

## IV. MAINLINE GEOMETRY/TYPICAL SECTION

*A Policy of Geometric Design of Highways and Streets, 5<sup>th</sup> Edition, 2004*, published by the AASHTO provides design guidelines for streets and highways. This manual is commonly referred to as The Green Book. For guidelines related to roadside clearance, obstructions, and barriers, the *Roadside Design Guide, Current Edition*, written by AASHTO was referenced. More specific guidance on interstate standards is provided in AASHTO's *A Policy on Design Standards Interstate System, Current Edition*.

The intent of the AASHTO Green Book is to provide guidance for the design of highways and streets. The book references a recommended range of values for critical dimensions based on established practices and recent research. The Green Book provides minimum values for critical dimensions of roadway design.

In order for the Purchase Parkway to be designated as I-69, the existing geometric conditions need to be compared to current interstate guidelines set forth by AASHTO. To identify these deficiencies and necessary design modifications, design information on the Purchase Parkway was collected from the Kentucky Transportation Cabinet's HIS, *As-Built Plans* for the Parkway, and site visits and compared to the current AASHTO guidelines for interstate highway facilities. A summary of this information is provided in **Appendix F**.

This chapter reviews the existing design speed, median width and type, clear zone, horizontal and vertical alignments, superelevation rates, and sight distance and compares them to the AASHTO guidelines. Although this chapter is based on comparing the existing geometric conditions of the Purchase Parkway to the minimum AASHTO guidelines set forth in the Green Book and other references mentioned, the Green Book permits and encourages sufficient design flexibility based on the project needs.

### A. Design Speed

The design speed of a facility dictates many of the geometric design parameters. The design speed selected is meant to satisfy a level of public expectation for safety and LOS.

The AASHTO minimum mainline design speed for a rural interstate is 70 mph and 50 mph for an urban interstate. According to the As-Built plans, this minimum requirement is met for the Purchase Parkway. The following sections and chapters that review existing mainline geometric conditions of the Purchase Parkway is based on these design speeds.

### B. Typical Roadway Sections

The Purchase Parkway has two typical roadway cross-sections. The Mayfield Bypass section of the Purchase Parkway was designed to lesser standards than the Purchase Parkway and is considered to be held to urban design standards due to its location within the city of Mayfield. These typical sections generally represent the existing conditions along the Parkway; however, any improvements made over the life of the Parkway may have resulted in changes to information that may not be represented in this study. The typical sections of the Purchase Parkway are shown in **Figure 4-1**.

#### 1. Lane Widths

The minimum lane width of a freeway facility is 12 feet. The existing lane widths of the Purchase Parkway mainline is 12 feet, therefore meeting the minimum AASHTO guidelines for interstate design.

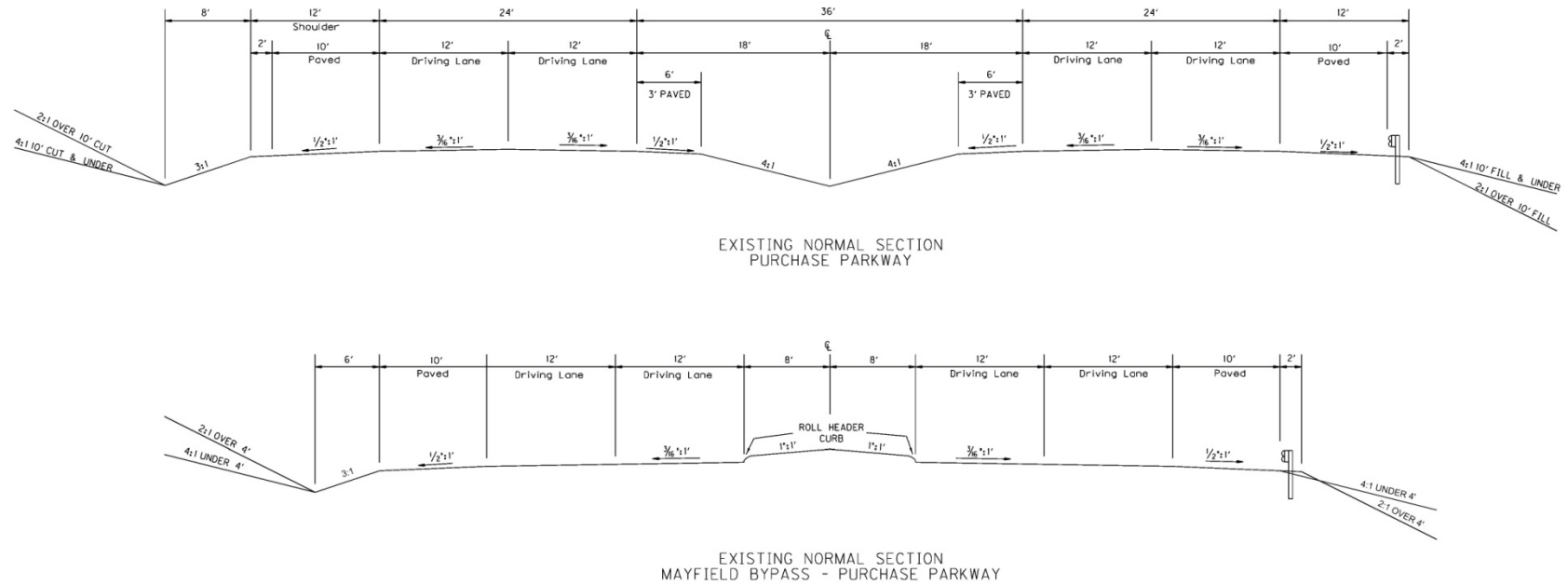


Figure 4-1 Existing Purchase Parkway Typical Section

Note: Typical Sections are based upon As-Built Plans provided by the Kentucky Transportation Cabinet

## 2. Shoulder Widths

The minimum AASHTO guidelines for interstate shoulders are 10 foot paved outside shoulder and 4 foot paved inside shoulder for each direction of travel. According to the As-built plans, the inside shoulder width on the Purchase Parkway is 6 foot wide, of which 3 feet is paved. The Mayfield Bypass does not have an inside shoulder. The AASHTO guideline for an inside shoulder is 4 feet paved. Therefore, the entire length of the Purchase Parkway does not comply with the AASHTO design guidelines for the inside shoulder width on freeways. Based on the existing (2010) directional design hourly volumes (**Table 3-7**), the Purchase Parkway outside paved shoulder width meets the minimum criteria.

A more detail summary of the locations of inside and outside widths is presented in **Table 4-1**.

PURCHASE PARKWAY	COUNTY	BEGIN MP	END MP	LENGTH (miles)	Shoulder Width (ft)	Paved Shoulder Width (ft)	AASHTO MINIMUM
OUTSIDE SHOULDERS	Fulton	0	3.43	3.43	12	10	10 ft paved (Truck DDHV ≤ 250 vph)
	Hickman	3.43	8.35	4.92	12	10	
	Graves	8.35	21.89	13.54	12	10	
	Graves	21.89	24.90	3.01	10	10	
	Graves	25.1	34.49	9.39	12	10	
	Marshall	34.49	51.40	16.91	12	10	
INSIDE SHOULDERS	Fulton	0	3.43	3.43	6	3	4 ft paved
	Hickman	3.43	8.35	4.92	6	3	
	Graves	8.35	21.9	13.55	6	3	
	Graves	21.89	24.90	3.01	0	0	
	Graves	24.90	34.49	9.59	6	3	
	Marshall	34.49	51.40	16.91	6	3	

**Table 4-1 Summary of Inside and Outside Shoulder Widths**

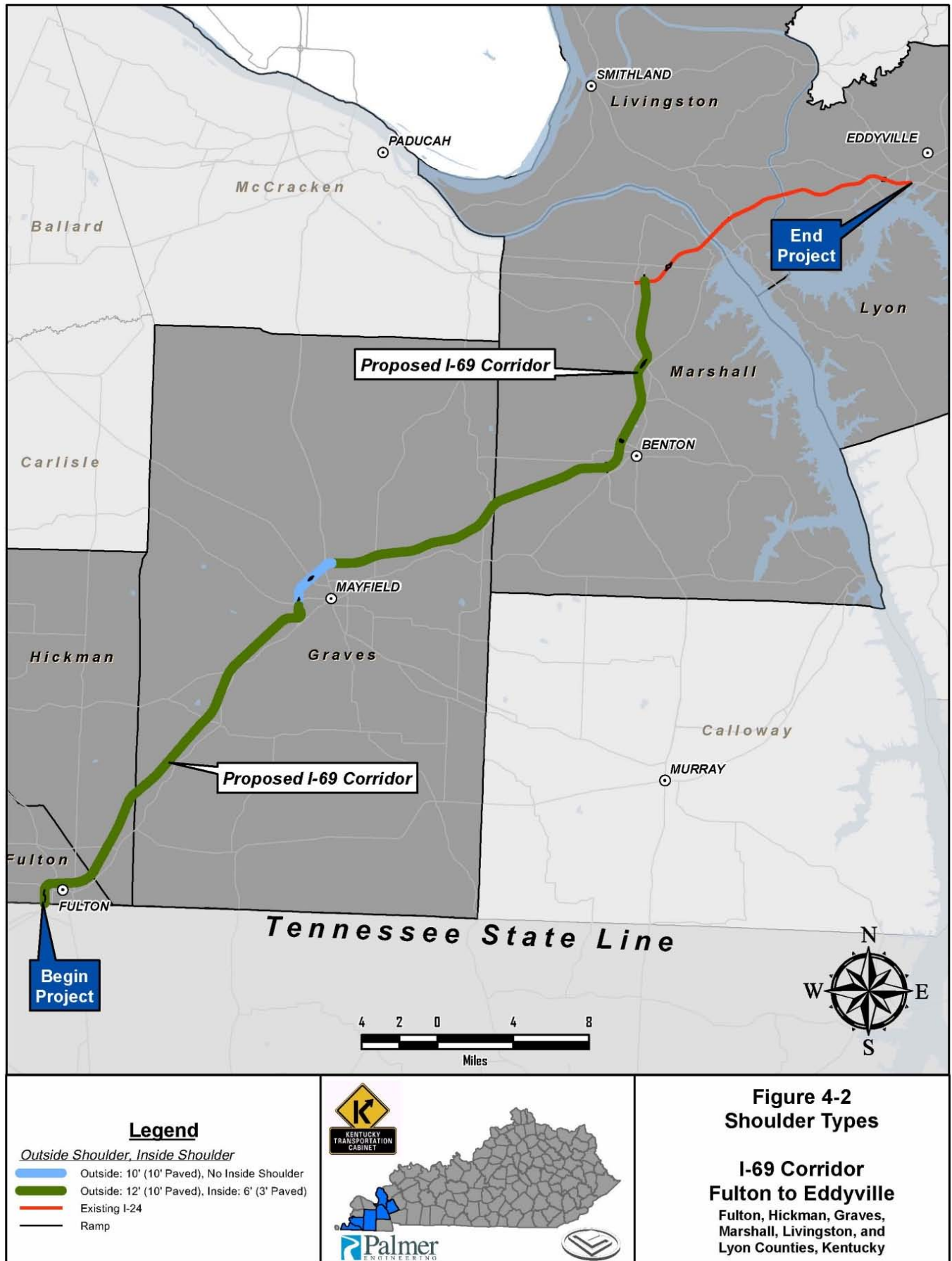
## 3. Median Width and Type

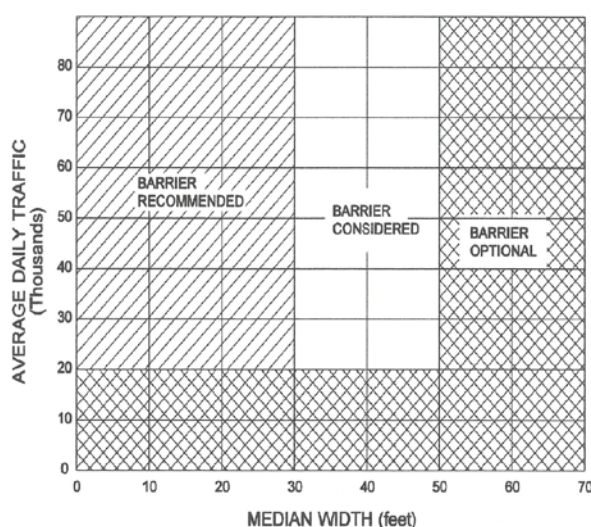
The purpose of a median separation is to provide driver comfort and safety. The width of a median is measured from the inside edge of the travel lane in one direction to the inside edge of the travel lane in the other direction. The median width also includes the shoulder width. The Purchase Parkway has a 36 foot depressed median, except for the Mayfield Bypass (MP 21.9-MP 24.9). This section has a 16 foot raised mountable median.

Guidelines contained within the AASHTO Green Book recommends a minimum 50 foot median for a rural interstate. Within the AASHTO *Policy on Design Standards, Interstate System* a minimum 36 foot median for a rural interstate is required. According to the Green Book, the minimum guidelines for an urban interstate are based on the number of lanes and number of large trucks. A ten foot median is recommended for a four lane urban interstate. This would allow for 4 foot inside shoulders and a 2 foot concrete median. For urban interstates with more than two lanes in each direction, the minimum median width is 22 feet for truck volumes less than 250 vph and 26 feet for truck volumes greater than 250 vph.



**Mayfield Bypass median and inside paved shoulder width does not meet current interstate standard**





**Suggested guidelines for median barriers on high-speed roadways**

The AASHTO's Roadside Design Guide is referenced to determine the warrants for barrier installation in the median. The guide provides a warrants chart based on average daily traffic, median width, and crash history. The chart to the left (Figure 6.1 in the *Roadside Design Guide*) is the warrant chart for the suggested guidelines for the installation of a median barrier on a high speed facility taken from Chapter 6 of the *Roadside Design Guide*. Chapter 6 has a detailed discussion of the installation of median barrier and curbs. Besides serving drainage purposes, curbs are not recommended on high speed facilities.

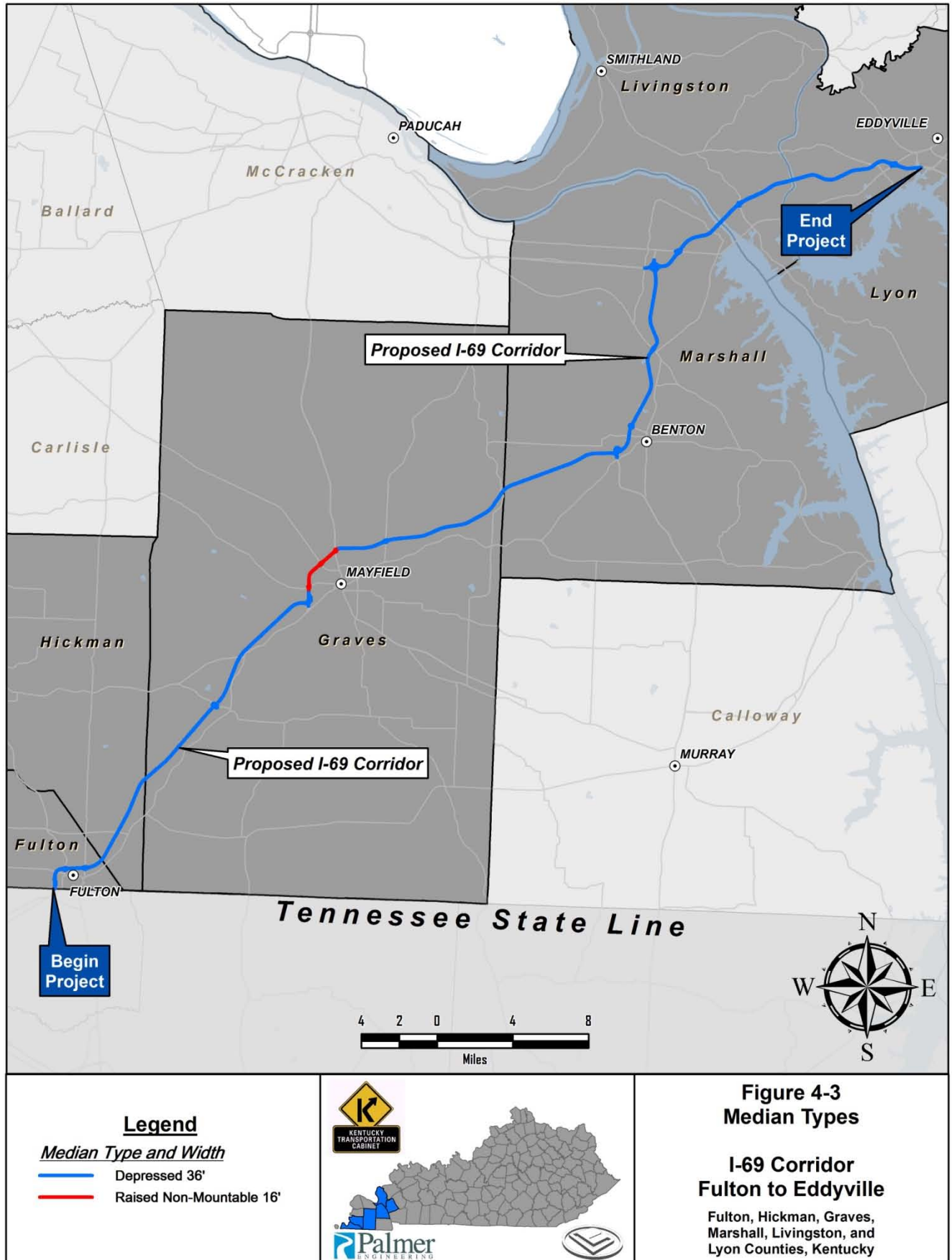
The median type and widths are provided below in **Table 4-2**. The location of these median attributes is shown in **Figure 4-3**.

The crash history review in Chapter III indicates that there is not a history of cross-over collisions on the Purchase Parkway. The current traffic (2010) volumes for the Purchase Parkway ranges from 7,060 vpd to 19,200 vpd. The future traffic (2040) volumes ranges from 12,800 vpd to 34,800 vpd without I-69 designation.

PURCHASE PARKWAY	COUNTY	BEGIN MP	END MP	LENGTH (miles)	MDIAN TYPE	MEDIAN WIDTH (ft)	AASHTO MINIMUM MEDIAN WIDTH
Rural	Fulton	0.00	3.43	3.43	Depressed	36	<b>RURAL</b> Depressed 36 ft
Rural	Hickman	3.43	8.35	4.92	Depressed	36	
Rural	Graves	8.35	20.50	12.15	Depressed	36	
Urban	Graves	20.50	21.89	1.39	Depressed	36	<b>URBAN</b> 10ft
Urban	Graves	21.89	24.90	3.01	Raised Non Mountable	16	
Urban	Graves	24.90	25.10	0.20	Depressed	36	
Rural	Graves	25.10	34.49	9.39	Depressed	36	
Rural	Marshall	34.49	51.40	16.91	Depressed	36	

**Table 4-2 Summary of Median Types and Widths along Purchase Parkway**

Based on the references, minimum guidelines and ADT, the Purchase Parkway median is in compliance.



#### 4. Clear Zones

The clear zone of a roadway is the area outside the edge of the travel lane, including the shoulder, that is free of obstructions and used for vehicle recovery. Guidelines for clear zone widths for roadways based on design speed, traffic volumes, fill/cut slopes, ditch slopes, and distance from fixed obstructions such as bridge piers, sign supports, culvert headwalls, trees, rock outcrops, and drainage channels are provided in the *Roadside Design Guide*.

A foreslope of 1V:4H or flatter is considered recoverable and a foreslopes between 1V:3H and 1V:4H is considered traversable, but non-recoverable. As described in the guide, the recommendation for a clear zone range is 30 to 46 feet for recoverable fill slopes (1V:4H or flatter) on a roadway with a design speed of 70 mph and Average Daily Traffic (ADT) greater than 6,000 vehicles. Foreslopes steeper than 1V:4H, obstructions should not be present in the vicinity of the toes of these slopes.

For a roadway in a cut section, the clear zone for backslope of 1V:3H or flatter varies from 22 feet to 30 feet.

In the review of the as-built plans, the fill and cut slopes vary from 1V:2H to 1V:4H, see typical provided in **Figure 4-1**. These side slopes depend on the height of fill or depth of cut required. Based on information available in as-built plans, it is not possible to readily summarize the clear zone distances for the Purchase Parkway.



Clear zones may require guardrail placement or extensions to meet current standards.

#### 5. Guardrail Placement and Condition

Guardrail is a longitudinal barrier to shield motorists from natural or man-made obstacles located on either side a traveled way. The guardrail protects a vehicle potentially leaving the roadway by absorbing the vehicle's energy, protecting it from roadside hazards. Chapter 5 of the *Roadside Design Guide* addresses the application and situation of guardrail placement. The information available on the as-built plans does not provide sufficient information to determine if the guardrail placement on the Purchase Parkway meets the current standard. A field review of the existing guardrail end treatment was conducted on the Purchase Parkway mainline and interchange ramps. This review showed that the end treatments on parkway meet current KYTC standards.

### C. Horizontal Alignment

This section includes the review of existing superelevation and horizontal curvature for the Purchase Parkway and compares them to the current minimum standards.

#### 1. Superelevation Rate

Superelevation (road banking) is the physical tilting of the roadway to help counteract the centripetal forces developed as a vehicle goes around a curve. Superelevation and friction keep a vehicle from sliding off the roadway while traveling through a curve. Superelevation is calculated based on design speed and horizontal curvature of the roadway. According to the AASHTO Policy on Geometric Design of Highways and Streets, current edition (commonly referred to as the Green Book), the maximum superelevation rate is controlled by climate conditions, terrain conditions, type of area, and frequency of slow-moving vehicles that may be affected by high superelevation rates. A specific maximum superelevation is not recommended for an Interstate facility by AASHTO. It is left to the user agencies to make specific policy decisions concerning allowable rates of superelevation. The KYTC policy references the Green Book for freeway geometric design. The Green Book provides superelevation rate tables for 4%, 6%, 8%, 10%, and 12% maximum superelevations. From review of as-builts plans and field inspection, it appears that the Purchase

Parkway was constructed on the basis of a 10% maximum superelevation. The superelevations for the Purchase Parkway are compiled in **Appendix F**.

## 2. Degree of Horizontal Curvature

The guidelines for horizontal curvature design were designated by degree of curvature during the design of the Purchase Parkway. The existing parkway was designed to a maximum 3° 00' curve, which equates to minimum radius of approximately 1910 feet. The current AASHTO guidance for minimum curvature references curve radius rather than degree of curvature. The current minimum horizontal curvature radius for a design speed of 70 mph for a rural interstate is 1810 feet, which equates to approximately 3°10' of curvature. The minimum radius for an urban interstate with a 50 mph design speed is 758 feet or approximately 7° 33' of curvature.



Horizontal curvature along the Purchase Parkway meets Interstate design guidelines

The smallest radius of curve is 1146 feet located on the Mayfield Bypass at MP 21.585 and MP 21.793, which equals a design speed of 59 mph with a 8% superelevation. Although this radius is the smallest, it meets the current minimum radius of 758 feet for an urban interstate with a design speed of 50 mph. The horizontal curves that are closest to exceeding the minimum radius for a rural interstate are located in Fulton County at MP 1.022 and Marshall County at MP 47.42. This curve has a radius of 1910 feet which still meets the minimum criteria. A compilation of horizontal curves is located in **Appendix F**.

## D. Vertical Alignment

The vertical alignment of a roadway depends on the existing terrain. The changes in vertical terrain result in the introduction of vertical curves into the roadway design. A vertical curve is classified as sag or crest. A sag vertical curve is used when traversing through a valley, and a crest vertical curve is introduced when traveling over a hill. The design of these curves is critical to stopping sight distance. Stopping sight distance is measured by how far a driver can see while traveling in typical vehicle and still maintain the ability to stop within that distance. Design speed, length of vehicle light beam distance, and approach and departing grades determine the length of crest and sag vertical curves.

### 1. Vertical Grade

The Purchase Parkway is considered to have a rolling terrain. AASHTO guidelines designate a maximum 4% vertical grade for a rural section with a rolling terrain and 5% for an urban section. According to the as-built plans, the Purchase Parkway meets this maximum criteria for both urban and rural sections. The largest vertical grade is at the vertical curves located at MP 21.075 (3.84%), MP 21.245 (3.84%, -3.87%), and MP 21.463 (-3.87%) on the Mayfield Bypass. The review of the as-built plans for the Purchase Parkway showed all sections met the maximum vertical grade.

## **2. Vertical Length of Curve**

The minimum length of curve was calculated based on the vertical grades of the approaching alignment, recommended rate of vertical curvature for a design speed. There are eight vertical curves that do not meet the recommended vertical length of curve based on this calculation. These eight vertical curve deficiencies are located in rural areas in Graves County at:

- MP 14.965 – Actual 500 feet, calculated minimum 696 feet;
- MP 18.727 – Actual 600 feet, calculated minimum 624 feet;
- MP 25.320 – Actual 536 feet, calculated minimum 584 feet;
- MP 27.517 – Actual 500 feet, calculated minimum 543 feet;
- MP 28.625 – Actual 400 feet, calculated minimum 438 feet;
- MP 29.970 – Actual 400 feet, calculated minimum 416 feet;
- MP 31.144 – Actual 400 feet, calculated minimum 467 feet;
- MP 31.646 – Actual 600 feet, calculated minimum 608 feet.

## **3. Stopping Sight Distance**

Stopping sight distance was reviewed for all vertical curves on the Purchase Parkway. Stopping sight distance is calculated based on design speed and sight distance. The minimum stopping sight distance for a 70 mph design is 730 feet and 425 feet for a 50 mph design speed. There are three vertical curves that have less than the minimum stopping sight distance. They are located in rural areas in Graves County at:

- MP 14.965 – Calculated Stopping Sight Distance 554 feet;
- MP 18.727 – Calculated Stopping Sight Distance 727 feet;
- MP 25.320 – Calculated Stopping Sight Distance 721 feet.