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US 127 2+1 Corridor Study
Lincoln & Casey Counties

Final Report | October 2023

WSP FDR TAYLOR SIEFKER WILLIAMS design group

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Executive Summary

The objective of the US 127 Corridor Study is to develop and evaluate potential improvement concepts to address safety and mobility along US 127, including the consideration of adding 2+1 passing lanes and the addition or extension of truck climbing lanes. The study area extends from MP 15.500 northeast of Liberty to MP 23.175 at the Casey / Lincoln County line then from MP 0.000 in Lincoln County to the Lincoln/Boyle County line at mile point (MP) 10.690, as shown in **Figure ES-1**. The full study area is 18.365 miles long.

KYTC provided a list of committed and proposed projects in the study area vicinity. There are two projects in the study area vicinity included in *Kentucky's 2022-2028 Enacted Highway Plan (Highway Plan*), shown below. Project 8-80150.00 is intended to implement the recommendations of this study following its conclusion and 8-8702.00 is likely to become an active project in the next Highway Plan. The associated improvements have been considered in the current study.

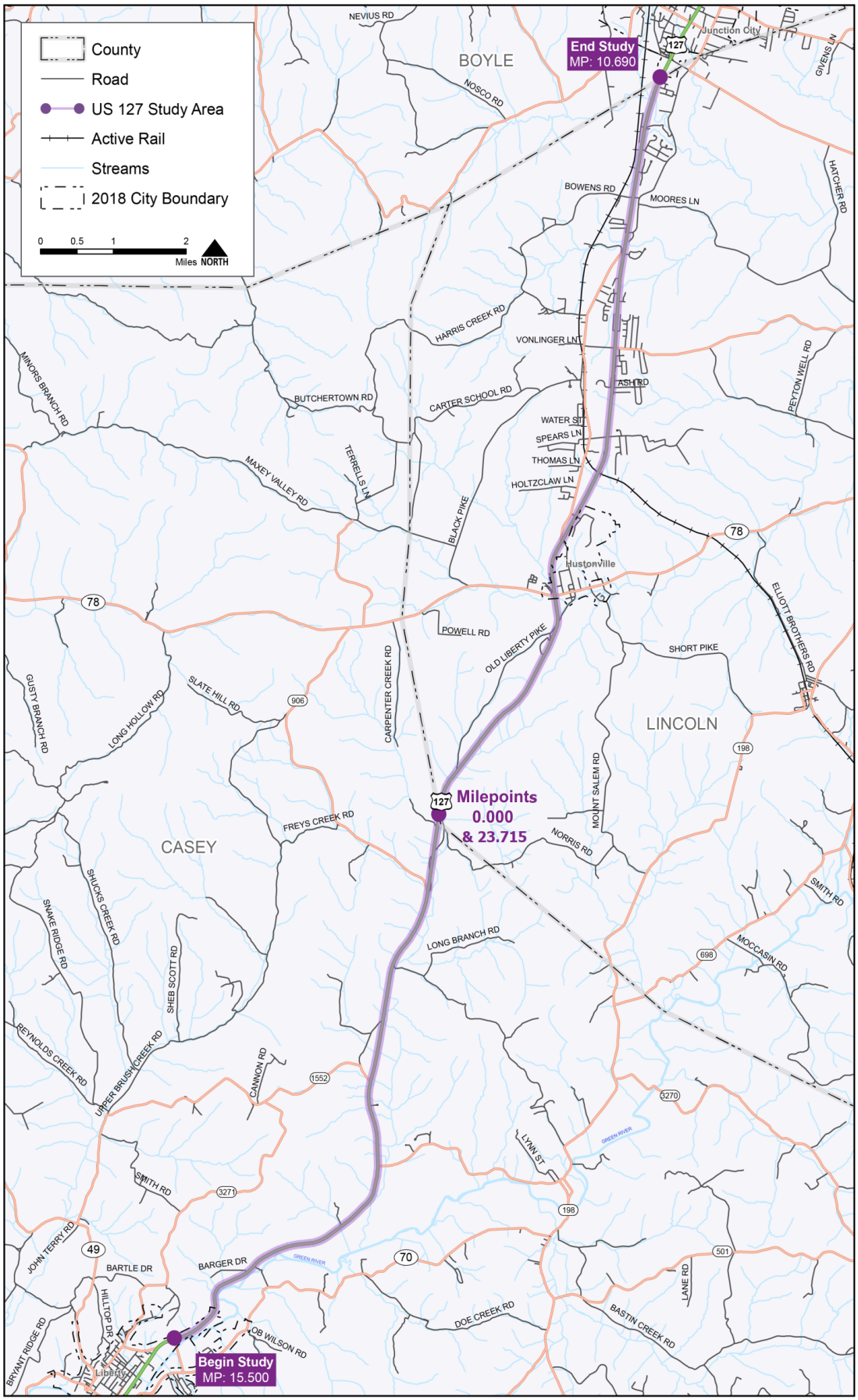
	Highway Plan Projects	Design	ROW	Utilities	Construction
8-80150.00 **MP 15.500-23.175**	Add lanes (2+1) to US 127 from Liberty to the Lincoln County line. (same as IP20200049)	2024	2026	2026	2028
8-8702.00 **MP 18.746-19.046**	Correct vertical alignment on US 127 and Kentucky Route (KY) 152 Near Intersection (same as IP20150181)	2023	2024	2024	2025
8-80000.00 **MP 9.60-9.74**	New Turning Lane at Arcadia View Drive	2021	2022	2022	2023
	CHAFs				
IP20210064	Improve safety and mobility along US 127 from Casey / Lincoln County line to Lincoln / Boyle County line. (8-80150.00 was extended to include this CHAF)				

Existing Conditions

A detailed inventory of the existing physical and geometric design characteristics was compiled to evaluate the existing conditions along US 127 and inform the development of improvement concepts. According to HIS data and a field review, a 12-foot lane width is maintained through most of the study area except for 11-foot lane width between MP 14.81 and 19.371 in Casey County. US 127 consists of two-lanes with a truck climbing lane in the northbound direction from MP 4.05 to 4.63. Turn lanes are intermittent through the study area. Paved shoulders are present, but the surface width varies throughout the study area from 2 feet to 11 feet. Grades in the study area range from 0.0% to 4.7%. The right-of-way is typically 60 feet to 85 feet from the road centerline in Casey County and greater than 100 feet from the road centerline in Lincoln County. The speed limit is set at 55 mph for the entire study area. There are 136 total access points across the study area. Of those, 100 access points are private driveways and 36 are unsignalized intersections. All intersections in the study area are unsignalized and stop controlled on the side street. There are no designated pedestrian or bicycle facilities on US 127 in the study area.

To estimate a future growth rate, historical traffic growth, model growth rates and population growth were considered. Despite a declining population in Casey and Lincoln counties, a 0.75% annual growth rate was chosen for AADT, DHV and truck volumes since traffic counts in the corridor consistently indicate this growth pattern. This growth rate resulted in 2045 AADTs ranging from 5,400 to 13,150.

Figure ES-1: US 127 Corridor Study Area



Operating speeds were analyzed temporally and geographically to determine their relation to US 127 operations. Vehicular 85th percentile travel speeds along US 127 were recorded above the posted speed limit of 55 mph (from 53 to 73 mph) along the entirety of the corridor during the peak hours of 7:00am and 4:00pm, with the exception of the KY 78 intersection approaches, which dip slightly below in the southbound direction. Vehicular speeds during the off-peak hours are up to 5 mph faster than during the peak hours. By location, speeds were generally higher in the middle of the study area and lower at either end likely due to entering the more urbanized areas of Liberty and Junction City.

A historical crash analysis was performed to examine traffic safety trends and to identify potential safety issues along US 127. Five years of data (2017 to 2021) were used in the analysis and within the five-year analysis period, 152 crashes were reported in the study area. A majority of the crashes (67.1%) were property damage only crashes. There were three fatal crashes, eight serious injury, and 13 minor injury crashes over the five-year study period. Of the 11 fatal and serious injury crashes, three involved motorcycles at intersections with specific narrative notes on sight being an issue. The manner of collisions for the fatal and serious injury crashes included roadway or lane departure crashes along segments and angle crashes at intersections. Speed was noted to be a factor in crash severity as there are changes throughout the corridor depending on intersection density and horizontal or vertical curvature.

Approximately 36 percent of crashes in the study area are single vehicle crashes followed by rear end (24%), and angle (18%) type crashes. A review of the single vehicle crashes showed that nearly half were animal involved collisions. Locations of crashes suggests that most crashes occurred in locations with access points and intersections or in areas where horizontal curvature changes to “C-Class” curves in Casey County, where most of the study area has “A-Class” curves. Rear end and angle crashes were fairly common at intersections and driveways.

Overall, US 127 operates safer than expected based on Excess Expected Crashes (EECs) and other safety data metrics. Operating speed and design speeds are not the same, as operating speeds are higher than the design speed. Based on crash reports, crash data, and public feedback, safety issues are typically linked to limited sight distance, sudden roadway geometric changes, and driver impatience in areas that lack provided passing zones and the drivers disobey the law and provided infrastructure. Due to the higher speeds of the study area and the narrow shoulders in some areas, an above average amount of crashes that occur along this facility resulted in a fatal or injury crash.

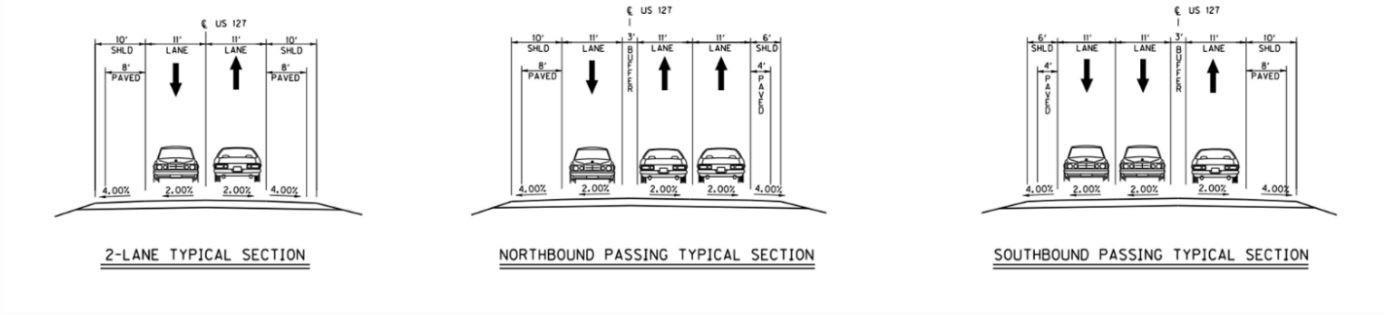
Development and Analysis of Potential Improvement Concepts

Based on the existing conditions, traffic operations, speed and safety analysis, an initial list of potential improvement concepts was developed and presented to the project team at the Project Team Meeting #2. Left turns in areas with added lanes, either 2+1 or truck climbing lanes, were eliminated. As part of the review and analysis of the corridor, a specific examination was done for Transportation Systems Management and Operations (TSMO) aspects and needs that would help the roadway operate at a better level across all criteria. TSMO recommendations were included in corridor and spot improvement concepts. The list of improvement strategies for the corridor, as well as spot improvements, were refined based on feedback from the Project Team and stakeholders, additional data generated to answer questions posed at project team meetings, and criteria based on the goals and objectives of the project. Each improvement strategy was also evaluated with respect to safety, traffic operations and mobility, environmental impacts, right-of-way impacts, and cost estimates.

Full Corridor Concept

With the Project Team’s concurrence, the initial separate corridor concepts from Project Team Meeting #2 were merged into one since they were becoming similar to one another through process of elimination of passing lane locations. Striped passing zones were re-introduced in several areas that could not accommodate 2+1 or climbing lanes due to access issues or due to intersections with left turns exceeding 10 per hour. Left turns exceeding 10 turns per hours in areas that added lanes, either 2+1 or truck climbing lanes, were eliminated. The merged corridor concept is shown below in **Figure ES-3**. The proposed cross-sections are shown in **Figure ES-2**. Additional elements that should be considered in the corridor that were derived from the TSMO assessment include confirmation of rumble strips (center & edges) throughout, upgrade guardrails to current height and standards, verify/re-locate No Passing Zone signs, enhance striping to full 6” width, and provide updated lighting where pedestrian or bicycle activity exists.

***Figure ES-2:* US 127 Corridor Concept Cross Sections**



* Lincoln County Typical Sections shown. Casey County shoulder options similar but vary in width.

Benefit-cost ratios for corridor concepts were separated into Casey County and Lincoln County, then a total cost and benefit-cost ratio was provided if both counties were completed as one project. The Casey County corridor concepts were broken into three types based on shoulder width, including eight-foot shoulders, six-foot shoulders, and four-foot shoulders (all with an additional two feet of unpaved shoulder), while Lincoln County had one corridor concept, maintaining the current eight-foot paved shoulder with two feet unpaved. The total benefit-cost ratio for the entire project ranged from 0.64 to 0.83 depending on the crash costs mentioned in section 8.1.8. The Casey County benefit-cost ratios were 0.58-0.76 for the eight-foot shoulder concept, 0.53-0.70 for the six-foot shoulder concept, and 0.41-0.54 for the four-foot shoulder concept and the Lincoln County benefit-cost ratio ranged from 0.68-0.88. While this ratio did not exceed 1.00, there was discussion regarding potential costs savings through shoulder width recommendations and right of way, especially in Casey County. **Table ES-1** has the full details of the benefit-cost analysis for each county and a total benefit-cost ratio at the bottom.

Figure ES-3: **US 127 Full Corridor Concept**

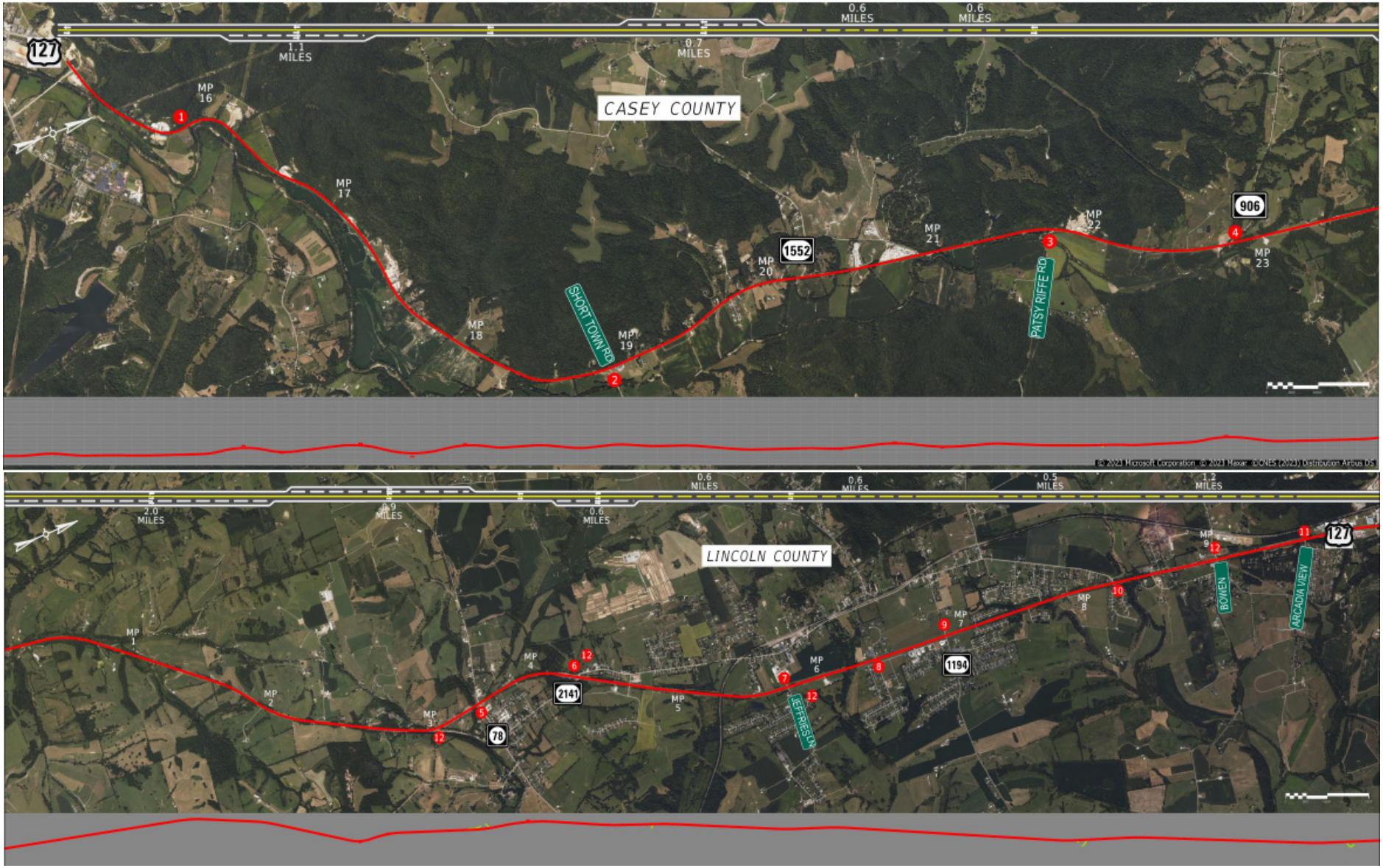


Table ES-1: Benefit-Cost Analysis for Recommended Full Corridor Concept

County	Full Concept	Description	Sub Concept	Sub Description	BMP	EMP	Total Cost	Construction Cost	Benefit / Cost Ratio Range
Casey	Full Build, 8' Shoulder	Full build for Casey County with 8' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$28,400,000	$21,000,000	0.58-0.76
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 8'	15.5	22.882			
	Full Build, 6' Shoulder	Full build for Casey County with 6' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$25,600,000	$19,100,000	0.53-0.70
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 6'	15.5	22.882			
	Full Build, 4' Shoulder	Full build for Casey County with 4' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$25,200,000	$18,900,000	0.41 - 0.54
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 4'	15.5	22.882			

County	Full Concept	Description	Sub Concept	Sub Description	BMP	EMP	Total Cost	Construction Cost	Benefit / Cost Ratio Range
Lincoln	Full Build, 8' Shoulder	Full build for Lincoln County with 8' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install southbound left turn lane at KY 2141/Danville Pike	4.1	4.25	$44,350,000	$39,500,000	0.68 - 0.88
			Left Turn Lane	Install southbound left turn lane at Jeffries Lane	5.74	5.75			
			Left Turn Lane	Install southbound left turn lane at Ash Road	6.4	6.41			
			Right Turn Lane	Install southbound right turn lane at Ash Road	6.4	6.41			
			Left Turn Lane	Install southbound left turn lane at Arcadia View Dr	9.6	9.7			
			Passing Lane	NB Passing Lane - MP 0-2	0	2			
			Passing Lane	SB Passing Lane - MP 2.3-3.4	2.3	3.4			
			Passing Lane	NB Passing Lane - MP 4-4.5	4	4.5			
			Passing Lane	NB Passing Lane - MP 5.9-6.8	5.9	6.8			
			Passing Lane	SB Passing Lane - MP 6.9-8.1	6.9	8.1			
			Enhanced Striping	Install 6 inch striping throughout	0	10.686			
	Full Concept	**Description**	**Sub Concept**	**Sub Description**	**BMP**	**EMP**	**Total Cost**	**Construction Cost**	**Benefit/ Cost Ratio Range**
Total	**Full Build**	**Full Build of Full Study Area**					**$72,750,000**	**$60,500,000**	**0.64-0.83**

Benefit cost ratios are based on 8 foot shoulders in Casey County.

Spot Improvement Concepts

The spot improvement concepts moved forward from the initial screening were also evaluated based on traffic operations, safety, environmental impacts, right-of-way impacts and costs, as well as input from the Project Team and Stakeholders. The benefit-cost ratio of the individual spot improvements varied. There was discussion of the value of each spot improvement, noting that the benefit-cost ratio for each improvement depended on the specific crash history and did not include mobility benefits provided such as warranted left turn lanes. It was also noted that cost estimates were based on the cost of constructing each improvement individually, and that costs may be lower when spot improvements were bundled together. **Table ES-2** shows the recommended spot improvements along with cost, reduction in fatal and injury crashes and the benefit-cost ratio.

Table ES-2: Recommended Spot Improvements for the US 127 Corridor

Number	Location	MP	Description	Cost	Fatal & Injury Crash Reduction (2017-2021)	Benefit / Cost Ratio
1	**Add curve chevrons near Liberty - NB and SB**	15.6-16.1 (Casey)	Chevrons to be added NB and SB, in addition to new speed advisory signs	D $1,090 R $0 U $0 C $10,900	16%	41.40
2	**Improve sight distance at Short Town Rd, add SB Left Turn Lane**	18.85-19.05 (Casey)	Levelling out two 'humps' on US 127 from private driveway to end of gas station parking lot will improve sight distance both directions from Short Town Rd. Also, close private driveway access to US 127.	D $101,000 R $0 U $15000 C $1,013,000	46%	0.09
3	**Improve sight distance at Patsy Riffe Rd**	21.6-21.85 (Casey)	Extending the intersections withUS 127 further north would provide better sight distance to the south. Also, retract unrequired guardrail to improve SB sight line.	D $74,000 R $20,000 U $60,000 C $739,000	25%	0.06
4	**Multiple improvements at KY 906**	22.80-22.87 (Casey)	1) Close southern end of Loop Rd 2) Cut rock face back to improve NB sight distance 3) Improve alignment of KY 906 to improve sight distance 4) Provide left turn lane from US 127 NB to KY 906 5) Add intersection warning signs 6) Improve alignment of northern end of Loop Rd to US 127	D $170,000 R $2,400 U $0 C $1,731,000	59%	0.86
5	**Improve sight distance at KY 78**	3.35-3.50 (Lincoln)	Move stop bar on KY 78 westbound forward to correct location	D $900 R $0 U $0 C $9,300	25%	70.52
6A	**Reduce potential conflicts at KY 2141/ Danville Pike - Option A**	4.10-4.25 (Lincoln)	Eliminate NB left turns onto KY 2141. Make KY 2141 and Danville Pike right-only onto US 127. Eliminate crossing across US 127. Add SB left turn lane onto Danville Pike.	D $48,000 R $0 U $15,000 C $482,000	44%	4.60
6B	**Reduce potential conflicts at KY 2141/ Danville Pike - Option B**	4.20 (Lincoln)	Close KY 2141. Make Danville Pike right-in right-out onto US 127. Add SB left turn lane onto Danville Pike.	D $52,000 R $0 U $15,000 C $522,500	44%	4.25

Number	Location	MP	Description	Cost	Fatal & Injury Crash Reduction (2017-2021)	Benefit / Cost Ratio
7	**Add SB Left Turn Lane at Jefferies Ln**	5.74-5.75 (Lincoln)	Provide warranted LTL. Will require splitting passing zone	D $34,000 R $0 U $0 C $343,000	44%	0.20
8	**Add SB Left Turn Lane at Ash Rd**	6.40-6.41 (Lincoln)	Provide warranted LTL	D $46,600 R $0 U $0 C $466,000	44%	0.05
9A	**Multiple improvements at KY 1194 - Option A**	6.85-7.00 (Lincoln)	1) Eliminate NB Left Turn from US 127 into KY 1194 2) Add guidestriping from KY 1194 to US 127 SB	D $300 R $0 U $0 C $3,000	0%	0.00
9B	**Multiple improvements at KY 1194 - Option B**	6.85-7.00 (Lincoln)	1) Close western part of KY 1194 onto US 127 2) Add guidestriping from KY 1194 to US 127 SB	D $4,000 R $0 U $15,000 C $39,000	0%	0.00
10	**Add SB Right Turn Lane at KY 2141/ Sierra Ln**	8.22-8.28 (Lincoln)	Provide warranted RTL	D $26,500 R $0 U $0 C $265,000	14%	1.35
11	**Add SB Left Turn Lane at Arcadia View Dr**	9.65-9.71 (Lincoln)	Provide warranted LTL. Will require splitting passing zone	D $50,400 R $0 U $0 C $504,000	44%	0.04
12	**Stripe angled intersection 'flares'**	(1) 3.09; (2) 5.75; (3) 8.54; (4) 9.02 (All Lincoln)	Stripe through pavement flares at (1)CS 3015; (2) Jeffries Ln; (3) KY 2141/Indian Camp Rd; (4) Bowens Loop Rd	D $100 R $0 U $0 C $1,100	0%	0.00
				D $100 R $0 U $0 C $1,100	0%	0.00
				D $100 R $0 U $0 C $1,100	0%	0.00
13	**Passing Lanes in Lincoln County**	5.9-8.1 (Lincoln)	Provide Passing Lane NB 5.9-6.8 and SB 6.9-8.1	D $840,000 R $480,000 U $150,000 C $8,400,000	42%	0.77

Study Recommendations

After discussing the refined list of potential improvement concepts and associated detailed evaluation at the third Project Team Meeting, the Project Team decided to carry the merged corridor concept forward, with the addition of NB and SB passing lanes in Lincoln County in combination with the spot improvement concept at KY 1194. The spot improvement concepts were accepted as a group. The corridor and spot improvement concepts were grouped by County as requested by the District.

Upon completion of this study, there are funds for future project development phases of this corridor in the Six Year Plan.

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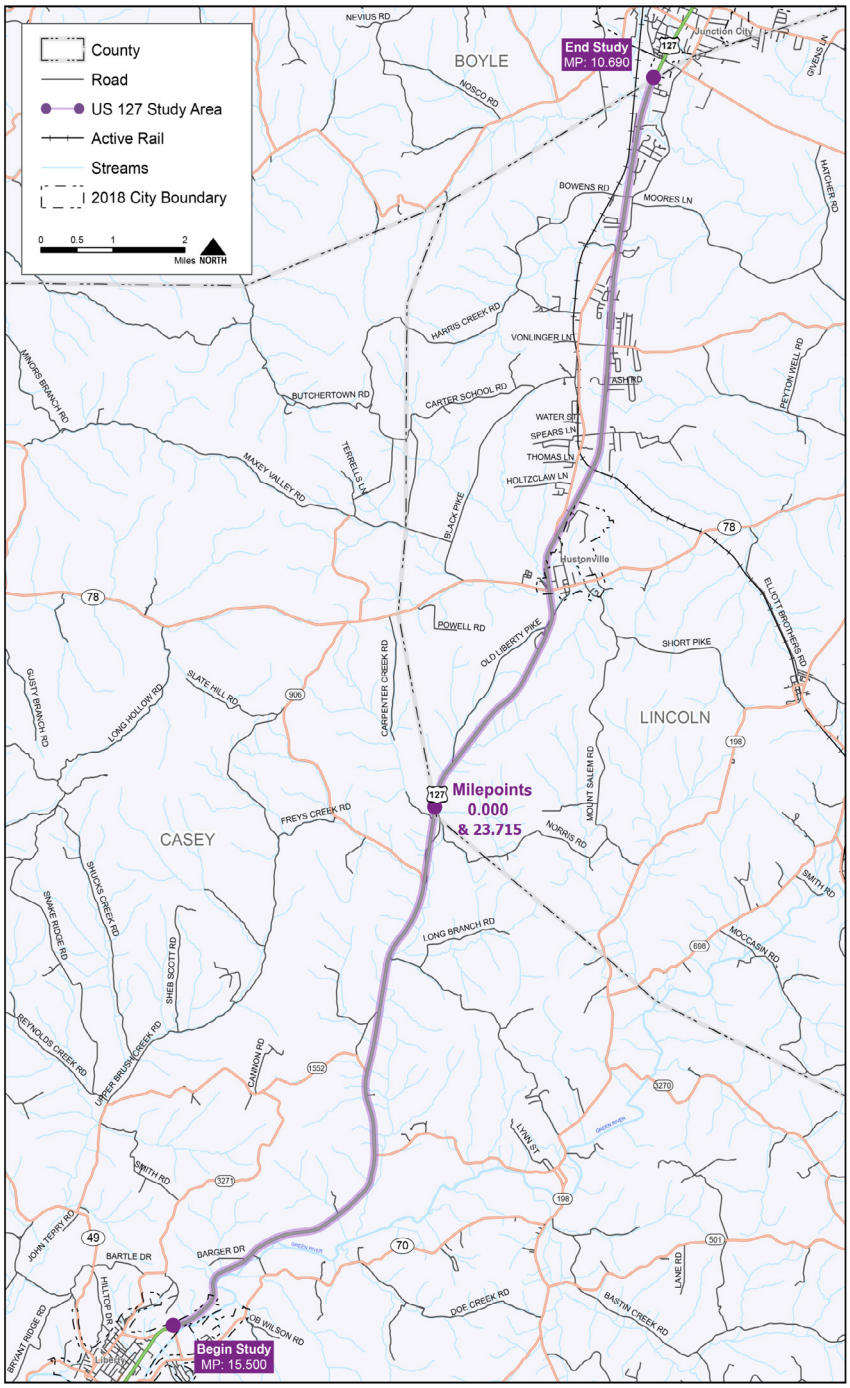
1 Introduction

The study area extends from MP 15.500 northeast of Liberty to MP 23.175 at the Casey / Lincoln County line, then from MP 0.000 in Lincoln to the Lincoln / Boyle County line at mile point (MP) 10.690, shown in **Figure 1.** The full study area is 18.365 miles long. The study evaluated multiple corridor-wide and spot improvement concepts and recommends those which KYTC may use for further project development and implementation. Members of the Project Team included KYTC District 8, KYTC Central Office Division of Planning, and the Consultant Team.

Figure 1: US 127 Study Area



1.1 Study Objective

The objective of the US 127 Corridor Study is to develop and evaluate potential improvement concepts to address safety and mobility along US 127, including the consideration of adding 2+1 passing lanes and the addition or extension of truck climbing lanes. A 2+1 road is a three-lane highway that has two travel lanes in one direction - one of which is used for passing - and one lane in the opposite direction. The passing lane often alternates every few miles[1].

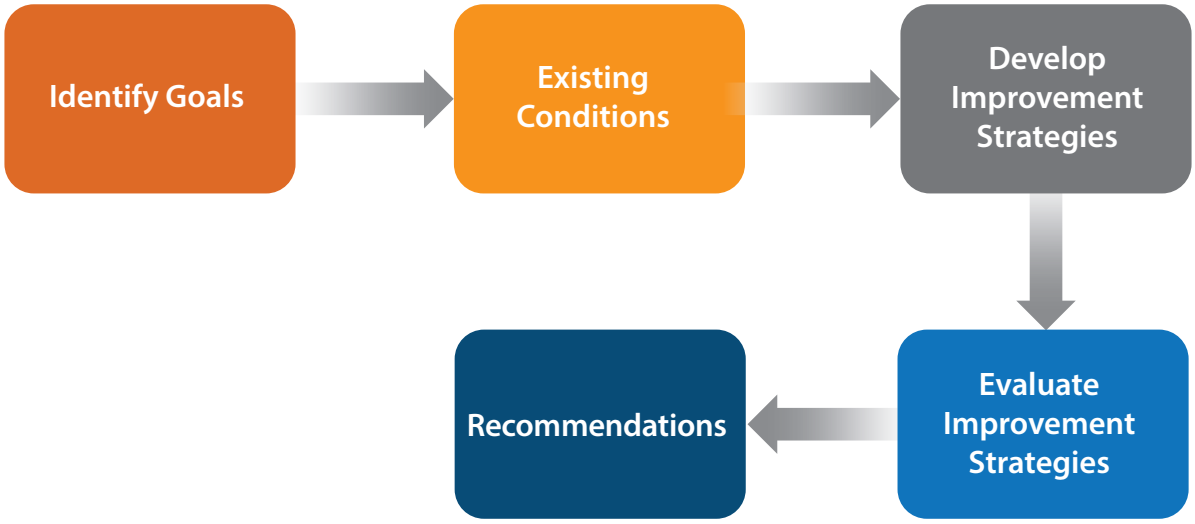
1.2 Study Process

The study process consists of five major elements, shown in **Figure 2**:

- Identify the goals of the study
- Examine the existing conditions and identify areas with safety and operational concerns
- Develop potential improvement strategies
- Evaluate the improvement strategies based on the study goals
- Recommend corridor-wide improvement strategies for KYTC to pursue in future project phases.

The subsequent chapters of this report detail these steps, with additional information provided in the appendices.

Figure 2: Study Process



1 https://transportation.ky.gov/Congestion-Toolbox/Pages/2-plus-1-Roadways.aspx

1.3 Study Goals

The goals of the study are to:

- Identify concepts to improve passing opportunities while not encouraging faster driving speed
- Improve the overall safety of the corridor
- Create concepts that are responsive to public stakeholders' and Local Elected Officials (LEOs) areas of concerns
- Develop and document a list of recommended long-term improvements based on the technical evaluation and feedback from the Project Team, LEOs, stakeholders, and the public.

1.4 Recent, Committed, and Proposed Projects / Relevant Studies

KYTC provided a list of committed and proposed projects in the study area vicinity. There are two projects in the study area vicinity included in *Kentucky's 2022-2028 Enacted Highway Plan (Highway Plan)*. The two projects listed in the KYTC Continuous Highway Analysis Framework (CHAF) database are the same as those listed in the Highway Plan. Each project is listed below with the year of phase programming shown. Project 8-80150.00 is intended to follow this study to implement the recommendations, 8-8702.00 is likely to become an active project in the next Highway Plan, and the associated improvements have been considered in the current study.

	Highway Plan Projects	Design	ROW	Utilities	Construction
8-80150.00 **MP 15.500-23.175**	Add lanes (2+1) to US 127 from Liberty to the Lincoln County line. (same as IP20200049)	2024	2026	2026	2028
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8-80000.00 **MP 9.60-9.74**	New Turning Lane at Arcadia View Drive	2021	2022	2022	2023
CHAFs					
IP20210064	Improve safety and mobility along US 127 from Casey / Lincoln County line to Lincoln / Boyle County line. (8-80150.00 was extended to include this CHAF)				

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2 Existing Conditions

A detailed inventory of the existing physical and geometric design characteristics was compiled to evaluate the existing conditions along US 127 and inform the development of improvement concepts. The following sources were used:

- KYTC Highway Information System (HIS) data
- KYTC record plans and bridge inspection reports
- Google Earth aerial imagery and Street View
- Field review

2.1 Roadway Geometrics

An inventory of roadway characteristics was completed to identify factors contributing to the safety, congestion and mobility issues along US 127.

2.1.1 Lane, Shoulder, and Median Width

According to HIS data and a field review, a 12-foot lane width is maintained through most of the study area except for 11-foot lane width between MP 14.81 and 19.371 in Casey County. US 127 consists of two lanes with a truck climbing lane in the northbound (NB) direction from MP 4.05 to 4.63. Turn lanes are intermittent through the study area.

Paved shoulders are present, but the surface width varies throughout the study area from 2 feet to 11 feet. **Figures 3** and **4** show the typical sections through the study area, with darker gray representing paved and lighter gray representing gravel shoulder. **Figures 5** and **6** show areas with shoulder widths of less than 10 feet.

***Figure 3*: Paved Shoulder Width in Casey County, MP 14.81 to 19.371**

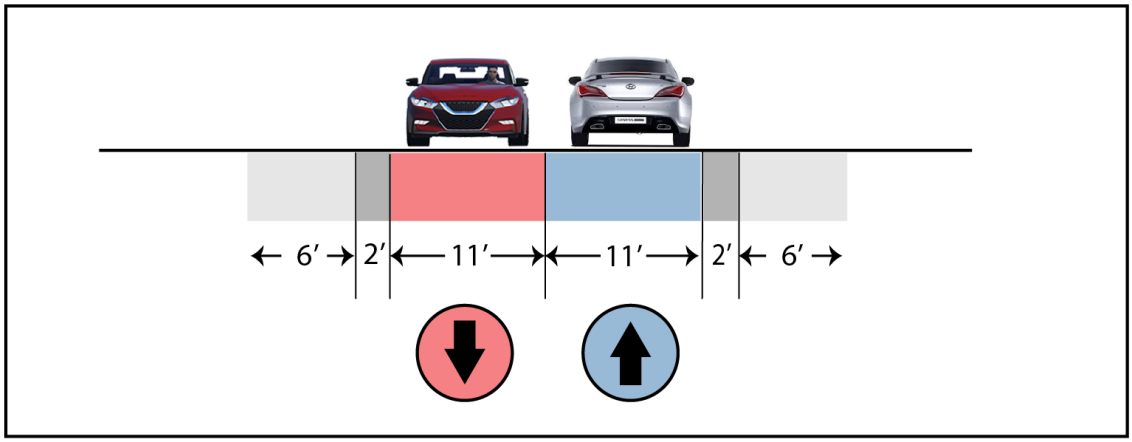


Figure 4: Paved Shoulder Width in Casey County (MP 19.371 to 23.715) and Lincoln County (MP 0.000 to 10.686)

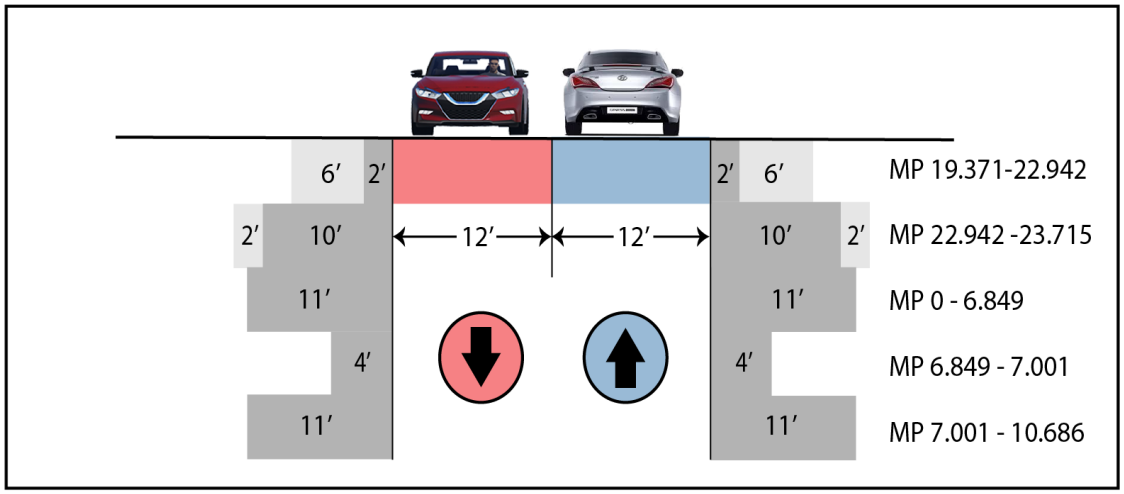


Figure 5: Paved Shoulder Width Less than 10 feet in Casey County

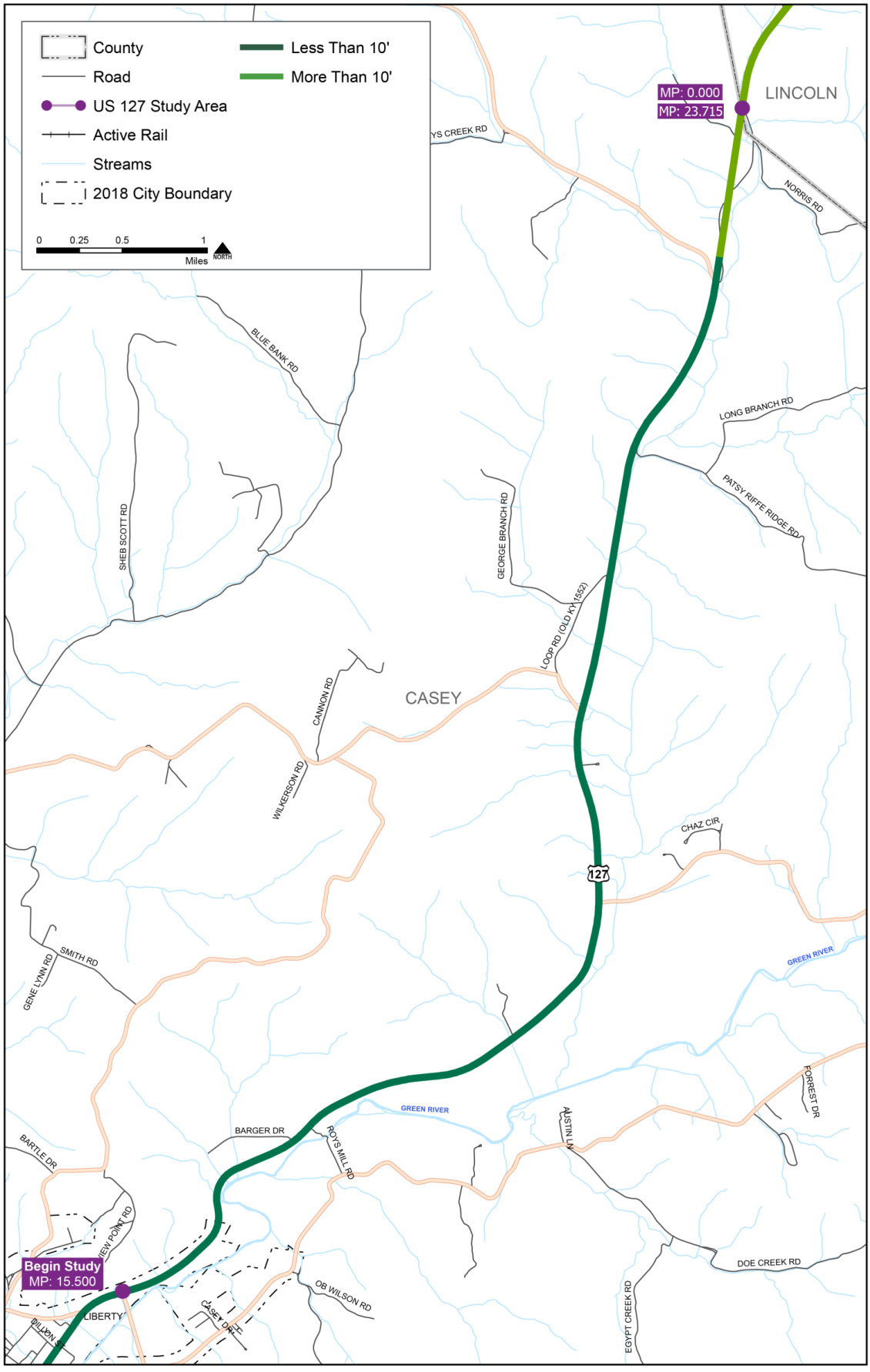
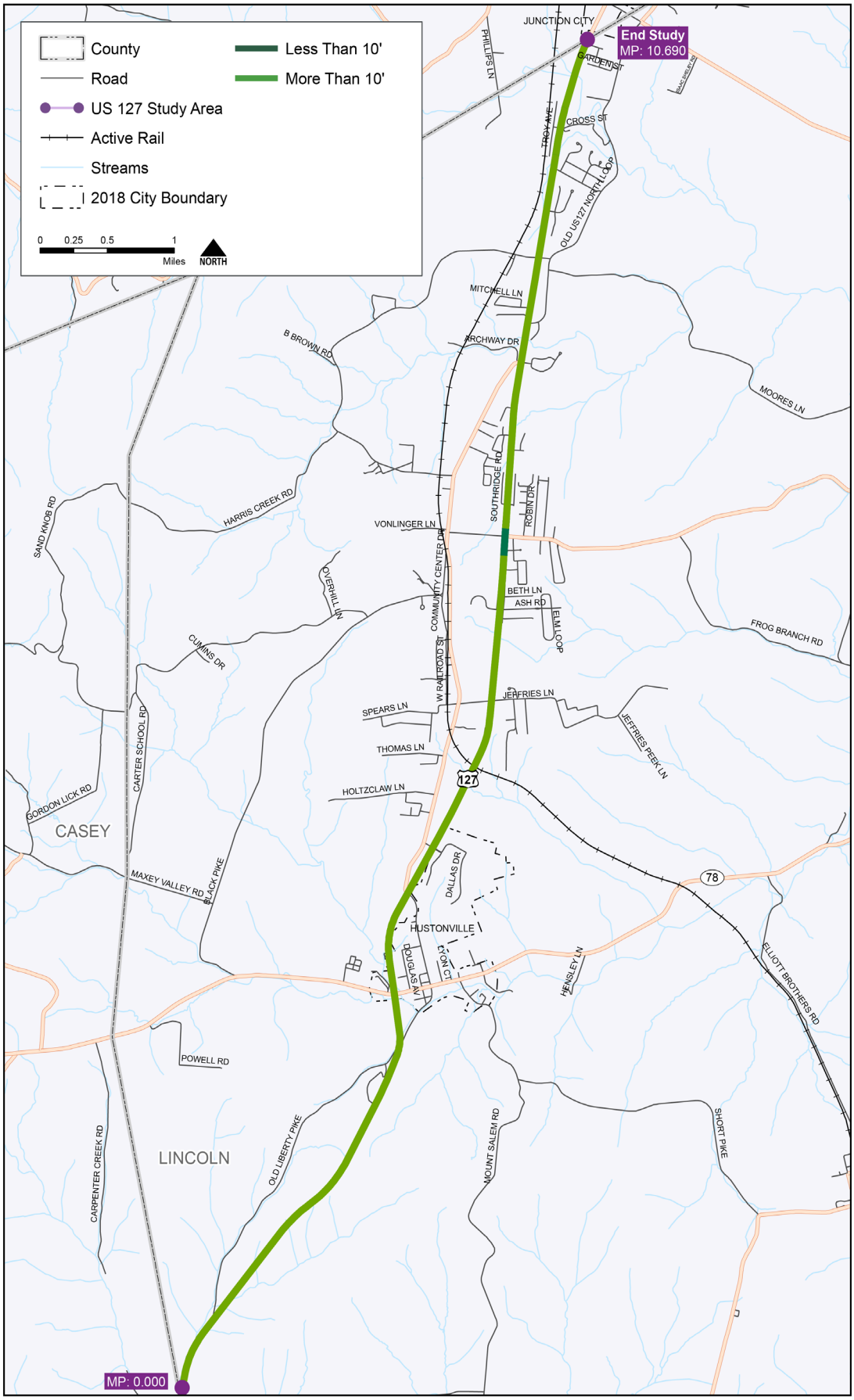


Figure 6: Paved Shoulders Less than 10 Feet in Lincoln County



2.1.2 Vertical Alignment

The posted speed limit on US 127 is 55 mph and the original design speed was 60 mph. The KYTC Highway Design Manual states that the maximum vertical grade is 4.0% for a design speed of 60 miles per hour (mph) or more for a rural arterial in rolling terrain. According to the 2018 AASHTO Geometric Design of Highways and Streets (Table 3-35), vertical curves must meet stopping sight distance (SSD) for crest vertical curves and headlight sight distance for sag vertical curves. The required SSD is 495 feet for a facility posted for 55 mph, which is met throughout the study area. The required SSD for 60 mph, the design speed, is met throughout the study area with the exception of a 200-foot segment at MP 15.7 (Casey County). Headlight Sight Distance (HLSD) is met throughout the study area at the 60 MPH design speed.

Grades in the study area range from 0.0% to 4.7% with the most variation in Lincoln County. The steepest grade is between MP 2.500 and MP 3.100 in the southbound (SB) direction in Lincoln County. The grade at the existing NB truck climbing lane, between MP 4.050 and MP 4.630, is 4.1% to 2.1%. While US 127's grades are not excessive, grades can contribute to vehicles getting stuck behind vehicles such as trucks that tend to slow on upward grades.

In Casey County hills were generally short and not very steep. In Lincoln County, where some of the grades might pass a warrant based on length and grade combined, they were evaluated against the warrant test for climbing lanes included in the AASHTO Policy on Geometric Design of Highways and Streets, 7th ed., Figures 3-21 and 3-22. **Table 1** shows the MPs, direction (NB / SB), and grades in Lincoln County. Both the posted speed limit of 55 mph and 70 mph were evaluated. 70 mph was evaluated since it is representative of the actual speeds in the majority of the corridor. Other than the existing truck climbing lane, no new segments were found to warrant additional truck climbing lanes.

MP Range	Grade (from HIVEi)	Direction	Length of Grade (ft)	Speed Reduction from 70 MPH (Fig. 3-21)	Speed Reduction from 55 MPH (Fig. 3-22)
0.5-2.0	3.6%	NB	8000	~20 MPH+	10 MPH
2.0-2.5	1.0%	SB	2600	~5 MPH	0 MPH
2.5-3.1	4.7%	SB	3200	~ 25 MPH+	13 MPH
3.6-4.3	4.1%	NB	3700	~25 MPH+	12 MPH
4.3-4.5	2.0%	NB	1000	0 MPH	0 MPH
4.5-5.0	1.7%	SB	2600	~5 MPH	0 MPH
5.4-6.2	2.0%	SB	4200	~10 MPH+	0 MPH
6.7-8.3	1.5%	SB	8500	~5 MPH+	0 MPH

2.1.3 Horizontal Alignment

The mainline horizontal curves throughout the study area meet both the minimum radius criteria and the superelevation criteria for a 60 mph design speed with the exception of a 200-foot segment at MP 15.7 in Casey County in an advisory speed zone.

2.1.4 Roadside Assessment

Guardrails are present intermittently along the study area, interspersed with rock cuts, shown in **Figures 7 and 8**. Shoulder rumble strips are present with some center lane rumble strips.

2.1.5 Bridge Geometrics & Deficiencies

There are 10 bridges along US 127 within the study area. All study area bridges are listed as “Fair or Good” for bridge condition. Bridge conditions are rated in accordance with the National Bridge Inspection Standards (NBIS) ratings which are made up of biennial inspection items that include but are not limited to: Sufficiency rating, substructure rating, superstructure rating, deck rating, vertical/horizontal clearance, and more.

Casey County Bridges

Bridge ID	Begin MP	Nearby Feature
023B00001N	22.801	Frey Cr.
023B00002N	23.589	Carpenter Cr.

Lincoln County Bridges

Bridge ID	Begin MP	Nearby Feature
069B00032N	0.002	Br. of Carpenter Cr.
069B00076N	3.403	Hanging Fork
069B00077N	3.501	Baughman Br.
069B00078N	5.252	NS line
069B00079N	7.693	Br of Harris cr.
069B00080N	8.421	Harris Cr.
069B00081N	9.746	Br. Of Knob Lick Cr.
069B00082N	10.396	Knob Lick Cr.

2.1.6 Right-of-Way Widths

The right-of-way is typically 60 feet to 85 feet from the road centerline in Casey County and greater than 100 feet from the road centerline in Lincoln County.

Figure 7: Roadside Assessment in Casey County

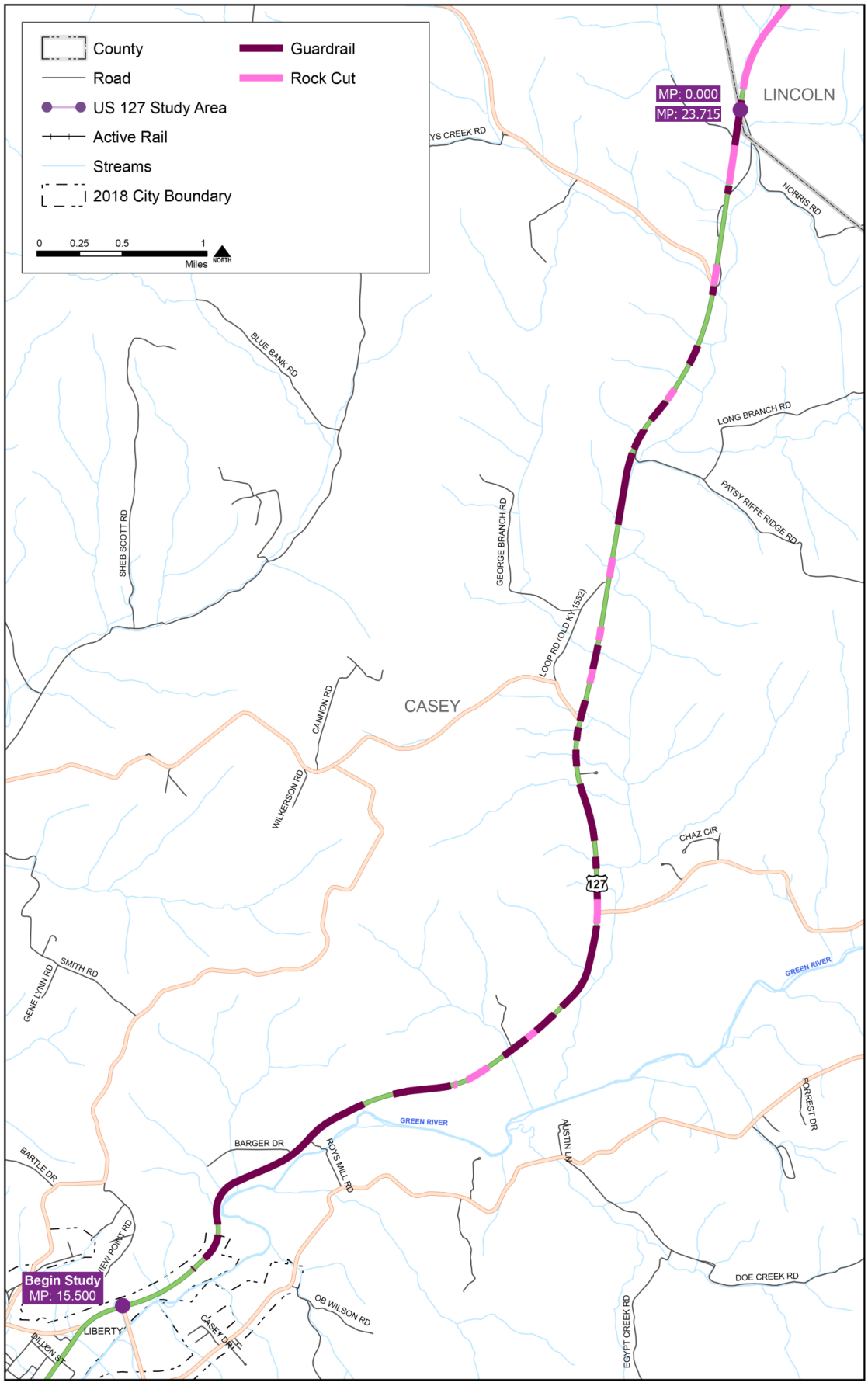
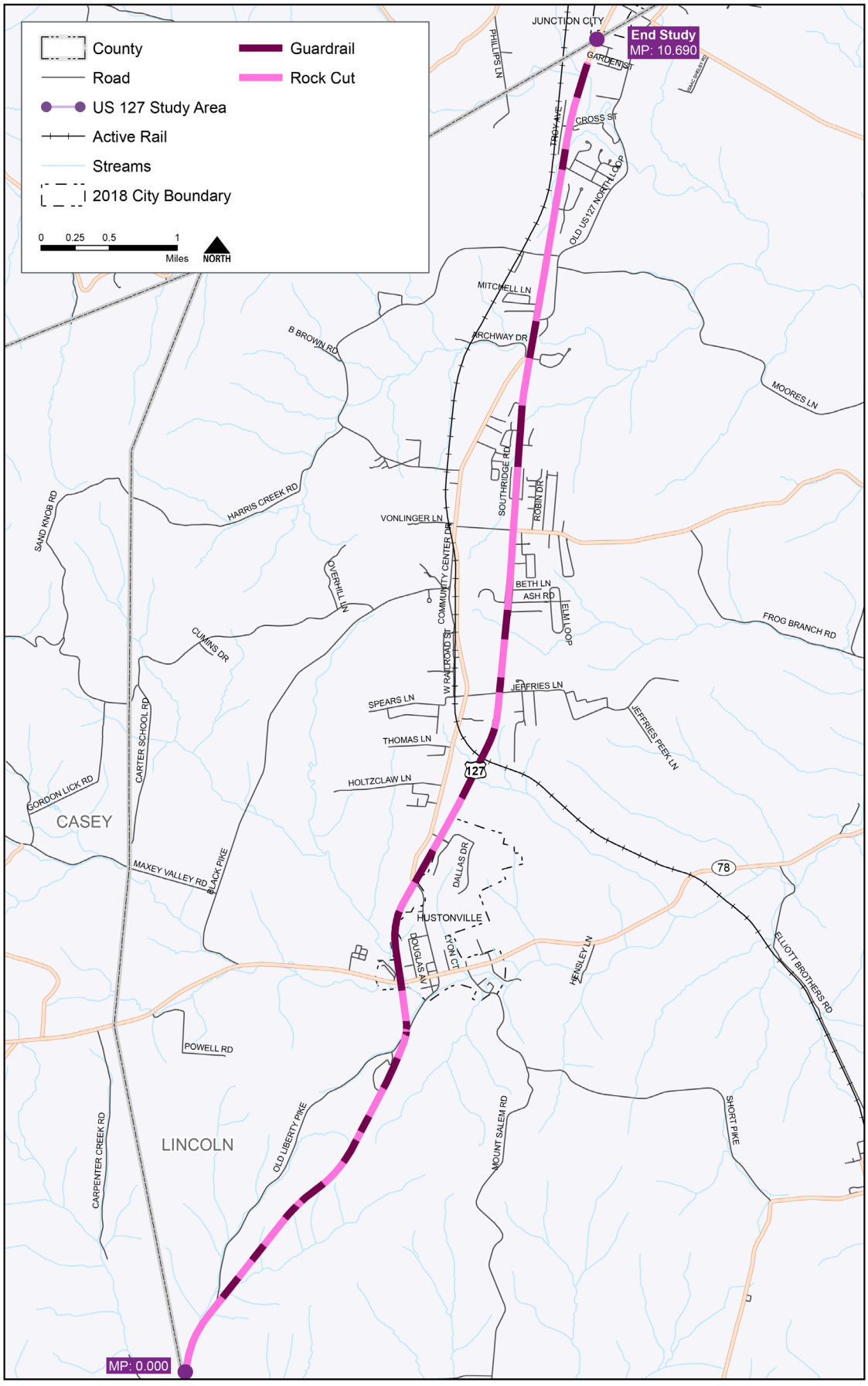


Figure 8: Roadside Assessment in Lincoln County



2.1.7 Speed Limit

The speed limit is set at 55 miles per hour (mph) for the entire study area, with advisory signs in Casey County at NB MP 18.26 (50 mph) and SB MP 16.25 (45 mph).

2.1.8 Functional Classification, Roadway System Designation, and Truck Routes

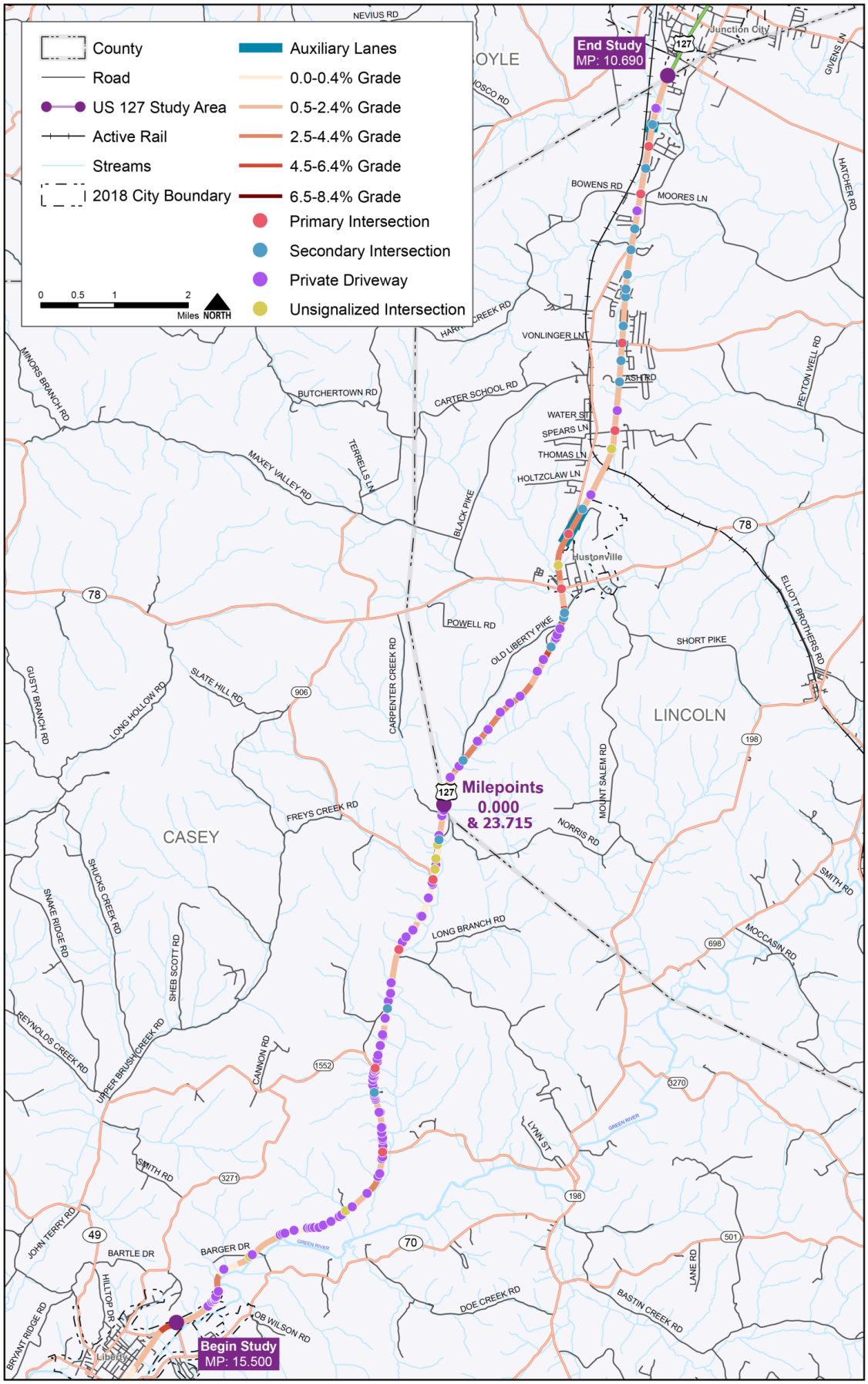
US 127 is classified as a Rural Principal Arterial from the beginning of the study area in the south to Arcadia View Drive and classified as an Urban Principal Arterial north of Arcadia View Drive to the Boyle County Line. It is part of the National Highway System but is not a Federal Designated Truck Route. The corridor allows for "AAA" Weight Class trucks, with an 80,000-pound maximum weight.

The study area is classified as Tier 3, having Statewide Regional Significance, for the Kentucky Highway Freight Network (KHFN), meaning the truck average annual daily traffic (AADT) is between 500 and 4,000 Vehicles Per Day (vpd).

2.1.9 Intersections and Access Points

There are 136 total access points across the study area. Of those, 100 access points are private driveways and 36 are unsignalized intersections. The access control is By Permit in Casey County and south of KY 78 in Lincoln County from MP 0.000 to MP 3.437. Partial access control is granted in the remaining portion of the study area in Lincoln County. For this reason, most private driveway access is in Casey County. **Figure 9** shows the locations of access points and intersections in the study area. For intersections, the Project Team identified primary intersections as those with higher turn movements that would have actual or estimated counts performed and may have, or require, stop control or turn lanes. Secondary intersections are those with few turn movements per hour, should be considered when developing passing lane concepts, but do not require actual traffic counts.

Figure 9: US 127 Intersections and Access Points



2.1.10 Intersection Control

All intersections in the study area are unsignalized and stop controlled on the side street. An overhead flashing beacon is present at the KY 78 intersection, shown in **Figure 10**.

Figure 10: Flashing Beacon at KY 78 Intersection

2.1.11 Intersection Skew & Sight Distance

Stopping sight distance on level roadways is 495 feet for 55 mph roadways, which is the controlling factor due to the speed limit for US 127. However, recognizing the higher actual traveling speeds on US 127, the Project Team considered stopping sight distance requirements for 60 mph (570 feet) and 65 mph (645 feet) for the ten highest volume intersections. Intersection sight distance for left turning vehicles from a minor road stopped controlled intersection is 610 feet (55 mph), 665 feet (55 mph), and 720 feet (55 mph). Three intersections do not meet the stopping sight distance of 495 feet or the intersection sight distance of 610 feet for left turning vehicles. Intersections should also be squared to the mainline and not skewed, as skewed intersections make turning and visibility difficult for drivers. Two intersections, Patsy Riffe Road and KY 906, are skewed and do not meet at a 90-degree angle with US 127. **Table 2** shows which intersections are skewed and which intersections do not meet sight distance requirements.

Table 2: Intersection Skew and Sight Distance

Intersection	Skewed	Meets 55 MPH Sight Distance Requirements	Meets 60 MPH Sight Distance Requirements	Meets 65 MPH Sight Distance Requirements
KY 1552 (Short Town Road)	No	No	No	No
KY 1552 (Loop Road)	No	Yes	Yes	Yes
Patsy Riffe Road	Yes	No	No	No
KY 906	Yes	No	No	No
KY 78	No	Yes	Yes	Yes
KY 2141 (Danville Pike)	No	Yes	Yes	Yes
Jeffries Lane	No	Yes	Yes	Yes
KY 1194	No	Yes	Yes	Yes
Bowens Loop Road	No	Yes	Yes	Yes
Arcadia View Drive	No	Yes	Yes	Yes

2.1.12 Turn Lanes

Within the study area, turn lanes are provided at the following intersections:

- Left and right turn lanes at KY 1194, both directions (MP 6.900 in Lincoln County, **Figure 11**), with the three-lane sections extending 250 feet in both directions
- Left turn lanes in both directions and a SB right turn lane Cross Street / Michelle Drive (MP 9.970 in Lincoln County, **Figure 12**)

2.2 TSMO Assessment and Overview

Transportation Systems Management and Operations (TSMO) is a set of strategies that focus on operational improvements that can maintain and even restore the performance of the existing transportation system before extra capacity is needed. The study area was reviewed for existing TSMO strategies, which include: truck climbing lanes in Lincoln County, various traffic devices and striping, and turn lanes at various intersections across the study area.

Figure 11: Turn Lanes at KY 1194 Intersection

Figure 12: Turn Lanes at Cross Street/Michelle Drive

2.3 Bicycle and Pedestrian Activity and infrastructure

Strava Metro data was consulted to examine pedestrian and bicyclist activity along US 127. Bicycle and pedestrian activity are low / nonexistent along US 127, which is expected given the speed, access, and land use in the study area. Parallel state and county routes appear to be used for biking. Based upon observations during the field visit some pedestrians walk along the shoulder and cross US 127 in the Hustonville area. The one location with the most US 127 crossings was at KY 78. There are no designated pedestrian or bicycle facilities on US 127 in the study area.

3 Traffic Volumes and Operations

The traffic analysis addressed three major topics: traffic volumes, traffic operations, and traffic safety. The first two topics are covered in this chapter, while traffic safety is presented in Chapter 4. The traffic volume work included examining historical traffic count data, gathering existing traffic counts, and forecasting future traffic to design year 2045. The traffic operations analysis included a capacity analysis using Highway Capacity Software (HCS2023) and Synchro software to determine if there are any existing operational deficiencies or if any are anticipated by 2045. Raw traffic count data as well as detailed traffic forecasts are presented in the US 127 Traffic Forecast Report attached in **Appendix A**. An overview of existing and future year traffic conditions is presented below.

3.1 Existing (2023) Volumes

The existing traffic volumes for AADT, Design Hour Volumes (DHV), and percent heavy vehicles were developed for the study area. Ten intersections were selected by the project team as primary intersections for evaluation. These primary intersections were analyzed using Synchro software and are presented in **Section 3.3**. With the study evaluating the appropriateness of a 2+1 roadway typical section for US 127, nineteen other intersections with volumes lower than what would typically warrant a full analysis were selected for a secondary evaluation. This secondary evaluation captured the number of left and right turning vehicles into and out of these intersections and was used as a factor in determining where passing lanes would be located and where providing dedicated left or right turn lanes are recommended. See **Section 6.1** for a description of 2+1 roadways and volume thresholds for the inclusion of turning lanes.

The Project Team selected 2023 as the baseline year for the existing conditions analysis. Current and historical AADT, K factors, and truck percentage data were obtained from KYTC for six count stations in the study area where there are short-term hourly counts. Turning movement counts were collected at five locations during the AM and PM peak hours. StreetLight turning movement count estimates were gathered at the remaining five primary intersections and all nineteen secondary intersections. All existing count data are presented in the US 127 Traffic Forecast Report in **Appendix A**.

Current and historical average AADT, K factors, and truck percentage information was obtained from KYTC along US 127 in the study area for years 2019 through 2022. Volumes prior to 2019 were obtained from the KYTC Count Station database. The counts provided hourly traffic volume data by vehicle class and direction. **Table 3** presents the traffic count information at the time of study.

Table 3: US 127 Study Area Historical Count Station Data

Station	County	Route	Begin MP	End MP	Count Year	AADT	K Factor	D Factor	% Single Truck*	% Combo Truck*	% Total Trucks*
023A61	Casey	US 127	15.026	18.946	2020	5,015	10	57	8.2	4.8	13.0
023037	Casey	US 127	18.946	22.816	2021	5,181	9.5	64	8.2	4.9	13.1
069517	Casey/Lincoln	US 127	22.816	3.437	2020	4,623	10.6	56	8.2	4.9	13.1
069505	Lincoln	US 127	3.437	6.939	2019	6,357	9.7	58	5.0	2.8	7.8
069760	Lincoln	US 127	6.939	9.019	2021	9,808	10.4	57	5.0	2.8	7.8
069778	Lincoln	US 127	9.019	10.686	2019	10,437	9.1	69	5.0	2.8	7.8

*Rounded to the nearest 0.1%

Peak period intersection turning movement counts (TMCs) for primary intersections were obtained from the Consultant Team (CT) and StreetLight (SL) data. The Project Team utilized turning movement volumes estimated from SL Data for five primary intersections where counts were not conducted and for all secondary study intersections. **Table 4** lists the primary study intersections evaluated as part of this study and the source of the TMCs for each.

Table 4: US 127 Primary Intersection and TMC Sources

Intersection #	Cross Street	Count Source
1	KY 1552 (Short Town Road)	CT
2	KY 1552 (Loop Road)	SL
3	Patsy Riffe Road	SL
4	KY 906	CT
5	KY 78	CT
6	KY 2141 (Danville Pike)	CT
7	Jeffries Lane	SL
8	KY 1194	CT
9	Bowens Loop Road	SL
10	Arcadia View Drive	SL

The count data show that volumes are generally consistent through Casey County, but in Lincoln County increase from south to north. In the AM peak, NB volumes are higher than SB and in the PM peak the SB volumes are higher than NB. **Figure 13** presents year 2023 volumes.

3.1.1 2023 AADT & DHV volumes

The study area was divided into 11 segments for evaluation, shown in **Table 5** and **Figure 13**. The AM and PM DHV for each segment was determined by using the highest peak hour volume between intersections from the turning movement count data. The AADT chosen for each forecast segment was calculated by applying the K factor to the higher of the AM and PM DHV of that segment. The resulting AADT volumes are presented in **Table 5**. In general, AADT increased from south to north through the study area.

Table 5: 2023 Table of Base Volumes

Segment	Description	AADT	AM DHV	PM DHV	AADTT	AM TDHV	PM TDHV
A	Beginning of Study to KY 1552 (Short Town Road)	4,600	410	460	600	55	60
B	KY 1552 (Short Town Road) to Old KY 1552 (Loop Road)	5,150	420	490	670	55	65
C	Old KY 1552 (Loop Road) to Patsy Riffe Road	4,850	370	460	630	50	60
D	Patsy Riffe Road to KY 906	5,150	390	490	670	50	65
E	KY 906 to KY 78	4,700	370	470	620	50	60
F	KY 78 to KY 2141 (Danville Pike)	5,900	450	570	460	35	45
G	KY 2141 (Danville Pike) to Jeffries Lane	6,700	570	650	520	45	50
H	Jeffries Lane to KY 1194	8,250	680	800	640	50	60
I	KY 1194 to Bowens Loop Road	9,950	800	1,000	770	60	75
J	Bowens Loop Road to Arcadia View Drive	10,800	780	1,030	840	60	80
K	Arcadia View Drive to End of Study	11,150	790	1,060	860	60	80

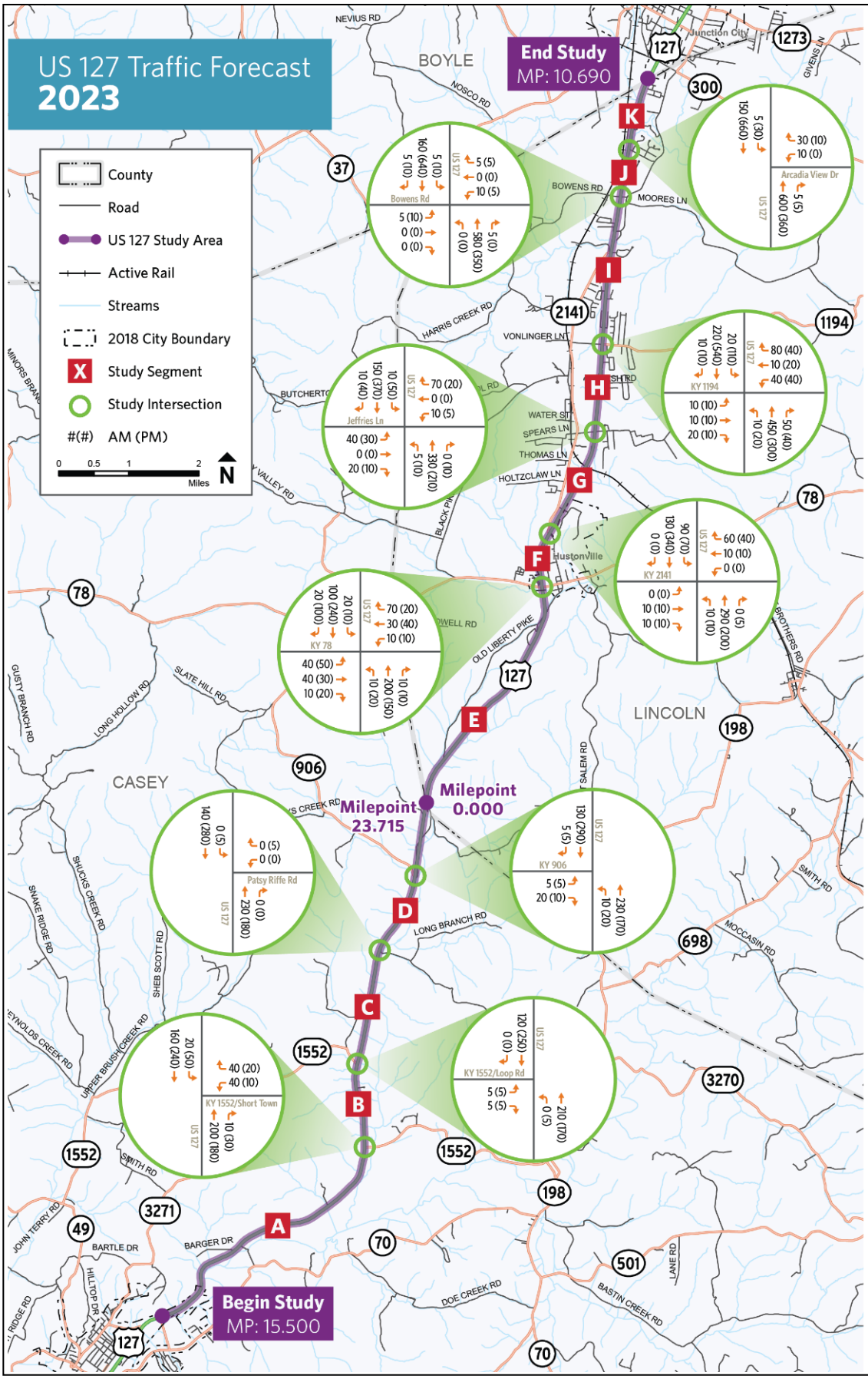
AADT rounded to the nearest fifty. AADTT and DHV rounded to the nearest ten. TDHV rounded to the nearest five.

3.1.2 2023 Truck Volumes

Truck percentage data was obtained from the KYTC Statewide Traffic Counts Map2. These data, along with the classification counts, were used to estimate Average Annual Daily Truck Traffic (AADTT) and truck DHVs (TDHV). Trucks make up approximately 13% of the daily traffic in Casey County and 8% of the daily traffic in Lincoln County. The TDHVs range from a low of 35 vph in the middle of the study area to a high of 80 vph near the end of the study area at the Boyle County line. **Table 5** and **Figure 13** presents 2023 AADTT and TDHV for each segment along US 127.

2 https://maps.kytc.ky.gov/trafficcounts/

Figure 13: US 127 Base Year (2023) Segment and Intersection Volumes



K	AADT	11,150
	DHV	1,060
	AADTT	860
	TDHV	80
J	AADT	10,800
	DHV	1,030
	AADTT	840
	TDHV	80
I	AADT	9,950
	DHV	1,000
	AADTT	770
	TDHV	75
H	AADT	8,250
	DHV	800
	AADTT	640
	TDHV	60
G	AADT	6,700
	DHV	650
	AADTT	520
	TDHV	50
F	AADT	5,900
	DHV	570
	AADTT	460
	TDHV	45
E	AADT	4,700
	DHV	470
	AADTT	620
	TDHV	60
D	AADT	5,150
	DHV	490
	AADTT	670
	TDHV	65
C	AADT	4,850
	DHV	460
	AADTT	630
	TDHV	60
B	AADT	5,150
	DHV	490
	AADTT	670
	TDHV	65
A	AADT	4,600
	DHV	460
	AADTT	600
	TDHV	60

3.2 Future (2045) Volumes

Traffic volumes were projected out to the 2045 design year to be consistent with the American Association of State Highway and Transportation Officials (AASHTO) policy, which calls for forecasts to be at least 20 years beyond the year in which the project plans, specifications, and estimates for construction are approved. The traffic forecast includes projections for AADT, DHV, and truck volumes. Details for the volume forecasting work are presented in the *US 127 Traffic Forecast Report* attached in **Appendix A**.

3.2.1 Traffic Growth Rate

The traffic growth rate was determined by comparing these three independent assessments:

1. US 127 historical traffic counts for growth trends
2. Results from the Kentucky Statewide Travel Demand Model (KYSTMv19 with 6,003 zones)
3. Expected population growth in Lincoln and Casey counties

The historical average traffic growth along US 127 was 0.69%. The KYTC Statewide Travel Demand Model with passing lanes modeled shows a growth rate of 0.74% per year. The population in Kentucky between 2010 and 2020 grew at a rate of approximately 0.4% per year and is expected to grow 0.2% per year out to 2045. In comparison to the overall state, Casey County population between 2010 and 2020 did not grow and is expected to decline at a rate of 0.3% per year in the future. Lincoln County population between 2010 and 2020 declined by 0.2% and is expected to decline at a rate of 0.4% per year in the future.

Given the historical traffic growth, model growth rates and local population that is expected to decline, a 0.75% annual growth rate for AADT, DHV, and truck volumes was selected for this study. This growth rate is sufficient to test traffic operational performance in the study area over the next 22 years.

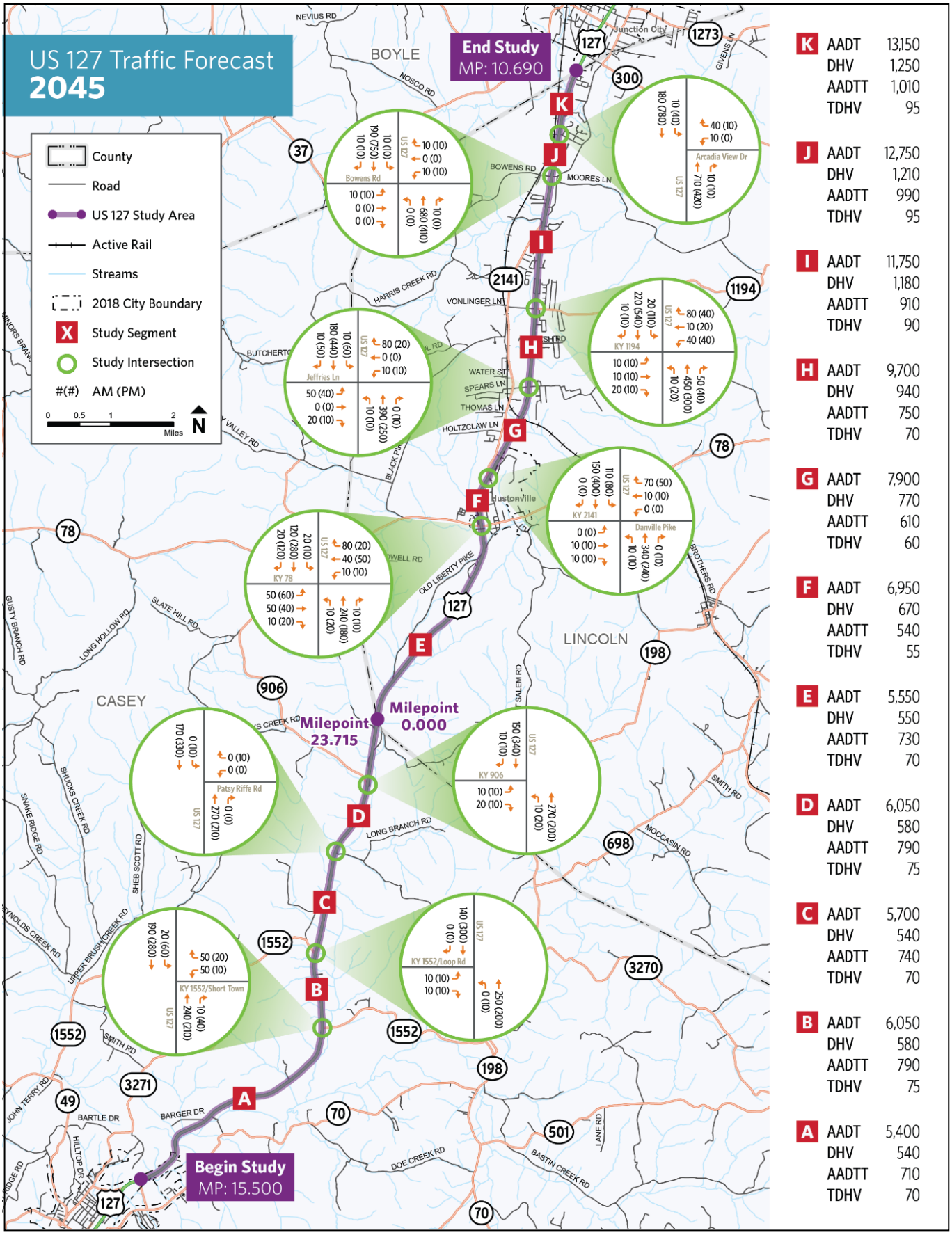
3.2.2 2045 Volumes

The projected 2045 AADT, DHVs, and truck volumes are presented in **Table 6** and **Figure 14**. AADTs are expected to range from a high of 13,150 vpd near the Boyle County line to a low of 5,400 vpd just north of Liberty, KY in Casey County. The PM peak presents the highest DHVs which range from a maximum of 1,250 vph near the Boyle County line to a minimum of 540 vph near Liberty, Kentucky.

Table 6: Future Year (2045) Traffic Volumes

Segment	Description	AADT	AM DHV	PM DHV	AADTT	AM TDHV	PM TDHV
A	Begin Project to KY 1552 (Short Town Road)	5,400	490	540	710	65	70
B	KY 1552 (Short Town Road) to Old KY 1552 (Loop Road)	6,050	500	580	790	65	75
C	Old KY 1552 (Loop Road) to Patsy Riffe Road	5,700	440	540	740	60	70
D	Patsy Riffe Road to KY 906	6,050	450	580	790	60	75
E	KY 906 to KY 78	5,550	440	550	730	60	70
F	KY 78 to KY 2141 / Danville Pike	6,950	530	670	540	45	55
G	KY 2141 / Danville Pike to Jeffries Lane	7,900	670	770	610	50	60
H	Jeffries Lane to KY 1194	9,700	800	940	750	60	70
I	KY 1194 to Bowens Loop Road	11,750	940	1,180	910	70	90
J	Bowens Loop Road to Arcadia View Drive	12,750	930	1,210	990	70	95
K	Arcadia View Drive to End of Project	13,150	940	1,250	1,010	70	95

Figure 14: US 127 Future Year (2045) Segment and Intersection Volumes



3.3 Traffic Operational Analysis

The traffic operational analysis was conducted using HCS2023 and Synchro software, which are based on the Highway Capacity Manual (HCM), 7th Edition methods to determine capacity and Level of Service (LOS). Highway LOS is a qualitative measure that is used to describe the operating conditions of a roadway or intersection based on factors such as speed, travel time, maneuverability, delay, and safety. It is characterized by an A to F scale with A representing the best operating conditions and F representing the worst.

US 127 is classified as a rural Principal Arterial (Functional Class 4) for most of the study area, except for the far northern end from Arcadia View Drive to the Boyle County line, which is classified as an urban Principal Arterial. The AASHTO Green Book guidelines suggest that rural arterials be designed to LOS B in level or rolling terrain and urban arterials be designed at LOS C or D. For the purposes of the operational analysis, US 127 was considered a two-lane highway throughout the study area. **Table 7** provides LOS criteria for the segment analysis.

Table 7: LOS Criteria for Two-lane Highways

LOS	Two-Lane Highway Posted Speed Limit ≥ 50mph Follower Density (followers/mi/ln)
A	≤ 2.0
B	> 2.0 – 4.0
C	> 4.0 – 8.0
D	> 8.0 – 12.0
E	> 12.0
F	Demand Exceeds Capacity

LOS B or better is acceptable for rural arterials in flat or rolling terrain
LOS is F when volume/capacity ≥ 1.0

At intersections, LOS is a measure of average operating conditions during an hour. It is based on average delay per vehicle for a specified time (the two peak traffic hours of the day). The LOS of two-way, stop-controlled (TWSC) intersections is defined in terms of the average vehicle delay of an individual movement(s) such as left turns, right turns or continuing straight. Although every analyzed intersection is unsignalized, **Table 8** provides LOS criteria for unsignalized and signalized intersections.

Table 8: LOS Criteria for Intersections

LOS	Average Control Delay TWSC (sec/veh)	LOS Description
A	≤ 10	Little or no delay
B	> 10 and < 15	Short traffic delays
C	> 15 and < 25	Average traffic delays
D	> 25 and < 35	Long traffic delays
E	> 35 and < 50	Very long traffic delays
F	> 50	Severe congestion

Using the criteria listed above, intersection as well as segment analysis was completed for both existing (2023) and future (2045) traffic along US 127.

3.3.1 Existing Conditions (2023) Analysis

Ten existing two-lane segments were analyzed on US 127. The section of US 127 from Jeffries Lane to the Boyle County line operates at LOS C in both the NB AM peak and the SB PM peak. All other segments operate at LOS A or B. The results are presented in **Figures 15 and 16**. Of the ten primary intersections analyzed, all currently operate at overall intersection LOS A under TWSC conditions during both the AM and PM peak periods. (Individual turning movement LOS was not analyzed as part of this study since none are signalized.). These results can also be seen in **Figures 15** and **16**.

Figure 15: 2023 Base Year Segment and Intersection LOS in Casey County

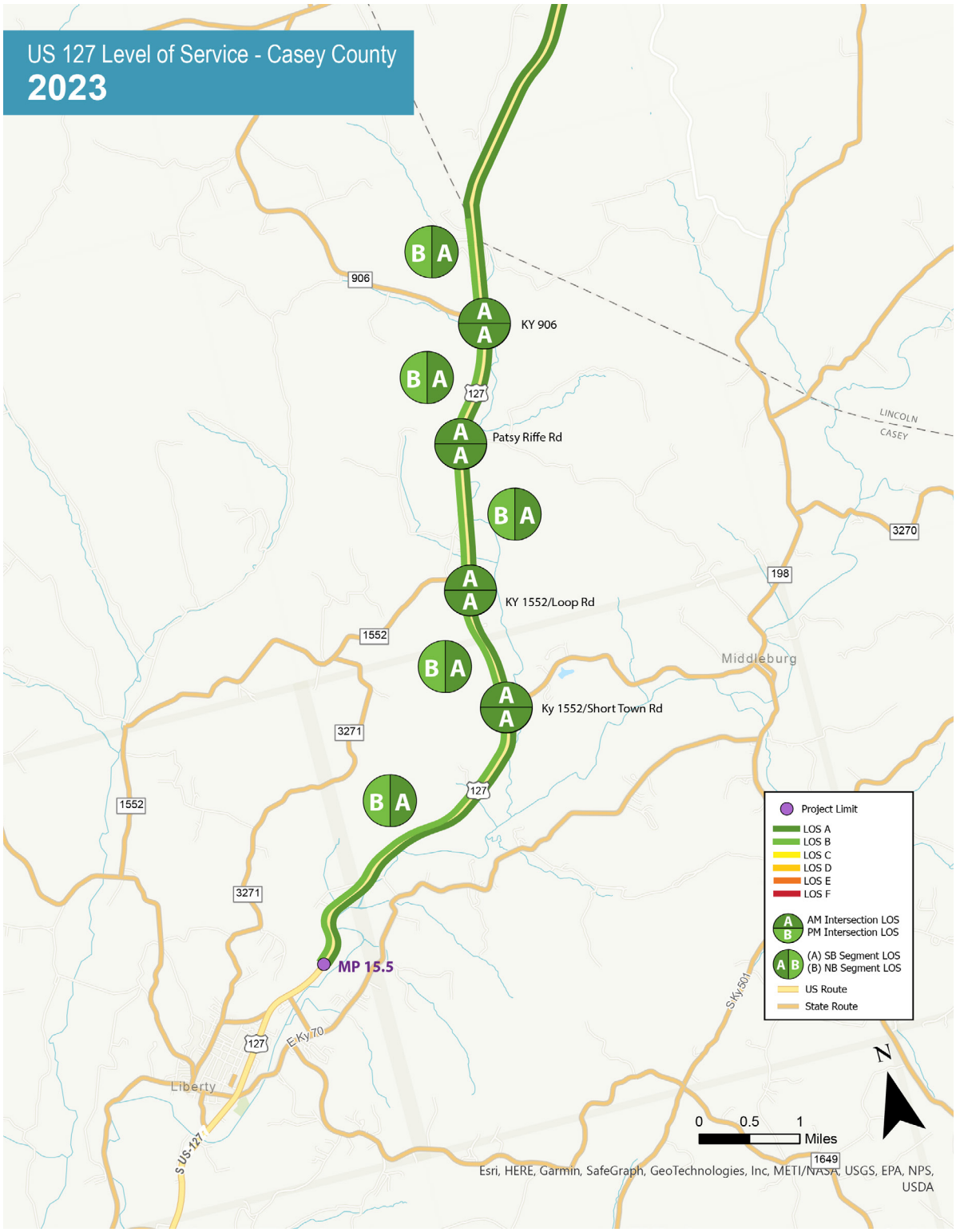
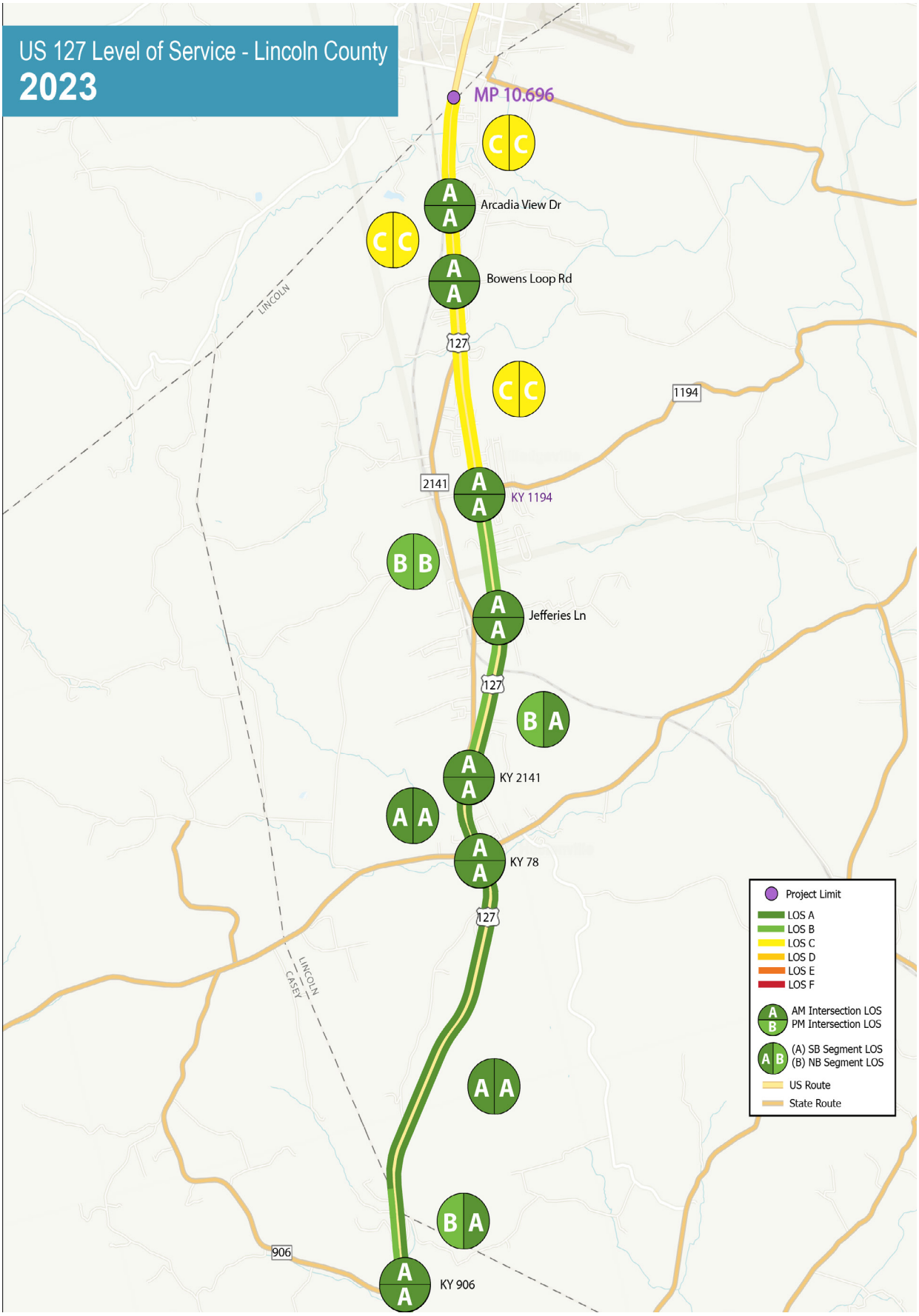


Figure 16: 2023 Base Year Segment and Intersection LOS in Lincoln County



3.3.2 Future No-Build Conditions (2045) Analysis

The ten US 127 segments were analyzed in 2045 for no-build conditions. Segments from the beginning of study near Liberty to KY 2141 will continue operating at overall LOS B or better, but north of KY 2141 segments begin to operate at LOS C or D in both the NB AM peak and the SB PM peak. The results are presented in **Figures 17** and **18**.

Of the ten primary intersections analyzed, all are expected to continue operating at LOS A or better during both the AM and PM peak hours under 2045 No-Build conditions. The results are also presented in **Figures 17** and **18** below.

Figure 17: 2045 Forecast Segment and Intersection LOS, Casey County

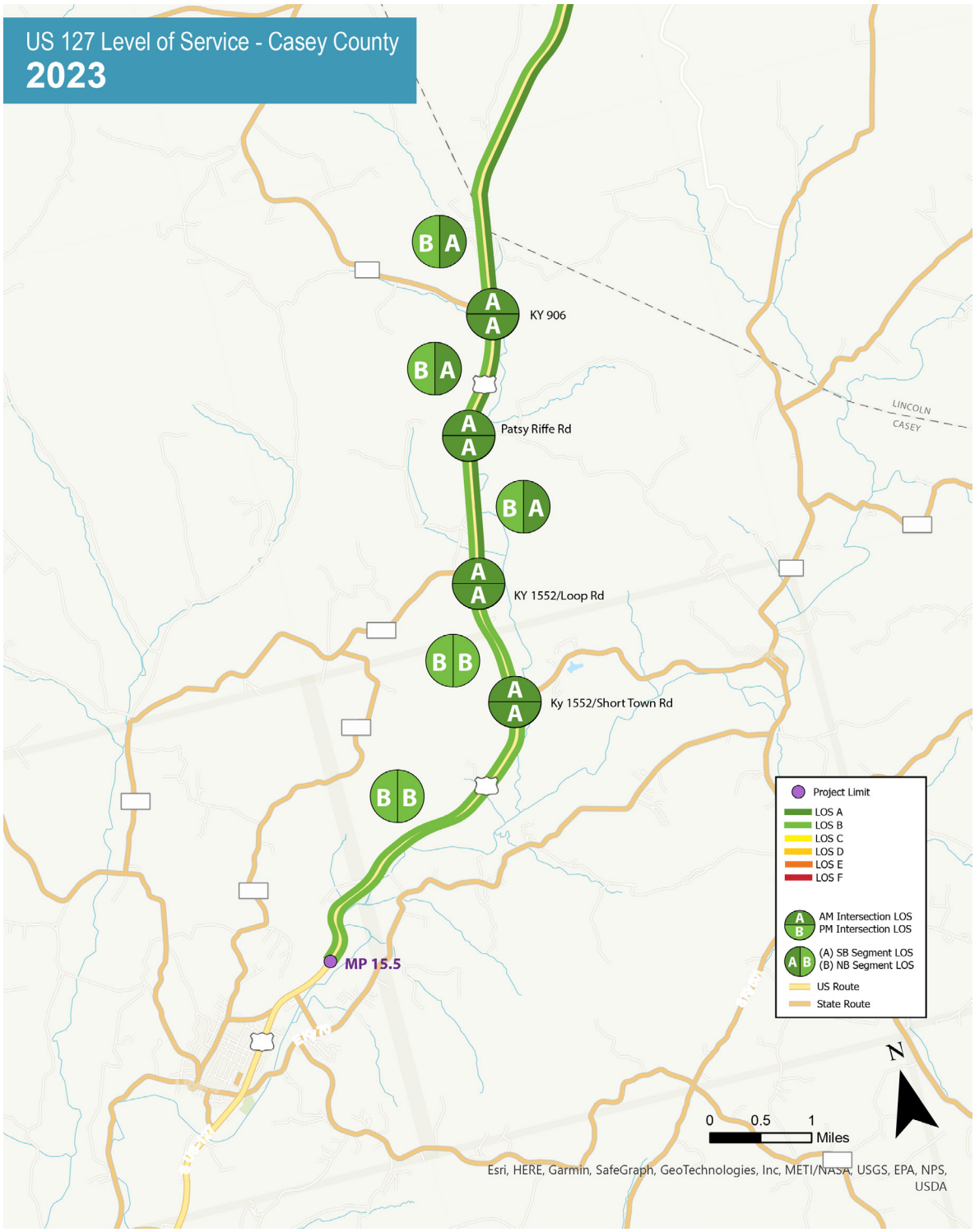
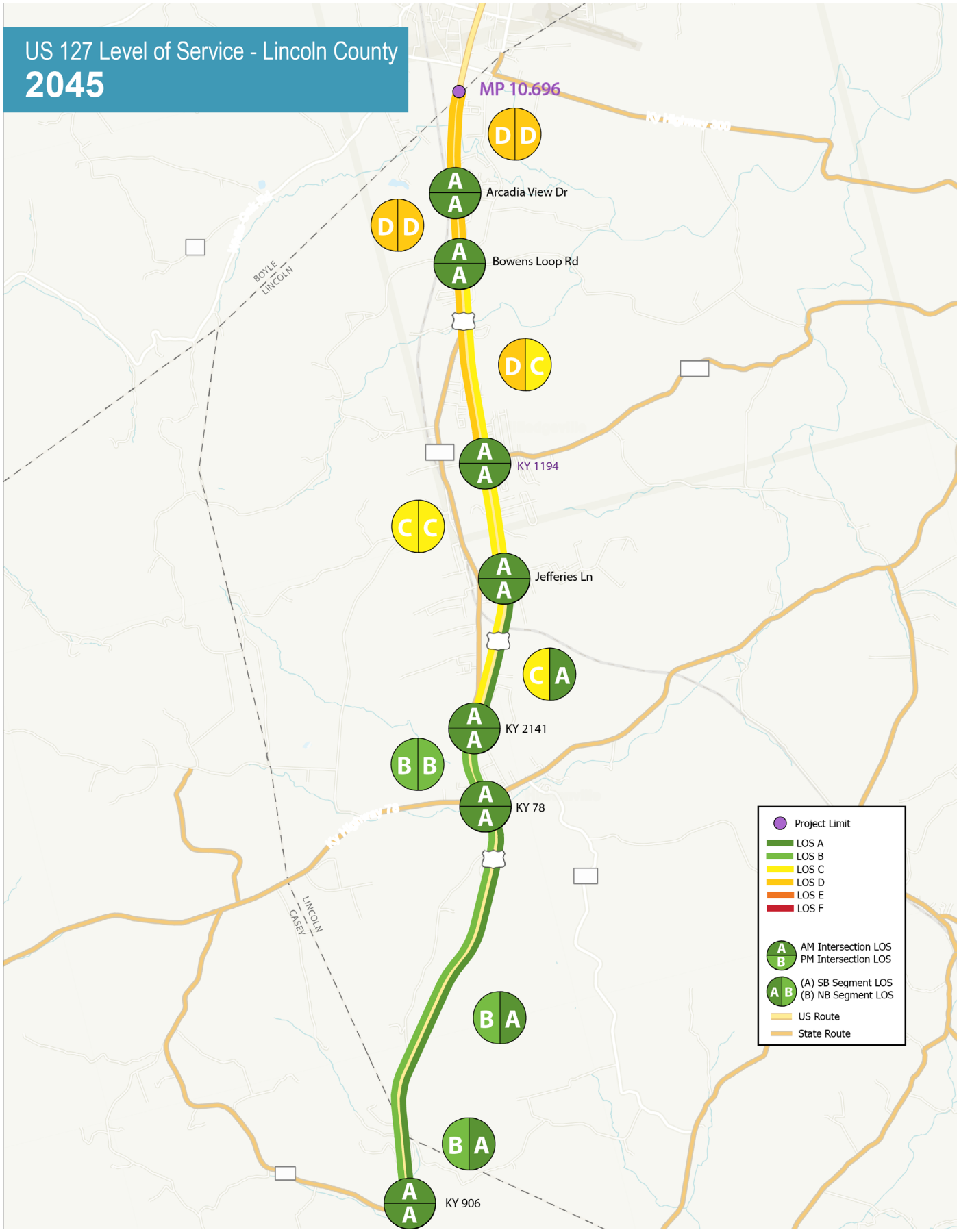


Figure 18: 2045 Forecast Segment and Intersection LOS



3.4 Corridor Speeds

Travel speeds can be an indicator of how a roadway is operating. Under normal operating conditions drivers on a two-lane highway would typically be traveling close to the posted speed limit. Locations with recurring operating speeds below the posted speed could indicate a geometric deficiency, such as a curve with a tight radius, or the lower speeds could be the result of intersection related delay, such as vehicles slowing down to turn into cross streets or driveways. Locations with recurring operating speeds greater than the posted speed indicate that drivers are comfortable traveling under the existing conditions with factors comprised of; roadway geometrics (lane and shoulder widths, horizontal curve radius, grade), access density, traffic volume levels, and pedestrian / bicycle activity. To aid in the speed evaluation, KYTC provided 2021 HERE speed data for the US 127 study area. The speed data were used to determine typical operating speeds throughout the day, including during peak traffic hours and off-peak hours for both cars and trucks. Car and truck 85th percentile speeds are shown in **Figure 19** and **20**.

Operating speeds were analyzed temporally and geographically to determine their relation to US 127 operations. Vehicular 85th percentile travel speeds along US 127 were recorded above the posted speed limit of 55 mph along the entirety of the corridor during the peak hours, with the exception of the KY 78 intersection approaches, which dip slightly below in the SB direction. Speeds tend to decrease slightly at the approaches to intersections, likely due to left turning vehicles slowing down on US 127 waiting for a gap in traffic and from vehicles turning onto US 127 accelerating. Additional speed graphs are included in **Appendix B** *US 127 Speed Analysis*.

The analysis of speeds by time-of-day indicate that vehicular speeds during the off-peak hours are up to 5 mph faster than during the peak hours of 7:00am and 4:00pm. By location, speeds were generally higher in the middle of the study area and lower at either end likely due to entering the more urbanized areas of Liberty and Junction City. There was not a clear correlation between operating speeds and crash locations. Crashes along the study area typically occurred at intersections. A full discussion of crashes is presented in **Chapter 4**.

Figure 19: Northbound 85th Percentile Car and Truck Speeds

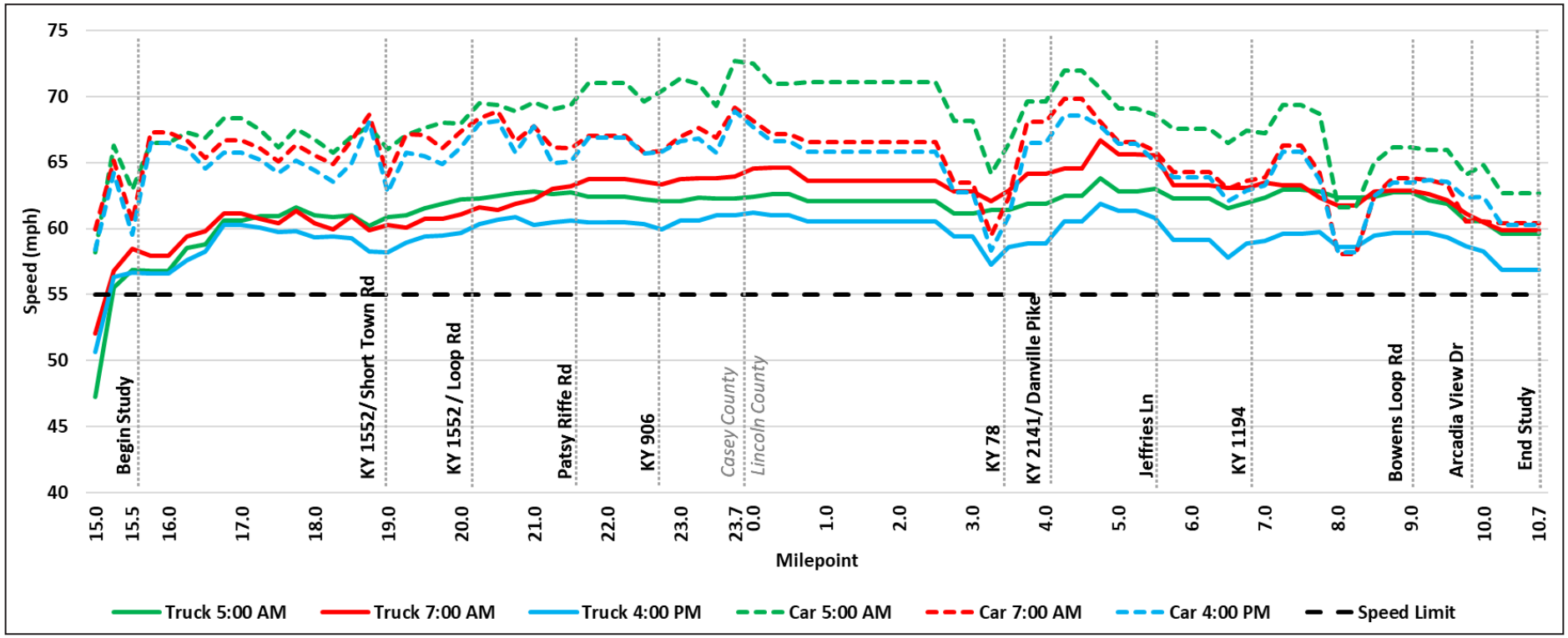
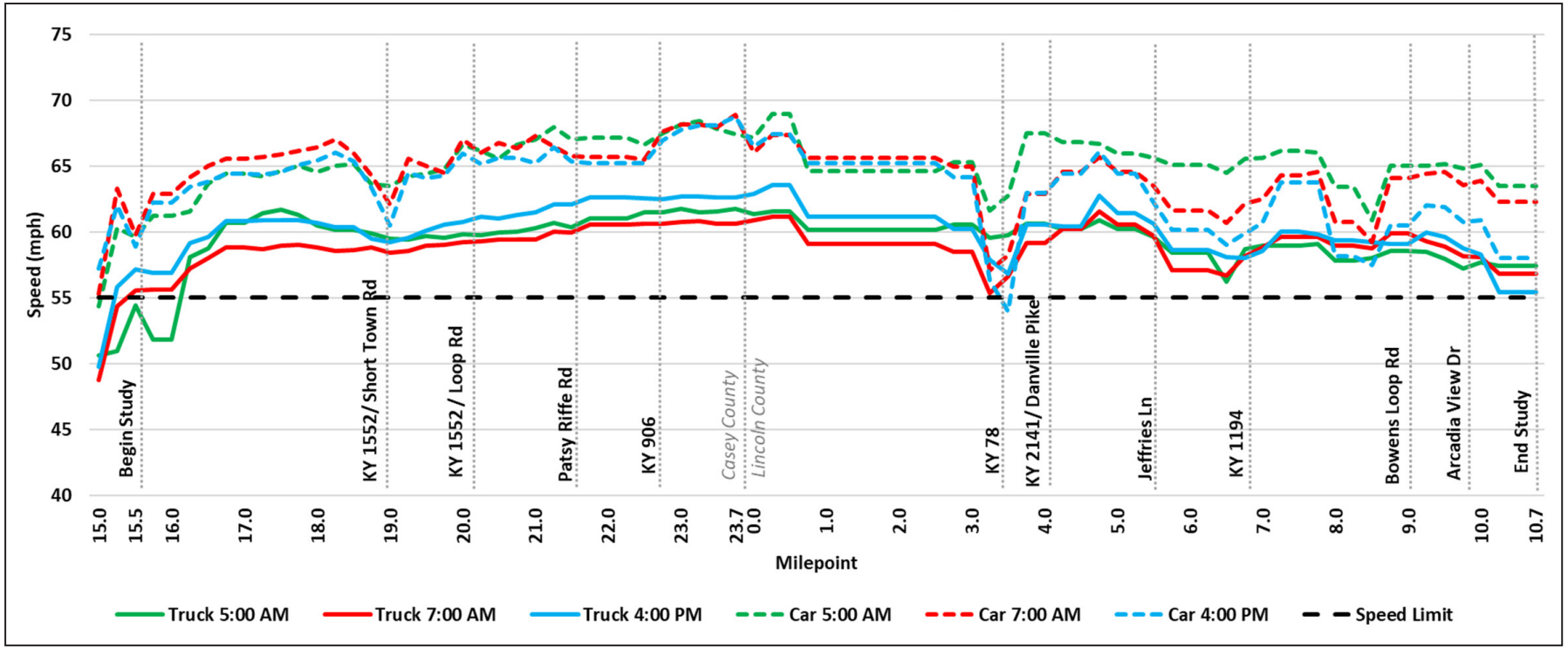


Figure 20: Southbound 85th Percentile Car and Truck Speeds



4 Safety

4.1 Historic Crash Analysis

A historical crash analysis was performed to examine traffic safety trends and to identify potential safety issues along US 127. The crash data were derived from data provided by KYTC in the Crash Data Access Tool (CDAT) and the Kentucky State Police (KSP) database. Five years of data (2017 to 2021) were used in the analysis and are presented throughout the rest of this chapter. Within the five-year analysis period, 152 crashes were reported in the study area. A breakdown of the crashes by severity is presented in **Table 9** and is shown in **Figure 23**. A majority of the crashes (67.1%) were property damage only crashes. There were three fatal crashes, eight serious injury, and 13 minor injury crashes over the five-year study period.

Of the 11 fatal and serious injury crashes, three involved motorcycles at intersections with specific narrative notes on sight being an issue. The manner of collisions for the fatal and serious injury crashes included roadway or lane departure crashes along segments and angle crashes at intersections.

Table 9: US 127 Crash Severity (2017-2021)

Severity of Crash	Crashes	Percent
Fatal Injury	3	2%
Serious Injury	8	5%
Minor Injury	13	9%
Possible Injury	26	17%
Property Damage Only	102	67%
Total	152	100%

Speed was noted to be a factor in crash severity, with some correlation to intersection density and horizontal or vertical curvature. Below, **Figures 21 and 22** highlight the 85th percentile speed in the NB and SB directions throughout the day. Fatal and serious injury crashes were added to the graph to identify if speed was a factor in the crash outcomes. Crashes in Casey County have a correlation between speed and roadway geometry, while crashes in Lincoln County and Casey County have crash correlations between speed, roadway geometry, and intersection sight distance.

Figure 21: US 127 Northbound 85th Percentile Speeds with KA Crash Locations

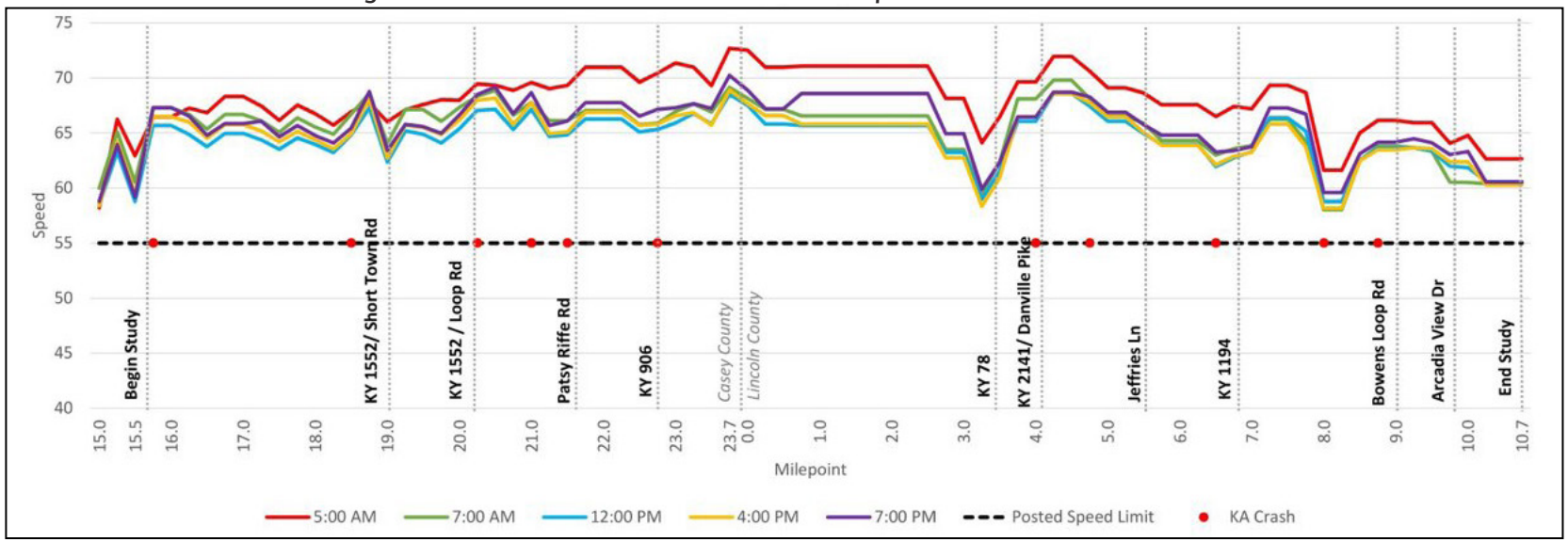


Figure 22: US 127 Southbound 85th Percentile Speeds with KA Crash Locations

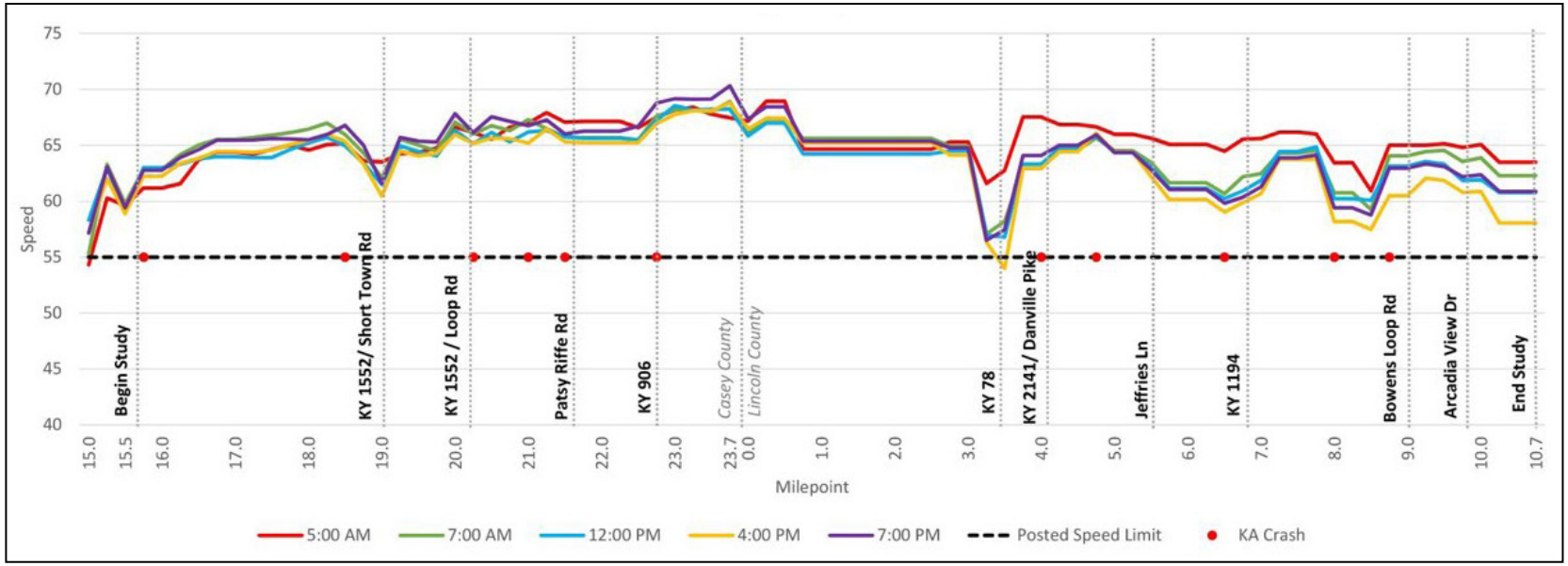
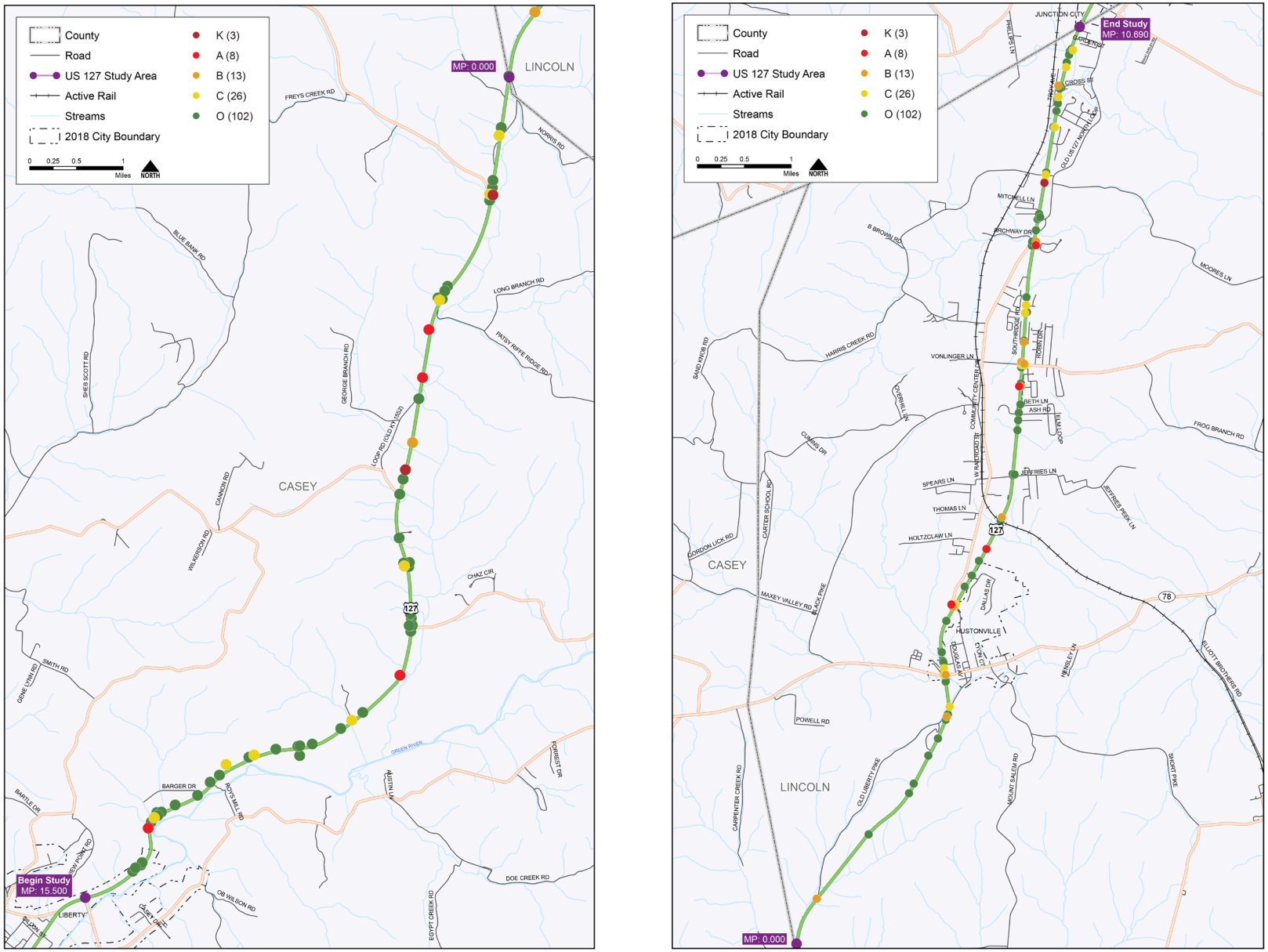


Figure 23: Crash Severity 2017-2021 Along US 127 for Casey County (left) and Lincoln County (right)



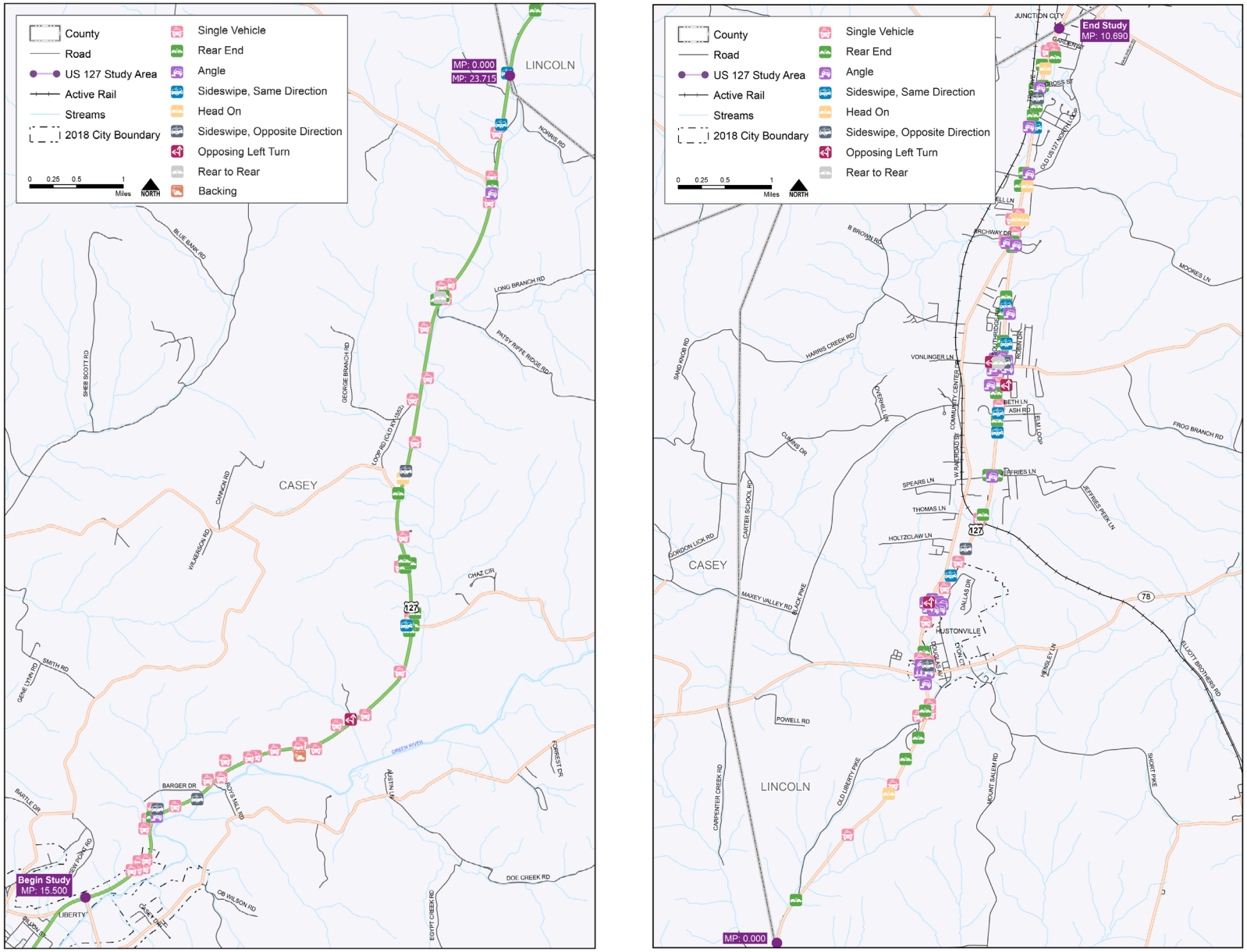
An examination of the type of crashes along US 127 is presented in **Table 10** and **Figure 24.** Approximately 36 percent of crashes in the study area are single vehicle crashes followed by rear end (24%), and angle (18%) type crashes. A review of the single vehicle crashes showed that nearly half were animal involved collisions. Locations of crashes suggests that most crashes occurred in locations with access points and intersections or in areas where horizontal curvature changes to "C-Class" curves in Casey County, where most of the study area has "A-Class" curves. Rear end and angle crashes were fairly common at intersections and driveways. This is consistent with the nature of the study area with its 136 access points, as discussed in **Section 2.1.9**.

A closer review of rear end crashes was performed to determine if there were any trends or contributing factors. Approximately 87% of rear end crashes involved a vehicle slowing down to turn or queueing as result of turning vehicles and 13% of rear end crashes involved an "other" collision at an intersection or access point. Removing left turning movements or providing left turning lanes has the potential to reduce rear end crashes.

Table 10: US 127 Crashes by Manner of Collision (2017-2021)

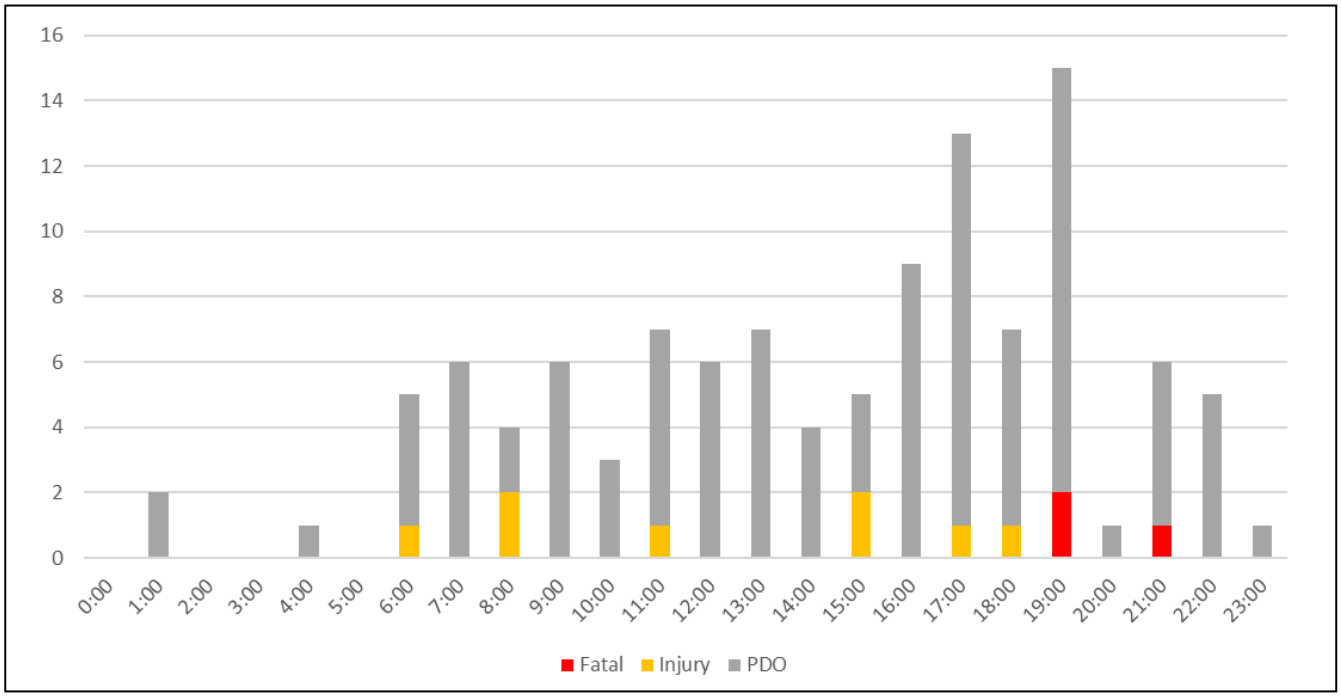
Crash Type	Crashes	Percent
Single Vehicle	55	36%
Rear End	37	24%
Angle	29	18%
Sideswipe-Same Direction	10	7%
Head On	7	5%
Sideswipe-Opposite Direction	7	5%
Opposing Left Turn	4	3%
Rear To Rear	2	1%
Backing	1	1%

Figure 24: US 127 Crash Type by Location (2017-2021) in Casey County (left) and Lincoln County (right)



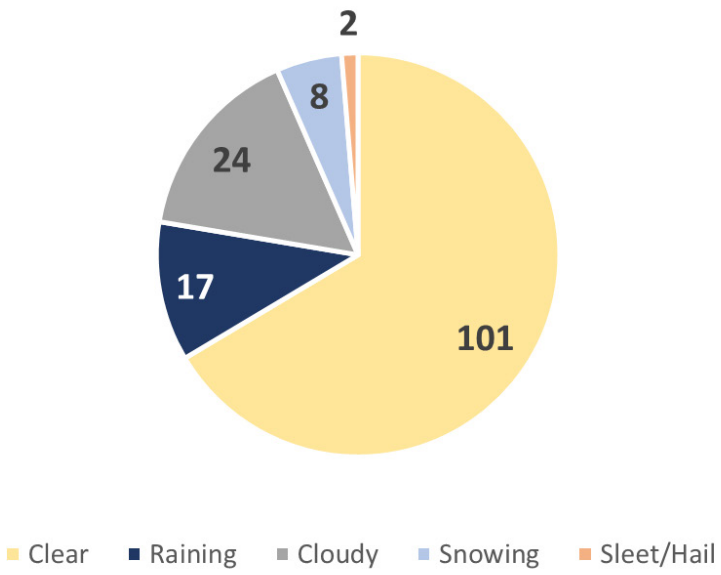
A review of crashes by time of day, **Figure 25**, shows that crashes tend to peak during the evening from 4:00 PM to 8:00 PM, with fatal crashes occurring during between 7:00 PM to 10:00 PM.

Figure 25: Injury Severity Collisions by Time of Day (2017-2021)



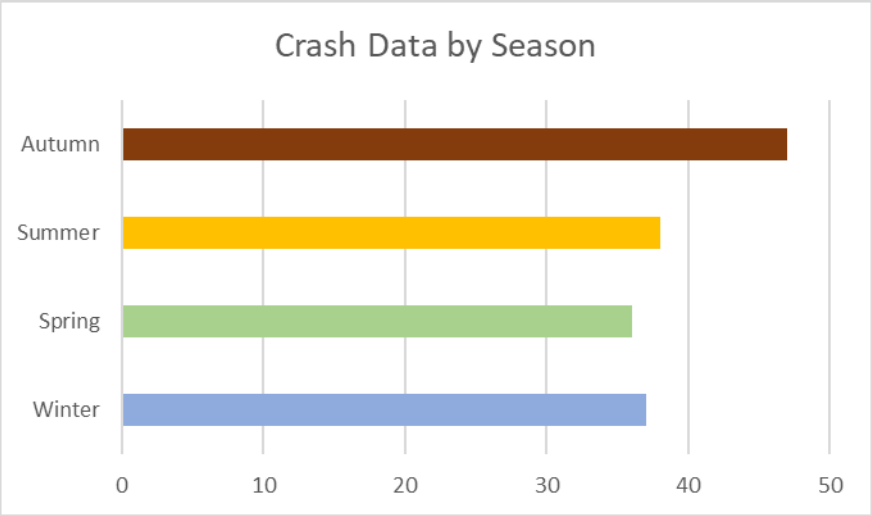
Weather conditions can greatly impact traffic safety. Most crashes along US 127 occurred during clear weather but reports of wet roadway conditions were factored in to see if any locations had specific roadway friction issues. Most wet roadway crashes were dispersed along the corridor and an exact trend was not found. **Figure 26** shows the breakdown of crashes by weather condition.

Figure 26: Crashes by Weather Condition



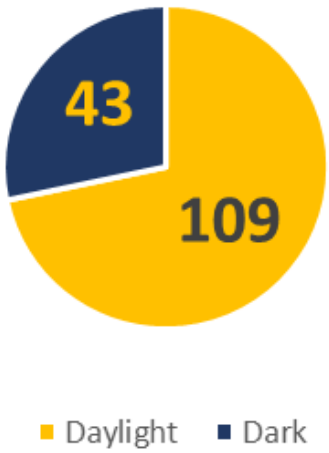
Similar to weather conditions, crash trends tend to show up during different times or seasons of the year. **Figure 27** shows the crashes by season along US 127. The crashes seem to peak during the Autumn months, which can be caused by people not being used to driving in the dark after summer. National trends show that dark conditions are when traffic safety is usually at its worst

Figure 27: Crashes by Season



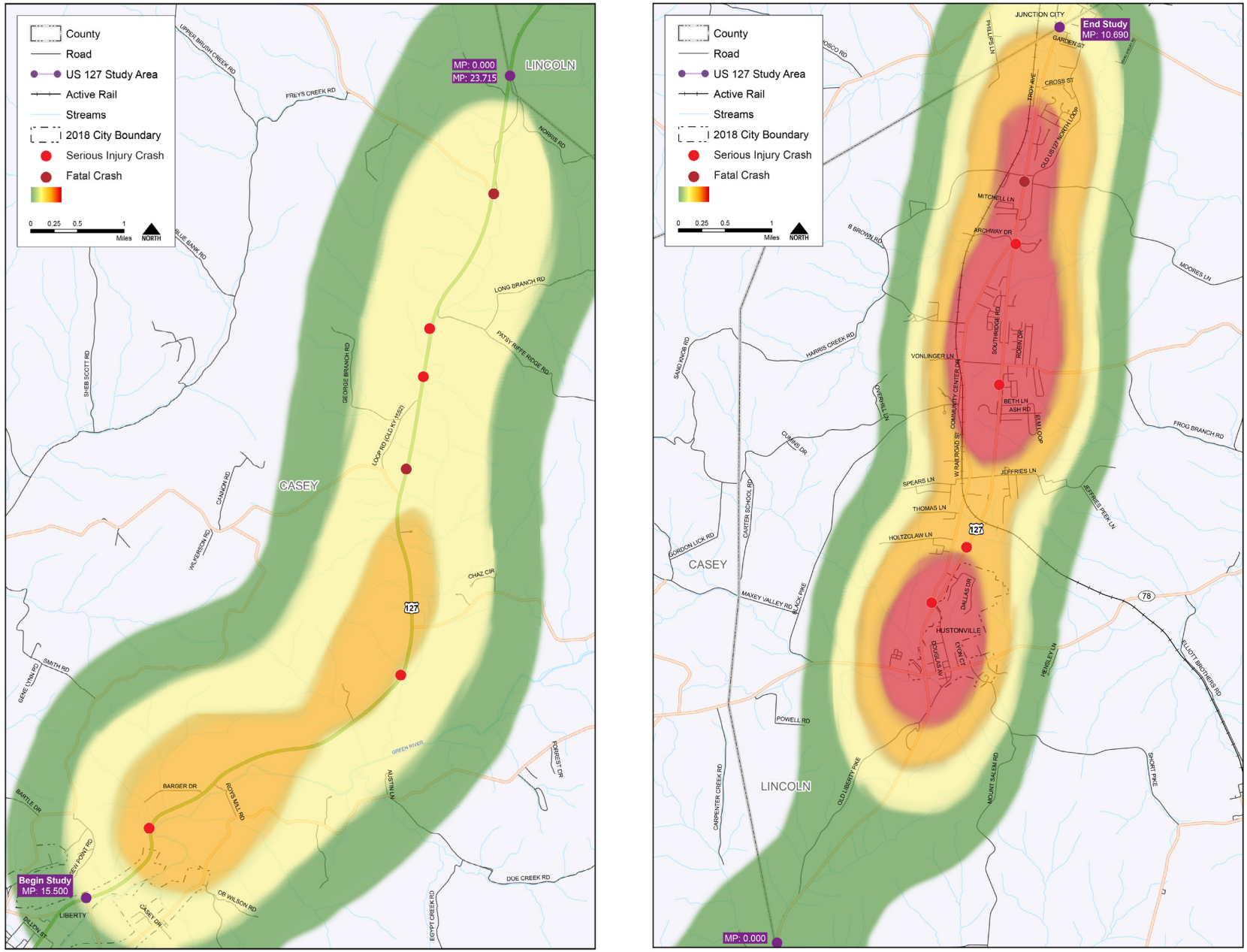
The majority of the crashes occurred during daylight hours as shown in **Figure 28**, however, approximately 28 percent occurred during dark or dawn / dusk hours indicating that lighting may be an issue along the study area. Crashes during dark and dawn / dusk conditions appear to be overrepresented as traffic usually drops significantly during dark conditions.

Figure 28: Crashes by Light Condition



The density of crashes along the study area was plotted (**Figure 29**) to show locations with higher concentrations of crashes. Two trends emerged from the analysis. The first is that crashes are generally denser in the Hustonville area and north of Hustonville in Lincoln County where a higher concentration of driveways and intersecting roadways are present. The second is that crashes are denser in the Casey County section where the road changes from a higher speed and straight corridor to sudden winding curves just north of Liberty.

Figure 29: US 127 Crash Density in Lincoln County (left) and Casey County (right)



US 127 segment crash rates and intersection crash rates were calculated using the 2017-2021 crash data and traffic volumes. The section of US 127 is considered as a two-lane rural principal arterial for everything besides the small section north of Arcadia View, which is considered an urban principal arterial. The crash rate is 42.61 per 100 million vehicle miles traveled (MVM), lower than both the statewide crash rates for rural principal arterials, 90 per 100 MVM, and urban principal arterials, 480 per 100 MVM.

The intersection crash rates are highlighted in the table below. Intersection crash rates varied throughout the corridor with the highest rates shown at KY 2141 / Danville Pike, KY 1194, and KY 78. **Table 11** provides further crash rate analysis details.

Table 11: US 127 Intersection Crash Rates - All Crashes

Intersection	MP	Crashes	Crash Rate[1]
KY 1552 (Short Town Road)	18.949	4	0.44
KY 1552 (Loop Road)	20.105	1	0.11
Patsy Riffe Road	21.745	4	0.42
KY 906	22.816	4	0.42
KY 78	3.438	7	0.60
KY 2141 (Danville Pike)	4.203	9	0.78
Jeffries Lane	5.744	3	0.26
KY 1194	6.941	11	0.61
Bowens Loop Road	9.021	4	0.21
Arcadia View Drive	9.677	1	0.05

[1]Crash rate is calibrated by using a rate per 1 million entering vehicles per intersection for comparison purposes.

4.2 Excess Expected Crashes & Highway Safety Manual Methods

KYTC and KTC have developed a more refined statistical methodology based on the Highway Safety Manual (HSM) to rank the safety needs of projects. Excess Expected Crashes (EEC) is based on a crash prediction model estimating the number of crashes expected on an average roadway segment of a given type and length. It represents the number of excess crashes a segment is experiencing compared to other similar type roadways, adjusting for traffic volumes and relevant statistical corrections. EEC is positive when more crashes are occurring than expected and negative when fewer crashes are occurring than expected.

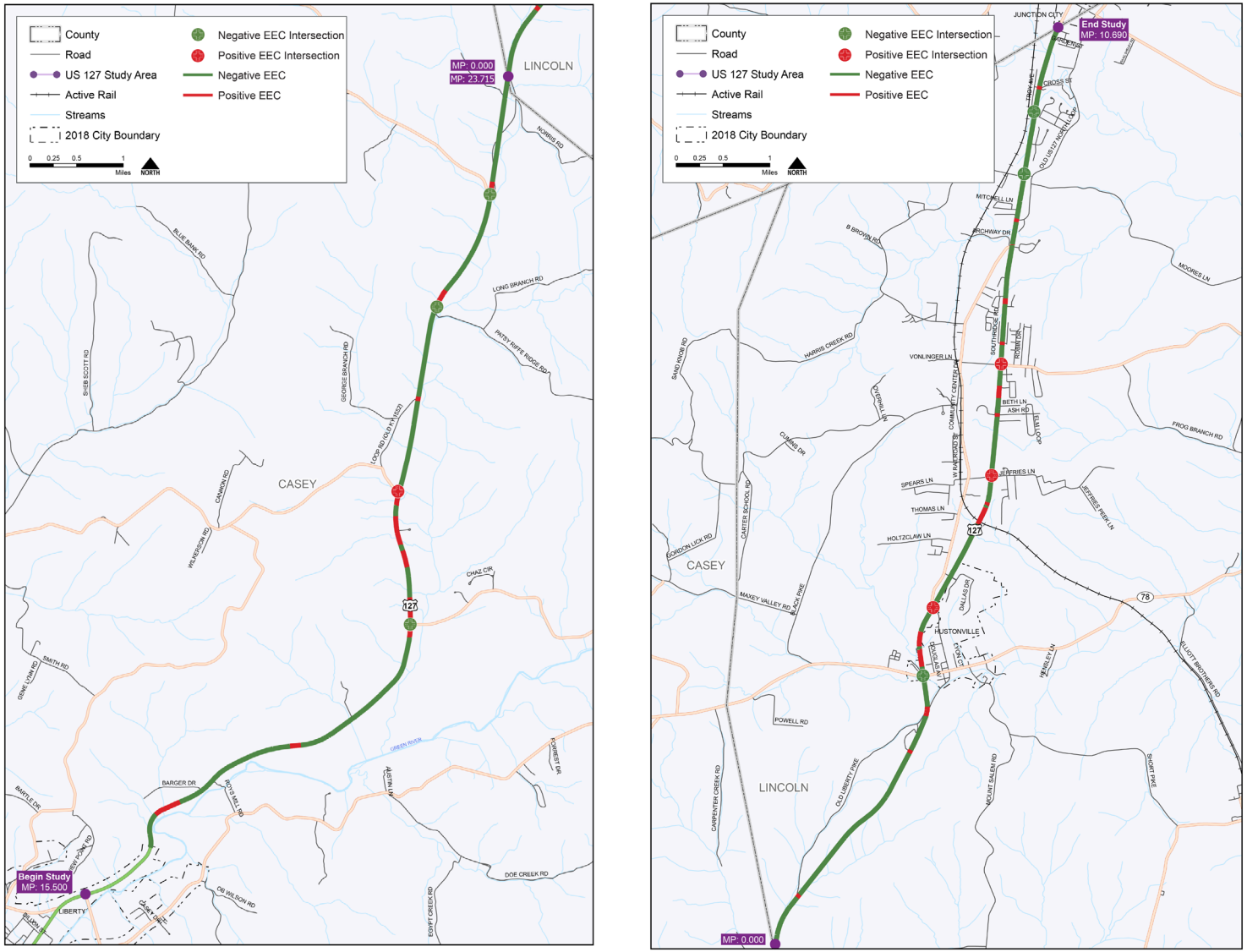
The EEC values for US 127 were obtained from KYTC and are color coded on **Figure 30**. US 127 experiences a mixture of positive and negative EEC values at intersections and segments. Basic trends from the EEC analysis show that the intersections with KY 1552 (Loop Rd), KY 2141 (Danville Pike), Jeffries Lane, and KY 1194 are experiencing greater than expected crashes. Most segments are experiencing less than expected crashes with the exception of the segment between KY 1552 (Loop Rd) and KY 1552 (Short Town Rd) and the segment between KY 78 and KY 2141 (Danville Pike), which have positive EEC values.

Segments are experiencing an overall negative EEC value with 150.66 less crashes than expected over five years. Intersections, however, have an EEC value of 0.79 over five years with a negative EEC (-0.36) for minor injury or property damage only crashes, and a positive value (1.15) for fatal and serious injury crashes. Overall, the study area experiences a negative EEC value of –149.87 indicating it experiences fewer than the expected number of crashes. These results indicate that overall, US 127 is operating better than would be predicted for a minor arterial roadway with similar traffic volumes and roadway characteristics.

To confirm KTC EEC methods, the HSM Analysis Spreadsheet tool was used as a verification tool of existing safety trends. Similar EECs were calculated for segments and intersections throughout the

corridor. A sum of all locations shows that US 127 operates at a negative EEC, which means there are less crashes occurring than expected. Two locations operate worse than the KTC EECs (more crashes than expected). The first being the intersection with Patsy Riffe Road and the second the segment between KY 2141 to mile point 5.606. It should be noted that the HSM tools do not have as detailed of information that the KTC EECs have, so the KTC EECs should be the driving factor in decision making for this study where the two methods differ.

Figure 30: US 127 Excess Expected Crashes Map (2017-2021)



4.3 Summary of Safety Issues & Use of Safety Data

Overall, US 127 operates safer than expected based on EECs and other safety data metrics. Operating speed and design speeds are not the same, as operating speeds are higher than the design speed of 60 mph. Based on crash reports, crash data, and public feedback, safety issues are typically linked to limited sight distance, sudden roadway geometric changes, and driver impatience in areas that lack provided passing zones resulting in the drivers disobeying the law and misusing provided infrastructure. Existing crash locations, EEC analysis, and the crash rate factor analysis highlight the intersection and segment locations that have safety issues with provided insight on typical crash types that occur for improvement development. Due to the higher speeds of the study area and the overall typical section, an above average amount of crashes that occur along this facility resulted in a fatal or injury crash.

The results for potential safety and traffic operational improvements at these locations are explored later in this report. The historic crash data, EEC information, and crash rates (calculated using the crash and volume data) were all used to evaluate the deficient locations and to develop both corridor wide and spot improvements.

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5 Environmental Overview

Data was collected for an Environmental Overview (EO) based on existing geographic information system (GIS) datasets, state and federal agency databases, literature research, and archival data. Desktop research was performed to identify and locate areas of importance or concern that lie within a study area along US 127, specifically between MP 15.500 and MP 23.715 in Casey County and MP 0.0 and 10.690 in Lincoln County. This study area encompasses a 600-foot buffer (i.e., 300 feet on either side of the existing roadway) from US 127 for all resources studied except cultural resources, which has a half-mile buffer (i.e., 0.25 miles on either side of the existing roadway). Once resources were identified, the potential for the project to impact the identified resources was considered. The detailed EO is attached as **Appendix C**.

The EO considers resources in the following two categories: Natural Environment (ecological resources [i.e., streams, wetlands, and floodplains]; threatened and endangered species) and Human Environment (air quality and noise issues; Environmental Justice / socioeconomic data; land use; underground storage tanks and hazardous materials; and historic and archaeological resources). In the following sections ecological resources and threatened and endangered species are considered the natural environment, while air quality, traffic noise, environmental justice, farmland, land use and neighborhoods, communities and community facilities, underground storage tanks and hazardous materials, and cultural resources are considered parts of the human environment.

A key consideration for all improvement concepts was whether they occur outside of existing right-of-way. Those occurring outside of existing right-of-way or creating ground disturbance have greater potential to impact natural and socioeconomic resources. If the project advanced to the design phase, the identified resources will require in-depth analysis and review to provide location approval (National Environmental Policy Act [NEPA] documentation) before transitioning to future phases of project development. Mapping showing these features are presented in **Figures 31 and 32**, respectively.

5.1 Human Environment

5.1.1 Streams, Wetlands, and Floodplains

The study area is in the headwaters of a major drainage basin leading to the Mammoth Cave National Park. The Green River, although not crossed by US 127 in the study area, roughly parallels the study area near its beginning in Casey County and is in places within the study area boundary. There are seven streams / stream sections within the study area in Casey County and 10 streams / streams sections within the study area in Lincoln County. Some of the major streams in the study area include George Branch, Carpenter Creek, Hanging Fork Creek, and Harris Creek. In addition, within the study area, there are 10 wetlands identified in Casey County and 10 wetlands identified in Lincoln County. Floodplains extend into the study area numerous times in Casey County and / or run parallel to the study area for nearly the entire length, while in Lincoln County floodplains intersect the study area multiple times.

5.1.2 Threatened and Endangered Species

Eleven federally listed species have potential to occur in the study area; species include three mammals (bats) and eight mussel species. The study area is located within potential habitat for the endangered gray bat, Indiana bat, and northern long eared bat. This habitat includes forested areas adjacent to the study area and forested riparian buffers. The Green River is habitat for the listed mussel species. Other larger streams in the study area may also have potential to provide habitat for these mussel species. Such streams would need to be assessed further during any NEPA documentation.

5.2 Natural Environment

5.2.1 Air Quality

The study area is in an attainment for all criteria pollutants and as such, a project level comprehensive air quality review would not be required. A project in the study area would also be considered "Lower Potential for Meaningful MSAT (Mobile Source Air Toxics) Effects" since the design year traffic would be less than 140,000 to 150,000 AADT. As such, a qualitative assessment of the emissions projections should be included in any future NEPA document.

5.2.2 Traffic Noise

Alignment changes which move the roadway off existing alignment and on new location meet Type I criteria per the Kentucky Transportation Cabinet's 2020 *Noise Analysis and Abatement Policy (2022 Update)*. Similarly, significant alterations to the existing alignment could also meet Type I criteria. Such alternations could include the addition of turn lanes with which the distance between a noise receptor and the traffic noise source is halved or the shielding between a receptor and the traffic noise source is removed exposing the line of sight between the two. In such cases, the entire project would be considered a Type I project and a noise analysis, which at minimum may require utilization of the *Traffic Noise Impact Screening Tool*, would be required per KYTC policy.

5.2.3 Environmental Justice

The Lake Cumberland Area Development District (LCADD) prepared the *US 127 Corridor Study Casey and Lincoln Counties Socioeconomic Study (last revised March 2023)* to assess the potential to encounter environmental Justice (EJ) populations within the study corridor. LCADD's analysis uses the county as the threshold for all Environmental Justice criteria. Based on the data obtained from the U.S. Census Bureau for race, income, age, disability, and Limited English Proficiency, the LCADD report noted the following:

- Population of Racial Minorities
  - Three block groups (BGs) in Casey County (CT 9501 BG 01, CT 9503.01 BG 01, and CT 9503.02 BG 03) were found to be above the reference threshold
  - One BG in Lincoln County (CT 9202 BG 04) was found to be above the reference threshold
- Population of People Below Poverty Level
  - No BGs in Casey County were found to have a higher percentage than the reference threshold
  - Two BGs in Lincoln County (CT 9202 BG 04 and CT 9201.02 BG 03) were found to have a higher percentage than the reference threshold
- Population of People 65 and Older
  - Three BGs in Casey County (CT 9503.01 BG 01, CT 9503.02 BG 03, and CT 9504 BG 01) were found to be above the reference threshold
  - Two BGs in Lincoln County (CT 9202 BG 03 and 9202 BG 4) were found to be above the reference threshold
- Population of People with a Disability
  - Three BGs in Casey County (CT 9503.01 BG 01, CT 9503.02 BG 03, CT 9504 BG 01) were found to be above the reference threshold
  - Two BGs in Lincoln County (CT 9202 BG 03 and CT 9202 BG 04) were found to be above the reference threshold
- Population with Limited English Proficiency
  - One BG in Casey County (CT 9503.02 BG 03) was found to be above the reference threshold
  - One BG in Lincoln County (CT 9202 BG 04) was found to be above the reference threshold

Any NEPA document must consider a project's potential to disproportionately impact these populations.

5.2.4 Farmland

Prime farmland soils exist throughout the study area, although a large portion of the study area has been previously developed as right-of-way and no longer qualifies as farmland. Around 60 percent soils within each of the Casey County and Lincoln County portions of the study area are prime farmland soils or farmland soils of statewide importance. Any future NEPA document will need to consider potential impacts to farmland, and particularly so if any improvements are proposed outside of existing right-of-way.

5.2.5 Land Use and Neighborhoods

Overall, the study area is a rural landscape with much of the development adjacent to US 127. The most extended developed areas are at the southern terminus in Liberty in Casey County and closer to the northern terminus in Hustonville in Lincoln County. Along the study area in Casey County, land is mostly used for industrial and other non-developed purposes. In Lincoln County, there is ample residential use, commercial use, and agricultural use in and around the study area.

5.2.6 Communities and Community Facilities

Based on a review of available online resources, Lincoln County has planning and zoning regulations and requirements, as governed by the county entity. No online resources indicated that Casey County has a planning and zoning agency. A review of Google imagery indicates that residences are located sporadically along US 127, particularly in the Casey County portion of the study area, with more clustering of residential area adjacent to US 127 in Lincoln County. Amish community influences have also been noted as evident in Casey County, as well as locations of manufactured homes and an apartment complex in the Lincoln County portion of the study area.

Several community facilities are located within the study area. These include three cemeteries, two educational facilities, two parks, a fire department, and one place of worship, which are spread throughout the study area in both counties. Based on review of online data, neither park has indication that Section 6(f) (i.e., Land and Water Conservation Fund) funds have been used in their development.

5.2.7 Underground Storage Tanks (USTs) and Hazardous Materials

In the study area in Casey County, there were nine UST and / or hazardous material sites. In the study area in Lincoln County, there were 23 UST and / or hazardous material sites. These identified sites may require additional assessment during any future design phase for potential to encounter hazardous materials and / or USTs.

5.2.8 Cultural Resources

Historic and archaeological resources exist in the study area (i.e., within one-quarter mile either side of the existing roadway). There is one property in the study area on the National Register of Historic Places (NRHP), five that meet the NRHP criteria, and 18 have no determination of eligibility for the NRPH. There were seven identified archeological sites within the study area, none of which were assessed for NRHP eligibility. Any future preferred alignment identified during a design phase of project development will likely require a phase I archaeology survey especially if it exists outside of the current right-of-way.

Figure 31: Casey County Environmental Map

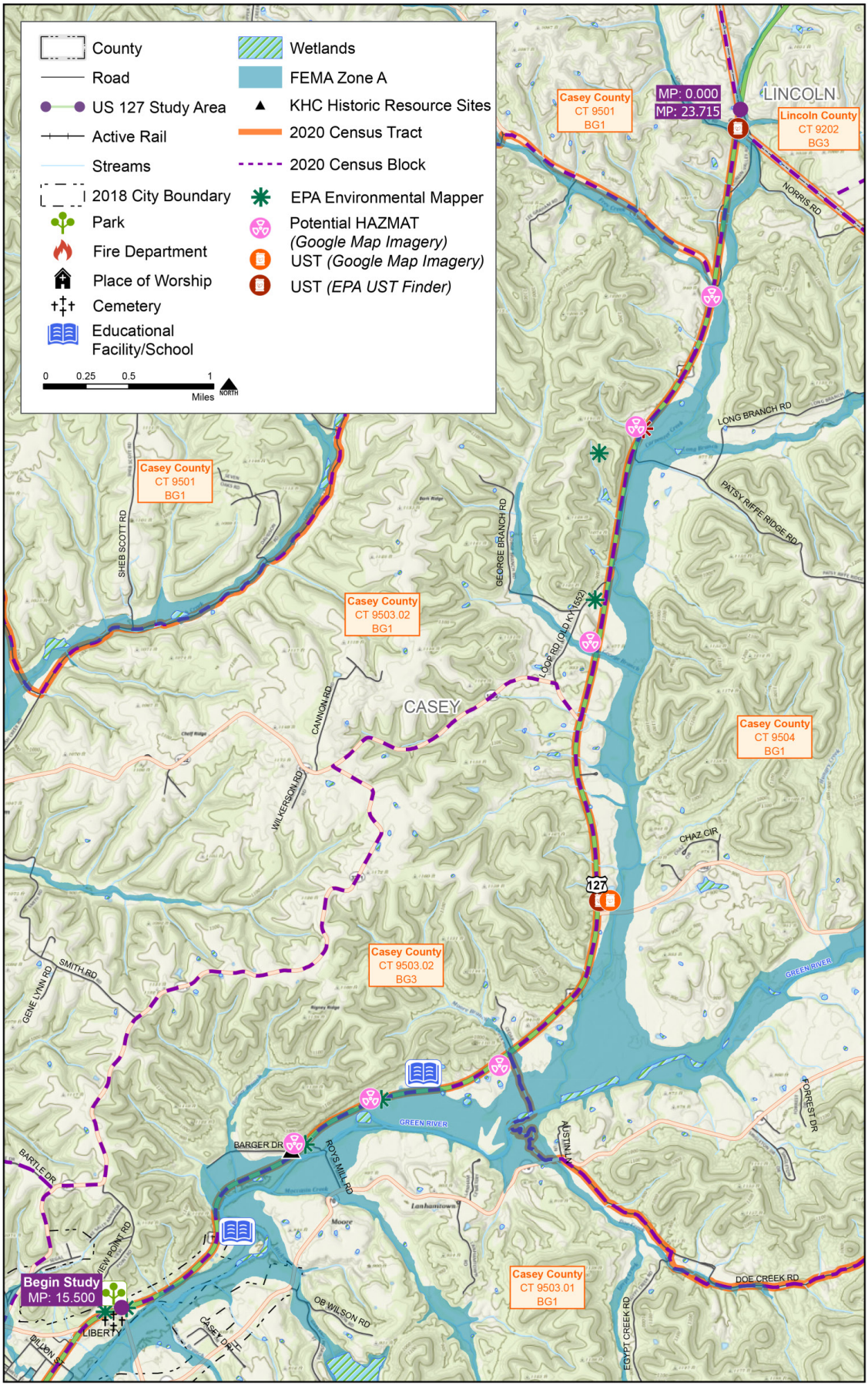
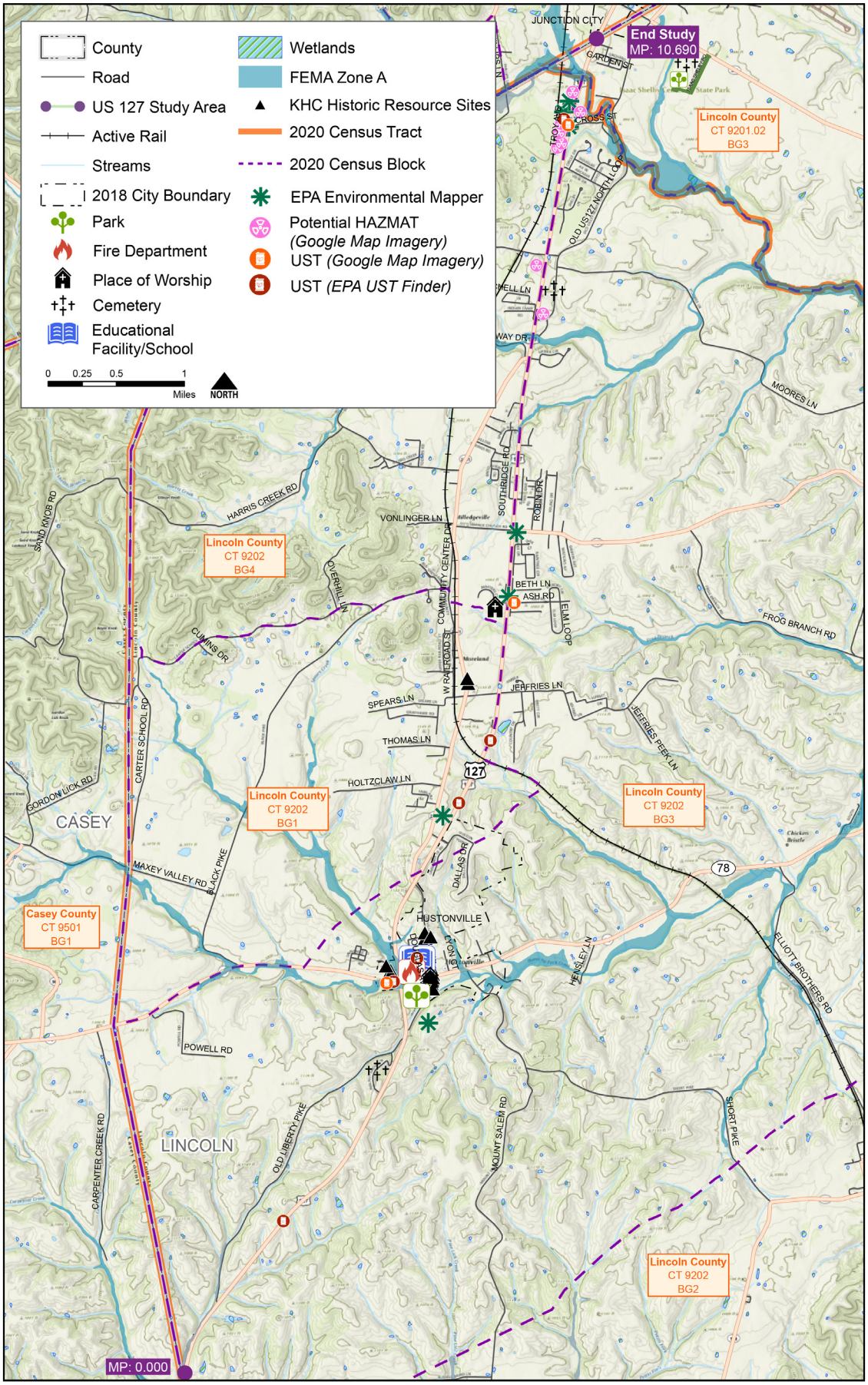


Figure 32: Lincoln County Environmental Map



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6 Development of Potential Improvement Concepts

Based on the existing conditions, traffic operations, speed and safety analysis, an initial list of potential improvement concepts was developed and presented to the Project Team at the second Project Team Meeting. Corridor-wide concepts and spot improvements were presented separately.

As part of the review and analysis of the study area, a specific examination was done for TSMO aspects and needs that would help the roadway operate at better levels across all criteria. Since US 127 is a rural corridor, this examination was not complex, but contributed to a more informed set of concepts. The results of the TSMO review suggested the following.

- Determine presence of or need for rumble strips and compare to roadway departure crash data.
- Guide striping may help drivers through intersections, especially given the speed of the corridor.
- Utilize newer six-inch striping width to improve visibility and support newer cars' lane warning systems.
- Given the presence of some pedestrian activity (e.g., KY 78 intersection), striping, signage and updated brighter lighting should be considered.

Specific spot improvements suggested from the TSMO review included:

- At the KY 2141 / Danville Pike intersection, consider an advance warning signal as well as a barrier-separated left turn acceleration lane from KY 2141 to US 127 NB, and the right turn from Danville Pike to US 127 SB.
- At the KY 906 intersection, consider an advance warning signal as a less expensive alternate to removing a rock cut. Also, remove the passing zone near the intersection to reduce conflicts.
- At SB US 127 near Barger Drive, approaching Liberty, install a speed warning sign with a speed limit, utilize a flashing curve warning sign, or use lane-wide rumble strips to inform drivers of a change in geometry.

In addition, concepts were developed according to KYTC's latest guidance found in *2+1 Roadway Guidance Update with Signing and Pavement Markings* and the *Highway Design Manual (HD-601)*. The guidance included meeting certain criteria such as:

- Design year volume of between 5,000 and 15,000 AADT
- Directional flow rate < 1,200 vehicles per hour (vph)
- Maximum 2-mile length
- Minimum ½ mile length (recommended length goes up with vph to reduce platoons)
- Uphill grades allow 2+1s to function better
- Avoid using at low speed curves
- More effective when left lane used for passing
- Use stopping sight distance when ending a 2+1 lane
- Locate lanes away from major intersections (10 left turn per hour is recommended limit)
- Adequate sight distance required on approach lane
- Do not end passing lanes at crests

6.1 Corridor-wide Potential Improvement Concepts

Potential improvement concepts that could be implemented for the entire corridor or sections of the corridor were developed and a high-level analysis of each concept was performed. This included passing opportunities provided, sight distance, warranted turn lanes and truck climbing lanes, expected right-of-way impacts, high-level traffic and safety performance, and what, if any, environmental impacts may result.

During the first Project Team Meeting the team reviewed KYTC design guidelines of 2+1 highways (listed above), as well as the operating characteristics of the corridor such as speed, differences between vehicle speeds that might cause platoons, shoulder widths, LOS, geometrics and sight distances, and follower density. The team discussed how the 2+1 guidelines in combination with the corridor's characteristics would guide the creation of initial concepts. The various improvement concepts developed are discussed in the following sections.

Striped passing zones may be used in the implementation of project recommendations, but the focus of the initial concepts was passing opportunities provided by additional travel lanes.

6.1.1 Corridor Concept 1

The first corridor-wide improvement concept was created to use 2+1 passing lanes wherever feasible in order to maximize safer passing opportunities as compared to striped passing zones (see **Figure 33**). Northbound (NB) 2+1 lanes would occur at six locations, one at an existing truck climbing lane in Lincoln County. These passing lanes total 5.4 miles in length. Eleven left turn lanes are included NB to provide safe left turns. In Lincoln County, due to a higher number of access points, a Two Way Left Turn Lane (TWLTL) is provided from Jefferies Lane to the Lincoln County Line. SB on US 127, six passing lane segments would be provided totaling 3.4 miles of passing lanes. Nine SB left turn lane lanes would be provided as well. The cross-section is assumed to have 11-foot mainline lanes, 11-foot passing lanes, a three-foot buffer between passing and mainline lanes, a four-foot paved shoulder in the passing direction and an eight-foot paved shoulder in the non-passing direction. The TWLTL is assumed to be 12 feet wide with 11-foot mainline lanes and eight-foot shoulders.

6.1.2 Corridor Concept 2

The second improvement concept was created with an emphasis on the use of truck climbing lanes (see **Figure 34**). Given the many vertical grade changes and the level of truck traffic that might prevent passing along US 127 in the study area, this concept seemed applicable. Truck climbing lanes have an almost identical crash reduction benefit to 2+1 lanes but are limited to use on grades that meet certain warrants of speed reduction, length, and improved truck and general traffic flow. In addition to warranted climbing lanes, 2+1 lanes were added if it there was no passing opportunity for approximately three to four miles.

NB, three segments of climbing / passing lanes would be provided totaling 3.6 miles. One of the climbing lanes includes the existing climbing lane but extends it over the crest to make it compliant with current design guidance. Five NB left turn lanes would be provided as well. Similar to Concept 1, a TWLTL extends from Jefferies Lane to the northern border of Lincoln County. SB, two climbing / passing lanes would be provided totaling 2.9 miles. Six SB left turn lanes would be included as well. The cross sections for Concept 2 are the same as for Concept 1.

6.1.3 Corridor Concept 3

The third improvement concept was developed as a Performance Based Flexible Solution (PBFS) with an emphasis on simply improving the safety of the existing striped passing zones (**see Figure 35**). The concept was presented to prompt further exploration and development with the project team, but generally would either lengthen or eliminate insufficient passing zones. It was noted that within the 18.2 mile study corridor, there are 11.82 miles of NB passing zone opportunities (65% of the total corridor) and 11.22 (61% of the total corridor) miles of SB passing zone opportunities. Since these passing opportunities seemed abundant and well-distributed throughout the corridor, it was decided to look at the safety aspects of the striped zones. Consideration was given to the generally higher speeds observed in the corridor (See **Section 3.4** above).

The team evaluated all existing striped passing zones for compliance with AASHTO Passing Sight Distance guidelines, assuming a 70 mph speed, reflective of the actual speed in the corridor (1,200 feet). NB passing zones that did not satisfy AASHTO guidelines at 70 mph speed, were: Casey County MP 19.521-MP 19.656 and MP 20.299-MP 20.374. Passing zones close to being too short include Casey County MP

20.19-MP 20.299 and MP 20.374-MP 20.468, Lincoln County MP 2.398-MP 2.453 and MP 2.453-MP 2.578. There were no SB passing zones that were found too short. SB passing zones found nearly too short included Lincoln County MP 3.092-MP 3.232, MP 2.398-MP 2.453, and MP 2.283-MP 2.398, as well as Casey County MP 20.299-MP 20.374. It is worth noting that all short or almost-short zones occurred where there is minor vertical or horizontal geometry that may limit sight distance.

6.1.4 Complete Streets

The KYTC Complete Streets, Roads, and Highways Policy states that Complete Streets methods shall include appropriate facilities to meet the needs of all users of the transportation system as KYTC plans, builds, rehabilitates, reconstructs, and maintains state jurisdiction streets, roads, and highways. In most cases, Complete Streets tools and strategies should be applied and were evaluated for this project. However, US 127 does not meet these warrants due to factors such as land use, low population density, low pedestrian or bicycle usage, engineering and / or financial constraints, lack of public need for such facilities, and at the forefront, safety.

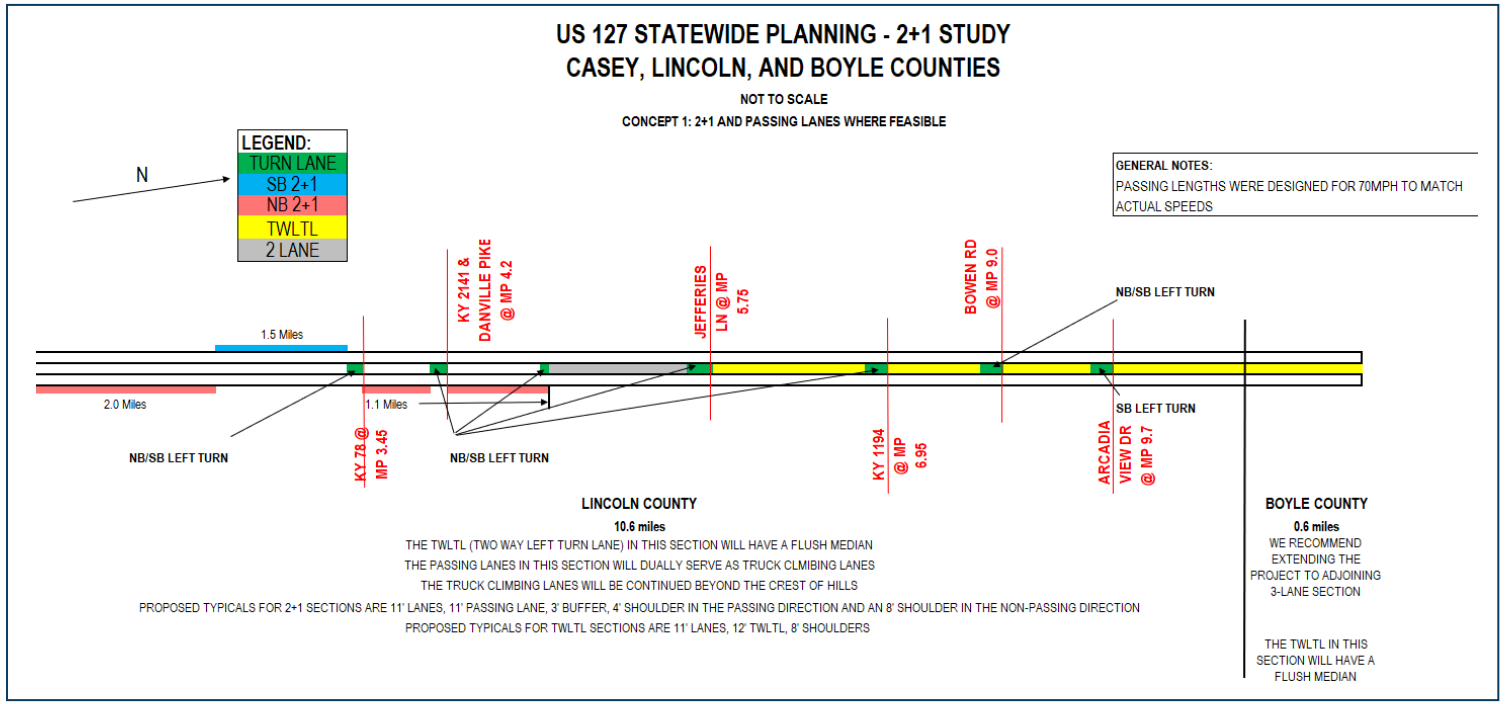
6.1.5 Access Management

In reviewing the entire corridor there are limited opportunities to reduce access to US 127. Most access points are residential driveways or small businesses. Selected streets might be closed if alternate routes to US 127 are available and a reasonable alternate distance for drivers exists. These street closing opportunities may contribute to safer operations and are explored during consideration of Spot Improvements (see **Section 6.2** below)

6.1.6 Revision of Corridor-Wide Potential Improvement Concepts

The corridor-wide potential improvement concepts described above were shared with the Project Team at the second Project Team Meeting. The Project Team decided not to move forward with certain concepts based on the information presented and discussion. The Project Team agreed to eliminate the TWLTL from further consideration in any of the concepts since it might be used for passing. This type of passing behavior has been observed at other locations within KYTC District 8. Due to concern for drivers increasing speeds by adding more passing lanes, the use of passing lanes only where needed was preferred. Also, the Consultant Team was asked to explore narrower shoulders to encourage reduced speeds.

Figure 33: Corridor Concept 1, Casey and Lincoln Counties



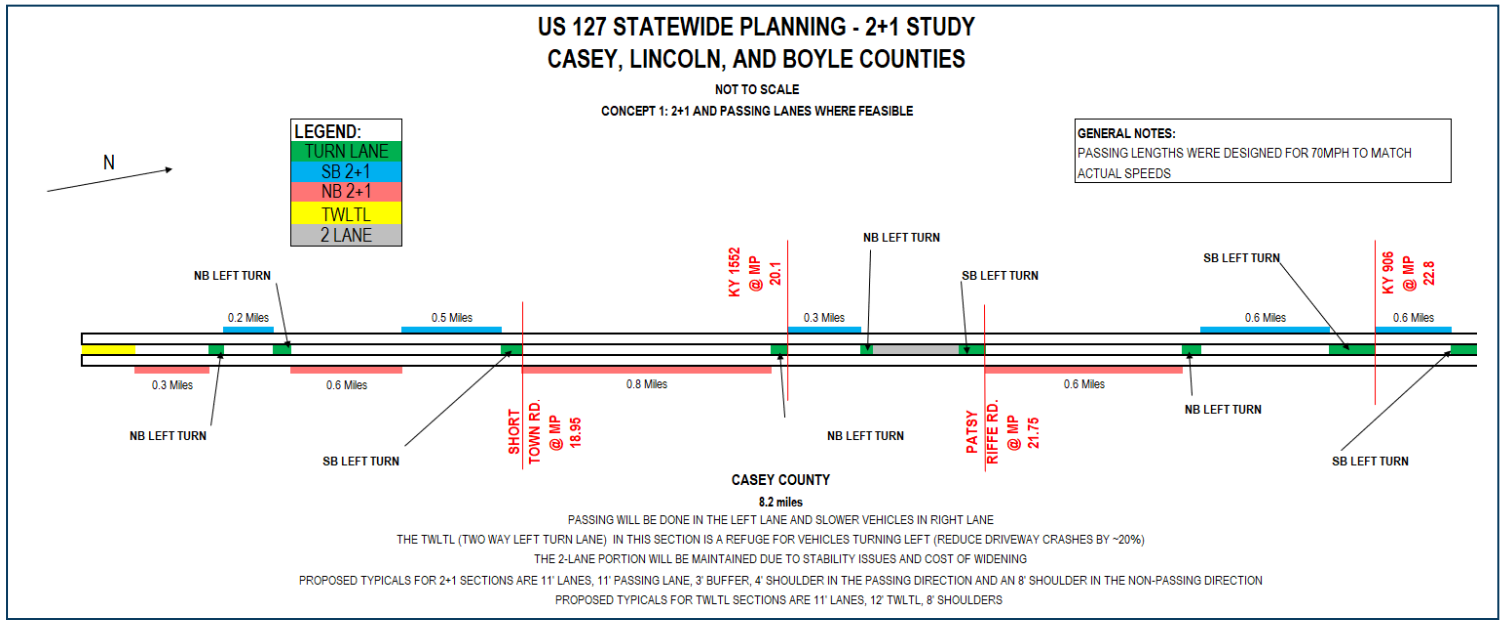
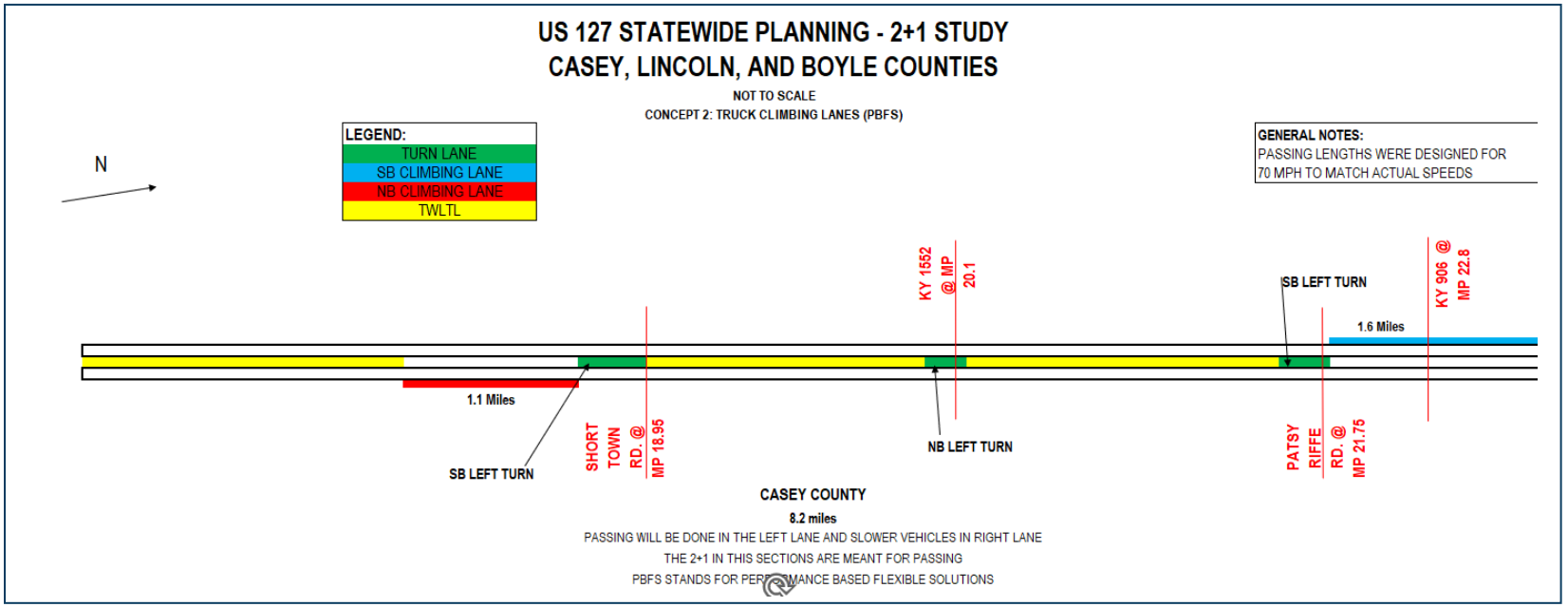


Figure 34: Corridor Concept 2, Casey and Lincoln Counties



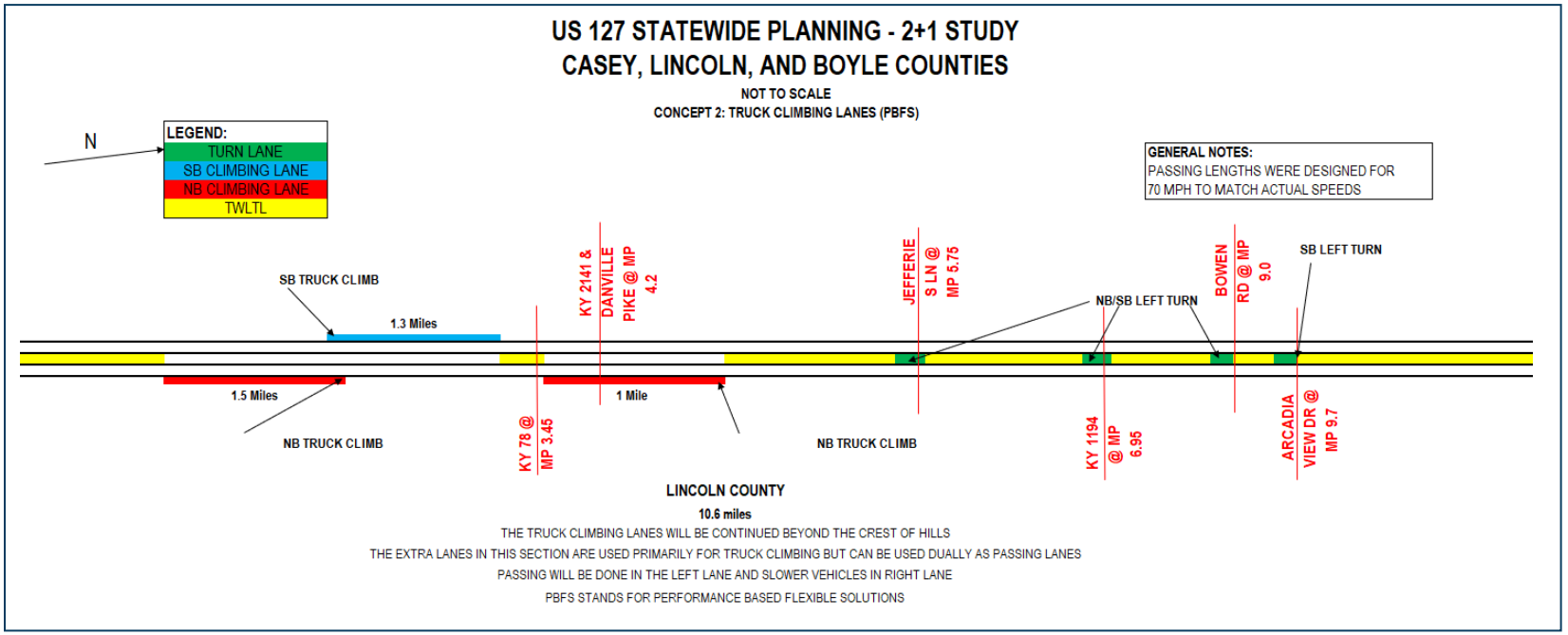
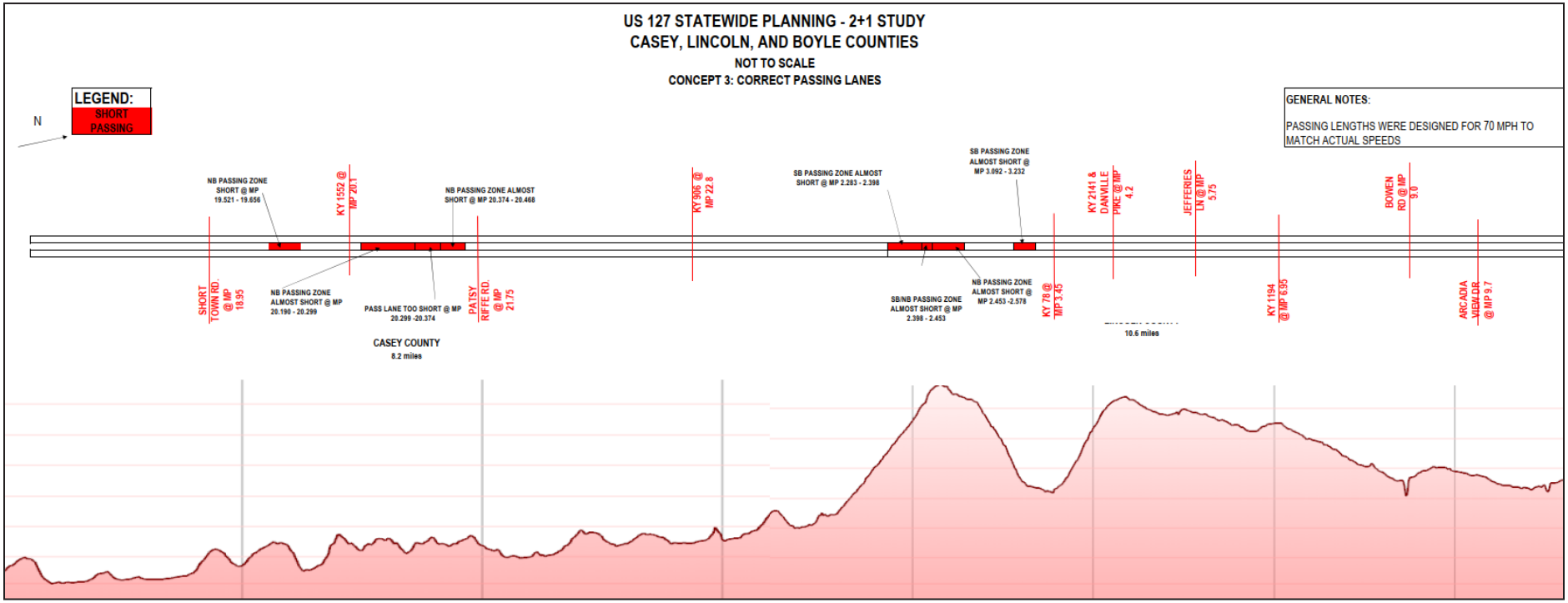


Figure 35: Corridor Concept 3, Casey and Lincoln Counties



6.2 Potential Spot Improvement Concepts

In addition to corridor-wide improvement concepts, spot improvement concepts were also developed based on a review of geometric, safety, and traffic data as well as a field review. The potential improvement concepts presented at the second Project Team Meeting are described below.

6.2.1 General Recommendations

A complete review and assessment of roadway aspects that support safer driver experience was recommended, with two types of features appearing that they need improvement in some areas within the corridor:

- Upgrade guardrails to current height & standards
- Complete rumble strips on outside edges and re-paint all striping in corridor (TSMO recommendation)

In addition to these corridor-wide features that need improvement, the specific spot improvements below were identified that would address safety and mobility issues on US 127.

6.2.2 Re-stripe Angled Intersections for Perpendicular Entry to US 127

At several intersections unstriped pavement 'flares' (extra pavement connecting US 127 to cross streets) exist that may cause turning vehicles to partially leave US 127, still allowing a conflict with through traffic from behind. Alternately, through traffic may attempt to pass turning vehicles, crossing into opposing traffic. To clarify vehicle intent and encourage predictable vehicle movement at intersections, these flares could be striped to reinforce the mainline location and turn locations. This safety improvement was recommended for US 127 intersections at CS 3015, KY 1552 / Short Town Road, KY 2141 / Danville Pike, Jeffries Lanes, KY 2141 / Sierra Lane, KY 2141 / Indian Camp Road, and Bowens Loop Road.

6.2.3 Access Control at KY 2141 / Danville Pike Intersection

District staff noted safety concerns at the KY 2141 / Danville Pike intersection in Hustonville during the first Project Team Meeting. The intersection of US 127 and KY 2141 / Danville Pike (MP 4.20 in Lincoln County) experienced a high number of angle crashes as well as an opposing and a rear end crash. Located on a slight grade, sight distance looking both NB or SB coming from either road is also not optimal especially with the higher speeds on US 127. The first option explored was closing all access from KY 2141 and Danville Pike to US 127.

The second option based on TSMO principles was to change Danville Pike to right-in, right-out only, and allow KY 2141 to only turn right out. SB and NB left turns from US 127 would still be allowed, and an advanced intersection warning signal would be installed.

6.2.4 SB near Barger Drive, Approaching Liberty

At the large curve near MP 15.5-MP 16.0 in Casey County, numerous single vehicle crashes have occurred as well as an angle crash and a sideswipe crash. While there are advisory signs SB and NB near the curve to lower speeds to 45 mph, the Consultant Team recommended updated curve warning signs as well as a dynamic speed sign to give drivers their current speed while entering the curve. This concept came out of the TSMO review.

6.2.5 Patsy Riffe Road Sight Distance

An issue with sight distance exists where Patsy Riffe Road enters US 127 at MP 21.75. There have been two rear end crashes, one rear-to-rear crash, and two single vehicle crashes at this intersection. An acceleration lane was proposed to allow drivers entering US 127 NB more time and distance to accelerate to the speed of other vehicles on US 127.

6.2.6 Access MAnagement

The corridor was reviewed for areas where improved access management could reduce the number of vehicle entry points onto US 127. After review, the area near MP 15.6, near Liberty Mini Storage and other businesses, with seven crashes nearby, presented an opportunity to reduce four driveways to two, and stripe two of the driveways to provide clearer lanes for turning left or right.

6.2.7 KY 1552 (Short Town Road)

At KY 1552 (Short Town Road), the site of a CHAF related to this study (IP20150181, MP 18.746-MP 19.046), a sight distance deficiency exists for vehicle pulling out of KY 1552 (Short Town Road). US 127 is generally at a higher elevation than KY 1552 on the north and south sides of the intersection. Five crashes occurred at the intersection including three rear-ends, one sideswipe and one single vehicle. The improvement proposed included raising KY 1552 (Short Town Road) to better match US 127's elevation, as well as closing the angled residential driveway just south of the intersection to eliminate an access to US 127 with poor sight lines.

6.2.8 KY 906

The intersection of KY 906 and US 127 poses several issues. Exiting KY 906, sight distance to the north is extremely limited due to a rock cut. This formation also limits the ability of drivers SB on US 127 to see vehicles exiting KY 906. In addition, when NB vehicles are making a left turn onto KY 906, there is no ability for through traffic to bypass them. Finally, the loop road opposite KY 906, although not high volume, is at an awkward offset position.

Two alternate improvements were proposed. The first was to cut straight through the rock slightly north of the existing KY 906/US 127 intersection to create a more perpendicular entrance from KY 906 to US 127, improving sight distance, and to close the lower end of the loop road. The second, which came from the TSMO review, was a lower cost alternate. This alternate also closed the lower end of Loop Road but re-striped the intersection of KY 906 to provide a better sight distance angle for drivers exiting KY 906 and added "Intersection Ahead" warning signs south and north of KY 906. In both alternates, the striped passing zone would be removed near KY 906.

6.2.9 Revision of Spot Improvement Concepts

The KYTC team members provided input on several spot improvements. Striping into intersections and was viewed as helpful. KYTC agreed with the concept of closing Danville Pike and KY 2141 but expressed the desire that as concepts continued to develop, at least KY 2141 would be closed. They also suggested examining the distance drivers would need to go if KY 2141 was closed. It was noted that Danville Pike could be a right-in-right-out if kept open. It was also suggested that shaving the rock cut back had been considered in the KY 906 option.

7 Stakeholder Outreach

In addition to three Project Team meetings between the Consultant Team and KYTC, outreach for this project included a meeting with local elected officials (LEOs) and stakeholders and a public survey. Meeting minutes, local official and stakeholder comments, and public survey results can be found in **Appendix D**.

7.1 Project Team Meeting #1

The first project meeting was held on March 2, 2023, at KYTC's District 8 office in Somerset, KY with a virtual option via MS Teams. The purpose of the meeting was to introduce the Project Team to the study's background and relevant existing conditions data and discuss the needs on the corridor. The Consultant Team presented existing conditions to demonstrate where grades, passing lanes, and other roadway geometrics lend to potential improvement given the concerns for passing opportunities and safety. Traffic and safety analyses were discussed, including level of service, HERE speed data, crash data and trends, and calculated EEC. Crash patterns were discussed, including hotspot locations and temporality of the crashes. The local stakeholder meeting and public survey format were discussed to solicit input on the existing conditions and gather additional issues. The next step was agreed upon to generate concepts to address identified issues within the study area for discussion at Project Team Meeting #2.

7.2 Project Team Meeting #2

Project Team Meeting #2 was held on April 13, 2023, at KYTC's District 8 office in Somerset, KY with a virtual option via MS Teams. The purpose of the meeting was to present the initial improvement concepts, both corridor-wide and spot improvements, to the Project Team. Discussion of the considerations for 2+1 lane design was also held, since this would be a key driver in developing the concepts. An update on the traffic growth rate for the corridor and additional patterns discerned from the crash reports was provided to the Project Team. Three corridor-wide concepts were presented. In addition, several spot improvements and potential TSMO strategies were presented. After discussion, one corridor concept was eliminated from further consideration and the other two would be refined to reduce the two-way-left-turn-lanes. Preparations for the public survey and LEOs and Stakeholders meeting were also discussed.

7.3 Public Survey

Community engagement with the public was conducted via a public survey to identify user concerns for travel along US 127 and gauge preferences for the potential improvement concepts. A MetroQuest survey was created that allowed respondents to pin markers on a map of the study area to identify specific areas of concern. Results indicated that local residents would like to see safety issues addressed and in longer sections of the roadway, the addition of passing opportunities. In the Lincoln County section, there were requests to reduce congestion along multiple sections of US 127.

7.4 Local Elected Officials & Stakeholder Meeting

A hybrid virtual and in-person meeting was held with local officials and stakeholders on June 14, 2023, at the Hustonville Fire Department. The project goals and objectives, schedule, and background were presented, as well as a brief review of existing conditions and relevant findings. Two corridor-wide and nine spot improvement concepts were presented. Corridor Concept One had more 2+1 passing lanes, but also extended the existing climbing lane. Corridor Concept Two provided more climbing lanes (both directions) but supplemented them with limited 2+1 lanes. The criteria of 2+1 lanes that were considered in developing the corridor concepts were discussed, as well as the safety benefits for the corridor, noting that 2+1 lanes and climbing lanes have very similar Crash Modification Factors (CMFs).

Comments regarding the corridor concepts focused on their safety aspects. Keeping the left turns from a 2+1 lane to a minimum was preferred. Also, there was a concern that too much passing opportunity would increase speeds, so it was agreed to be conservative in the use 2+1 lanes so as not to encourage higher speeds. It was also agreed after the meeting that the Consultant Team could consolidate the two corridor concepts into one.

The following were comments to further advance or eliminate the various Spot Improvement Concepts:

- There was interest in reducing traffic crossing US 127 from Danville Pike to KY 2141.
- Also at KY 2141 / Danville Pike there are many SB left turning vehicles onto Danville Pike during school drop-off and pick-up times that need to be accommodated.
- Right-in-right-outs at Danville Pike should be considered, requiring some type of non-mountable median barrier. Alternatives should also eliminate the NB left turn onto 2141.
- Barry Lee of Casey County Schools noted that school buses have issues at KY 906 with stopped traffic waiting to turn. A turning lane to improve safety was discussed.
- At KY 1194, it was noted that the NB left turn lane is underutilized and the team could consider converting this to a SB merge / acceleration lane.
- At KY 1552 (Short Town Road), it was believed that a second vertical geometry 'hump' occurs near the gas station and needed to be considered, as well as the potential for a SB left turn lane.
- Regarding the concept to construct a curb and gutter cross section near the KY 78 intersection, maintenance typically does not like curb and gutter on rural routes. Also, some attendees were also unsure if adding curb and gutter would truly slow down vehicles.

7.5 Project Team Meeting #3

The final project team meeting was a hybrid virtual and in-person meeting held on August 2, 2023. The study purpose, schedule, selected existing condition data were revisited, and 2045 LOS was discussed. Also, the public survey and stakeholder meeting results were discussed. A total of 58 people responded to the survey. Sight distance, passing and safety were high concerns, and the details of the 'pin drop' issues by respondents were discussed, by county. The Consultant Team then reviewed the list of summarized themes from the Stakeholder Meeting and how they guided the new single corridor concept. Additionally, the Environmental Overview was reviewed.

In reviewing the new single Corridor Concept there was discussion about stopping sight distance, passing zones as opposed to passing lanes, and crash locations. Passing zones in the new concept were eliminated if stopping sight distances were insufficient at 70 mph. Speed increases were not significant when 2+1s were added. The Project Team agreed that drivers in the corridor were observed not using the striped passing zones out of caution, so they may not be used enough to provide real passing opportunities and suggested exploring a 2+1 or a four-lane passing area in Lincoln County, NB and SB if possible, perhaps in conjunction with creating a right-in, right-out spot improvement at KY 1194. The overall benefit-cost ratio of the corridor was reviewed, noting that there was no quantification of the mobility benefit provided although mobility was part of the project goals. It was also noted that the Consultant Team should explore reducing the costs of the 8-foot shoulders and the right-of-way for them in Casey County.

Regarding spot improvement concepts, each was reviewed for applicable crash modification factors and costs, location vs EECs, as well as benefit-cost ratios. Additional left and right turn lanes were added where warranted. The summarized benefit-cost for all 12 spot improvements was 1.64, again, without quantifying the added benefit of mobility improvements they provide. The Project Team supported the entire list of updated spot improvement concepts, but suggested spot improvement 9A / 9B should become a right-in right-out, whether as part of a passing lane or not.

Regarding packaging of the corridor concept and spot improvements, the District noted that packaging would be funding dependent, but felt the corridor concepts and spot improvement concepts should be bundled together and broken down by county. Also, the suggested new Lincoln County passing lane should be treated as a spot improvement. The District also asked to see costs for smaller shoulders explored on the regular lanes and passing lanes for the Casey County concept in case that helps the viability of the project.

8 Evaluation of Potential Improvement Strategies

The list of improvement strategies for the corridor, as well as spot improvements, were refined based on feedback from the Project Team and stakeholders, additional data generated to answer questions posed at prior project team meetings, and criteria based on the goals and objectives of the project. Each improvement strategy was also evaluated with respect to safety, traffic operations and mobility, environmental impacts, right-of-way impacts, and cost estimates. These criteria are described below in more depth.

8.1 Evaluation Criteria

8.1.1 Corridor Speed

The impact to operating speeds resulting from adding passing lanes was investigated. Equation 15-A3 from the *Highway Capacity Manual, 7th edition* was used to estimate the percent speed increase adding passing lanes would have on a two-lane highway. Factors affecting the change in speed include the directional volume of traffic, free flow speed, percent heavy vehicles, and the passing lane length. Results for US 127 show that the addition of passing lanes at locations in the corridor-wide concept would increase operating speeds by 1.1 percent, which leads to an average increase in speed within the passing lanes of 0.7 mph over existing operating speeds. **Table 12** provides changes in operating speeds in passing lanes for each direction of travel in the peak hours.

Table 12: Change in Operating Speed Along Passing Lanes

			Total Directional Passing Lane Length* (miles)	Average Speed Increase in Passing Lane (%)	Existing Average Free Flow Speed (mph)	New Free Flow Speed (mph)	Free Flow Speed Increase (mph)
2045	Northbound	AM	4.6	1.4	67.1	68.0	0.9
		PM	3.0	0.8	67.1	67.6	0.5
	Southbound	AM	4.6	1.3	67.1	68.0	0.9
		PM	3.0	0.8	67.1	67.6	0.5
Average Increase				1.1			0.7

*The length shown represents the total length of passing lanes in each direction of travel

8.1.2 Traffic Operations and Passing Opportunity

Improving operational aspects is one method to meet the goals of improving mobility and safety. Criteria examined to measure operational improvement included improving the ability to pass safely, advantages provided by various shoulder widths and buffer zones between mainline lanes and 2+1 lanes, the warranted need for turn-lanes, and potential improved LOS. Appropriateness of each concept to support expected speed profiles in the corridor was also taken into consideration.

The corridor-wide concept of adding passing lanes strategically where they would benefit passing, such as on upgrades, resulted in 16 segments. A balance of added passing lanes and two-lane segments was pursued to improve mobility without encouraging excessive speeds in long passing lanes. Left turns exceeding 10 turns per hour were eliminated in areas with added lanes, either 2+1 or truck climbing lanes. In addition, effort was made to space passing opportunities so that drivers would not have excessive distances to wait for a chance to pass a slower vehicle.

All segments are expected to perform at a LOS B or better except for some segments north of the KY 78 intersection, which are expected to operate at LOS C in the NB AM peak hour and at LOS C or D in the SB PM peak hour. All passing lanes will operate at LOS A or B. The results are presented in **Table 13.**

Table 13: 2045 Build Segment LOS

	Segment Description					Northbound		Southbound	
County	Begin MP	Begin Description	End MP	End Description	Lanes*	AM Peak Hour LOS	PM Peak Hour LOS	AM Peak Hour LOS	PM Peak Hour LOS
Casey	15.500	Begin Study	16.000	Begin NB Passing Lane	Two	A	A	A	A
Casey	16.000	Begin NB Passing Lane	17.100	End NB Passing Lane	Passing	A	A	A	A
Casey	17.100	End NB Passing Lane	19.200	End SB Passing Lane	Two	B	B	A	B
Casey	19.200	End SB Passing Lane	19.900	Begin SB Passing Lane	Passing	A	A	A	A
Casey	19.900	Begin SB Passing Lane	23.701	Begin NB Passing Lane	Two	A	A	A	B
Lincoln	0.000	Begin NB Passing Lane	2.000	End NB Passing Lane	Passing	A	A	A	B
Lincoln	2.000	End NB Passing Lane	2.300	End SB Passing Lane	Two	A	A	A	A
Lincoln	2.300	End SB Passing Lane	3.400	Begin SB Passing Lane	Passing	A	A	A	A
Lincoln	3.400	Begin SB Passing Lane	4.000	Begin NB Passing Lane	Two	B	A	A	B
Lincoln	4.000	Begin NB Passing Lane	4.600	End NB Passing Lane	Passing	A	A	A	C
Lincoln	4.600	End NB Passing Lane	5.900	Begin NB Passing Lane	Two	B	B	A	C
Lincoln	5.900	Begin NB Passing Lane	6.800	End NB Passing Lane	Passing	A	A	A	C
Lincoln	6.800	End NB Passing Lane	6.900	End SB Passing Lane	Two	B	B	A	C
Lincoln	6.900	End SB Passing Lane	8.100	Begin SB Passing Lane	Passing	C	B	A	B
Lincoln	8.100	Begin SB Passing Lane	9.021	Bowens Loop Road	Two	C	B	A	D
Lincoln	9.021	Bowens Loop Road	10.690	End Study	Two	C	B	A	D

Note: Bold italicized text indicate the LOS in passing lanes
*Two = two-lane roadway, Passing = two-lane roadway with passing lane in one direction

Of the 10 primary intersections analyzed, all are expected to operate at an overall LOS A or better during both the AM and PM peak hours under 2045 Build conditions. The results are presented in **Table 14** below.

Table 14: : 2045 Build Intersection LOS

Intersection	Control Type	AM Peak Hour Delay (s)	AM Peak Hour LOS	PM Peak Hour Delay (s)	PM Peak Hour LOS
Arcadia View Drive	Unsignalized	1.0	A	0.4	A
Bowens Drive	Unsignalized	0.8	A	0.8	A
KY 1194	Unsignalized	3.5	A	4.3	A
Jeffries Lane	Unsignalized	3.4	A	2.4	A
KY 2141	Unsignalized	2.5	A	1.8	A
KY 78	Unsignalized	5.7	A	4.9	A
KY 906	Unsignalized	0.8	A	0.7	A
Patsy Riffe Road	Unsignalized	0.0	A	0.4	A
Old KY 1552 Medley La	Unsignalized	0.5	A	0.6	A
KY 1552	Unsignalized	2.4	A	1.3	A

8.1.3 Predictive Safety Analysis

A predictive safety analysis was performed for the corridor-wide concept and for each spot improvement concept to estimate the potential reduction in crashes over a 20-year period. Applicable Crash Modification Factors (CMFs) were identified from the HSM or the CMF Clearinghouse3. The CMFs were applied to relevant historic crashes to estimate the number and percent of crashes that could have been prevented. These results were then extrapolated to estimate the crashes that could be prevented over a 20-year period.

CMFs used in this analysis for the corridor-wide concept are presented in **Table 15**. These CMFs were applied to relevant crashes that occurred within the areas of proposed improvement for adding passing lanes, widening shoulders, installing wider edgelines, and upgrading guardrail to current standards. CMFs used for the analysis of spot improvements are presented in **Table 16**. With the exception of spot improvements at the KY 906 intersection, which included multiple improvement types, only one CMF was applied to each spot improvement. This predictive safety analysis was used in the benefit-cost analysis as one component in determining the value of each concept.

Table 15: Corridor-Wide Concept Crash Modification Factors

CMF Description	CMF ID / HSM Source	Value(s)
Periodic Passing Lanes on Rural Two-Lane Highway	CMF ID: 4082	0.58 (KABC)
Add or Widen Paved Shoulder: Rural Two-Lane	HSM Table 13-7	0.67 – 0.89
Install Wider Edge lines (4in to 6in)	CMF ID: 4737	0.635 (KABC)
Upgrade Guardrail	CMF ID: 5551	0.835 (KABC)

3 http://www.cmfclearinghouse.org/

Table 16: Spot Improvement Concept Crash Modification Factors

CMF Description	CMF ID / HSM Source	Value(s)	Spot Improvement Number (see Figure 37)
Install Chevron Signs on Horizontal Curves	CMF ID: 2438	0.84 (KABC)	1
Flatten Crest Vertical Curve	CMF ID: 720	0.80	2
Improve Intersection Sight Distance (Function)	CMF ID: 9656	0.75	3,4,5
Provide Left-Turn Lane on One Major Road Approach	CMF ID: 253	0.56	4, 6A, 6B,7,8,10,11
Install Advance Warning Signs (Positive Guidance)	CMF ID: 1684	0.65 (Angle)	4
Periodic Passing Lanes on Rural 2-Lane Highway	CMF ID: 4082	0.58 (KABC)	13

8.1.4 Sight Distance

The study area was analyzed for insufficient stopping and passing sight distance at 55 mph, but also at 65 mph, which more accurately represents the 85th percentile speed throughout the corridor. Existing striped passing zones that had insufficient passing sight distance were noted, as well as segments that had insufficient stopping sight distance. The corridor concepts presented have both stopping and passing sight distance sufficient for drivers travelling 65 mph.

8.1.5 Environmental Impacts

The environmental resources identified and considered included: ecological resources (i.e., streams, wetlands, and floodplains), threatened and endangered species and important habitats; air and noise issues; EJ / socioeconomic data; land use; hazardous materials; and historic and archaeological resources. Impacts to these resources were considered in the evaluation.

8.1.6 Right-of-Way Impacts

For each improvement concept, acres of right-of-way required and property acquisitions (how many properties would require a building take) were quantified. The costs of these impacts were included in the cost estimates.

8.1.7 Cost Estimates

Cost estimates for each corridor and spot improvement concept were developed in 2023 dollars using recent unit costs. Construction costs were used for the detailed evaluation, although these costs took into consideration right-of-way. These costs were used to calculate the benefit-cost ratio. Full design, right-of-way, utility, and construction costs were developed for the final recommended concepts shown in **Chapter 9**.

8.1.8 Benefit-Cost Analysis

A high-level benefit-cost analysis was conducted to estimate the value of the corridor-wide concept and the spot improvements. Cost estimates for each concept were developed in 2023 dollars using recent unit costs that include design, right-of-way, utility, and construction costs. Crash costs specific to Highway District 8, as developed by KYTC Highway Safety Improvement Program (HSIP), were used. Given that crashes are rare and random events and that discretion is applied to the severity of injury recorded, crash severities were grouped to form a blended crash cost and predicted over a 20-year crash reduction horizon. The future benefits were discounted at the USDOT recommended 7% discount rate. To maintain consistency within the benefit-cost analysis, crash costs in 2023 dollars was used. No benefits were quantified for improved mobility aside from LOS and increase in speeds, but input from the Project Team and stakeholders were considered in the evaluation of improvement concepts focused on the availability and safety of added passing areas.

For the corridor-wide concept, overall crash costs were grouped by KABC and O since the CMFs provided by FHWA and the CMF Clearinghouse are separated this way. The crash costs used from the KYTC HSIP team for KYTC District 8 equaled $1,179,844.59, which is significantly higher than the statewide average. Another crash cost for KABC crashes was estimated based on the corridor alone and that analysis provided a crash cost of $894,000. Both costs were used for the benefit-cost analysis to provide a range that includes a corridor level analysis and a district-wide analysis. **Figure 38** shows the benefit-cost ratio of the corridor-wide concepts by county.

For the spot improvements, an overall crash cost for KAB (fatal, serious injury, minor injury) crashes were grouped and CO (suspected injury and property damage only) crashes were grouped for intersection crash costs. Due to the CMFs used, there was a distinct application of KAB crashes and CO crashes. These costs were used to calculate the benefit-cost ratio. **Figure 39** shows the benefit-cost ratio for each of the spot improvements.

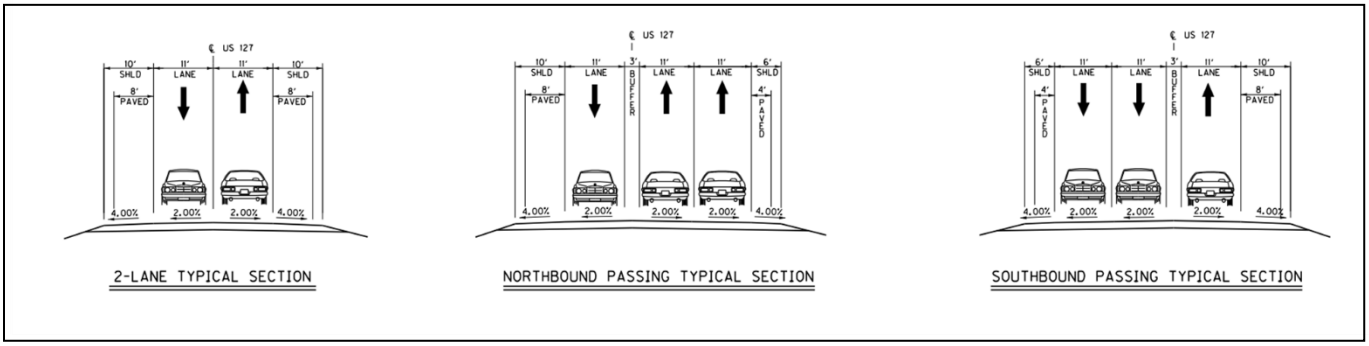
8.2 Analysis of Corridor-Wide Potential Improvement Concepts

Using the criteria listed in the previous section, as well as Stakeholder Meeting and Public Survey input, the corridor-wide potential improvement concepts were revised, evaluated and presented to the Project Team at the third Project Team meeting. With the Team's concurrence, the initial separate corridor concepts were merged into one since they were becoming similar to one another through process of elimination of passing lane locations. In addition, striped passing zones were re-introduced in several areas that could not accommodate 2+1 or climbing lanes due to access issues or due to intersections with left turns exceeding ten per hour. The merged corridor concept is shown below in **Figure 37**, as well as **Appendix E**. The proposed cross-sections are shown in **Figure 36**. Additional elements that should be considered in the corridor that were derived from the TSMO assessment include confirmation of rumble strips (center & edges) throughout, upgrade guardrails to current height and standards, verify / re-locate No Passing Zone signs, enhance striping to full 6" width, and provide updated lighting where pedestrian or bicycle activity exists.

The benefit-cost ratio of the corridor concept was updated based on the third Project Team meeting. Benefit-cost ratios for corridor concepts were separated into Casey County and Lincoln County, then a total cost and benefit-cost ratio was provided if both counties were completed as one project. The Casey County corridor concepts were broken into three types based on shoulder width, including eight-foot paved shoulders, six-foot paved shoulders, and four-foot paved shoulders (all with 2 feet of unpaved), while Lincoln County had one corridor concept. The total benefit-cost ratio for the entire project ranged from 0.64 to 0.83 depending on the crash costs mentioned in section 8.1.8. The Casey County benefit-cost ratios were 0.58-0.76 for the eight-foot shoulder concept, 0.53-0.70 for the six-foot shoulder concept, and 0.41-0.54 for the four-foot shoulder concept and the Lincoln County benefit-cost ratio ranged from 0.68-0.88.

There was discussion regarding the cost of the shoulder width recommendations and right of way, especially in Casey County, as a potential way to reduce costs and improve the benefit-cost ratio. **Figure 38** has the full details of the benefit-cost analysis for each county and a total benefit-cost ratio at the bottom.

Figure 36: Corridor Concept Cross-Sections



*Lincoln County Typical Sections shown. Casey County shoulder options similar but vary in width.

Figure 37: Merged Corridor Concept, Casey and Lincoln Counties

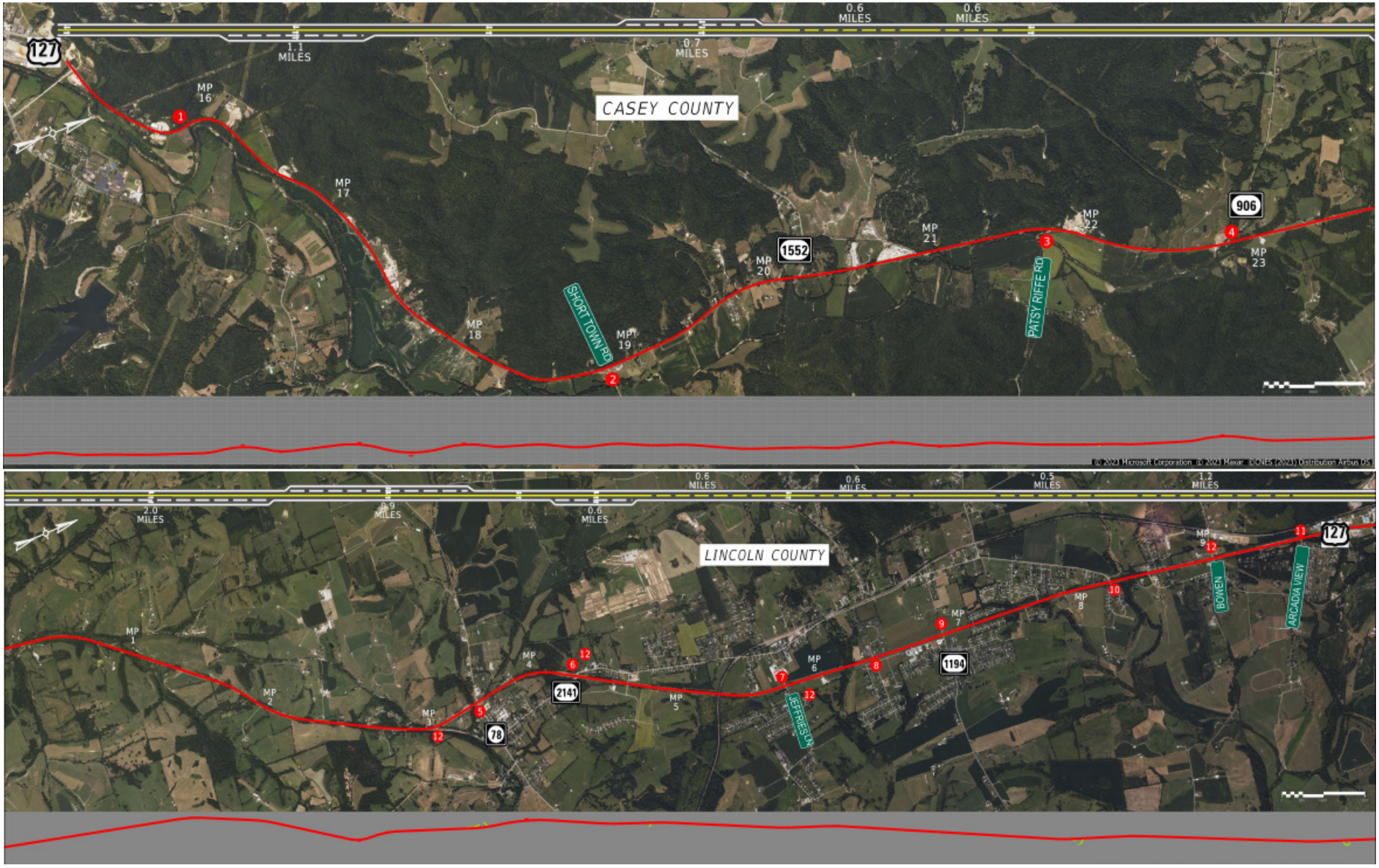


Figure 38: US 127 Benefit-cost Analysis for Corridor Concepts by County

County	Full Concept	Description	Sub Concept	Sub Description	BMP	EMP	Total Cost	Construction Cost	Benefit / Cost Ratio Range
Casey	Full Build, 8' Shoulder	Full build for Casey County with 8' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$28,400,000	$21,000,000	0.58-0.76
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 8'	15.5	22.882			
	Full Build, 6' Shoulder	Full build for Casey County with 6' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$25,600,000	$19,100,000	0.53-0.70
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 6'	15.5	22.882			
	Full Build, 4' Shoulder	Full build for Casey County with 4' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install northbound left turn lane at KY 906	21.6	21.85	$25,200,000	$18,900,000	0.41 - 0.54
			Left Turn Lane	Install southbound left turn lane at Short Town Road	18.85	19.05			
			Passing Lane	NB Passing Lane	16	17.1			
			Passing Lane	SB Passing Lane	19.2	19.9			
			Enhanced Striping	Install 6 inch striping throughout	15.5	22.882			
			Shoulder Width	Increase Shoulder Width to 4'	15.5	22.882			

County	Full Concept	Description	Sub Concept	Sub Description	BMP	EMP	Total Cost	Construction Cost	Benefit / Cost Ratio Range
Lincoln	Full Build, 8' Shoulder	Full build for Lincoln County with 8' shoulders, passing lanes, enhanced striping, turn lanes, and guardrail upgrades	Left Turn Lane	Install southbound left turn lane at KY 2141/Danville Pike	4.1	4.25	$44,350,000	$39,500,000	0.68 - 0.88
			Left Turn Lane	Install southbound left turn lane at Jeffries Lane	5.74	5.75			
			Left Turn Lane	Install southbound left turn lane at Ash Road	6.4	6.41			
			Right Turn Lane	Install southbound right turn lane at Ash Road	6.4	6.41			
			Left Turn Lane	Install southbound left turn lane at Arcadia View Dr	9.6	9.7			
			Passing Lane	NB Passing Lane - MP 0-2	0	2			
			Passing Lane	SB Passing Lane - MP 2.3-3.4	2.3	3.4			
			Passing Lane	NB Passing Lane - MP 4-4.5	4	4.5			
			Passing Lane	NB Passing Lane - MP 5.9-6.8	5.9	6.8			
			Passing Lane	SB Passing Lane - MP 6.9-8.1	6.9	8.1			
			Enhanced Striping	Install 6 inch striping throughout	0	10.686			
	Full Concept	**Description**	**Sub Concept**	**Sub Description**	**BMP**	**EMP**	**Total Cost**	**Construction Cost**	**Benefit/ Cost Ratio Range**
Total*	**Full Build**	**Full Build of Full Study Area**					**$72,750,000**	**$60,500,000**	**0.64-0.83**

Benefit cost ratios are based on 8 foot shoulders in Casey County

8.3 Analysis of Potential Spot Improvement Concepts

The spot improvement concepts moved forward from the initial screening were also evaluated using the previously listed criteria. Based on discussion with the Project Team in Project Team Meeting #2 as well as input from Stakeholders Meeting, several spot improvements were modified and presented at Project Team Meeting #3. Additional spot improvement concepts were added for evaluation as well (see the complete list in **Figure 39**.

The benefit-cost ratio of the individual spot improvements varied. There was discussion of the value of each spot improvement, noting that the benefit-cost ratio for each improvement depended on the specific crash history and did not include mobility benefits provided such as warranted left turn lanes. It was also noted that cost estimates were based on the cost of constructing each improvement individually, and that costs may be lower when spot improvements were bundled together.

Figure 39: US 127 Spot Improvement Concepts and Associated Benefit-cost Ratios

Number	Location	MP	Description	Cost	Fatal & Injury Crash Reduction (2017-2021)	Benefit / Cost Ratio
1	**Add curve chevrons near Liberty - NB and SB**	15.6-16.1 (Casey)	Chevrons to be added NB and SB, in addition to new speed advisory signs	D $1,090 R $0 U $0 C $10,900	16%	41.40
2	**Improve sight distance at Short Town Rd, add SB Left Turn Lane**	18.85-19.05 (Casey)	Levelling out two 'humps' on US 127 from private driveway to end of gas station parking lot will improve sight distance both directions from Short Town Rd. Also, close private driveway access to US 127.	D $101,000 R $0 U $15000 C $1,013,000	46%	0.09
3	**Improve sight distance at Patsy Riffe Rd**	21.6-21.85 (Casey)	Extending the intersections withUS 127 further north would provide better sight distance to the south. Also, retract unrequired guardrail to improve SB sight line.	D $74,000 R $20,000 U $60,000 C $739,000	25%	0.06
4	**Multiple improvements at KY 906**	22.80-22.87 (Casey)	1) Close southern end of Loop Rd 2) Cut rock face back to improve NB sight distance 3) Improve alignment of KY 906 to improve sight distance 4) Provide left turn lane from US 127 NB to KY 906 5) Add intersection warning signs 6) Improve alignment of northern end of Loop Rd to US 127	D $170,000 R $2,400 U $0 C $1,731,000	59%	0.86
5	**Improve sight distance at KY 78**	3.35-3.50 (Lincoln)	Move stop bar on KY 78 westbound forward to correct location	D $900 R $0 U $0 C $9,300	25%	70.52
6A	**Reduce potential conflicts at KY 2141/ Danville Pike - Option A**	4.10-4.25 (Lincoln)	Eliminate NB left turns onto KY 2141. Make KY 2141 and Danville Pike right-only onto US 127. Eliminate crossing across US 127. Add SB left turn lane onto Danville Pike.	D $48,000 R $0 U $15,000 C $482,000	44%	4.60
6B	**Reduce potential conflicts at KY 2141/ Danville Pike - Option B**	4.20 (Lincoln)	Close KY 2141. Make Danville Pike right-in right-out onto US 127. Add SB left turn lane onto Danville Pike.	D $52,000 R $0 U $15,000 C $522,500	44%	4.25
7	**Add SB Left Turn Lane at Jefferies Ln**	5.74-5.75 (Lincoln)	Provide warranted LTL. Will require splitting passing zone	D $34,000 R $0 U $0 C $343,000	44%	0.20
8	**Add SB Left Turn Lane at Ash Rd**	6.40-6.41 (Lincoln)	Provide warranted LTL	D $46,600 R $0 U $0 C $466,000	44%	0.05

Number	Location	MP	Description	Cost	Fatal & Injury Crash Reduction (2017-2021)	Benefit / Cost Ratio
9A	**Multiple improvements at KY 1194 - Option A**	6.85-7.00 (Lincoln)	1) Eliminate NB Left Turn from US 127 into KY 1194 2) Add guidestriping from KY 1194 to US 127 SB	D $300 R $0 U $0 C $3,000	0%	0.00
9B	**Multiple improvements at KY 1194 - Option B**	6.85-7.00 (Lincoln)	1) Close western part of KY 1194 onto US 127 2) Add guidestriping from KY 1194 to US 127 SB	D $4,000 R $0 U $15,000 C $39,000	0%	0.00
10	**Add SB Right Turn Lane at KY 2141/ Sierra Ln**	8.22-8.28 (Lincoln)	Provide warranted RTL	D $26,500 R $0 U $0 C $265,000	14%	1.35
11	**Add SB Left Turn Lane at Arcadia View Dr**	9.65-9.71 (Lincoln)	Provide warranted LTL. Will require splitting passing zone	D $50,400 R $0 U $0 C $504,000	44%	0.04
12	**Stripe angled intersection 'flares'**	(1) 3.09; (2) 5.75; (3) 8.54; (4) 9.02 (All Lincoln)	Stripe through pavement flares at (1)CS 3015; (2) Jeffries Ln; (3) KY 2141/Indian Camp Rd; (4) Bowens Loop Rd	D $100 R $0 U $0 C $1,100	0%	0.00
				D $100 R $0 U $0 C $1,100	0%	0.00
				D $100 R $0 U $0 C $1,100	0%	0.00
13	**Passing Lanes in Lincoln County**	5.9-8.1 (Lincoln)	Provide Passing Lane NB 5.9-6.8 and SB 6.9-8.1	D $840,000 R $480,000 U $150,000 C $8,400,000	42%	0.77

8.4 IIJA Grant Program Emphasis Analysis

The proposed improvements could be funded through several possible mechanisms. While traditional state and federal funding programs could be used, it is also possible that one or more improvement concepts could be funded through programs included in the 2021 Infrastructure Investment and Jobs Act (IIJA) also known as the Bipartisan Infrastructure Law (BIL).

- **Local and Regional Project Assistance Program**[4] - This competitive grant program is expected to have a notice of funding opportunity (NOFO) in 2024. It is similar to the prior Rebuilding American Infrastructure with Sustainability and Equity (RAISE) grant program. Several of the concepts could score well in this program as they improve safety and benefit a rural area. However, this program is very competitive and there are likely to be other projects in the state that would rate more highly for the criteria in this program.
- **Rural Surface Transportation Grants Program**[5] - This competitive grant program is expected to have a NOFO in 2024. The rural nature of the project area and the focus on safe mobility could make several of the concepts competitive for this program. This could be pursued to fund one of the larger concepts or several of the spot improvements.
- **Nationally Significant Multimodal Freight and Highway Projects (INFRA)**[6] - This program awards competitive grants for multimodal freight and highway projects with national or regional significance that improve safety, travel efficiency, and the reliability of freight movement and people in and through both urban and rural areas. A state Department of Transportation or local government are eligible applicants. With US 127 being part of the National Highway System it meets program eligibility criteria. It is anticipated that a NOFO for this funding opportunity will be available in 2024.

Again, traditional state and federal funding programs (through the highway plan process) may be appropriate for upgrades in this corridor, but there are other possible sources of competitive funding if needed.

4 RAISE Discretionary Grants | US Department of Transportation
5 The Rural Surface Transportation Grant Program | US Department of Transportation
6 The INFRA Grant Program | US Department of Transportation

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9 Study Recommendations

After discussing the refined list of potential improvement concepts and associated detailed evaluation at the third Project Team Meeting, the Project Team decided which concepts to carry forward into future project phases. The merged corridor concept was approved, but the addition of NB and SB passing lanes in Lincoln County was requested. This addition was created and approved after the meeting, moving it ahead as a spot improvement because of its colocation with the spot improvement concept at KY 1194.

The entire group of spot improvement concepts was accepted as a whole, noting that costs for the improvements may be reduced if bundled together.

Project sheets for corridor concept and spot improvement are included in **Appendix E**.

The District requested that when summarizing the corridor and spot improvement concepts for continuation into phase 1 design that they be grouped by County, recognizing that the original CHAF for this project (IP20200049) was a study to improve safety and mobility along US 127 from Liberty to Casey / Lincoln Co. Line. (Same as Highway Plan item 8-80150.00).

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10 Next Steps

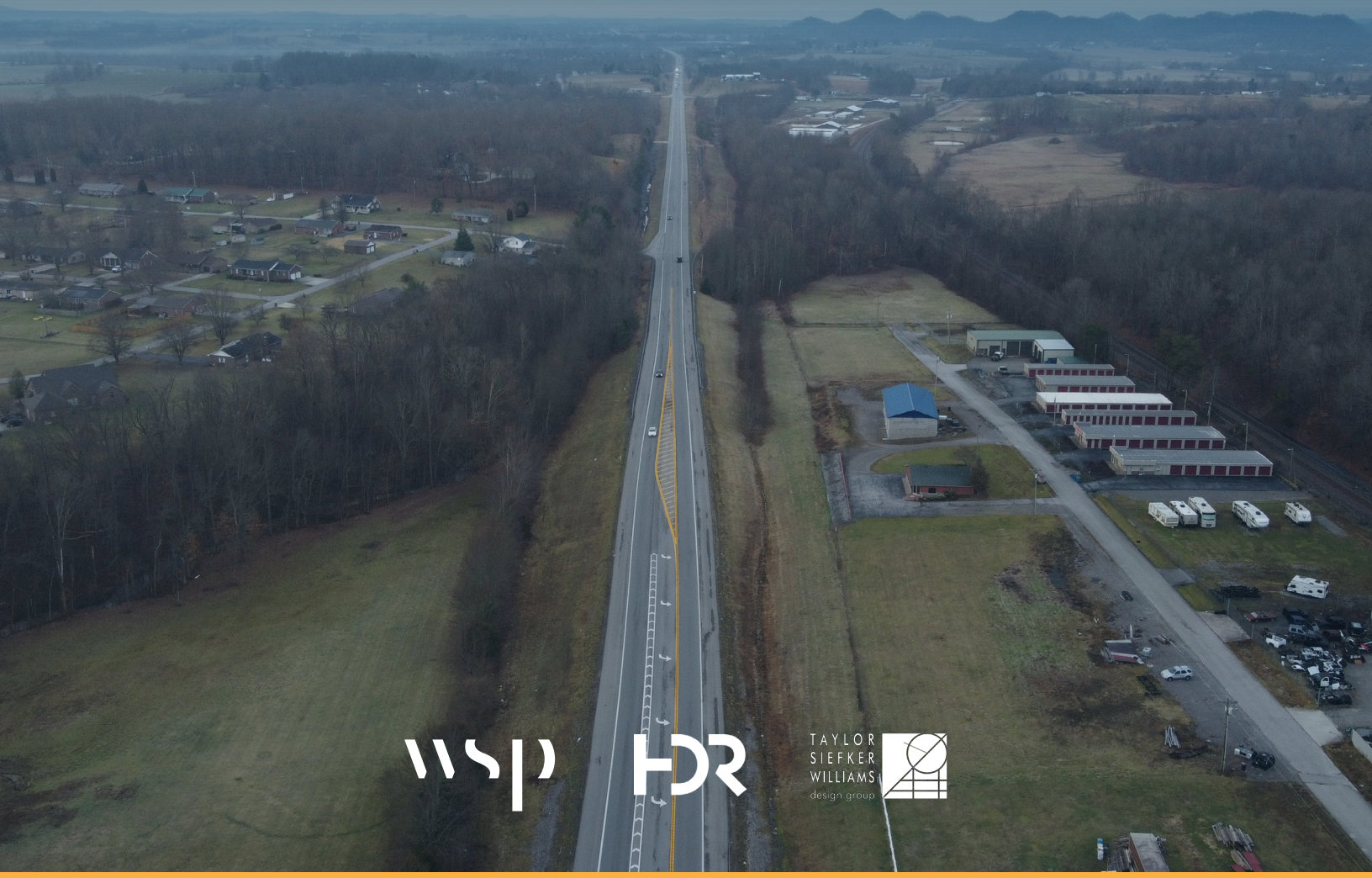
Upon completion of this study selected recommended improvement concepts will be moved through project development. There are funds for future project development phases of this corridor in the Six Year Plan.

10.1 Contacts

Written requests for additional information should be sent to the KYTC Division of Planning Director, 200 Mero Street, Frankfort, Kentucky 40622.

TEAM KENTUCKY®

TRANSPORTATION CABINET



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