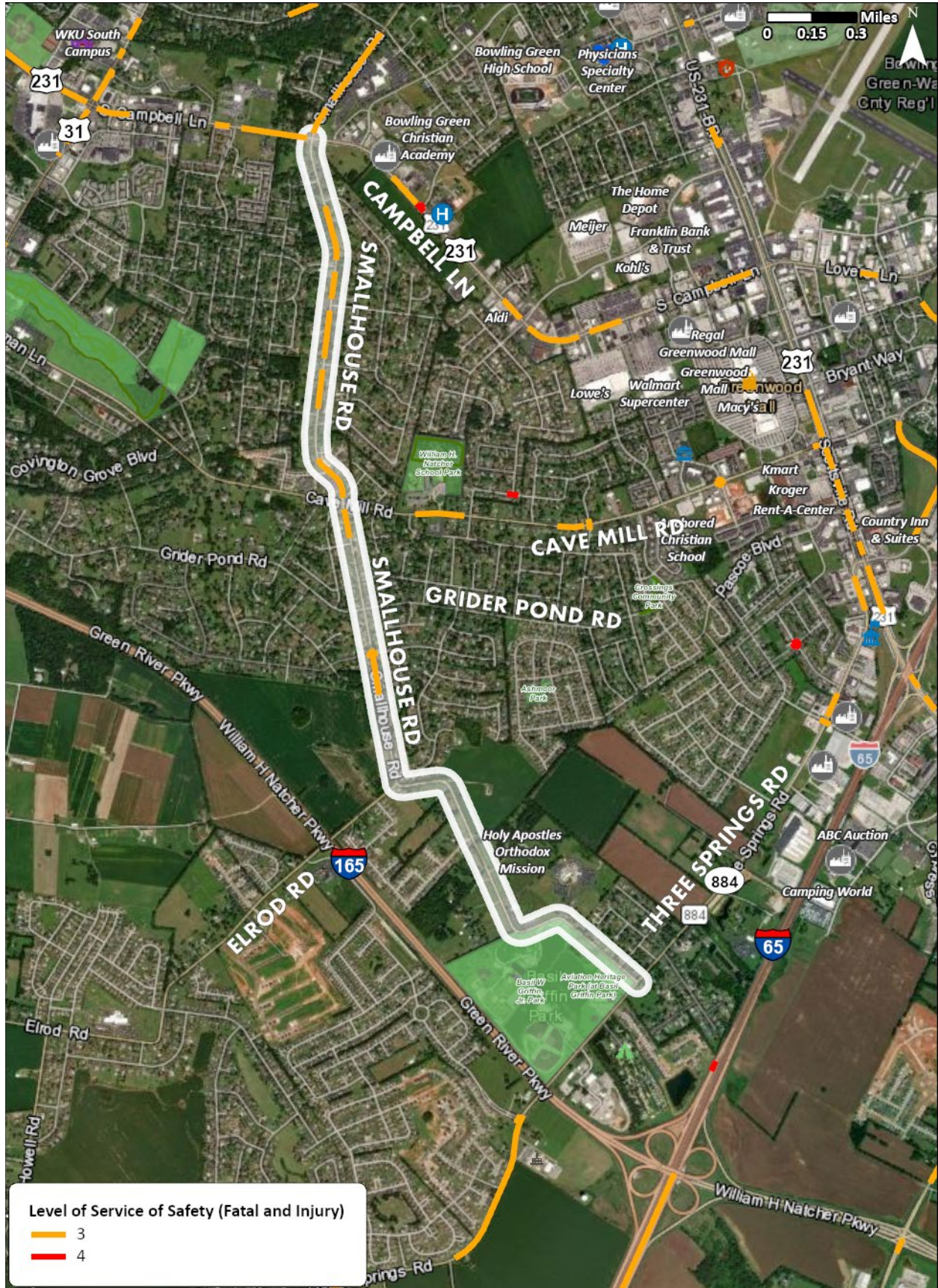


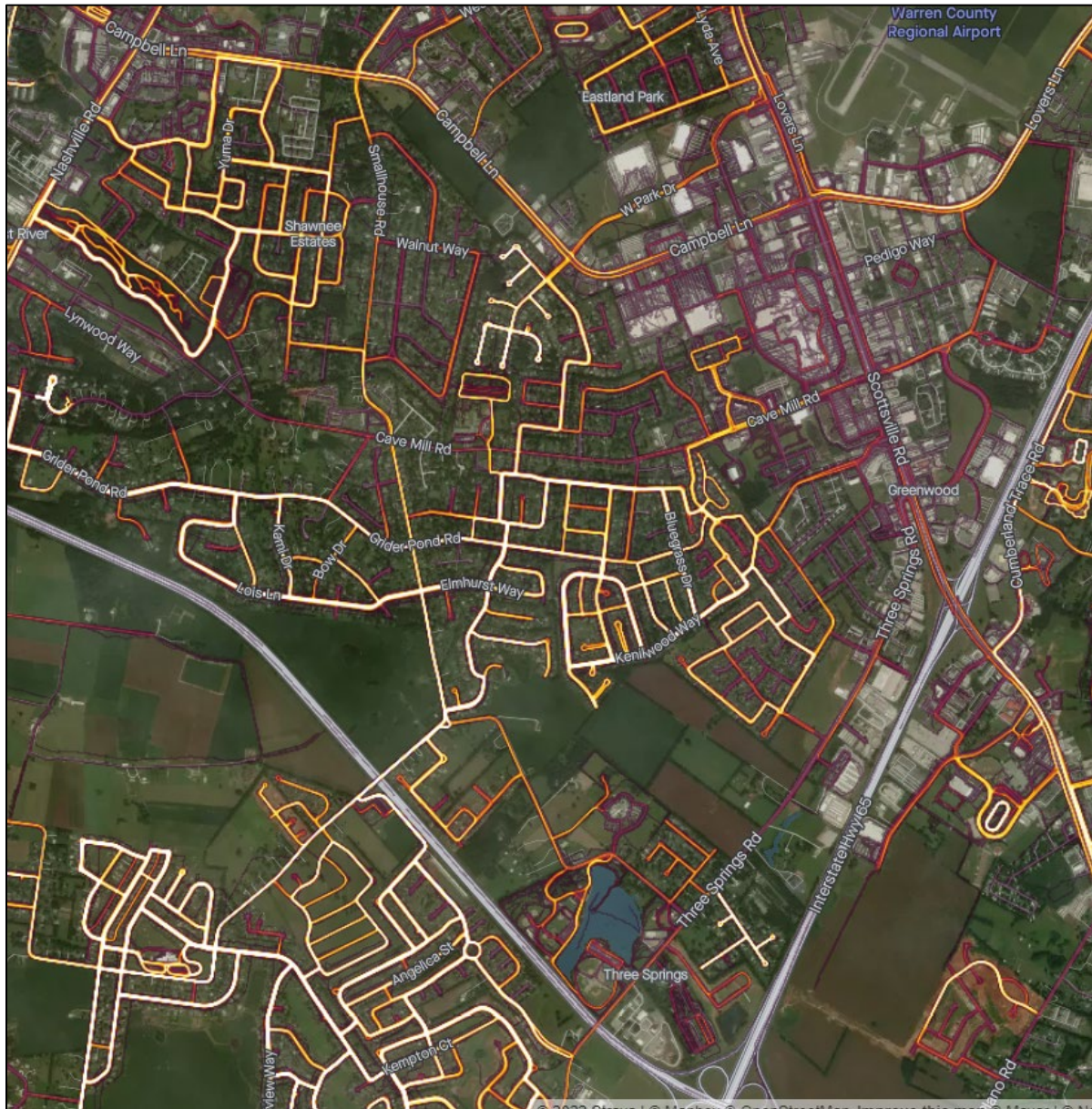
Figure 14. Level of Service of Safety



2.5 Bicycle and Pedestrian Accommodations

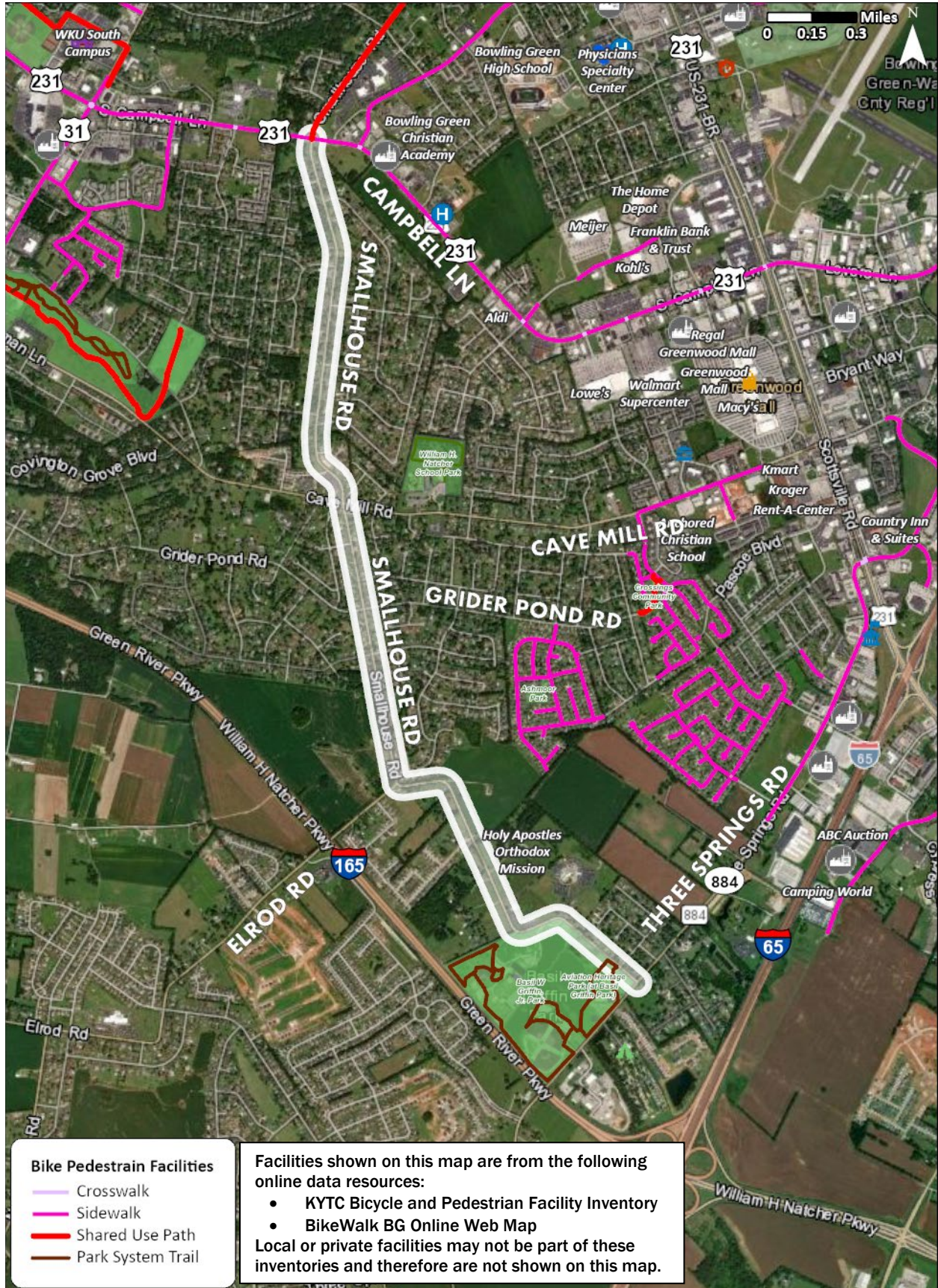
Strava is a social network application for exercise that records activities and allows the user to share them with friends and followers. Data from Strava is available which shows a record of a user’s activity for either biking or walking and displayed as a heat map. **Figure 15** is a heat map of user activity showing where people actively ride their bicycle or walk as recorded through the Strava app. The brighter the color equals more activity. As shown in the figure, there is activity along the corridor, increasing closer to Basil Griffin Park.

Figure 15. Strava Bicycle Data



While the heat map shows some bicycle activity on Smallhouse Road, there is no bicycle or pedestrian accommodation along the corridor within the study area. Most of the activity is east and west of the corridor including several areas with sidewalks, greenways, and trail systems. North of Campbell Lane is a recently constructed shared use path along Smallhouse Road. At the southern end of the corridor is a system of trails through Basil Griffin Park. The location of these features is shown in **Figure 16**. Opportunities to connect Smallhouse Road to these facilities will be explored.

Figure 16. Existing Bicycle and Pedestrian Accommodations



2.6 Summary of Existing Conditions for Intersections and Corridor

The following pages provide an infographic style layout to summarize the collected data discussed in previous sections of this chapter. Pages 30 – 34 provide summaries of the five intersections:

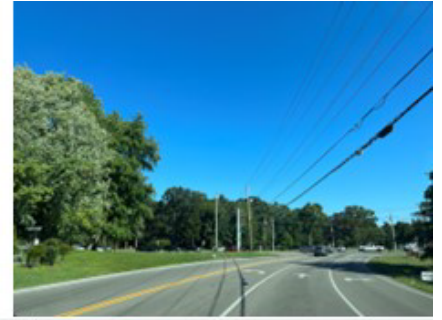
- Smallhouse Road at Campbell Lane (Page 30)
- Smallhouse Road at Cave Mill Road (Page 31)
- Smallhouse Road at Grider Pond Road (Page 32)
- Smallhouse Road at Elrod Road (Page 33)
- Smallhouse Road at Three Springs Road (Page 34)

A summary of existing conditions for the corridor is on Page 35.

1

Smallhouse Road at Campbell Lane

2022 Existing Conditions



Geometrics

Smallhouse Rd

Campbell Ln

Urban Major Collector

Functional Classification

30

Approach Speed

City

Ownership

Urban Principal Arterial

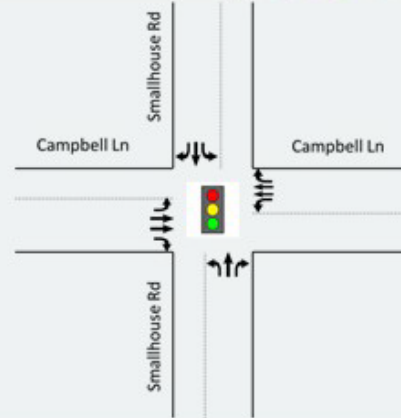
Functional Classification

35 / 45

WB / EB Approach Speed

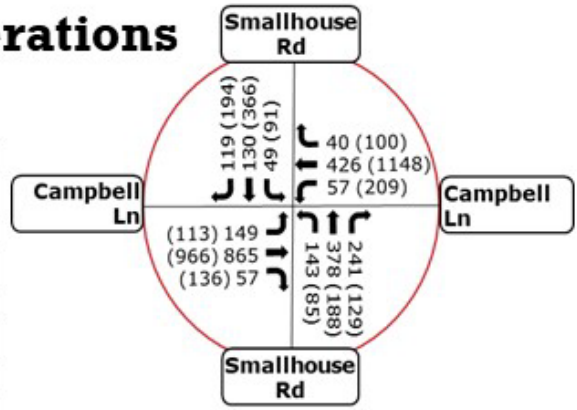
KYTC

Ownership



Traffic Volumes and Operations

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)
AM	Eastbound (Campbell)	C (33.8)	C (23.3)
	Westbound (Campbell)		C (21.4)
	Northbound (Smallhouse)		D (52.2)
	Southbound (Smallhouse)		D (45.9)
PM	Eastbound (Campbell)	D (42.4)	C (29.6)
	Westbound (Campbell)		C (27.6)
	Northbound (Smallhouse)		E (68.4)
	Southbound (Smallhouse)		F (83.1)

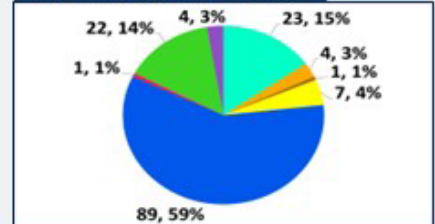


Crash Analysis

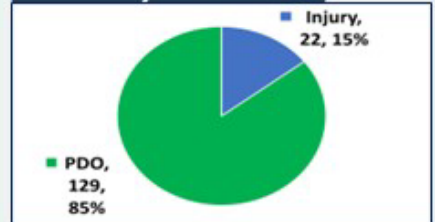
- ANGLE
- BACKING
- HEAD ON
- OPPOSING LEFT TURN
- REAR END
- REAR TO REAR
- SIDESWIPE - OPPOSITE DIRECTION
- SIDESWIPE - SAME DIRECTION
- SINGLE VEHICLE



Manner of Collision



Severity



2

Smallhouse Road at Cave Mill Road

2022 Existing Conditions



Geometrics

Smallhouse Rd

Cave Mill Rd

Urban Major Collector

Urban Major Collector

Functional Classification

Functional Classification

30

Approach Speed

35

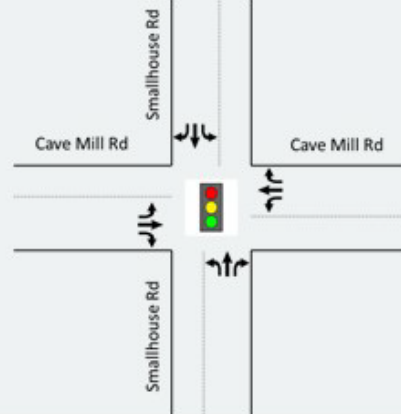
Approach Speed

City

Ownership

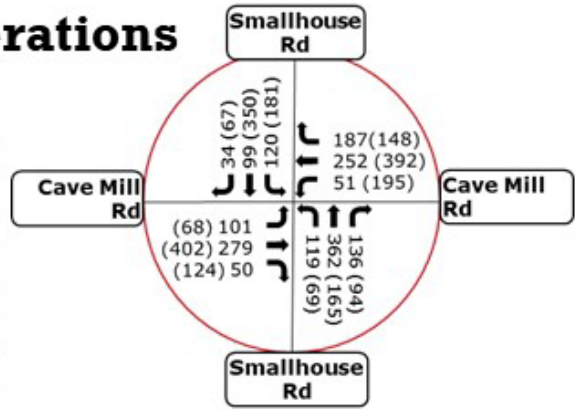
City

Ownership



Traffic Volumes and Operations

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)
AM	Eastbound (Cave Mill)	C (22.4)	C (20.6)
	Westbound (Cave Mill)		C (22.3)
	Northbound (Smallhouse)		C (24.8)
	Southbound (Smallhouse)		B (19.7)
PM	Eastbound (Cave Mill)	D (22.0)	C (23.4)
	Westbound (Cave Mill)		B (19.7)
	Northbound (Smallhouse)		C (20.8)
	Southbound (Smallhouse)		C (24.1)

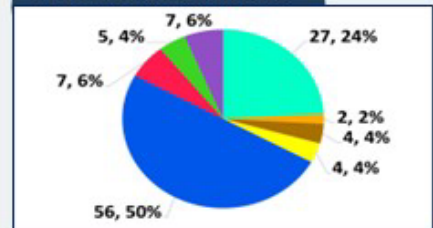


Crash Analysis

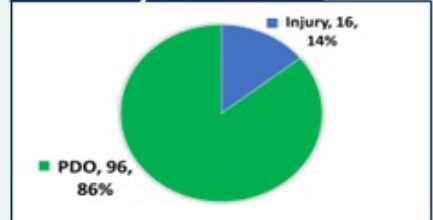
- ANGLE
- BACKING
- HEAD ON
- OPPOSING LEFT TURN
- REAR END
- REAR TO REAR
- SIDESWIPE - OPPOSITE DIRECTION
- SIDESWIPE - SAME DIRECTION
- SINGLE VEHICLE



Manner of Collision



Severity



3

Smallhouse Road at Grider Pond Road

2022 Existing Conditions



Geometrics

Smallhouse Rd

Grider Pond Rd

Urban Major Collector

Local

Functional Classification

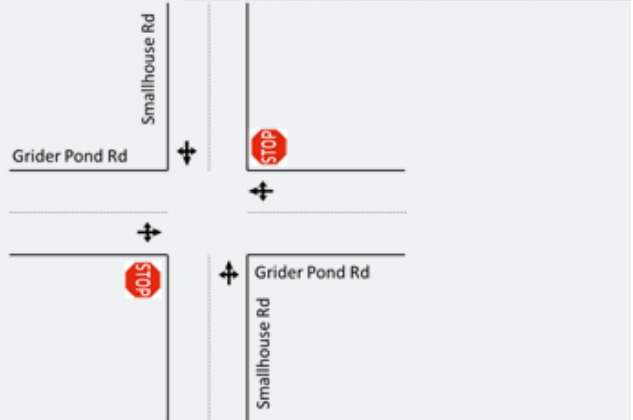
Functional Classification

30
Approach Speed

25
Approach Speed

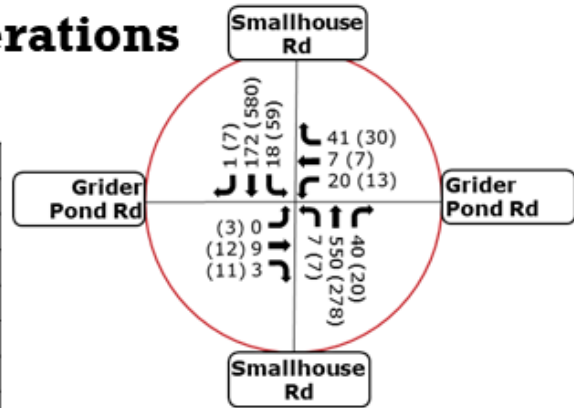
City
Ownership

City / County
Ownership



Traffic Volumes and Operations

Period	Approach	Approach LOS (Delay in Seconds)
AM	Eastbound (Grider Pond)	C (17.2)
	Westbound (Grider Pond)	C (18.7)
	Northbound (Smallhouse)	A (7.6)
	Southbound (Smallhouse)	A (9.1)
PM	Eastbound (Grider Pond)	C (21.4)
	Westbound (Grider Pond)	C (18.7)
	Northbound (Smallhouse)	A (8.9)
	Southbound (Smallhouse)	A (8.1)

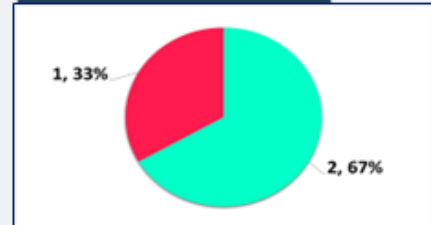


Crash Analysis

- ANGLE
- BACKING
- HEAD ON
- OPPOSING LEFT TURN
- REAR END
- REAR TO REAR
- SIDESWIPE - OPPOSITE DIRECTION
- SIDESWIPE - SAME DIRECTION
- SINGLE VEHICLE



Manner of Collision



Severity



4

Smallhouse Road at Elrod Road

2022 Existing Conditions



Geometrics

Smallhouse Rd

Elrod Rd

Urban Major Collector

Urban Major Collector

Functional Classification

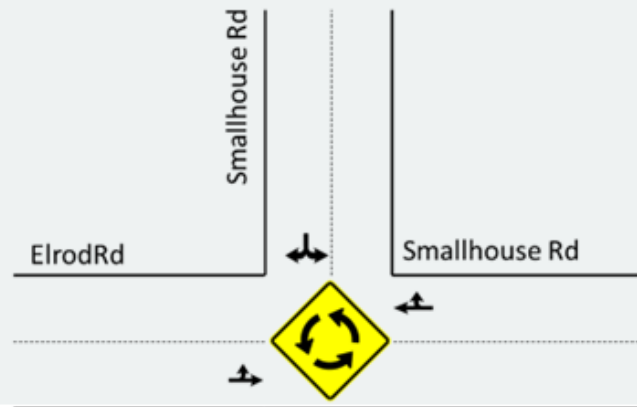
Functional Classification

30
Approach Speed

35
Approach Speed

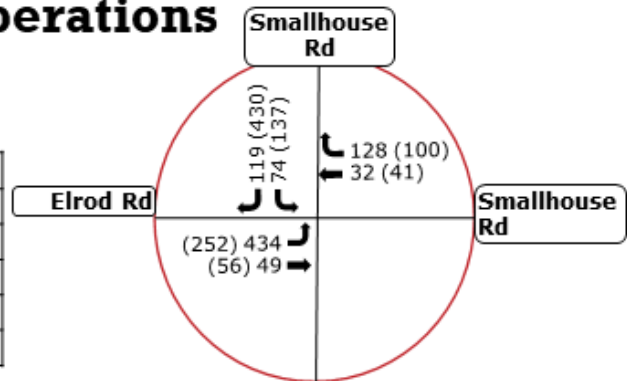
County
Ownership

County
Ownership



Traffic Volumes and Operations

Period	Approach	Overall LOS (Delay in Seconds)	Approach LOS (Delay in Seconds)
AM	Eastbound (Elrod)	A (6.6)	A (7.5)
	Westbound (Elrod)		A (6.9)
	Southbound (Smallhouse)		A (4.2)
PM	Eastbound (Elrod)	A (7.1)	A (6.1)
	Westbound (Elrod)		A (5.1)
	Southbound (Smallhouse)		A (8.2)



AM (PM) Peak Hour Volume

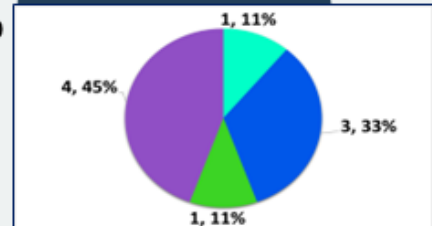


Crash Analysis: Post Roundabout – Oct 2020

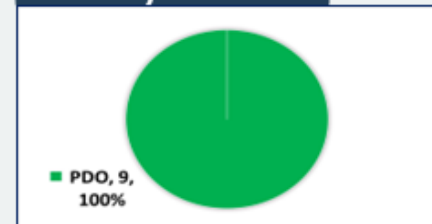
- ANGLE
- BACKING
- HEAD ON
- OPPOSING LEFT TURN
- REAR END
- REAR TO REAR
- SIDESWIPE - OPPOSITE DIRECTION
- SIDESWIPE - SAME DIRECTION
- SINGLE VEHICLE



Manner of Collision



Severity





Smallhouse Road at Three Springs Road

2022 Existing Conditions



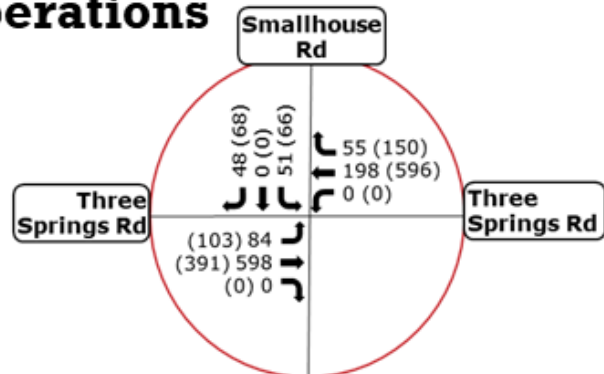
Geometrics

Smallhouse Rd	Three Springs Rd
Urban Major Collector	Urban Major Collector
Functional Classification	Functional Classification
35 Approach Speed	45 Approach Speed
County Ownership	County Ownership



Traffic Volumes and Operations

Period	Approach	Approach LOS (Delay in Seconds)
AM	Eastbound (Three Springs)	A (1.1)
	Westbound (Three Springs)	A (0.0)
	Southbound (Smallhouse)	C (17.3)
PM	Eastbound (Three Springs)	A (2.0)
	Westbound (Three Springs)	A (0.0)
	Southbound (Smallhouse)	D (33.3)



AM (PM) Peak Hour Volume

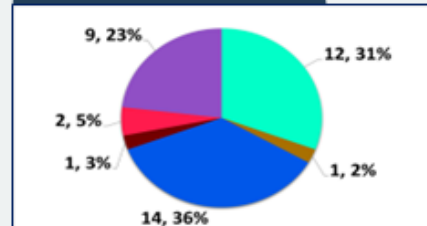


Crash Analysis

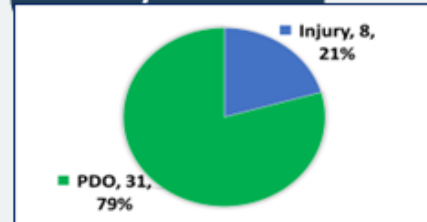
- ANGLE
- BACKING
- HEAD ON
- OPPOSING LEFT TURN
- REAR END
- REAR TO REAR
- SIDESWIPE - OPPOSITE DIRECTION
- SIDESWIPE - SAME DIRECTION
- SINGLE VEHICLE



Manner of Collision



Severity



Smallhouse Road Corridor

Campbell Ln to Three Springs Rd



2022 Existing Conditions



Geometrics

Urban Major Collector
Functional Classification

Two 10' Lanes, No Median, 0'-1' Shoulders
Typical Section

30 / 35 mph
Posted Speed Limit

47 - 49 mph
85th % Speed Limit

City / County
Ownership

50' - 60'
Approximate Right-of-Way



Traffic Volumes and Operations

AADT

- **Three Springs Rd to Elrod Rd:** 3,612 vpd ('19)
- **Elrod Rd to Cave Mill Rd:** 8,233 vpd ('19)
- **Cave Mill Rd to Campbell Ln:** 7,930 vpd ('20)
- **Campbell Ln to Three Springs Rd:** 9,325 vpd ('17)

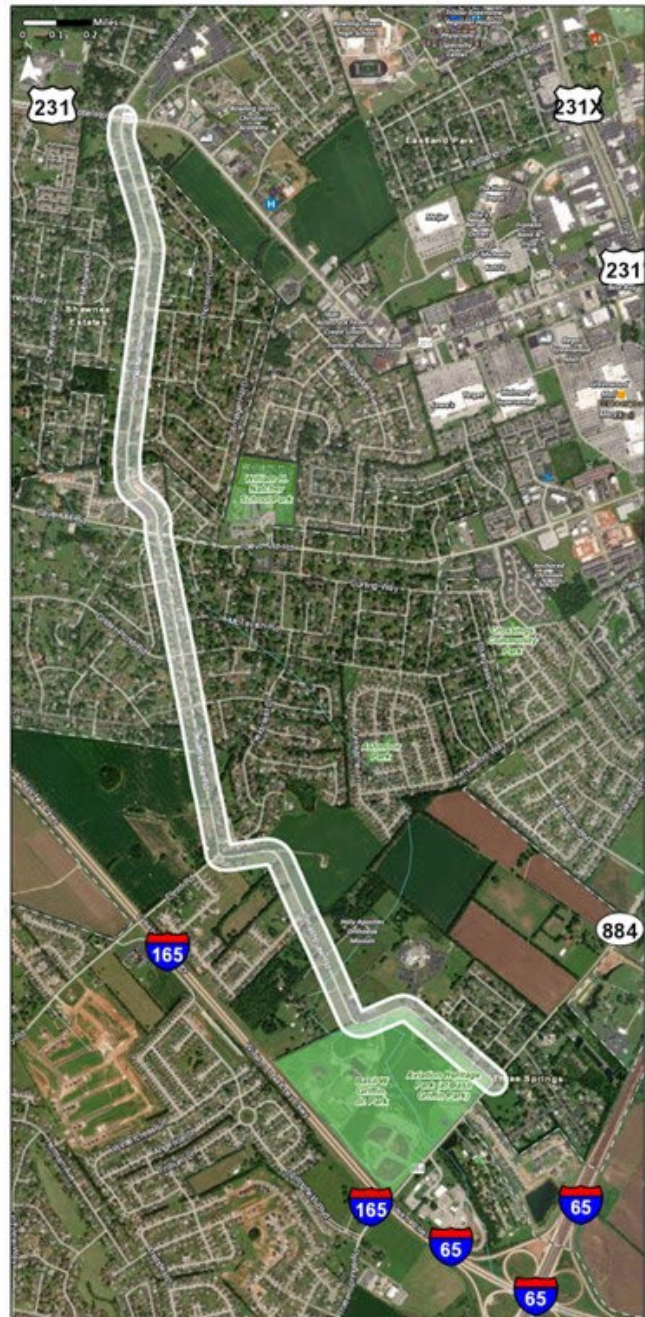
LOS / BLOS

- **Three Springs Rd to Elrod Rd:** LOS A / BLOS E
- **Elrod Rd to Cave Mill Rd:** LOS D / BLOS E
- **Cave Mill Rd to Campbell Ln:** LOS E / BLOS E
- **Overall LOS:** LOS C / BLOS E
- **Overall Delay:** 25 sec/veh



Crash Analysis

- Several Single Vehicle Crashes at sharp curves including injury collisions.
- High Rear End and other intersection related crashes on segment between Cave Mill Rd and Campbell Ln due to higher volumes and access points.



Chapter 3 – Environmental Overview

An Environmental Overview was conducted to identify resources and potential issues for consideration during the development of improvement concepts. Natural and human environmental resources were identified from a literature/database review. Study area environmental resources are summarized in the following sections with supplemental mapping and resources included in **Appendix B**.

3.1 Natural Environment

Streams and Wetlands

There are no identified streams that cross this portion of Smallhouse Road. There are a few wetlands near the study area, with the largest being a lake at Basil Griffin Park. An underground conduit (i.e., Karst topography) can be found in multiple areas. There is a Special Use Water Area in the south on Three Springs Road.

Floodplains

Smallhouse Road is in the Lost River Rise Spring, which is designated as non-supportive for primary contract recreation. Smallhouse Road has Zone A Flood Hazard areas near Grider Pond Road and Basil Griffin Park. Zone A refers to a flood zone that is a low-lying area close to lakes, ponds and other large bodies of water with a 1% annual chance of flooding (100-year flood or base flood).

Prime Farmland

Prime Farmland can be found in the southern portion of the study area between Basil Griffin Park and Lois Lane.

Critical and Endangered Species

Warren County is listed as a Critical Habitat for the Indiana Bat. Other Threatened and Endangered species with the potential to be in the project area are listed in **Table 5**.

Table 5. Threatened / Endangered Species

Common Name	Scientific Name	Status
Gray Bat	<i>Myotis grisescens</i>	Endangered
Indiana Bat	<i>Myotis sodalis</i>	Endangered
Northern long-eared bat	<i>Myotis septentrionalis</i>	Endangered
Round Hickorynut	<i>Obovaria subrotunda</i>	Threatened
Clubshell	<i>Pleurobema clava</i>	Endangered
Fanshell	<i>Cyprogenia stegaria</i>	Endangered
Longsolid	<i>Fusconaia subrotunda</i>	Threatened
Pink mucket	<i>Lampsilis abrupta</i>	Endangered
Rabbitsfoot	<i>Quadrula cylindrica cylindrica</i>	Threatened
Ring pink	<i>Obovaria retusa</i>	Endangered
Rough pigtoe	<i>Pleurobema plenum</i>	Endangered
Kentucky cave shrimp	<i>Palaemonias ganteri</i>	Endangered
Price's potato-bean	<i>Apios priceana</i>	Threatened

The Whooping Crane (*Grus Americana*) and Monarch Butterfly (*Danaus plexippus*) are noted as “experimental population, non-essential and candidate species” and therefore do not yet require surveys.

3.2 Human Environment

The human environment typically refers to the built environment or the communities where we live. It includes elements such as land use, community features, and historic districts and properties.

Land Use

The land adjacent to Smallhouse Road within the study area is primarily zoned as residential and agricultural. The residential zoning on either side of Smallhouse Road extends from south of Campbell Lane to Elrod Road with an additional area northeast of the intersection with Three Springs Road. Agricultural zoning is found south of Elrod Road to Parkside Lane.



Community Features

Several community features are located along Smallhouse Road or are directly accessed by this route. These include:

Churches

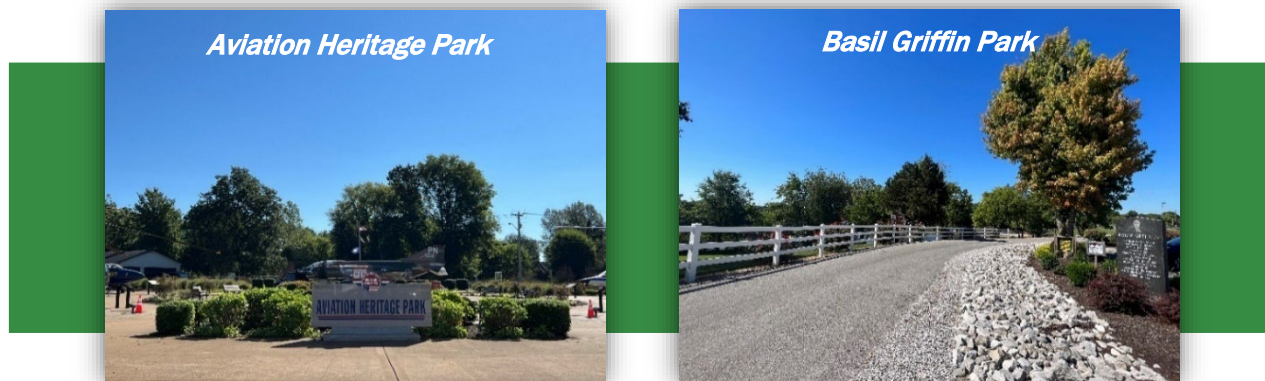
- Calvary Baptist Church
- Cave Mill Baptist Church
- The Church of Jesus Christ of Latter-day Saints
- Holy Apostles Orthodox Church
- Holy Spirit Catholic Church
- Lakeview Fellowship
- Living Hope Baptist Church
- Three Springs Baptist Church

Schools

- Bowling Green Junior High School
- William H. Natcher Elementary
- Bowling Green Christian Academy
- Foundation Christian Academy
- Smart Start Academy

Recreation

- Basil Griffin Park (additional protections should be considered relative to Section 6(f) of the Land and Water Conservation Act)
- Aviation Heritage Park



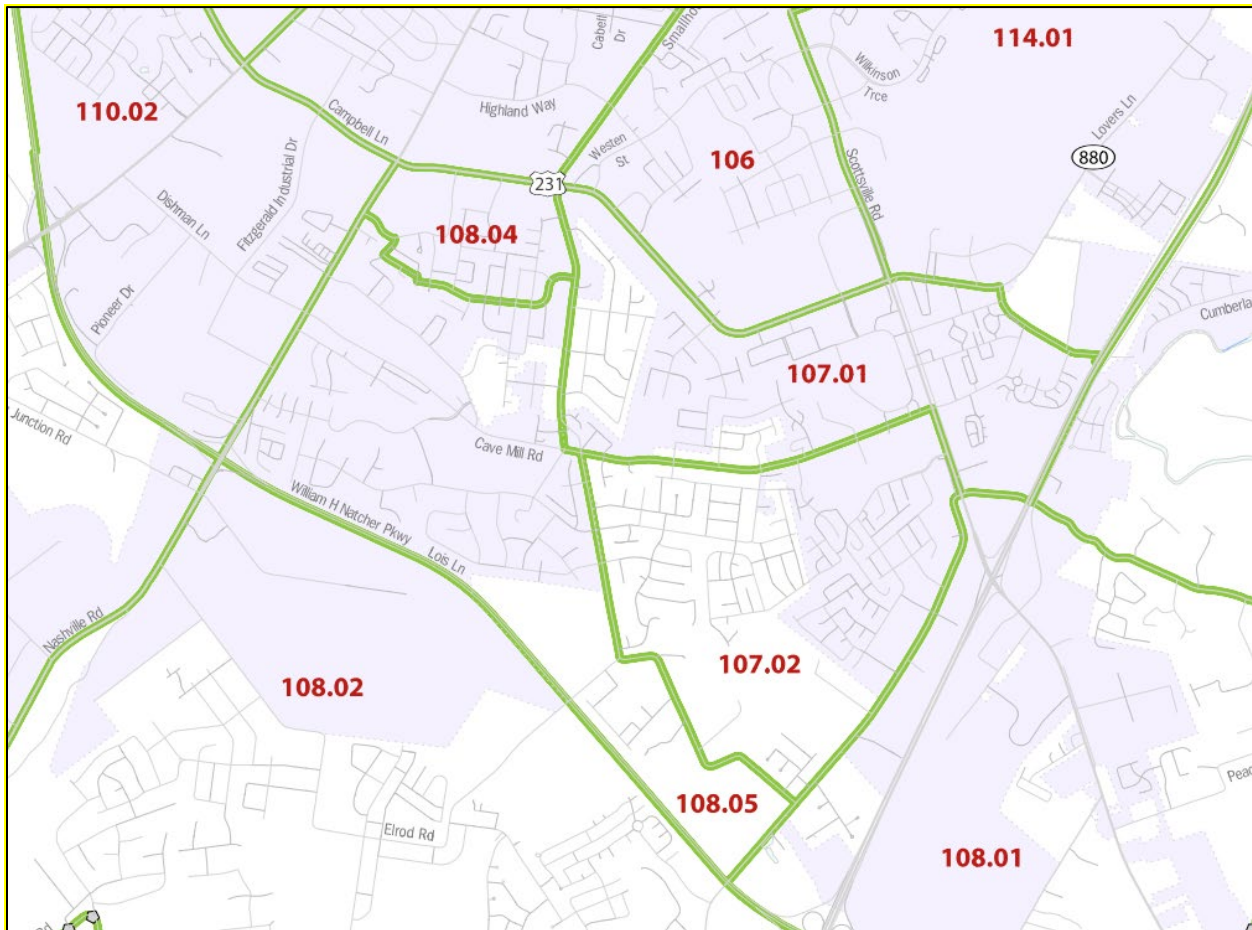
Cultural Resources

There are no identified National Register Historic Places located near the study area.

3.3 Socioeconomic Study

Socioeconomic Environmental Justice data is available through the [Warren County Planning Commission's GIS website](#) located on the EJSreen. Information collected at this stage is to assist the Steering Committee and subsequent users of the study in making informed and prudent transportation decisions in the study area with regard to the requirements of Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (signed February 11, 1994). Statistics are provided on rates of minority, low-income, unemployment, elderly, disabled, limited English proficiency, and education based on 2021 Socioeconomic indicators. There are four US census tracts within the study area from Three Springs Road to Campbell Lane (see **Figure 17**). **Table 6** shows the percentile ranges for each. Census Tract 108.04, near Shawnee Estates, was above the 80th Percentile for Low Income, Less than High School Education, Linguistically Isolated, and was in the 75th Percentile for Unemployment Rate. Census Tract 107.01, in the northeast portion of the study area, was in the 81st Percentile for Over Age 64, and 73rd Percentile for Unemployment.

Figure 17. Study Area US Census Tracts



Source: [2020 US Census - Census Tract Reference Map](#)

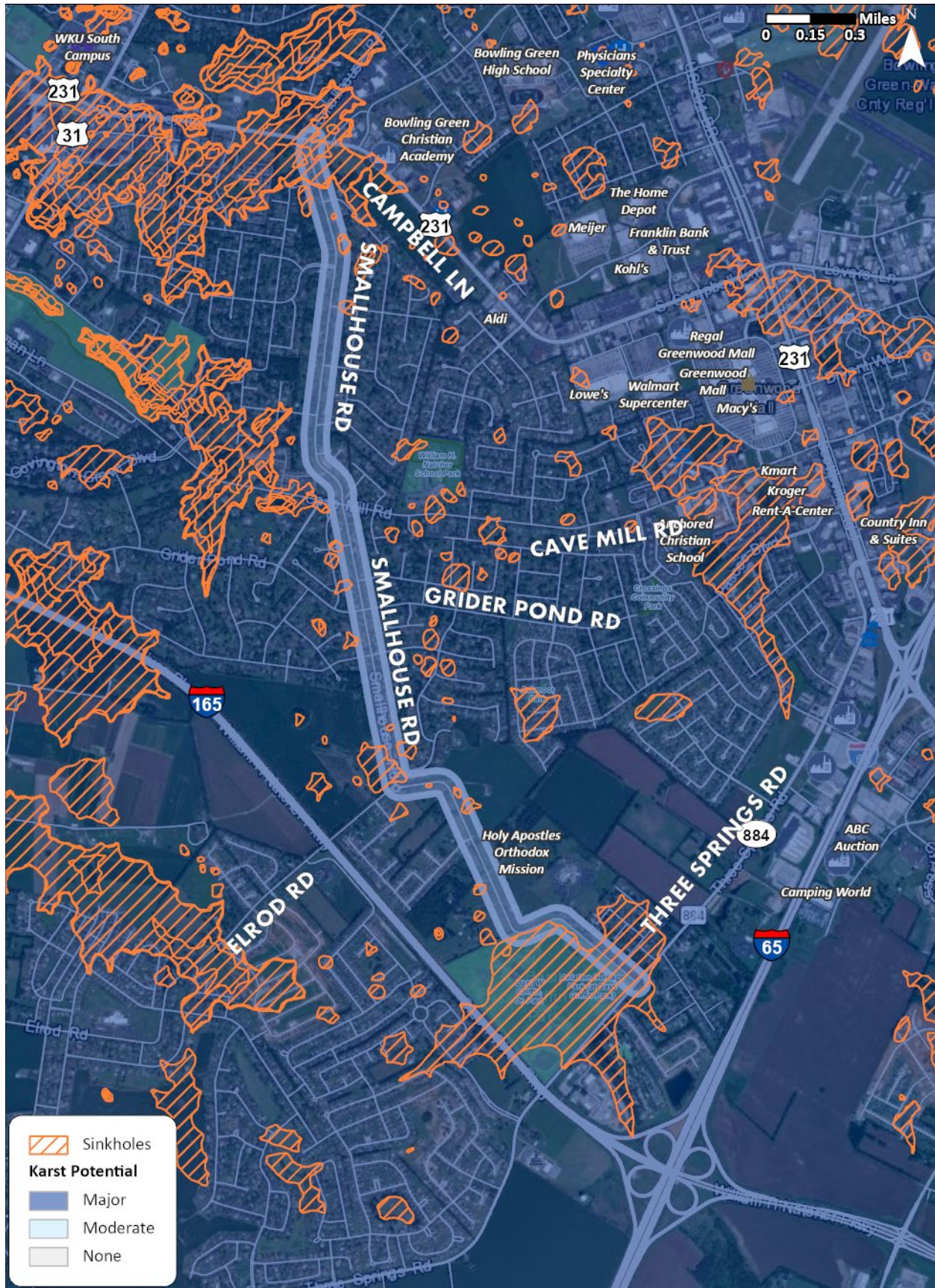
Table 6. Summary of Socioeconomic Data

Population Group	Percentile			
Census Tract	107.01	107.02	108.04	108.05
People of Color	19	29	34	35
Low Income	31	21	95	65
Less Than High School Education	28	33	80	62
Linguistically Isolated	67	64	84	68
Over Age 64	81	75	31	62
Unemployment Rate	73	31	75	42

Chapter 4 – Geotechnical Review

Smallhouse Road is located in the Pennyroyal Sinkhole Plain landform. This landform is comprised of rolling hills and flat agricultural land. The Sinkhole Plain is characterized by extensive Karst geology and related underground stream networks. As shown in **Figure 18**, the entirety of Smallhouse Road has a high potential for Karst. In addition, there are a number of identified sinkholes that could impact future projects. Factors in construction with these features includes unpredictable grading and development costs; vulnerability to groundwater contamination; and, increased susceptibility to flooding and soil erosion.

Figure 18. Geophysical Features



Chapter 5 – Community Engagement

During the course of the study, multiple outreach and collaborative meetings were held. These include:

- **Steering Committee Meetings:** Three meetings were held with the Steering Committee which consisted of BG-WC MPO, CCPC of Warren County, Warren County Public Works, City of Bowling Green, and KYTC District 3 personnel. These meetings were conducted to discuss study progress and next steps. Summaries of the meetings are provided in **Appendix C** for reference.
- **Community Survey:** An interactive online survey published during the beginning stages of the study to gauge the desire and needs of the local community for improvements to Smallhouse Road.
- **Public Meeting:** An open house style meeting to inform attendees about the study and provide an opportunity to collect feedback on improvement concepts.

5.1 Community Survey

The Community Survey served as the initial introduction of the public to the study. A postcard was developed to provide context for the study and included a link to the online survey. A copy of the postcard is included in **Appendix C**. The postcard was sent out to mail delivery routes adjacent to the study area via Every Door Direct Mailer (EDDM) which is a bulk-rate delivery service offered by the United States Postal Service (USPS). The routes are highlighted in blue in **Figure 19**. This resulted in a total of 4,229 postcards distributed along and in the vicinity of the study area. Postcards were sent out on December 14, 2022. The online survey was open from December 14, 2022 through January 14, 2023. A total of 280 people completed the survey. **Figure 20** shows the response rate by day for the survey.

Figure 19. Community Survey Distribution Map

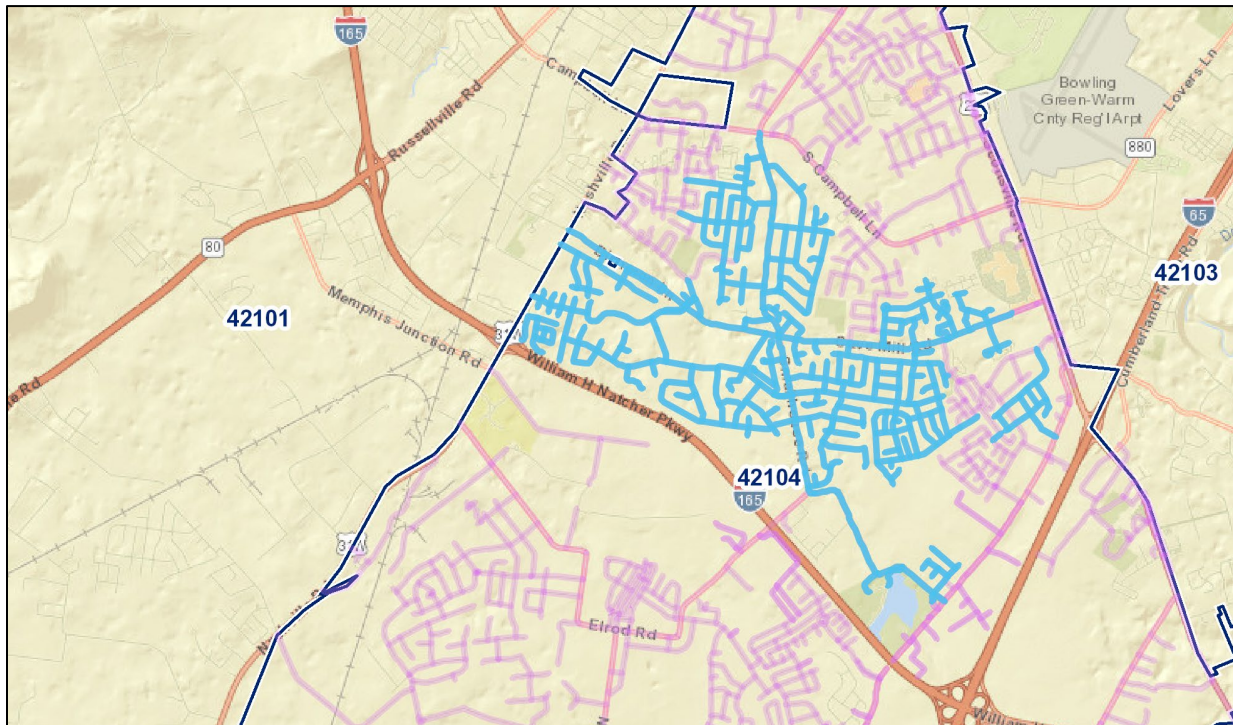
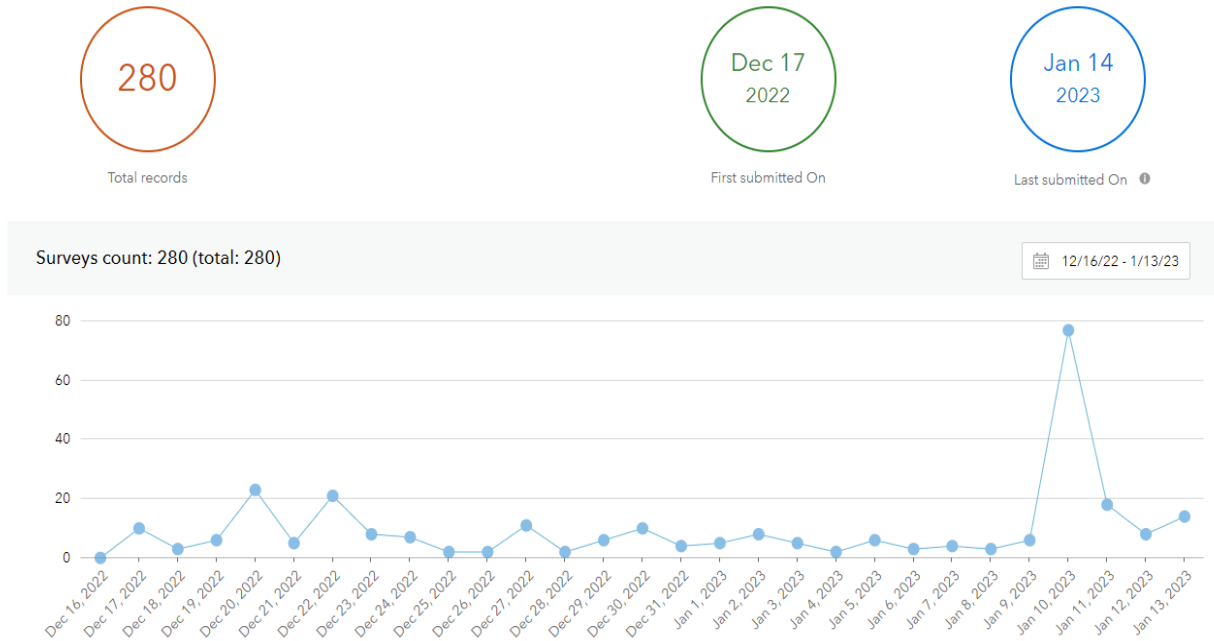


Figure 20. Community Survey Response Rate



An increase in responses is shown between January 9 and January 11, 2023 as a result of additional outreach through emails to schools and churches located in close proximity to the study area. These include:

Churches:

- Holy Spirit Catholic Church (direct through email)
- Lakeview Fellowship (via website)
- Holy Apostles Orthodox Church (via website)
- Living Hope Baptist Church (direct through email)
- Calvary Baptist Church (direct through email)

Schools:

- Bowling Green Junior High School (direct through email)
- William H. Natcher Elementary (direct through email)

A detailed summary of information received from the online survey is included in **Appendix C**. The survey focused on identifying needs by users and assessing the willingness of the users to accept tradeoffs for competing needs. This information helped inform the next phase of the study – improvement concept development. The top answers provided in the survey by question include:

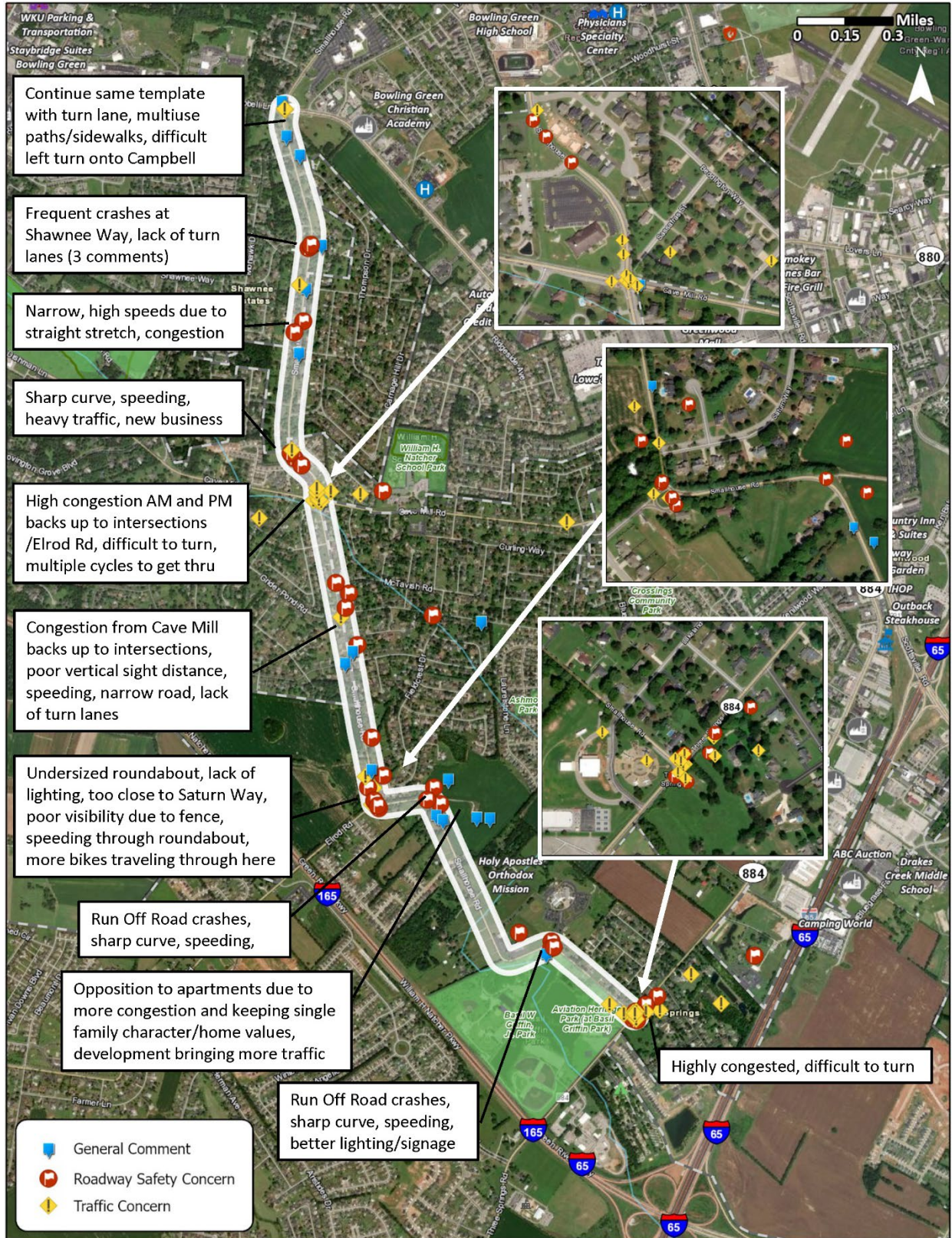
- Addressing safety is the most important of criteria to consider for improvements to the corridor.
- Congestion, followed by narrow shoulders and lack of turn lanes, are priority concerns.
- Cave Mill Road is the intersection most respondents would like to see improved.

A series of tradeoff questions were posed to help gauge desires of improvements relative to impacts. The following represents the majority opinion for each.

- Provide a balanced mix of better traffic flow versus local access.
- Prefer higher-cost, major, long-term improvements over lower-cost, minor, short-term improvements.
- Provide a balanced mix of fixing existing issues versus planning for future needs.
- Provide additional pavement width for vehicles and / or sidewalks, bike paths, or Multi-Use Paths.
- Open to consideration of new designs / non-traditional improvement concepts.

At the end of the survey, participants were able to place markers for locations of traffic operations concerns, safety concerns, or general comments. An overview map showing the distribution of location identifiers and summarized public comments is provided on **Figure 21**.

Figure 21. Community Survey Interactive Comment Map Summary



5.2 Public Meeting

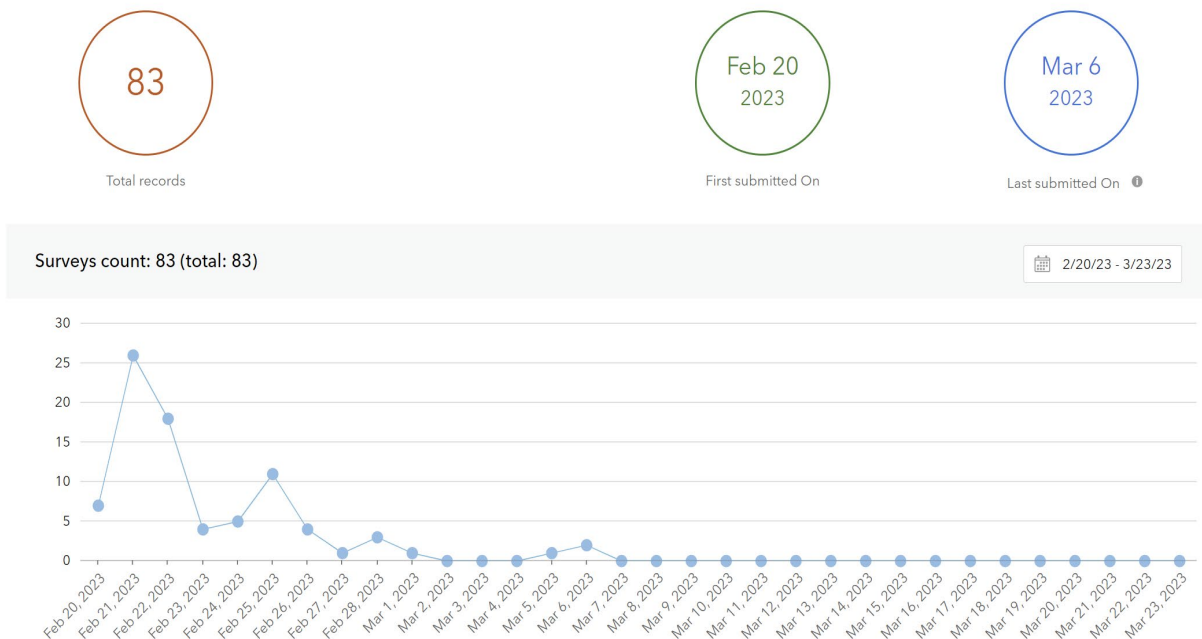
The public meeting was the second opportunity for residents and users of the corridor to provide input on the study. It was held at the Holy Spirit Catholic Church on February 20, 2023, from 5:30 – 7:00 PM (Central Time). A flyer was developed to share details about the public meeting. A copy of the flyer is included in **Appendix C**. The flyer was sent via email to all participants in the Community Survey that provided contact information, to local schools and churches, and posted on the MPO website. In addition, local media advertised the public meeting (WKBO). Finally, three variable message signs were stationed strategically along the corridor. A total of 217 people attended the open house style public meeting. Approximately twenty percent (42) of attendees have an address directly on Smallhouse Road.

Attendees were shown exhibits displaying the following:

- Goals and Objectives
- Study Area
- Crash Distribution
- Existing Bicycle / Pedestrian Network
- Community Survey Summary
- Existing Traffic Operations (Simulation shown on loop on screen)
- Spot Improvement locations and draft concepts
- Corridor draft concepts

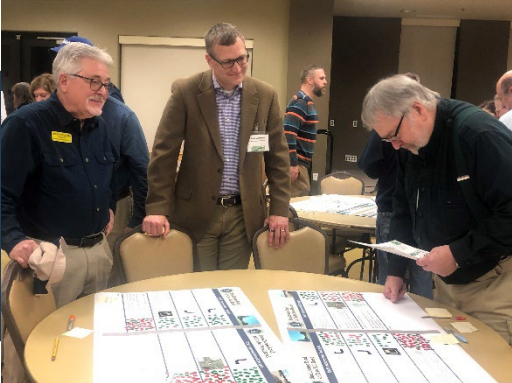
Attendees were given red and green stickers to place next to improvement concepts they liked as well as disliked. For those unable to attend or needed extra time to provide input, an online survey was available from February 20, 2023, through March 6, 2023. During that time there were 83 responses. **Figure 22** shows the response rate by day for the survey.

Figure 22. Public Meeting Survey Response Rate



Smallhouse Road Study

A summary of input from the meeting and survey is included in **Appendix C**. Input on concepts and corridor treatments is included later in this report during the discussion of improvement concept development and analysis.



Chapter 6 – Future Year (2045) Traffic Forecast

For evaluation of future traffic operation along Smallhouse Road and the major intersections, traffic volumes were forecasted to the future year of 2045 (year determined by the Steering Committee).

The first step in determining appropriate growth rates to apply to existing volumes was to review projects and development with the potential to impact growth over the next twenty plus years. Previous studies and identified / planned projects were presented at the beginning of this report (Chapter 1). This information was reviewed to determine which transportation improvement projects would result in changes in capacity and / or traffic flow. The BG-WC MPO also provided major potential development / land use changes. This review resulted in the following as having direct impacts on growth:

- Item No. 3-8707.00 in the CHAF database - construct a new interchange on the Natcher Parkway at Elrod Road in Bowling Green (MP 3.4 to MP 4.0).
- Talbott Place, Inc made a motion at the November 17, 2022, Planning Commission meeting for a 48.72 tract zone change at 4100 Smallhouse Road from agriculture to single family and townhouse / multi-family residential. Initially denied re-zoning at meeting. It is likely development may be approved in the future with a lower density (possible density may be seven units per acre).

Several sources / tools were considered in conjunction with this information to develop growth rates. These include:

- Historical traffic growth analysis (KYTC Traffic Count Reporting System)
- Population trends and projections (Kentucky State Data Center)
- Bowling Green – Warren County Regional Travel Demand Model (BG-WC TDM)

Historical Traffic Growth Analysis

Linear trendline growth rates were determined based on traffic growth analysis within the study area. This analysis utilized traffic counts obtained from KYTC's traffic database and included counts from 2007 to 2022. A spreadsheet was developed which analyzed growth trends based on linear equations. The presented trendline growth rate is a best fit line based on AADTs from the past 15 years. Please note – data from the year 2020 was removed from consideration due to atypical traffic patterns during the COVID-19 Pandemic.

Based on this data, the growth rates identified for each segment within or adjacent to the study area are shown in **Table 7**.

Population Trends and Projections

Population data was obtained from the Kentucky State Data Center for Warren County and Kentucky. **Table 8** displays recent census data as well as population projections. As shown in the table, Warren County is expected to continue to grow at a high pace at 44.6% growth between 2020 and 2050, which is much higher than the state average at 6.2%.

Table 7. Trendline Growth Rates

Station	Route	Projected Growth Rate	# Counts	Most Recent Count Year
114559	Three Springs Road West	1.60%	5	2021
114A69	Three Springs Road East	2.44%	2	2017
114D1 2	Smallhouse Road	4.87%	3	2019
114C66	Elrod Road	1.11%	3	2021
114C62	Smallhouse Road	6.60%	3	2019
114C10	Cave Mill Road East	1.16%	3	2017
114C11	Cave Mill Road West	0.10%	3	2017
114C09	Smallhouse Road	1.24%	3	2017
114C60	Campbell Lane East	-0.51%	11	2021
114C61	Campbell Lane West	0.00%	11	2019
114C07	Smallhouse Road	-0.46%	4	2019

Table 8. Population Growth

Area	2010 Census	2020 Census	2030 Projection	2040 Projection	2050 Projection	% Growth (2020 - 2050)
Kentucky	4,339,367	4,505,836	4,641,150	4,721,118	4,785,233	6.2%
Warren Co.	113,792	134,554	156,715	181,295	194,531	44.6%

Bowling Green – Warren County Travel Demand Model

KYTC provided growth information from the BG-WC TDM with a base model year of 2018 and future year of 2045. KYTC coded the new interchange at I-165 and Elrod Road per exhibits provided for conceptual design in 2015. The conceptual design also included a parallel route to Smallhouse Road south of Elrod Road connecting to Three Springs Road north of the existing intersection (see concept figure in **Appendix D**). Two scenarios were created for future year growth – with and without the interchange. **Table 9** shows the overall growth rates for each location based on these model runs.

Table 9. Growth Rates from BG-WC TDM

Location	Segment	2045 No Interchange Model Output	2045 With Interchange Model Output
Campbell Lane to Cave Mill Road	Homestead Court	1.8%	1.7%
	Campbell Lane	1.9%	1.8%
	Shawnee Way	2.3%	2.2%
	Fleenor Way	2.3%	2.3%
Cave Mill Road to Elrod Road	Cave Mill Road	2.9%	2.3%
	Grider Pond Road	3.7%	3.6%
	Lois Lane	8.0%	7.9%
	North of Elrod Road (North of Connector)	5.1%	5.5%
	North of Elrod Road (South of Connector)	5.1%	-0.4%
Elrod Road to Three Springs Road	South of Elrod Road	4.8%	7.2%
	North of Three Springs Road	2.8%	-0.2%

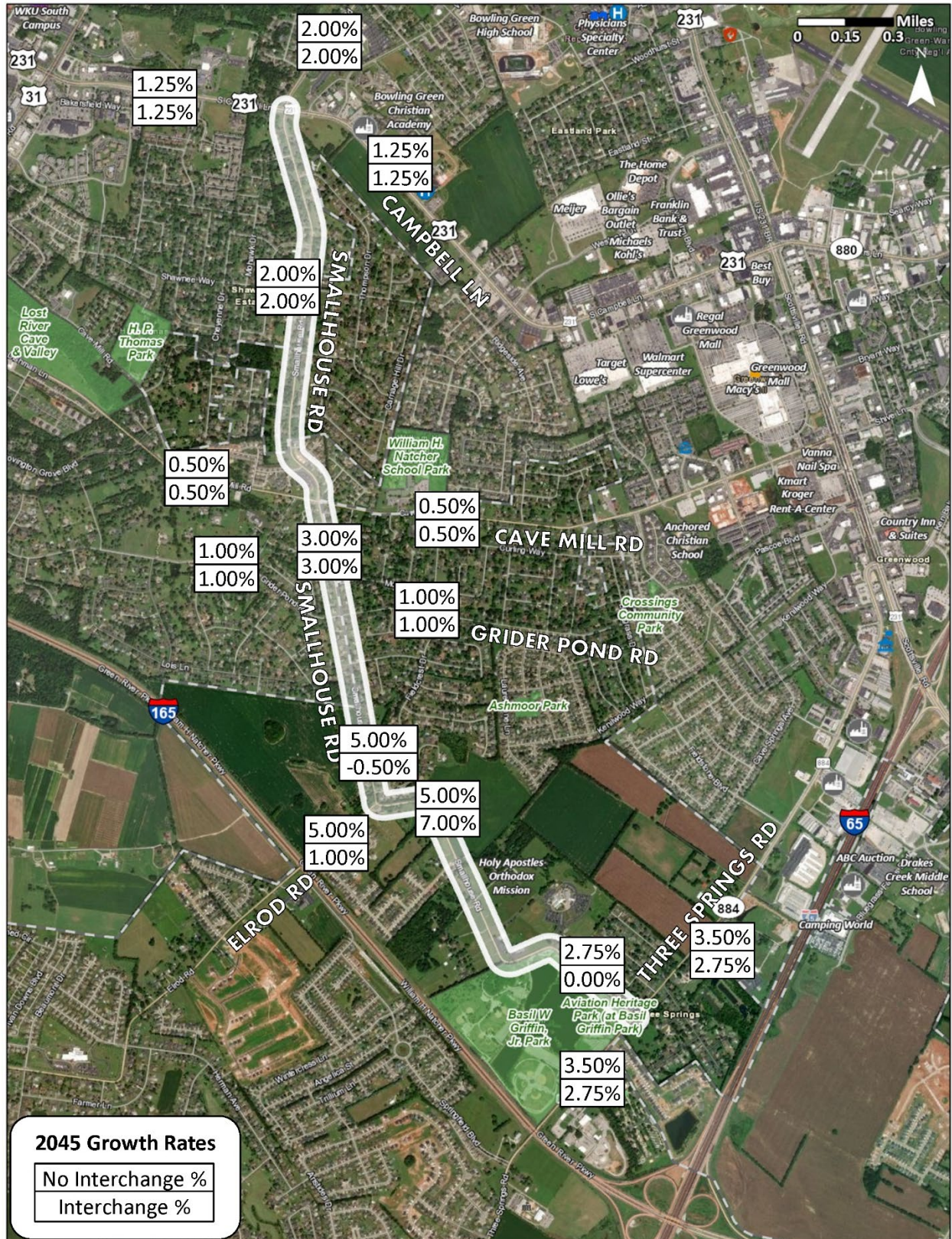
North of Elrod Road, both scenarios have similar growth patterns. The introduction of the new interchange and connector route decreases traffic just north of the existing Elrod Road roundabout and shows increases in traffic just south of the roundabout.

Growth Rate Selection

With this information, multiple growth rates were selected to reflect identified growth patterns along the corridor and side streets. **Figure 23** shows the resulting growth rates. Most traffic growth rates per year are in the range of 0 – 2% per year. Incorporating the data from the historical traffic growth and high population growth, the Steering Committee was in agreement with the range of 2% - 5% growth without the interchange and -0.5% to 7% with the interchange.

Supplemental figures and more detailed growth information is included in **Appendix D**. The resulting turning movement volumes at each major intersection are included in the same appendix. These volumes are used to help develop and evaluate improvement concepts.

Figure 23. Growth Rates



Chapter 7 – Intersection / Spot Improvement Concepts

Chapter 7 is the first of two chapters devoted to the development and analysis of improvement concepts. The improvement concept development methodology is presented along with information collected / analyzed to help with the decision-making process to arrive at a prioritized list of projects. Chapter 7 focuses on spot improvements which include improvements to the study area intersections as well as any other identified individual location with needs for improvement. Chapter 8 focuses on the corridor to arrive at a plan for improvements to the typical section. While ultimately all improvements proposed and recommended are intended to work together for a cohesive master plan for Smallhouse Road, the development and analysis discussion is presented by improvement type for organizational purposes.

In this chapter, the process is summarized for the identification of where improvements may be beneficial, along with the development of improvement concepts for the identified locations. The existing conditions analysis and coordination with the Steering Committee and public informed and guided the development and evaluation of improvement locations and concepts.

7.1 Identification of Intersection / Spot Improvement Locations

At the outset of the study, five priority intersections were identified for evaluation. These include:

1. US 231 (Campbell Lane)
2. Cave Mill Road
3. Grider Pond Road
4. Elrod Road
5. KY 884 (Three Springs Road)

These formed the first list of locations to be considered for evaluation and development of improvement concepts.

Further review throughout the corridor was performed to identify other additional minor intersections / spots with opportunity for improvements. Considerations included:

- Geometric data (horizontal or vertical curvature issues)
- EEC data (LOSS 3 or 4 locations)
- Public response (Community Survey)
- Traffic operations analysis

Four additional locations were identified through this process.

6. Shawnee Way
7. Curve Near Cave Mill Road
8. Curve Near Elrod Road
9. Curves by Basil Griffin Park

Shawnee Way at Smallhouse Road is a Stop-controlled intersection on the minor approach (Shawnee Way) that provides access to Shawnee Estates (identified as a location of potential Environmental Justice populations). Input from the Community Survey noted multiple crashes have occurred at this intersection along with difficulty turning into / out of this side street. North and

south of the intersection the EEC values are categorized as LOSS 3. As a result, this intersection was included for consideration of improvements.

Review of the horizontal geometry combined with examination of crash data resulted in identifying three spot locations for improvements. The curve just north of Cave Mill Road ranges from an E to D in degree of horizontal curvature. It also has a LOSS value of 3. The curve just east of Elrod Road has a horizontal degree of curvature of E. Field observation noted damage to the fence line / side of the road from vehicle collisions. The back-to-back curves near the Basil Griffin Park / Holy Spirit Church access have a horizontal degree of curvature of F. There is a reduced speed sign (15 mph) as well as guardrail; however, the guardrail looks to have been repeatedly struck. Feedback from the community also noted difficulty turning into / out of the park. Based on these findings, these three locations were also included for consideration of improvements.

The location of all nine intersections / spots are shown in **Figure 24**.

Figure 24. Intersection / Spot Improvement Locations



7.2 Identification of Intersection / Spot Improvement Concept Options

With a list of possible improvement locations, the next step was to identify potential improvement concept options to address needs. Some additional analysis was performed to assist with the development.

Additional Review of Crash Data / Safety Countermeasures

Detailed crash records were requested from KYTC where the crash types warranted further investigation into potential contributing factors. The locations include:

- Curve Near Cave Mill Road
- Curve Near Elrod Road
- Curves Near Basil Griffin Park

Crash records provided by KYTC were files directly associated with the curve.

There were nine crashes identified within the vicinity of the curve just north of Cave Mill Road during the five-year evaluation period. A review of the associated data and narratives found that five of eight crashes occurred during wet roadway conditions.

Near the curve by Elrod Road, nine crashes occurred during the five-year evaluation period. Most crashes (five) were identified as a sideswipe collision and occurred on wet roadway conditions (seven of nine).

Seven crashes were identified along the curves near Basil Griffin Park during the five-year evaluation period. Of these seven crashes, three were single vehicle crashes with three identified as an angle crash. Over half (four of seven) also occurred during wet roadway conditions.

The additional information from the crash record narratives is helpful to identify potential contributing factors or trends in crashes and use that data to develop improvement concepts. A resource used to translate the trends into improvement concepts is an initiative by the Federal Highway Administration (FHWA) that is a collection of twenty-eight countermeasures and strategies that have been found to be effective in reducing the number and severity of crashes. Using the FHWA Proven Safety Countermeasures website yielded several strategies that are applied to the spot locations.

Turn Lane Evaluation

Grider Pond Road is one of the focus intersections that does not have exclusive turn lanes. As a result, turn lane warrants were conducted to see if current / future year volumes exceed thresholds (indicating turn lanes are warranted). The results are shown in **Table 10**. The highlighted green boxes indicate where the warrant is met.

Table 10. Turn Lane Warrant Analysis – Grider Pond Road

Period	Approach	Turn Lane Direction	Meets Warrant?	
			AM	PM
2022	Smallhouse Road NB	Right	No	No
		Left	No	No
	Smallhouse Road SB	Right	No	No
		Left	No	Yes
	Grider Pond Road EB	Right	No	No
		Left	No	No
	Grider Pond Road WB	Right	No	No
		Left	No	No
2045	Smallhouse Road NB	Right	No	No
		Left	No	No
	Smallhouse Road SB	Right	No	No
		Left	Yes	Yes
	Grider Pond Road EB	Right	No	No
		Left	No	No
	Grider Pond Road WB	Right	No	No
		Left	No	No

Upon examination of the results, a left turn lane is warranted in the southbound direction of Smallhouse Road at this intersection in the PM peak period in 2022 and in both peak periods in 2045.

There are two additional locations where turn lanes may be considered – at the intersection of Smallhouse Road and Shawnee Way and at Basil Griffin Park / Parkside Lane. Turning movement counts were not collected as part of this study, therefore turn lane warrants cannot be evaluated at this time. If turn lanes are considered a recommended improvement at these locations, counts should be collected for further evaluation.

Improvement Concepts

Using the data and additional analysis to further define needs, the following pages list proposed improvement concepts and additional information supporting project need. This information includes relevant traffic and safety analysis along with input from the Community Survey and the public meeting. The green and red dots represent the voting exercise at the public meeting and subsequent online survey where participants were able to “vote” in favor of (green dot) or against (red dot) each concept.





A concept that is becoming increasingly used more in lieu of full roundabouts is a mini-roundabout. The mini-roundabout concept features similar safety and operational benefits of a traditional roundabout with the exception that the center and splitter islands are low-profile and easily traversable. Color or texture treatment may be used for the center island to delineate traffic flow, yet accessible to trucks and large vehicles travelling through the intersection. The footprint of a mini-roundabout typically is within the existing limits of the intersection thereby reducing construction costs and minimizing the need for right-of-way purchase. More information on mini-roundabouts can be found in [Traffic Calming ePrimer of the FHWA Highway Safety Programs](#).

1

Smallhouse Road at Campbell Lane

Draft Improvement Concepts







Traffic		<p>Concept: Extend NB Right Turn Lane</p> <p>Info:</p> <ul style="list-style-type: none"> • Queue Length in AM > available storage • Primary crash type is rear-end (5 of 10 for approach) • Level of Service E for right turns (Scale = A to F) 	<p>Public Input</p> <p>● ●</p> <p>87 4</p> <p>(96%) (4%)</p>
		<p>Concept: Extend WB Right Turn Lane</p> <p>Info:</p> <ul style="list-style-type: none"> • Queue Length in PM > available storage • Primary crash type is rear-end (16 of 28 for approach) • Level of Service C for right turns (Scale = A to F) 	<p>Public Input</p> <p>● ●</p> <p>70 4</p> <p>(95%) (5%)</p>
Safety		<p>Concept: Add Backplates to Signal Heads with Retroreflective Borders</p> <p>Info:</p> <ul style="list-style-type: none"> • Primary crash type is rear-end (89 of 151) • FHWA Countermeasure = 15% reduction in all crashes 	<p>Public Input</p> <p>● ●</p> <p>51 4</p> <p>(93%) (7%)</p>
Geometric	 MUTCD	<p>Concept: Construct Roundabout</p> <p>Info:</p> <ul style="list-style-type: none"> • Helps reduce speeds on approaches serving as a traffic calming measure • FHWA Countermeasure = 78% reduction in fatal and injury crashes (22 of 151 injury crashes; no fatal) 	<p>Public Input</p> <p>● ●</p> <p>51 127</p> <p>(29%) (71%)</p>

2

Smallhouse Road at Cave Mill Lane

Draft Improvement Concepts



Traffic		<p>Concept: Extend WB Right Turn Lane</p> <p>Info:</p> <ul style="list-style-type: none"> • Queue Length in AM equal to available storage • Primary crash type is rear-end (8 of 10 for approach) • Level of Service C for right turns (Scale = A to F) 	<p>Public Input</p> <p>● ●</p> <p>45 10</p> <p>(82%) (18%)</p>
		<p>Concept: Extend SB Right Turn Lane</p> <p>Info:</p> <ul style="list-style-type: none"> • Queue Length in PM equal to available storage • One rear-end and one angle crash on approach • Level of Service C for right turns (Scale = A to F) 	<p>Public Input</p> <p>● ●</p> <p>37 9</p> <p>(80%) (20%)</p>
Safety		<p>Concept: Add Backplates to Signal Heads with Retroreflective Borders</p> <p>Info:</p> <ul style="list-style-type: none"> • Primary crash type is rear-end (56 of 112) • FHWA Countermeasure = 15% reduction in all crashes 	<p>Public Input</p> <p>● ●</p> <p>31 2</p> <p>(94%) (6%)</p>
Geometric	 <p>MUTCD</p>	<p>Concept: Construct Roundabout</p> <p>Info:</p> <ul style="list-style-type: none"> • Helps reduce speeds on approaches serving as a traffic calming measure • FHWA Countermeasure = 78% reduction in fatal and injury crashes (16 of 112 injury crashes; no fatal) 	<p>Public Input</p> <p>● ●</p> <p>43 84</p> <p>(34%) (66%)</p>

3

Smallhouse Road at Grider Pond Road

Draft Improvement Concepts



		Concept: Add SB Left Turn Lane	Public Input
Traffic		Info: <ul style="list-style-type: none"> Warranted per KYTC Turn Lane Calculations Primary crash type is rear-end (3 of 6) FHWA Countermeasure = 28-48% reduction in all crashes 	  57 1 (98%) (2%)
Geometric		Concept: Construct Mini-Roundabout	Public Input
		Info: <ul style="list-style-type: none"> Smaller in size to limit right of way impacts Has mountable central and splitter islands Helps reduce speeds on approaches serving as a traffic calming measure 	  14 61 (19%) (81%)
		Concept: Construct Roundabout	Public Input
	MUTCD	Info: <ul style="list-style-type: none"> Room for larger vehicles in travel lane Large size will impact right of way Helps reduce speeds on approaches serving as a traffic calming measure 	  21 81 (21%) (79%)

4

Smallhouse Road at Elrod Road

Draft Improvement Concepts



Safety

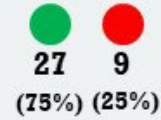


Concept: Reduce Speed with Additional / Enhanced Pavement Markings

Info:

- Optional lane-use arrows / pavement markings may help with direction and use
- Multiple comments in Community Survey about navigation and speed

Public Input

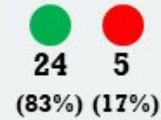


Concept: Enhanced Signage

Info:

- Optional signage may help with direction and use
- Multiple comments in Community Survey about navigation and speeding.

Public Input

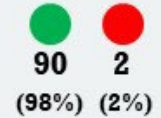


Concept: Add Lighting

Info:

- 4 of 13 crashes were at dusk or night
- FHWA Countermeasure = 33-38% reduction in nighttime crashes

Public Input



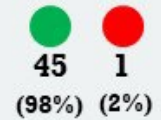
Missouri DOT

Concept: Add Edge Rumble Strips

Info:

- Multiple crashes not reported
- Field review found property damage (fence) from running off road crashes
- FHWA Countermeasure = 16% reduction in run-off road crashes

Public Input



5

Smallhouse Road at Three Springs Road

Draft Improvement Concepts



Geometric



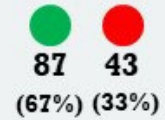
MUTCD

Concept: Construct Roundabout

Info:

- Primary crash type is rear-end / angle
- 8 injury crashes over past 5 years
- Currently in design phase with KYTC
- FHWA Countermeasure = 82% reduction in fatal and injury crashes

Public Input



6

Smallhouse Road at Shawnee Way

Draft Improvement Concepts



Traffic

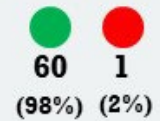


Concept: Add Separate NB Left Turn Lane

Info:

- Community Survey input included 3 comments about frequent crashes and lack of turn lanes
- 6 of 9 crashes were rear-end crashes

Public Input



Geometric

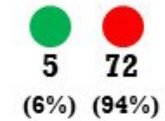


Concept: Construct Mini-Roundabout

Info:

- Smaller in size to limit right of way impacts
- Has mountable central and splitter islands
- Helps reduce speeds on approaches serving as a traffic calming measure

Public Input



7

Smallhouse Road at Curve Near Cave Mill Road

Draft Improvement Concepts



Safety

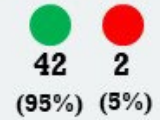


Concept: Add Chevron Signage / Enhanced Signage

Info:

- Horizontal Curve Class E (Scale = A to F)
- Community Survey input noted this was a sharp curve
- Speeding is an issue and there is heavy traffic

Public Input



Concept: Pavement Friction Management

Info:

- 5 of 8 crashes on wet roadway conditions
- FHWA Countermeasure = 48% reduction in injury crashes at horizontal curves

Public Input



8

Smallhouse Road at Curve Near Elrod Road

Draft Improvement Concepts



Safety

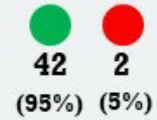


Concept: Add Chevron Signage

Info:

- Horizontal Curve Class E (Scale = A to F)
- 5 sideswipe crashes
- 7 of 9 crashes on wet roadway conditions

Public Input

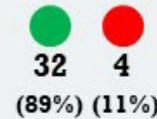


Concept: Tree Trimming to Improve Sight Distance

Info:

- FHWA Countermeasure = ~20% reduction in crashes
- Benefit depends on distance of tree trimming / removal

Public Input



Concept: Pavement Friction Management

Info:

- 7 of 9 crashes on wet roadway conditions
- FHWA Countermeasure = 48% reduction in injury crashes at horizontal curves

Public Input

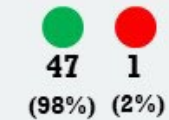


Concept: Geometric Improvements (Realignment / Flatten Curve / Increase Clear Zone)

Info:

- Sharp curve with no room for recovery
- FHWA Countermeasure = 8% - 44% reduction in all crashes depending on the extent of improvements

Public Input



9

Smallhouse Road at Curves by Basil Griffin Park

Draft Improvement Concepts



		Concept:	Info:	Public Input
Traffic		Add Dedicated Left and Right Turn Lanes to Park Access	<ul style="list-style-type: none"> 4 of 7 crashes angle or turn-related FHWA Countermeasure = reductions in all crashes between 28% - 48% for left turn lane installation and 14=26% for right turn lane installation 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> ● 66 (81%) </div> <div style="text-align: center;"> ● 15 (19%) </div> </div>
		Enhanced Signage	<ul style="list-style-type: none"> Horizontal Curve Class F (Scale = A to F) 3 single vehicle & 3 angle crashes 4 of 7 crashes on wet roadway conditions 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> ● 39 (100%) </div> <div style="text-align: center;"> ● 0 (0%) </div> </div>
Safety		Pavement Friction Management	<ul style="list-style-type: none"> 4 of 7 crashes on wet roadway conditions FHWA Countermeasure = 48% reduction in injury crashes at horizontal curves 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> ● 30 (97%) </div> <div style="text-align: center;"> ● 1 (3%) </div> </div>
		Geometric Improvements (Realignment / Flatten Curve / Increase Clear Zone)	<ul style="list-style-type: none"> Sharp curve with no room for recovery FHWA Countermeasure = 8% - 44% reduction in all crashes depending on the extent of improvements 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> ● 49 (100%) </div> <div style="text-align: center;"> ● 0 (0%) </div> </div>

7.3 Revised Improvement Concepts

The spot improvement draft concepts were reviewed by the Steering Committee following the public meeting. Some additional analysis was performed to refine and provide additional information to help with determining recommendations.

Additional context / conceptual layout / phase costs for improvements that would require substantial modifications to the existing configuration and / or geometry are in **Appendix E** for reference.

Future Year (2045) Traffic Operations

At this point in the study, future year (2045) traffic volumes were evaluated to determine how proposed improvement concepts may operate in the long term as well as if there are any additional needs. **Table 11** shows the results of the 2045 traffic analysis. The analysis was prepared for two scenarios – with and without a new interchange at Natcher Parkway / Elrod Road – as previously discussed in Chapter 6 – Future Year (2045) Traffic Forecast.

Several additional improvement concepts were identified through this analysis to help address future traffic growth. These include:

Smallhouse Road at Campbell Lane

- Construct dual westbound left turn lanes with receiving lanes
- Additional thru lanes on Campbell Lane
- One lane versus two lanes for roundabout
- Reroute left turns with new connection at Westen Street

Cave Mill Road

- One lane versus two lanes for roundabout

Smallhouse Road at Elrod Road

- Additional southbound right turn with yielding bypass lane

The intersection of Smallhouse Road at Campbell Lane is expected to have poor LOS and delay in 2045 (LOS E / 72.3 seconds of delay) without any modifications. The concept of adding additional through lanes along Campbell Lane was identified as a potential option to provide more capacity and improve LOS. It will improve LOS from E to D but will require substantial construction and require significant right-of-way. With other options that provide improvements with less costs and impacts, this concept was not evaluated further. The traffic operations analysis for the roundabout options showed future LOS and delay that is more than the No Build. This is likely due to the imbalance in traffic with Campbell Lane carrying approximately double (~31,000 – 35,000 AADT) the traffic volume of Smallhouse Road (~17,000 AADT) in 2045. Both a one lane and two-lane roundabout are LOS F. Therefore these options were also removed from further consideration.

The intersection of Smallhouse Road and Cave Mill Lane is expected to operate at LOS D with a delay of 38.6 seconds in 2045. A roundabout was identified as a potential improvement concept. Future year traffic operations show that a one-lane roundabout will result in a decrease in LOS (LOS F) and more delay (104.6 seconds). A two-lane roundabout was then considered which was found to improve LOS to LOS C with 16.6 seconds of delay. Therefore, the one-lane roundabout was removed from further consideration.

Table 11. Future Year (2045) Traffic Operations

Intersection Spot Improvements	2045 Peak Hour (No Interchange)		2045 Peak Hour (With Interchange)		Notes
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	
1 - US 231 Campbell Lane					
<i>No Build</i>	E	72.3	E	72.3	210 second cycle length (PM Peak).
<i>Signal Phasing / Timing Optimization</i>	D	54.6	D	54.6	130 second cycle length. Not coordinated with US 231 intersections (US 31W, Westen St, etc.).
<i>Construct Dual Westbound Left Turn Lanes with Receiving Lane</i>	D	50.1	D	50.1	270 westbound lefts with only ~300' of storage and no room to extend due to Westen St. Eastbound left 95th % Queue No Build is 340', Build is 205' under optimized timing.
<i>Construct Additional Thru Lanes</i>	D	40.0	D	40.0	1,245 to 1,480 through vehicles. 95th % max through queue is 910' in No Build, 420' in Build under optimized signaling. Would allow shorter cycle length, shortening queues for all movements including westbound left.
<i>Prohibit Left Turns at Campbell Lane by Providing Connection Between a New Intersection on Smallhouse Road and Westen Street</i>	C	33.6	C	33.6	LOS B at new intersection and LOS D at Westen St. For Westen St., balanced volumes with Smallhouse Rd. and assumed moderate traffic in and out of Westen St. and signal timing optimization.
<i>Construct Single Lane Roundabout</i>	F	727.7	F	727.7	Includes yielding right-turn lanes.
<i>Construct Dual Lane Roundabout</i>	F	128.9	F	128.9	Includes additional receiving lanes on Smallhouse Rd. and free flow right-turn bypass lanes for all approaches.

Table 11. Future Year (2045) Traffic Operations (continued)

Intersection Spot Improvements	2045 Peak Hour (No Interchange)		2045 Peak Hour (With Interchange)		Notes
	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	
2 - Cave Mill Road					
<i>No Build</i>	D	38.6	D	38.6	-
<i>Signal Phasing / Timing Optimization</i>	D	36.9	D	36.9	-
<i>Construct Single Lane Roundabout</i>	F	104.6	F	104.6	Includes yielding right-turn lanes on all approaches.
<i>Construct Dual Lane Roundabout</i>	C	16.6	C	16.6	Includes additional receiving lanes on Smallhouse Rd. and Cave Mill Rd. and yielding right-turn bypass lanes for all approaches. (42.4 seconds delay, LOS E without any bypass lanes.)
3 - Grider Pond Road					
<i>No Build</i>	E	46.8	E	46.8	Side street LOS / delay only. Little to no delay on Smallhouse Rd.
<i>Add Southbound Left Turn Lane</i>	E	39.9	E	39.9	Side street LOS / delay only. Little to no delay on Smallhouse Rd.
<i>Construct Mini-Roundabout</i>	C	19.7	C	19.7	Would introduce delay on Smallhouse Rd. that would not be there otherwise.
<i>Construct Roundabout</i>	C	19.7	C	19.7	Would introduce delay on Smallhouse Rd. that would not be there otherwise.
4 - Elrod Road					
<i>No Build</i>	F	60.8	A	8.7	-
<i>Construct Southbound Right Turn Lane with Yielding Bypass Lane</i>	C	17.0	A	6.9	925 southbound right turns for the No Interchange scenario.
5 - Three Springs Road					
<i>No Build</i>	F	934.1	F	87.1	Interchange option includes new route to Smallhouse Rd. from Three Springs Rd.
<i>Construct Single Lane Roundabout</i>	F	93.5	D	33.8	-

Cost Estimates

Planning-level (high-level) cost estimates were produced for each of the improvement concepts by estimating the 2023 costs of Design, Right-of-way acquisition, Utilities, and Construction. No surveying or detailed design was performed. Construction quantities such as pavement, earthwork, traffic items, etc. were estimated for each item determined to be necessary to construct the proposed improvements. Recent construction costs were provided by the City of Bowling Green for the shared use path on Smallhouse Road from Ridgecrest Avenue to the intersection with Scottsville Road and the roundabouts at Rockingham Avenue and Shive Lane. These were consulted for comparison to help refine costs. Factors were applied to increase this amount to account for contingencies, miscellaneous items not estimated, and small-project inflation. This cost was then multiplied by a factor to estimate the design cost if it was over the base design amount. High-level utility location and identification was performed to determine estimates of relocation based on any potential improvement impacts. Mapping for the following utilities were reviewed:

- Electric – Bowling Green Municipal and Warrant RECC
- Water – Bowling Green Municipal and Warren County Water District
- Sewer – Bowling Green Municipal and Warren County Water District

For improvements that had a potential impact on areas outside of right-of-way, the impact area was estimated with a per acre cost assigned.

Total cost estimates are provided in the summary tables by improvement (**Tables 12 – 20**). Costs by phase (i.e., design, right-of-way, utilities, and construction) for concepts with reconfigurations are included in **Appendix E**. Two variations of the right turn lane at Elrod Road are included for future consideration – merge and yield conditions.

Return on Investment

Benefits of a transportation investment measure the direct and positive effects of that project over a specified period of time. A return on investment (ROI) analysis can be leveraged as one of the many tools to consider improvements and support decisions for infrastructure investment. Relying upon guidance from the U.S. Department of Transportation Benefit-Cost Analysis Guidance for Discretionary Grant Programs (January 2023), there are four primary areas of project benefit that can be translated into monetary values. These include:

- Travel Time Savings (vehicle-hours traveled or VHT)
- Vehicle Operating Costs (vehicle-miles traveled or VMT, which is the most common variable that affects vehicle operating costs)
- Safety Benefits (reduction in the likelihood of fatalities, injuries, and property damage resulting from crashes on the investment)
- Emissions Reduction Benefits

Costs for this planning stage are focused on capital costs – the total investment required to prepare an improvement for service. Maintenance costs are not included as the initial period focuses on the benefit of construction. All monetary values are in constant (2023) dollars. Discounting (the process of converting the costs and benefits that take place in different years into a common year) is not included in this high-level analysis.

The emphasis for this study has been on the consideration of improving safety and operational performance. As noted through the existing conditions analysis and development of future year volumes, traffic operations are generally at an acceptable level for the corridor throughout the study area. Therefore, this analysis focuses on identifying the safety benefits and comparing that to the investment cost to determine a ROI ratio.

To translate the safety benefits associated with an improvement, crash modification factors (CMFs) from the Crash Modification Factors Clearinghouse were applied to the number of applicable

crashes at each location to determine an estimated number of crashes “saved” by implementing the countermeasure. The estimated crash reduction number was then multiplied by an estimated cost per crash. The costs per crash were determined based on initial research completed by Vanasse Hangen Brustlin, Inc. (VHB) and broken down by the KABCO severity scale. KYTC has further developed a spreadsheet using these costs calibrated by the severity distribution for each District using the historic crash severity breakdown. Comparing the estimated crash benefit to the estimated project cost yields a ROI value. Anything over a value of 1 indicates a positive return on investment. Simplified, the process for determining ROI for this study is:

$(\text{Estimated Crash Reduction \% (from CMF)}) \times (\text{Total Number of Crashes CMF Applies To}) \times (\text{Average Crash Cost}) = \text{Estimated Crash Benefit}$

$\text{ROI} = \text{Estimated Crash Benefit} / \text{Estimated Project Cost}$

For the shorter-term, lower-cost spot improvements, the ROI value is provided for a five-year period. For larger scale investments such as full intersection reconstruction, the ROI is provided for a 20-year period. All values are shown in **Tables 12-20** by location.

Table 12. Refined Improvement Concepts – Campbell Lane

1 Smallhouse Road at Campbell Lane





	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	E (72.3)	151	N/A	\$0	N/A
Traffic	Signal Phasing / Timing Optimization	D (54.6)	151	N/A	N/A	N/A
	 Extend NB Right Turn Lane	N/A	10	For: 87 Against: 4	\$250,000	2:1 (5 Years)
	 Extend WB Right Turn Lane	N/A	28	For: 70 Against: 4	\$250,000	5:1 (5 Years)
	 Construct Dual WB Left Turn Lanes with Receiving Lane	D (50.1)	28	N/A	\$2,125,000	No applicable CMF
Safety	 Add Retroreflective Backplates	N/A	151	For: 51 Against: 4	\$2,500	700:1 (5 Years)
Geometric	 Reroute Left Turns with New Connection at Westen Street	C (33.6)	151	N/A	\$2,800,000	13:1 (20 Years)

Table 13. Refined Improvement Concepts – Cave Mill Road

2 Smallhouse Road at Cave Mill Road

	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	D (38.6)	112	N/A	\$0	N/A
Traffic	Signal Phasing / Timing Optimization	D (36.9)	112	N/A	N/A	N/A
	 Extend WB Right Turn Lane	N/A	10	For: 45 Against: 10	\$250,000	2:1 (5 Years)
	 Extend SB Right Turn Lane	N/A	1	For: 37 Against: 9	\$250,000	1:1 (5 Years)
Safety	 Add Retroreflective Backplates	N/A	112	For: 31 Against: 2	\$2,500	500:1 (5 Years)
Geometric	 Construct Roundabout (2 Lane)	C (16.6)	112	For: 43 Against: 84	\$2,960,000	3:1 (20 Years)

Table 14. Refined Improvement Concepts – Grider Pond Road

3 Smallhouse Road at Grider Pond Road

	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	E (46.8)	6	N/A	\$0	N/A
Traffic	 Add SB Left Turn Lane	E (39.9)	6	For: 57 Against: 1	\$450,000	1:1 (5 Years)
Geometric	 Construct Mini-Roundabout	C (19.7)	6	For: 14 Against: 61	\$1,100,000	1:1 (20 Years)
	 Construct Roundabout (1 Lane)	C (19.7)	6	For: 21 Against: 81	\$1,405,000	1:1 (20 Years)

Table 15. Refined Improvement Concepts – Elrod Road

4 Smallhouse Road at Elrod Road






	Concept	No Interchange - 2045 LOS (Delay)	With Interchange - 2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	F (60.8)	F (8.7)	13	N/A	\$0	N/A
Safety	 Add Additional / Enhanced Pavement Markings	N/A	N/A	4 (ABC Only)	For: 27 Against: 9	\$5,000	80:1 (5 Years)
	 Add Enhanced Signing	N/A	N/A	13	For: 24 Against: 5	\$5,000	No applicable CMF
	 Add Lighting	N/A	N/A	13	For: 90 Against: 2	\$5,000	45:1 (5 Years)
	 Add Edge Rumble Strips	N/A	N/A	13	For: 45 Against: 1	\$5,000	35:1 (5 Years)
Geometric	 Add Additional SB Right Turn with Yielding Bypass Lane	C (17.0)	A (6.9)	13	N/A	\$1,100,000	No applicable CMF



Table 16. Refined Improvement Concepts – Three Springs Road

5 Smallhouse Road at Three Springs Road

	Concept	No Interchange - 2023 LOS (Delay)	With Interchange - 20245 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	F (934.1)	F (87.1)	22	N/A	\$0	N/A
Geometric	Construct Roundabout	F (93.5)	D (33.8)	22	For: 87 Against: 43	See Note	See Note

Note: Potential Roundabout to be completed under KYTC Item No. 3-8818.00 as part of a larger project.

Table 17. Refined Improvement Concepts – Shawnee Way

6 Smallhouse Road at Shawnee Way						
	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	TBD	13	N/A	\$0	N/A
Traffic	 Add NB Left Turn Lane	TBD	9	For: 60 Against: 1	\$450,000	2:1 (20 Years)
Geometric	 Construct Mini-Roundabout	TBD	13	For: 5 Against: 72	\$1,090,000	1:1 (20 Years)
	 Construct Roundabout (1 Lane)	TBD	13	N/A	\$1,380,000	1:1 (20 Years)

Note: Turn movement counts were not collected at this intersection – therefore operations were not assessed.

Table 18. Refined Improvement Concepts – Curve Near Cave Mill Road

7 Smallhouse Road at Curve Near Cave Mill Road



	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	N/A	8	N/A	\$0	N/A
Safety	 Add Chevron Signage / Enhanced Signage	N/A	8	For: 42 Against: 2	\$5,000	50:1 (5 Years)
	 Provide Pavement Friction Management	N/A	8	For: 48 Against: 0	\$50,000	5:1 (5 Years)

Table 19. Refined Improvement Concepts – Curve Near Elrod Road










8 Smallhouse Road at Curve Near Elrod Road		Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build		No Build	N/A	9	N/A	\$0	N/A
Safety		Add Chevron Signage / Enhanced Signage	N/A	9	For: 28 Against: 0	\$5,000	100:1 (5 Years)
		Conduct Tree Trimming	N/A	9	For: 32 Against: 4	\$2,500	110:1 (5 Years)
		Provide Pavement Friction Management	N/A	9	For: 24 Against: 0	\$50,000	10:1 (5 Years)
Geometric		Provide Geometric Improvements / Realignment	N/A	9	For: 47 Against: 1	Varies	Varies

Table 20. Refined Improvement Concepts – Curves by Basil Griffin Park

 Smallhouse Road at Curves by Basil Griffin Park						
	Concept	2045 LOS (Delay)	# Crashes	Public Input	Planning Cost Estimate	ROI
No Build	No Build	N/A	7	N/A	\$0	N/A
Traffic	 Add Dedicated Left and Right Turn Lanes to Park Access	TBD	7	For: 66 Against: 15	\$950,000	1:1 (20 Years)
Safety	 Add Enhanced Signage	N/A	7	For: 39 Against: 0	\$5,000	80:1 (5 Years)
	 Provide Pavement Friction Management	N/A	7	For: 30 Against: 1	\$50,000	10:1 (5 Years)
Geometric	 Provide Geometric Improvements	N/A	7	For: 49 Against: 0	Varies	Varies

Note: Turn movement counts were not collected at this intersection – therefore operations were not assessed.

Chapter 8 – Corridor Improvement Concepts

8.1 Identification of Corridor Improvement Concept Options

The focus of this chapter is the examination of the segments between the intersections, with emphasis on balancing the needs of all users (vehicle, bus, truck, bicycle, and pedestrian). A key reference for determining context-appropriate applications for improvements to the corridor is the recently developed Complete Streets, Roads, and Highways Manual (Kentucky Transportation Cabinet). The following is a review and summary of pertinent information that helped inform the corridor improvement concept development from this document.

Key Points and Considerations based on Complete Streets Guidance

Definitions and Key Points
Key words for Complete Streets = Safety; Focus on LAND USE, CORRIDOR, USER
Provide opportunity for art, commerce, community beyond transportation
Six principles: 1. Fatal/Serious Crashes, 2) Safe vehicles / speeds for humans making mistakes, 3) Vulnerable = Countermeasures and speed, 4) Responsibility = Countermeasures, 5) Safety is proactive = accessibility to first responders / hospitals, 6) Redundancy
No specific Complete Street Policy for City of Bowling Green or Warren County.
Need to include facilities based on Complete Streets if pedestrian / bicycle activity exists determined through observation, Strava, or public input.
Guidance specifics gap distance as 1.5 miles for pedestrians and 3 miles for bicyclists as maximum distance willing to travel for trips.

Considerations for Smallhouse Road
Furnishing Zone / Trees / Seating / to provide a buffer. Need about 4' for buffer.
Separate pedestrians with a bike lane then small grass area before sidewalk (3-4 feet buffer).
Current Corridor = vehicle lanes only.
Elements to Consider = Dedicated bicycle lane, shared street, sidewalk, shoulder.
Elements Dismissed = Curbside Management (no need for parking / deliveries); dedicated bus lane (no current service).
Determine appropriate element based on land use context, roadway geometry, access management, and demand.

Land Use

Need to subdivide the corridor based on context – consider transition zones.

Smallhouse Road is somewhere between suburban and urban.

Lots of gaps. Look at connections that provide safe passage for pedestrians – particularly crosswalks between intersections.

Potential for additional build-out of property near airport beacon.

Suburban Streets, Roadways, and Highways Characteristics & Space

Target Speed is 30-45 mph.

Fully shared lanes should only be considered in significantly constrained right-of-way with no other alternate or parallel path.

Consider separate sidewalks with raised curbs. May be option with least right-of-way impact.

Potential Corridor / Segment Options

Sidewalk on One Side with Buffer (similar to Smallhouse Road north of Campbell Lane)

Paved Shoulders

Shared-Use Path on One Side with Raised Curb Separation

Center Turn Lane and Paved Shoulders

Traffic Calming / Reduced Speeds

Additional Stop Signs on Smallhouse Road (Shawnee Way; Cedarwood Way; Grider Pond Road; Lois Lane)

Narrow lanes from 10' to 9'

Education

Enforcement

Radar Speed Sign

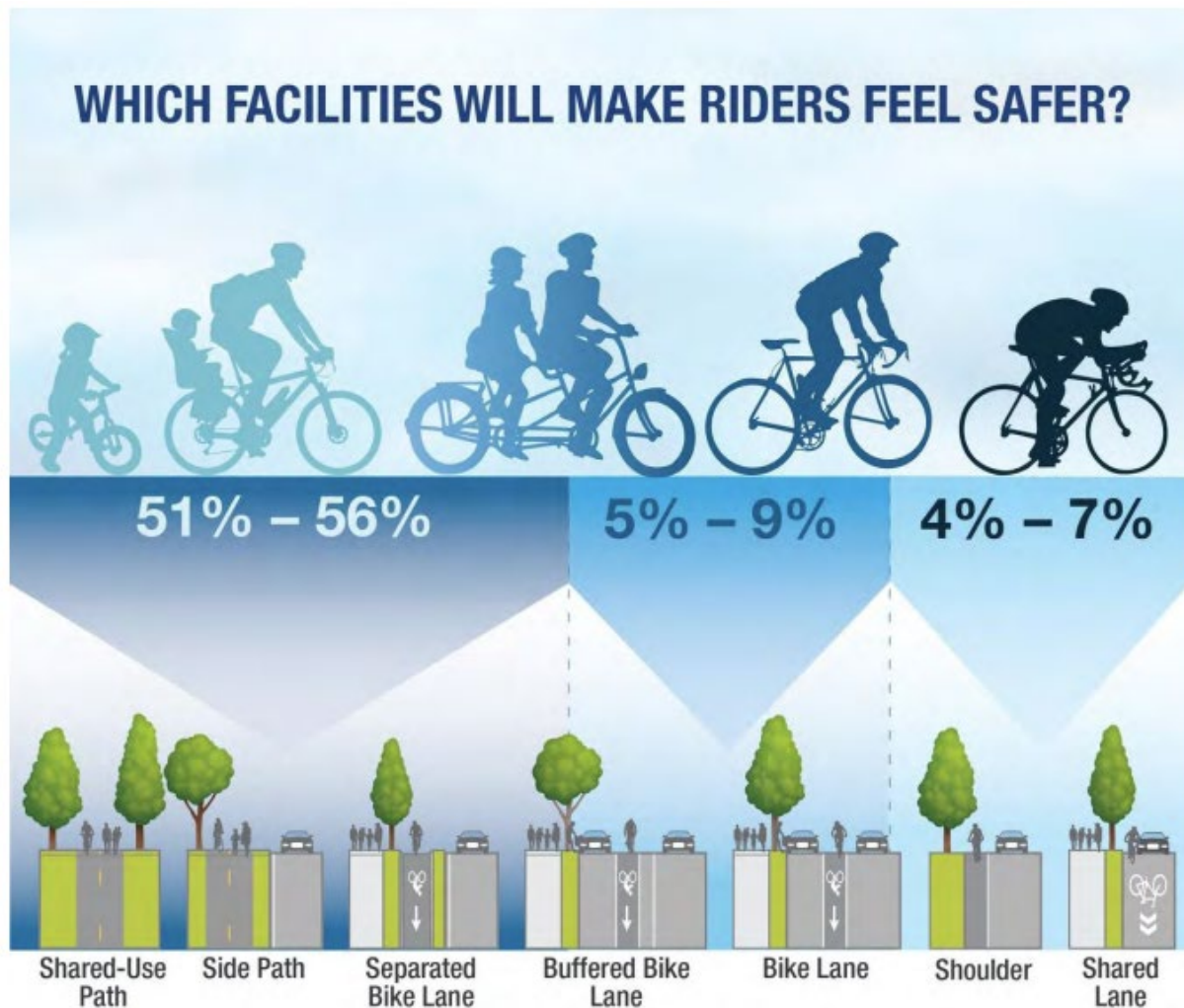
Traffic Calming (traffic circles, roundabouts)

Consider One Way Segment

Other Corridor Options
Lighting
Striping
Enhanced Curve Signage (Chevrons)

An additional resource used to help form corridor improvement options is the Bowling Green - Warren County Bicycle and Pedestrian Master Plan (2022). In the plan, the FHWA Bikeway Selection Guide (2019) shows the scale of comfort levels that cyclists have for different types of bicycle facilities. For reference it is included as **Figure 25** in this report. The graphic shows most riders feel more comfortable and are more likely to utilize off-street or separated bicycle facilities than roads with only bike lanes, paved shoulders, or on-road cycling.

Figure 25. Bicycle Facility Comfort Level



Note: Percentages represent the level of comfort that people feel bicycling, according to peer-reviewed surveys as recently as 2016.
Source: FHWA Bikeway Selection Guide: https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf
 For more information, please visit FHWA's Bicycle and Pedestrian Program webpage: https://www.fhwa.dot.gov/environment/bicycle_pedestrian/

Based on preferences discussed during the second Steering Committee Meeting, the use of sharrows and speed tables / humps was dismissed from further study. As shown in **Figure 25**, shared lane bicycle markings, or sharrows, are the least effective method to help incorporate / encourage bicycle activity. With the current speed and function of Smallhouse Road, speed tables or humps are not appropriate and therefore not included as an improvement option.

Considerations to keep in mind with further corridor / segment option development include:

- Ease of maintenance with paved shoulders
- Drainage structures that are bicycle friendly
- All improvements must be ADA compliant
- Can use green (colored) pavement markings

Other design considerations for typical section element sizing includes:

- Sidewalks require a minimum of 4'. Can go up to 5-6'.
- Bicyclists require a minimum of 4' with 5' or more preferred.
- Shared use path (SUP) is 10' minimum with a recommended range of 10-14 feet (can be reduced to 8' for site specific conditions) + 5' offset or physical barrier.
- Travel lane widths can range from 10-11' with a minimum of 9' in constrained conditions.
- Plantings require a minimum of 4' to be used as a buffer.
- Center turn lane should be 11-14'.

Combinations of typical section elements were prepared and presented to the public for their input. **Figure 26** shows concept images of each combination. The graphics are not to scale and are for conceptual purpose only. During any subsequent design phase, exact widths, material (i.e. asphalt / concrete), and drainage treatment (i.e. curb and gutter / ditch) will be determined.

Being mindful of changes in context throughout the corridor, input was also requested on desired typical section based on location. For example, the character and land development changes near the Elrod Road intersection. Therefore, different typical sections may be selected to better serve needs.

Figure 26. Corridor Improvement Concepts



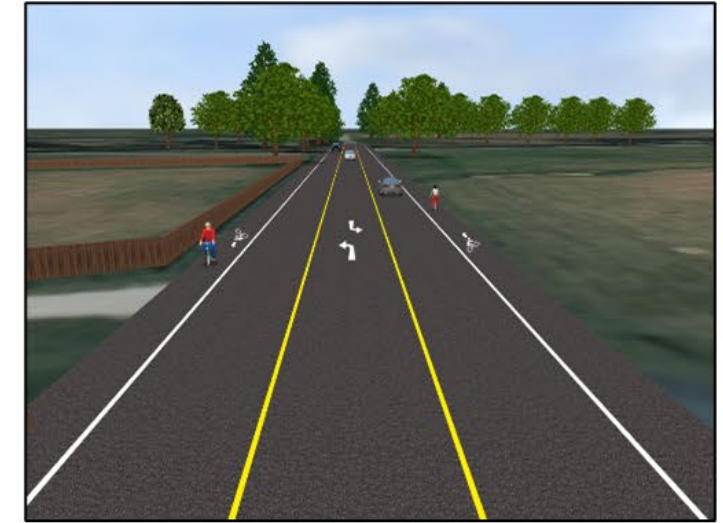
Existing (~ 20')



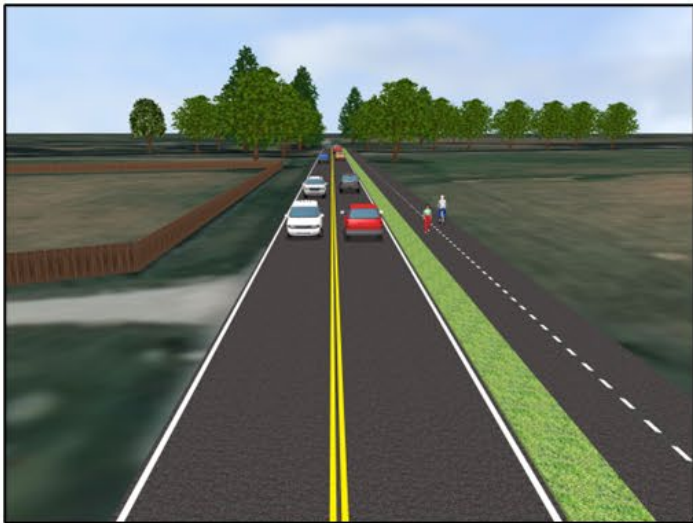
Striped Bicycle Lanes (~32')



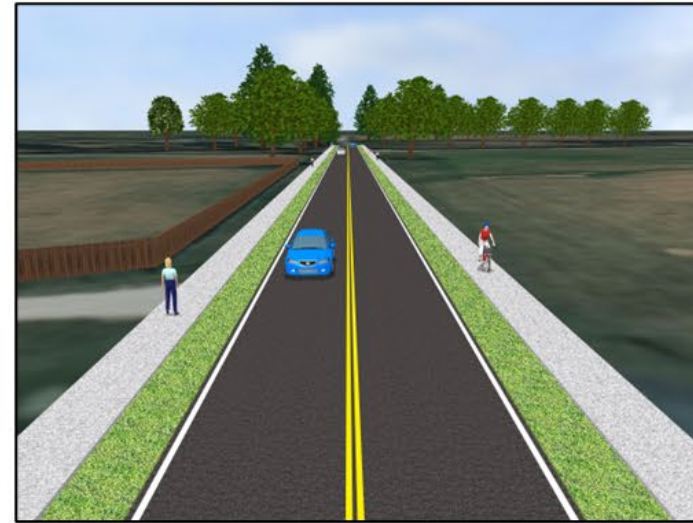
Center Turn Lane, Sidewalk on One Side with Buffer (~43')



Center Turn Lane with Striped Bicycle Lanes (~44')



Shared-Use Path on One Side with Buffer (~36')



Sidewalk on Both Sides with Buffers (~40')



Center Median with Shared-Use Path on One Side w/ Buffer (~46')



Wider Shoulders, Shared-Use Path on One Side w Buffer (~46')

8.2 Revised Corridor Improvement Concept Options

Technical analysis, public input, and discussion with the Steering Committee resulted in narrowing down the list of potential typical sections. **Figure 27** shows the results of the public meeting (both in person and online). The green and red dots represent the voting exercise at the public meeting and subsequent online survey where participants were able to “vote” in favor of (green dot) or against (red dot). The results show the majority of respondents are in favor of either a sidewalk or shared use path on one side in conjunction with a two-way left-turn lane (TWLTL).

Figure 27. Corridor Improvement Concepts - Public Meeting Results



The Steering Committee agreed for the northern section to be a transition from an urban to rural section with the TWLTL (from Campbell Lane to Cave Mill Road, then potentially down to Grider Pond Road / Elrod Road).

In addition to the TWLTL, the Steering Committee agreed with the recommendation of a wide sidewalk or shared use path (SUP) on one side of roadway with buffer. South of Elrod Road, a SUP with buffer for future potential widening and / or improvements to the transportation network is preferred. Regarding pavement type, runners / bicyclists in the Bowling Green area have requested pavement instead of concrete. The transition from paved to concrete SUP provides visual differentiation from the more urban portion of Smallhouse Road north of Campbell Lane.

Other options evaluated include traffic calming measures. **Table 21** displays the public’s preferences (in person and online). All presented options were liked except for narrowing the travel lanes to nine feet.

As noted during the public meeting, an additional recommendation is to move mailboxes from one side of the road to the appropriate side with that house. This was part of the newly constructed project on Smallhouse Road north of Campbell Lane.

Table 21. Speed Reduction Options – Public Meeting Summary

Concept	Description	Like	Dislike
	Education	4	0
	Radar Speed Sign	15	2
	Enforcement	9	3
	Narrow Lanes (9')	0	14
	Traffic Calming	14	2

Cost estimates and ROI analysis were completed for the preferred typical section using a similar methodology as that described in Chapter 7 for the intersection / spot improvements.

Phase costs for the full corridor are as follows:

Design: \$550,000
 Right-of-way: \$2,400,000
 Utilities: \$710,000
 Construction: \$7,010,000
 Total: \$10,670,000

For these cost estimates, construction limits assume improvements are carried out through all intersections. They do not include the intersection / spot improvement costs presented in Chapter 7. However, if intersection improvements were completed in conjunction with corridor improvements there would likely be some economy of scale and cost savings. **Appendix E** contains conceptual drawings to help determine costs. The SUP is shown on the side of Smallhouse Road that initial evaluation indicates would minimize impacts. Specific crossings and / or side is to be determined during design phases.

Chapter 9 – Study Outcomes

9.1 Prioritized Projects

The Smallhouse Road Study resulted in a range of conceptual improvements for future implementation. Improvement concepts primarily focused on areas with safety, traffic operations, and multimodal (bicycle / pedestrian) needs. Utilizing additional tools including operations analysis, traffic forecasting, Steering Committee input, public input and a high-level return on investment analysis, a prioritized list of recommendations for improvements has been compiled. The prioritization is broken down by the following categories:

- **Short Term** projects include those that are either relatively low cost or can be implemented relatively quickly using resources such as maintenance dollars. These projects would not need to go through the SHIFT process to be constructed. There are 14 total Short Term projects. **Table 22** lists the project location and improvement concepts for this category.
- **High Priority** projects include those that were overall in a higher tier of ratings based on crash history, ROI analysis, and public input. There are 5 total High Priority projects. **Table 23** lists the project location and improvement concepts for this category.
- **Medium Priority** projects include those that were overall in the middle tier of ratings based on crash history, ROI analysis, and public input. There are 3 total Medium Priority projects. **Table 24** lists the project location and improvement concepts for this category.
- **Low Priority** projects included those that are overall in the lowest tier of ratings based on crash history, ROI analysis, and public input. There are 6 total Low Priority projects. **Table 25** lists the project location and improvement concepts for this category.
- **Other Projects** include those that are broader in nature (i.e. corridor-wide or a longer segment), consolidated projects, or policy-based. There are 3 total 'Other' projects. **Table 26** lists the project location and improvement concepts for this category.

A number of the short term projects target improving safety at intersections and curves throughout the corridor. The high priority projects include improvements that will help with traffic operations now at Campbell Lane and Cave Mill Road. The construction of the mini-roundabout at Shawnee Way is included as it falls in the high priority segment of corridor improvement between Campbell Lane and Cave Mill Road. The same reasoning was used to determine priority of installing a mini-roundabout at Grider Pond Road as it will be more efficient to include improvements at this intersection in conjunction with corridor improvements between Cave Mill Road and Elrod Road.

Long term (lower priority) improvements are improvements that are needed to address traffic operations in the future (2045). As traffic grows in the area, it is suggested to monitor traffic operations and use these improvements as options to address this growth accordingly. The southern portion of corridor improvements is shown as a long term priority as modifications should be considered in conjunction with future development and other modifications to the surrounding roadway network (i.e. the I-165 interchange with Elrod Road and new Three Springs Road connection). If the Three Springs Road Connector moves forward, consideration should be given to incorporation of a SUP in the typical section, possibly in lieu of constructing the SUP along the existing corridor.

In addition to the prioritization tables, **Figure 28** illustrates the priority of corridor improvements.

Table 22. Short Term Projects



Short Term





Location	Concept	Public Input	Planning Cost Estimate	ROI
Campbell Lane	 Signal Phasing / Timing Optimization	N/A	N/A	N/A
	 Add Retroreflective Backplates	For: 51 Against: 4	\$2,500	700:1 (5 Years)
Cave Mill Road	 Add Retroreflective Backplates	For: 31 Against: 2	\$2,500	500:1 (5 Years)
Elrod Road	 Add Additional / Enhanced Pavement Markings	For: 27 Against: 9	\$5,000	80:1 (5 Years)
	 Add Enhanced Signing	For: 24 Against: 5	\$5,000	No applicable CMF
	 Add Lighting	For: 90 Against: 2	\$5,000	45:1 (5 Years)
	 Add Edge Rumble Strips	For: 45 Against: 1	\$5,000	35:1 (5 Years)
Curve Near Cave Mill Road	 Add Chevron Signage / Enhanced Signage	For: 42 Against: 2	\$5,000	50:1 (5 Years)
	 Provide Pavement Friction Management	For: 48 Against: 0	\$50,000	5:1 (5 Years)
Curve Near Elrod Road	 Add Chevron Signage / Enhanced Signage	For: 28 Against: 0	\$5,000	100:1 (5 Years)
	 Conduct Tree Trimming	For: 32 Against: 4	\$2,500	110:1 (5 Years)
	 Provide Pavement Friction Management	For: 24 Against: 0	\$50,000	10:1 (5 Years)
Curves by Basil Griffin Park	 Add Enhanced Signage	For: 39 Against: 0	\$5,000	80:1 (5 Years)
	 Provide Pavement Friction Management	For: 30 Against: 1	\$50,000	10:1 (5 Years)

Table 23. High Priority Projects

High Priority	Location	Concept	Public Input	Planning Cost Estimate	ROI
High Priority	Campbell Lane	 Extend NB Right Turn Lane	For: 87 Against: 4	\$250,000	2:1 (5 Years)
		 Extend WB Right Turn Lane	For: 70 Against: 4	\$250,000	5:1 (5 Years)
	Cave Mill Road	 Extend WB Right Turn Lane	For: 45 Against: 10	\$250,000	2:1 (5 Years)
	Shawnee Way	 Construct Mini-Roundabout (in conjunction with high priority segment – Campbell to Cave Mill)	For: 5 Against: 72	\$1,090,000	1:1 (20 Years)
	Corridor – Campbell Lane to Cave Mill Road	 Construct TWLTL with SUP on one side with buffer.	For: 103 Against: 14	\$4,270,000	3:1 (20 Years)

Table 24. Medium Priority Projects










Medium Priority	Location	Concept	Public Input	Planning Cost Estimate	ROI
Medium Priority	Campbell Lane	 Construct Dual WB Left Turn Lanes with Receiving Lane	N/A	\$2,125,000	No applicable CMF
	Grider Pond Road	 Construct Mini-Roundabout (in conjunction with medium priority segment – Cave Mill to Elrod)	For: 14 Against: 61	\$1,100,000	1:1 (20 Years)
	Corridor – Cave Mill Road to Elrod Road	 Construct TWLTL with SUP on one side with buffer.	For: 103 Against: 14	\$4,270,000	1:1 (20 Years)

Table 25. Low Priority Projects

Location	Concept	Public Input	Planning Cost Estimate	ROI
Campbell Lane	 Reroute Left Turns with New Connection at Westen Street	N/A	\$2,800,000	13:1 (20 Years)
Cave Mill Road	 Construct Roundabout (2 Lane)	For: 43 Against: 84	\$2,960,000	3:1 (20 Years)
Elrod Road	 Add Additional SB Right Turn with Yielding Bypass Lane	N/A	\$1,100,000	No applicable CMF
Curve Near Elrod Road*	 Construct Geometric Improvements / Realignment	For: 47 Against: 1	Varies	Varies
Curves Near Basil Griffin Park*	 Construct Geometric Improvements / Realignment	For: 49 Against: 0	Varies	Varies
Corridor – Elrod Road to Three Springs Road	 Construct SUP on one side with buffer.	For: 105 Against: 27	\$2,130,000	N/A

Long Term
(Low Priority)

*Geometric improvements at these locations should be explored further if the new interchange / connector project does not move forward in the future.

Table 26. Other Projects

Location	Concept	Public Input	Planning Cost Estimate	ROI
Other	 Education	For: 4 Against: 0	N/A	N/A
	 Radar Speed Sign	For: 15 Against: 2	TBD	TBD
	 Enforcement	For: 9 Against: 3	N/A	N/A

Note: For each segment of the corridor, traffic calming measures should be implemented at time of construction. This includes incorporating the mini-roundabouts at Shawnee Way and Grider Pond Road. Relocation of mailboxes to correspond to side of the roadway with the residence should also be part of the construction process during each phase.

Figure 28. Corridor Improvement Priorities



9.2 Next Steps

The next phase in the project development process is Preliminary Engineering. If federal funds are used or permits will be required, additional environmental analyses will be required to satisfy the National Environmental Policy Act (NEPA).

The City of Bowling Green has begun design plans for a portion of the SUP between Campell Lane and Thimble Finger Way. No additional funding currently exists for implementation of recommendations. All identified high, medium, low priority, and other projects would need to be integrated into the Bowling Green & Warren County MPO Transportation Improvement Program or Kentucky's Strategic Highway Investment Formula for Tomorrow (SHIFT) depending on project location. Short Term projects may be initiated through maintenance funds. The City of Bowling Green, Warren County, KYTC and the MPO should collaborate on project funding and implementation.

9.3 Additional Information

Additional information or questions regarding this study can be obtained from the Bowling Green and Warren County MPO.

APPENDIX A: Turning Movement Counts

APPENDIX B: Environmental Overview Maps

APPENDIX C: Meeting Summaries

- 1. Steering Committee Meeting No. 1**
- 2. Steering Committee Meeting No. 2**
- 3. Steering Committee Meeting No. 3**
- 4. Postcard for Community Survey**
- 5. Community Survey Results**
- 6. Public Meeting Flyer**
- 7. Public Meeting Results**

APPENDIX D: Future Year (2045) Traffic Forecast

APPENDIX E

Supplemental Conceptual Improvement Figures

1. Campbell Lane: Construct Dual WB Left Turn Lanes with Receiving Lane
2. Campbell Lane: Reroute Left Turns with New Connection at Westen St
3. Cave Mill Road: Construct Roundabout (Two Lane)
4. Grider Pond Road: Construct Mini Roundabout
5. Grider Pond Road: Construct Full Roundabout
6. Elrod Road: Add Additional SB Right Turn with Merging Bypass Lane
7. Elrod Road: Add Additional SB Right Turn with Yielding Bypass Lane
8. Shawnee Way: Construct Mini Roundabout
9. Shawnee Way: Construct Full Roundabout
10. Corridor: Campbell Lane to Cave Mill Road
11. Corridor: Cave Mill Road to Elrod Road
12. Corridor: Elrod Road to Three Springs Road