FINAL REPORT

US 41 Traffic and Access Management Study
Henderson County
KYTC Item No. N/A

Prepared for:

Kentucky Transportation Cabinet
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Executive Summary

The Kentucky Transportation Cabinet (KYTC) initiated the US 41 Traffic and Access Management Study in Henderson County with funding from the Evansville Metropolitan Planning Organization (MPO). The study examines the need for and types of improvements necessary along the US 41 corridor, from north of the US 60 interchange to the intersection with Wolf Hills Road. The study serves as the first step in establishing the purpose and goals of the project, identifying potential concerns, and evaluating preliminary alternatives.

Purpose and Need

The purpose of this project is to relieve congestion and improve safety along the US 41 corridor from north of the US 60 interchange (MP 16.386) to the intersection with Wolf Hills Road (MP 18.538). Safety is the primary concern along US 41, along with alleviating isolated pockets of congestion, as exhibited at Watson Lane.

This portion of US 41 carries a heavy mix of local and regional traffic as it connects Henderson, KY with Evansville, IN via twin bridges over the Ohio River. It not only serves as a connection between these interdependent cities, but also provides access to numerous businesses, industries, governmental organizations, and homes. The US 41 bridges provide the only river crossing in the area, resulting in traffic volumes on US 41 between 38,000 and 40,000 vehicles per day. The most congested segment is US 41 between Marywood Drive and Watson Lane with a volume-to-capacity (V/C) ratio of 0.96. All signals are operating at acceptable levels of service (LOS) except the signal at Watson Lane, which operates at a LOS E in the AM and LOS F in the PM. This signal fails due to delays from vehicles turning off of and onto Watson Lane.

Over the three-year period between January 2012 and December 2014, there were 433 crashes reported along the US 41 corridor, which includes 86 injury collisions. The percentage of injury collisions is higher along US 41 than on similar roads in Kentucky. Rear-end collisions made up 41 percent of the crashes, angle collisions made up 24 percent of the crashes, and opposing-left-turn collisions made up five percent of the crashes. These collisions total 70 percent of all the crashes along the study area portion of US 41 and are likely related to access management and congestion.

Alternatives Development

Community outreach helped guide the study, particularly in identifying potential issues and developing alternatives. Over the course of the study, the project team held three in-person project team meetings and two stakeholders/local officials meetings.

Based on early input from stakeholders and local officials, the project team decided the focus of the study would be to identify short-term, "quick-win" improvements that can be implemented quickly and independently as well as a long-term improvement plan that can be implemented as funding becomes available. Improvement concepts were developed to improve operational

and safety deficiencies that result from the combination of heavy traffic volumes, signalized and unsignalized intersections, and access concerns.

US 41 is functionally classified as an urban principal arterial, yet it provides a significant level of access to adjacent properties. Along the 2.152-mile study area portion of US 41 there are approximately 119 access points (55 per mile). Most of those access points are south of Watson Lane (70 access points per mile). An effective access management program can reduce crashes by as much as 50 percent, increase roadway capacity by 23 to 45 percent, and reduce travel time and delay by as much as 40 to 60 percent[1].

Following the development of the initial improvement concepts, shown in **Figure ES-1**, the project team met with stakeholders and local officials in August 2015. Improvement concepts were presented and attendees were asked to complete a questionnaire to help the project team understand priorities from a local perspective. The first question asked respondents to rank the importance of seven transportation goals in order from 1 to 7 where 1 is the highest importance. Improving safety (1.5) and reducing congestion (2.0) were the highest ranked goals. The second question asked the respondents to rate the importance of the conceptual improvement projects on a scale from 1 to 5, where 1 indicates the project is not important and 5 indicates very important. Improvements to Watson Lane scored the highest (4.6) followed by the construction of an Eastern Backage Road (3.9). Relocating the traffic signal at Audubon Village Shopping Center to Barker Road and improvements to Elm Street both were also rated high (3.7).

Recommendations

The recommendations for the US 41 Traffic and Access Management Study are based on their ability to meet the purpose and need, the input received, and the alternative development process. The completion of the I-69 corridor between Kentucky and Indiana will affect future demand along US 41 (i.e., the six-lane widening concept would not be warranted if a new I-69 bridge is built between Evansville and Henderson). Therefore, the costs of proposed improvements were evaluated against future needs. In light of the technical data, comments from stakeholders, and results of the survey, the project team worked together to prioritize each of the improvements.

- **High Priority (in order)**
    - **Improvement 4 – Watson Lane Intersection:** Watson Lane is by far the most congested intersection in the study area. Based on the traffic analyses, southbound dual left turn lanes are needed on US 41. This will require widening Watson Lane east of US 41 to accommodate dual receiving lanes. There are also heavy delays during peak hours for westbound vehicles turning right from Watson Lane to northbound US 41. To help reduce this delay, the existing right-turn bay can be extended and a right-turn overlap phase can be implemented within the signal timing to increase capacity. Dual right turn lanes may also be considered during future phases of the project.

[1] Transportation Research Board (TRB) Access Management Manual

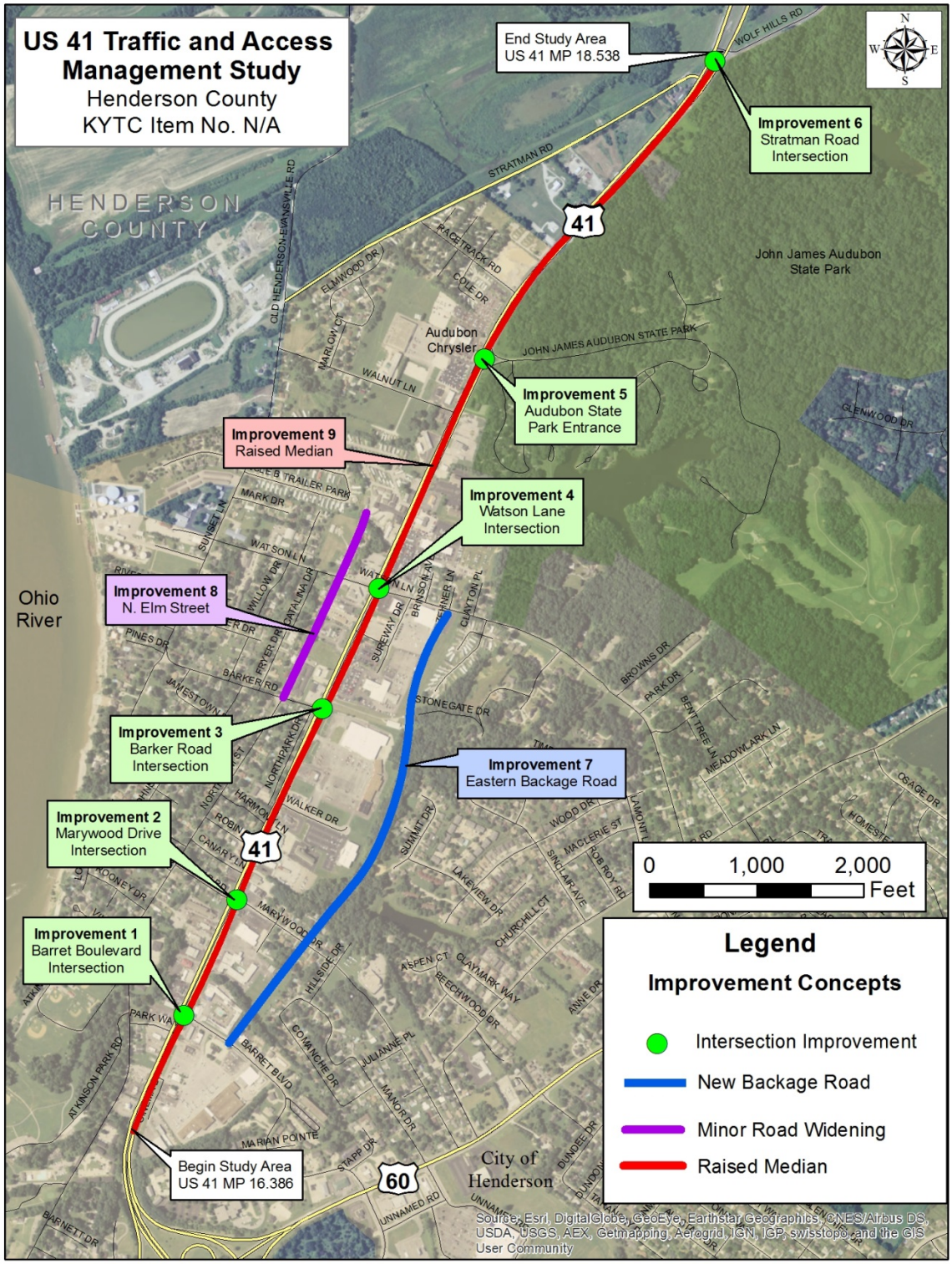


Figure ES-1: Improvement Concepts

- **Improvement 3 – Barker Road Intersection:** Move the signalized entrance at the Audubon Village Shopping Center north to Barker Road. Elm Street functions as backage road to most of the businesses on the west side of US 41. This would relieve congestion at Watson Lane by providing another signalized location for vehicles to turn left onto US 41. Widen the new Audubon Village Shopping Center entrance and Barker Road to accommodate additional turn lanes and improve capacity at the signal. Allow passenger vehicle U-turns at the signal.

- **Improvement 7 – Eastern Backage Road:** Construct a new backage road on the east side of US 41 between Barret Boulevard and Watson Lane. Provide connections to the existing shopping centers along US 41 and the new signal at Barker Road. The Eastern Backage Road can be designed all at once but built in segments as funding becomes available. Based on input from the final local officials and stakeholders meeting, the construction of sidewalks, bicycle lanes, and/or a shared use path should be considered during future design phases. Currently, there are few facilities for pedestrians and bicyclists on the east side of US 41. Also consider having the Eastern Backage Road line up with the Audubon State Park parcel off Watson Lane, where a new park entrance is under consideration.

- **Medium Priority (in no particular order)**
  - **Improvement 1– Barret Boulevard Intersection:** Add a signal and extend Barret Boulevard to N. Elm Street west of US 41. Widen Barret Boulevard to accommodate additional turn lanes and improve capacity at the signal. Some safety concerns were expressed at the project team meeting about adding a traffic signal at Barret Boulevard because of its proximity to the US 60 interchange. As a result, two concepts were developed for the Barret Boulevard intersection:
    - **Option 1 – Full Signal:** Add an outside lane on northbound US 41 for the interchange ramp. Terminate the extra lane at Barret Boulevard and remove the mainline lane drop on northbound US 41.
    - **Option 2 – "3/4 Signal":** The new Elm Street Connector will become a left-in, right-in/right-out with a signal and Barret Boulevard will be converted to a right-in/right-out. This would allow northbound traffic to flow freely through the intersection. This configuration is similar to the "Green T" intersection concept[2]. This appears to be the preferred alternative of the project team and stakeholders but should be evaluated further during future design phases.
  - **Improvement 2 – Rettig Road / Marywood Drive Intersection:** Provide a better alignment for Rettig Road and Marywood Drive. Widen each road to accommodate dedicated left-turn lanes and improve capacity at the signal. Allow passenger vehicle U-turns at the signal.
  - **Improvement 5 – Audubon State Park Entrance:** Reconfigure the skewed "Y" shape entrance to a single point entrance perpendicular to US 41. In the event a

[2] http://safety.fhwa.dot.gov/intersection/resources/casestudies/fhwasa09016/fhwasa09016.pdf

raised median is constructed along US 41, consider aligning the new Audubon State Park entrance with the Audubon Chrysler entrance.

- **Improvement 6 – Stratman Road / Wolf Hills Road Intersection:** Reconstruct the Stratman Road and Wolf Hills Road offset approaches to a single intersection to accommodate U-turns and potentially add a signal. Widen each road to accommodate additional turn lanes and improve capacity at the signal. In the event a raised median is constructed along US 41, provide a jughandle off Stratman Road to accommodate U-turns for northbound semi-trucks.

- **Improvement 8 – N. Elm Street:** Add shoulders on N. Elm Street between Barker Road and Watson Lane. Add turn lanes at the Barker Road and Watson Lane intersections to increase capacity. In the event a raised median is constructed along US 41, consider extending N. Elm Street north of Watson Lane to provide a connection to the mobile home park.

- **Improvement 9 – Raised Median:** The raised median concept is shown extending the entire length of the corridor with median openings at the signalized intersections and the Audubon State Park entrance. The proposed typical section would not require additional right-of-way along US 41 except at intersections where additional turn lanes are required. The raised median can be implemented in phases, or the ultimate limits may be shortened as needed. The limits of the raised median and the typical section will ultimately be determined during future phases of the project.

- **No Priority**
  - **Safety and Mobility Improvement Plan:** In addition to short-term, "quick-win" improvements that can be implemented quickly and independently, the project team was also tasked with developing a long-term improvement plan that can be implemented as funding becomes available. The Safety and Mobility Improvement Plan combines improvements 1 through 9, as described above. Future design, right-of-way, utility and construction phases for this project are not included in the current Six Year Highway Plan. The project team has estimated the Safety and Mobility Improvement Plan to cost $30.86 million, which will likely make such an undertaking infeasible as a single project.

  - **Improvement 10 – Six-Lane Widening:** Widen US 41 to three through lanes in each direction. Construct a raised median, which is currently proposed extending the entire length of the corridor with median openings at the signalized intersections and the Audubon State Park entrance. The proposed typical section would require 12 feet of additional right-of-way along US 41. Drainage requirements and turn lanes at intersections will likely require additional right-of-way. The limits of the raised median and the typical section will ultimately be determined during future phases of the project. The six-lane widening concept would not be warranted if a new I-69 bridge is built crossing the Ohio River between Evansville and Henderson.

Planning level cost estimates were prepared for each improvement concept, shown in **Table ES-1**, based on unit costs plus additional costs for special features (i.e., culverts and traffic signals). KYTC District 2 assisted in this effort by providing right-of-way and utility cost estimates.

Improvement	Description	Design	Right-of-Way	Utilities	Construction	TOTAL
1	Barret Boulevard Intersection (Option 1)	$ 290,000	$ 1,000,000	$ 600,000	$ 2,900,000	$ 4,790,000
1	Barret Boulevard Intersection (Option 2)	$ 240,000	$ 1,000,000	$ 600,000	$ 2,400,000	$ 4,240,000
2	Marywood Drive Intersection	$ 120,000	$ 350,000	$ 850,000	$ 800,000	$ 2,120,000
3	Barker Road Intersection	$ 170,000	$ 350,000	$ 300,000	$ 1,100,000	$ 1,920,000
4	Watson Lane Intersection	$ 350,000	$ 1,000,000	$ 1,200,000	$ 3,500,000	$ 6,050,000
5	Audubon State Park Entrance	$ 110,000	$ 250,000	$ 200,000	$ 700,000	$ 1,260,000
6	Stratman Road Intersection (Option 1)	$ 380,000	$ 300,000	$ 400,000	$ 3,800,000	$ 4,880,000
6	Stratman Road Intersection (Option 2)	$ 430,000	$ 400,000	$ 400,000	$ 4,300,000	$ 5,530,000
7	Eastern Backage Road	$ 330,000	$ 4,000,000	$ 750,000	$ 3,800,000	$ 8,880,000
8	N. Elm Street	$ 150,000	$ 750,000	$ 750,000	$ 1,000,000	$ 2,650,000
9	Raised Median	$ 1,060,000	$ 3,350,000	$ 3,550,000	$ 10,300,000	$ 18,260,000
--	Safety & Mobility Improvement Plan	$ 1,460,000	$ 8,050,000	$ 5,050,000	$ 16,300,000	$ 30,860,000
10	Six-Lane Widening	$ 1,740,000	$ 6,500,000	$ 4,500,000	$ 19,100,000	$ 31,840,000

Table ES-1: 2015 Cost Estimates

1.0 INTRODUCTION

The US 41 Traffic and Access Management Study was initiated by the Kentucky Transportation Cabinet (KYTC) to evaluate the need for and impacts of transportation improvements along US 41 in Henderson County. The project includes an examination of the route north of the US 60 interchange to the intersection with Wolf Hills Road in Henderson, Kentucky.

The US 41 Traffic and Access Management Study is not listed in the 2014-2020 KYTC Six Year Highway Plan. This study is funded through the Evansville Metropolitan Planning Organization (MPO) with $100,000 in funds. Future design, right-of-way, utility and construction phases of this project are not included in the 2014-2020 KYTC Six Year Highway Plan.

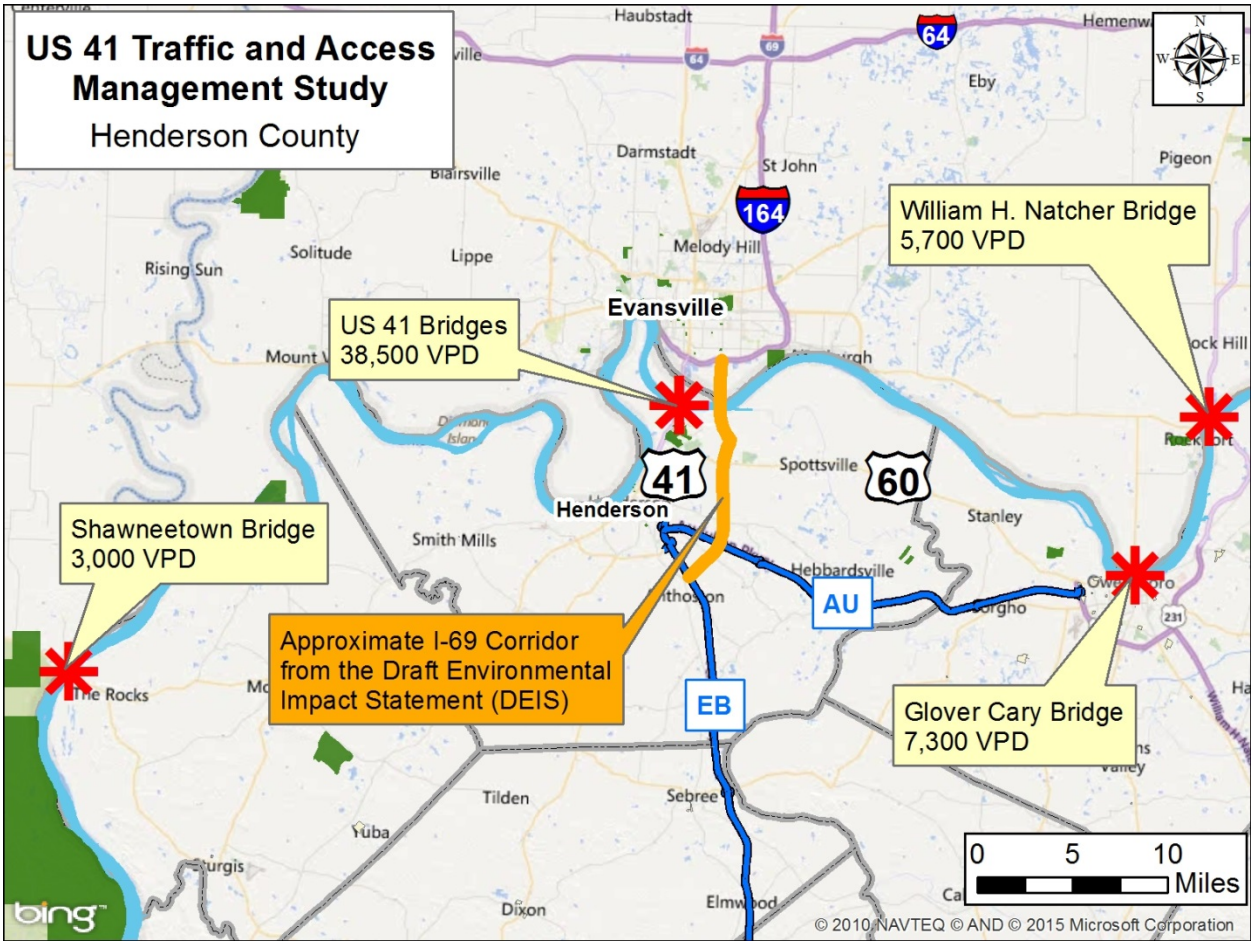
This study has been undertaken to seek feasible strategies to more effectively manage access along the corridor in order to improve the efficiency and safety of US 41. The completion of the I-69 corridor between Kentucky and Indiana could affect future traffic demand along US 41. Therefore, the cost of proposed improvements will be evaluated against future needs. This study recommends a set of projects aimed at enhancing access in a responsible manner, resulting in a plan that can be implemented to facilitate future access management opportunities.

1.1 STUDY AREA

The study area is located in Henderson, Kentucky and is bound to the south by the US 60 interchange (MP 16.386) and to the north by the Wolf Hills Road intersection (MP 18.538). This portion of US 41 carries a heavy mix of local and regional traffic as it connects Henderson, KY with Evansville, IN via twin bridges over the Ohio River. The US 41 bridges provide the only river crossing in the area, as shown in **Figure 1**, resulting in traffic volumes on US 41 between 38,000 and 40,000 vehicles per day. The proposed I-69 corridor and Ohio River crossing from the 2004 Draft Environmental Impact Statement (DEIS) between Evansville, IN and Henderson, KY is shown in **Figure 1**. The total corridor length is 2.152 miles. Improvements along this corridor are being considered due to its importance in providing access to Indiana and local commercial areas along US 41 in Kentucky. **Figure 2** shows the study area in more detail.

1.2 COMMITTED PROJECTS

There are a number of other projects listed in the 2014-2020 KYTC Six Year Highway Plan in Henderson County, shown in **Figure 3**. Of those, there is one project in the study area, Item 2-715.00, under which the KYTC District 2 will add turn lanes at the US 41 intersection with Wolf Hills Road.



(Note: Traffic volumes from KYTC CTS Database in Vehicles per Day, VPD)

Figure 1: Regional Ohio River Bridge Crossings

Outside of the Six Year Plan Projects, there are three projects on KYTC's Unscheduled Needs list that have active Project Identification Forms (PIF's) along US 41 or adjacent to the study limits:

- PIF 02 051 B0041 1.00 – Reconstruct interchange at US 60 in Henderson (MP 16.1-16.2)
- PIF 02 051 B0041 1.70 – Major widening to six lanes from US 60 to KY 414 in Henderson County (MP 16.193 – 18.496)
- PIF 02 051 B0041 4.80 – Improve safety and level of service on the eastern approach of the Watson Lane intersection. (MP 17.407 – 17.507)

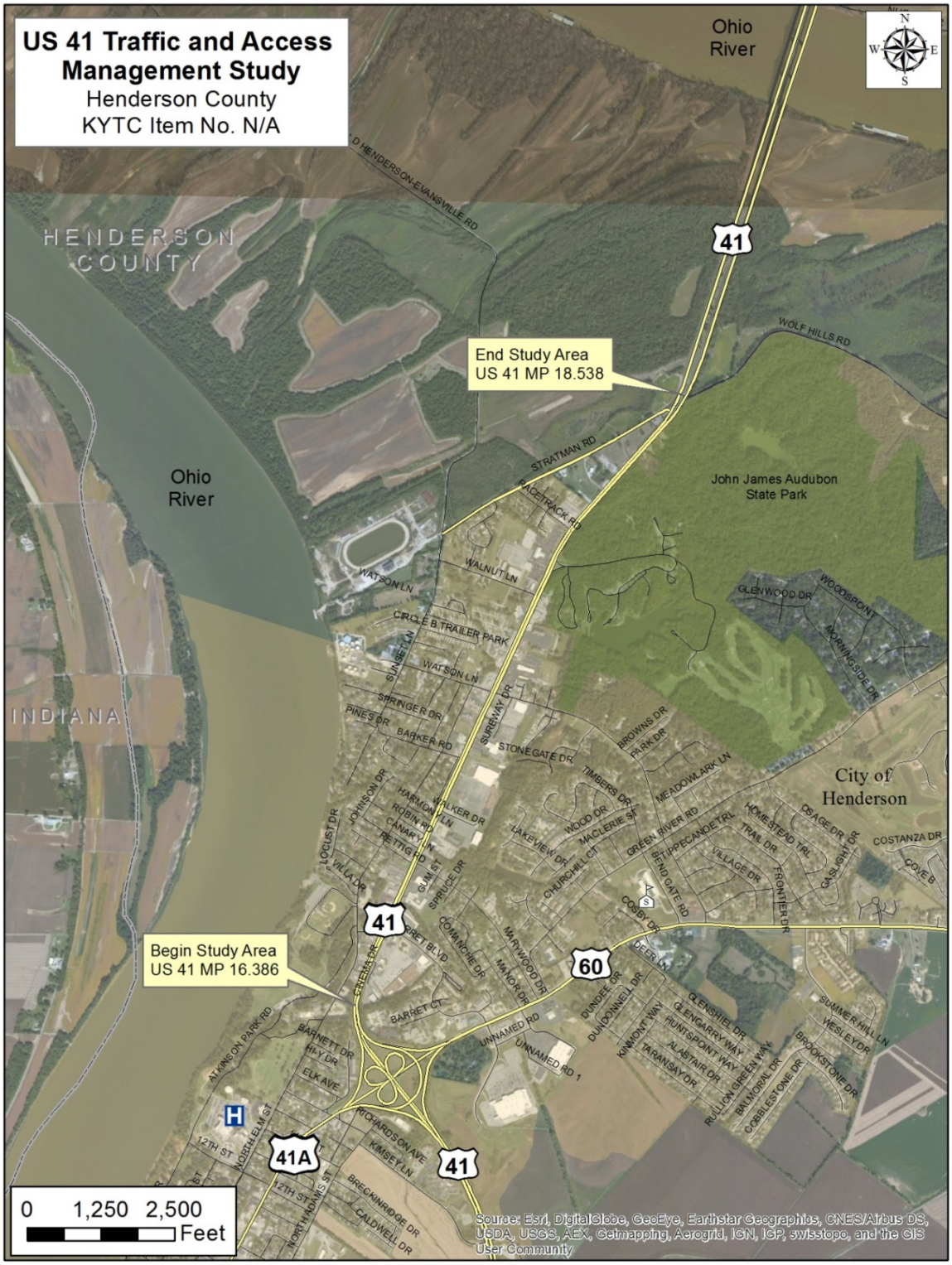


Figure 2: Study Area – US 41 Traffic and Access Management Study

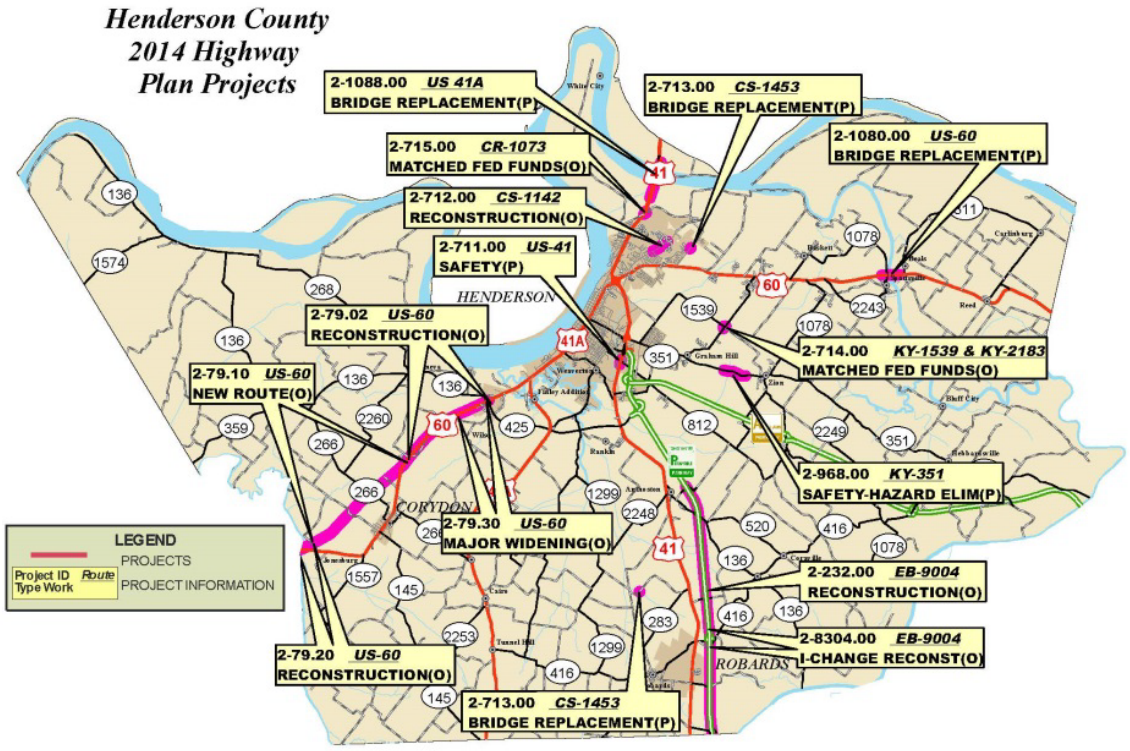


Figure 3: Henderson County 2014 Highway Plan Projects
(Source: KYTC Division of Program Management)

2.0 PURPOSE AND NEED

As a result of the existing conditions analysis, project team input and local officials/stakeholders input, a purpose and need statement for this study was developed to be used during future project development efforts, including design and environmental activities. The purpose and need statement establishes why KYTC is proposing to advance a transportation improvement and drives the process for improvements, alternative consideration, analysis, and selection.

> *The purpose of the US 41 Traffic and Access Management project is to relieve congestion and improve safety along the US 41 corridor from north of the US 60 interchange to the intersection with Wolf Hills Road.*

Safety is the primary concern along US 41, along with alleviating isolated pockets of congestion as exhibited at Watson Lane. The following needs were identified over the course of the study.

2.1 CONGESTION

A detailed discussion of the traffic analyses performed for the US 41 Traffic and Access Management Study is found in Chapter 3. This portion of US 41 carries a heavy mix of local and

regional traffic as it connects Henderson, KY with Evansville, IN via twin bridges over the Ohio River. It not only serves as a connection between these interdependent cities, but also provides access to numerous businesses, industries, governmental organizations, and homes. The US 41 bridges provide the only river crossing in the area, resulting in traffic volumes on US 41 between 38,000 and 40,000 vehicles per day. The most congested segment is US 41 between Marywood Drive and Watson Lane with a V/C ratio of 0.96. All signals are operating at acceptable levels of service (LOS) except the signal at Watson Lane, which operates at a LOS E in the AM and LOS F in the PM. This signal fails due to delays from vehicles turning off and onto Watson Lane.

2.2 SAFETY

A detailed discussion of the crash analysis along US 41 is found in Chapter 3. Over the three-year period between January 2012 and December 2014, there were 433 crashes reported along the US 41 corridor, which includes 86 injury collisions. The percentage of injury collisions is higher along US 41 than similar roads in Kentucky.

Rear end collisions made up 41 percent of the crashes, angle collisions made up 24 percent of the crashes, and opposing left turn collisions made up five percent of the crashes. These collisions total 70 percent of all the crashes along the study area portion of US 41 and are likely related to access management and congestion.

Along the 2.152-mile study area portion of US 41 there are approximately 119 access points (55 per mile). Most of those access points are south of Watson Lane (70 access points per mile). Many of the crashes can be attributed to the overabundance of intersections and driveways.

Critical crash rate factors (CRF) were calculated for the three-year study period. If the CRF is 1.0 or greater, it is unlikely that the crashes can be attributed to random occurrence. Two segments along the study route were found to have a CRF over 1.00; Segment 1 between the US 60 interchange and Marywood Drive (0.421 miles) has a CRF of 1.67 and Segment 2 between Marywood Drive and Watson Lane (0.600 miles) has a CRF of 1.41. Five 3/10 mile spots were also found to have a CRF greater than 1.00.

3.0 EXISTING CONDITIONS

Conditions of the study area's existing transportation network are examined in the following section. The information compiled includes roadway facilities and geometrics, crash history, and traffic volumes within the study area. Data for this section were collected from the Kentucky Transportation Cabinet's (KYTC's) Highway Information System (HIS) database, aerial photography, as-built plans, and field review. A summary of the information contained within the KYTC HIS database is included in **Table 1**.

Begin Milepoint	End Milepoint	Description	Functional Classification	AADT (Year)	Truck %	Speed Limit	Facility Type	Lane Width	Shoulder Width	Median Width
16.386	16.654	North of US 60 Interchange to North of Barrett Blvd	Urban Principal Arterial	37,700 (2011)	10.79%	45 mph	4 Lanes	12'	10' Paved (East) 2' Curbed (West)	30' (12' Left Turn Lanes and 6' Raised Mountable Median)
16.654	16.807	North of Barrett Blvd to Marywood Dr							2' Curbed	
16.807	17.407	Marywood Dr to Watson Ln		40,400 (2011)						
17.407	17.633	Watson Ln to Holiday Inn Express		38,415 (2012)						
17.633	18.055	Holiday Inn Express to North of Race Track Rd				50 mph				
18.055	18.308	North of Race Track Rd to South of Stratman Rd				55 mph				
18.308	18.538	South of Stratman Rd to Wolf Hills Rd							10' Paved	

Table 1: US 41 Highway Characteristics Summary

3.1 ROADWAY SYSTEM

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

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

Figure 4 shows the functional classification of roadways within the study area.

Figure 4: Functional Classification

US 41 and the Breathitt Parkway (EB 9004, formerly known as the Pennyrile Parkway) are the primary corridors that provide north-south regional connectivity for both commerce and the traveling public in Henderson County. US 41 carries a heavy mix of local and regional traffic as it connects Henderson, KY with Evansville, IN via twin bridges over the Ohio River, which is the only river crossing in the area. US 41 is an Urban Principal Arterial with a 45 to 55 mile per hour (MPH) posted speed limit and an average daily traffic (ADT) ranging from approximately 38,000 to 40,000 vehicles per day (vpd) through the study area. US 41 is also part of the National Highway System and is a Federal Designated Truck Route on which vehicles with increased dimensions (STAA vehicles) may operate.

3.2 ROADWAY GEOMETRIC CHARACTERISTICS

As part of the study effort, a review of existing geometrics along study area roadways was performed and compared against geometric standards in *AASHTO's A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011*, commonly referred to as the "Green Book". The existing typical section for US 41 is shown in **Figure 5**.

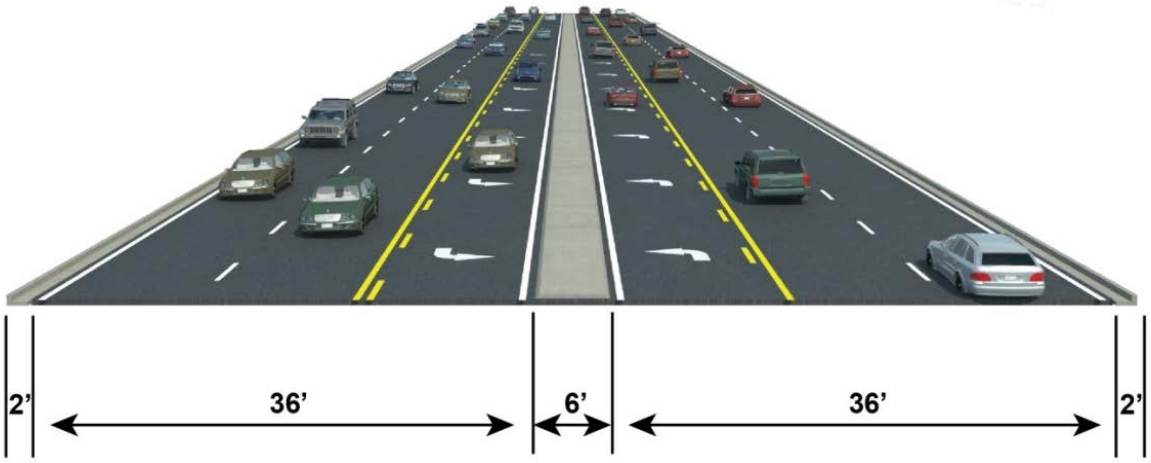


Figure 5: Existing US 41 Typical Section

The estimated lane widths throughout study area roadways are shown on **Figure 6**. US 41 has 12-foot wide lanes throughout the study area. Based on current Green Book design guidelines, 12-foot wide lanes are desirable, where practical, on high-speed, free flowing, principal arterials (Green Book Section 7.3.3). Under interrupted-flow operating conditions at lower speeds (45 MPH or less), narrower lane widths are normally adequate and have some advantages. For example, reduced lane widths allow more lanes to be provided in areas of restrictive right-of-way and allow shorter pedestrian crossing times because of reduced crossing distances. There is one crosswalk on US 41 at the signalized intersection at the Audubon Village Shopping Center. Arterials with reduced lane widths are also more economical to construct. An 11-foot lane width is adequate for through lanes, continuous two-way left-turn lanes, and lanes adjacent to a painted median.

Figure 6: Lane Widths

Estimated shoulder widths from KYTC's HIS databased throughout the study area are shown in **Figure 7**. Curb and gutter is not typically classified as a "shoulder" in KYTC's HIS database. Shoulders are desirable on any highway, and urban arterials are no exception. They contribute to reducing the crash frequencies by affording maneuver room and providing space for immobilized vehicles. They also serve as speed change lanes for vehicles turning into driveways and intersections and provide storage space for plowed snow. In areas where sufficient right-of-way exists to consider shoulders, the recommended minimum usable shoulder width is eight feet for arterial roadways with an ADT greater than 2,000 vpd (Green Book Table 7-3).

Despite the many advantages of shoulders on arterial streets, their use is generally limited in urban areas by restricted right-of-way and the need to use the available right-of-way for traffic lanes. In urban areas, the outside edges of shoulders may be curbed and a closed drainage system provided to minimize the amount of right-of-way needed. In addition, curbs are often appropriate in heavily developed areas as a means of controlling access (Green Book Section 7.3.3). When providing shoulders is not practical and curbs are to be used, they should be offset two feet from the edge of the traveled way. Based on a field review, US 41 in the study area primarily has curb and gutter (the gutter pan is two feet wide), which varies somewhat from the dimensions in the HIS database and is adequate based on current Green Book guidelines. There are short segments at the beginning and end of the study area where 10-foot wide paved shoulders are provided.

Horizontal and vertical alignment characteristics throughout the study area are shown in **Figure 8** and **Figure 9.** Based on the HIS data, there are some horizontal and vertical curves along US 41 that do not meet current design standards but all horizontal curves are considered safe at the posted speed limit and all vertical curves along US 41 appear to have adequate sight distance.

3.3 STRUCTURES

Based on the KYTC Bridge Data Miner, there are no structures located along the study corridor. There are two US 41 Ohio River Bridges north of the study area. The US 41 bridge carrying northbound traffic was built in 1932 and has a sufficiency rating of 69.8. The US 41 bridge carrying southbound traffic was built in 1965 and has a sufficiency rating of 67.7. The sufficiency rating assigns individual structures with a measure in which to remain in service. A rating of 100 percent indicates a structure is entirely satisfactory and a rating of zero percent indicates a structure is completely deficient. Bridges are eligible for federal funding for rehabilitation if they have a sufficiency rating below 80 percent. If a bridge has a rating below 50 percent it is considered eligible for replacement funding.

3.4 MULTIMODAL FACILITIES (TRANSIT, BICYCLE, AND PEDSTRIAN)

The City of Henderson operates the Henderson Area Rapid Transit (HART). HART operates busses daily Monday through Saturday from 6:00 AM to 5:30 PM. There are six bus routes that service the US 41 study area.

Figure 7: Shoulder Widths

Figure 8: Horizontal Alignment

Figure 9: Vertical Alignment

Currently, no bike lanes or sidewalks are provided along the corridor, but there are crosswalks at the signalized intersection at the Audubon Village Shopping Center. The Evansville Metropolitan Planning Organization (MPO) developed The Greater Henderson Bicycle and Pedestrian Master Plan[3]. No bicycle or pedestrian improvements were proposed along US 41 in the master plan. However, bicycle routes were proposed along adjacent roadways including Stratman Road, Wolf Hills Road, Green River Road, Watson Lane, Marywood Drive, Rettig Road, Sunset Lane, Barker Road, and Elm Street with a proposed crossing of US 41 at Marywood Drive.

The Greater Henderson Bicycle and Pedestrian Master Plan also recognized the importance of providing safe bicycle and pedestrian connections between neighborhoods, schools, and major shopping centers. There are no schools along the study area portion of US 41, but two commercial centers were identified – Sureway and Audubon Village.

3.5 EXISTING TRAFFIC VOLUMES

The latest average daily traffic (ADT) volumes are shown on **Figure 10** for the study area. Traffic volumes on US 41 range from 38,000 to 40,000 vehicles per day (VPD) with 11 percent trucks. Turning movement traffic counts were collected in March 2015 at six locations along US 41. Examination of the traffic approaching each intersection suggests 3,000 to 3,500 vehicles per hour (VPH) travel along US 41 during the peak hours.

Volume-to-Capacity (V/C) ratios were estimated based on the existing counts along US 41. The V/C ratio indicates where roadway segments approach or exceed the daily volume of traffic they can accommodate. This is the preferred KYTC methodology for evaluating the adequacy of roadway segments. The target design year V/C ratio is 1.0 for urban areas. A V/C greater than this indicates the road is congested, i.e., operating above its design capacity. In the case of US 41, all roadway segments are currently approaching design capacity with V/C ratios between 0.84 and 0.96. The most congested segment is US 41 between Marywood Drive and Watson Lane, which has a V/C ratio of 0.96. A summary of the V/C ratios is shown in **Table 2**.

Begin Segment	Begin MP	End Segment	End MP	Count Station	Average Daily Traffic (VPD)	Count Year	Level of Service (LOS)	Volume to Capacity (V/C) Ratio
US 60	16.386	Marywood Dr	16.807	051B22	37,700	2011	C	0.90
Marywood Dr	16.807	Watson Ln	17.407	051B73	40,400	2011	C	0.96
Watson Ln	17.407	Wolf Hills Rd	18.538	051P58	38,415	2012	C	0.84

Table 2: Existing Volume-to-Capacity for US 41 Corridor Segments

[3] http://www.evansvillempo.com/Bike_Ped_Plans/henderson%20bike%20ped%20plan%202013_final.pdf

Figure 10: Average Daily Traffic (ADT) Volumes

Level of service (LOS) is a qualitative measure describing operational conditions within a traffic stream, based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. There are six levels of service, having letter grades A through F. LOS A is associated with free-flow conditions, high freedom to maneuver, and little or no delay. Conditions at or near capacity typically are associated with LOS E. At LOS F, traffic conditions are oversaturated and exceed capacity, with low travel speeds, little or no freedom to maneuver, and high delays. In urban areas, LOS D or better is desirable. This is the preferred KYTC methodology for analyzing the adequacy of an intersection.

LOS was calculated at the signalized intersections along the corridor, based on the existing lane configuration, traffic controls, existing signal timing, and peak hour volumes from the 2015 turning movement counts. As shown in **Table 3**, all signals are operating at acceptable levels of service (LOS) except the signal at Watson Lane, which operates at a LOS E in the AM and LOS F in the PM.

Intersection	AM Existing		PM Existing	
	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS
US 41 at:				
Marywood Drive/Rettig Road	7.9	A	10.5	B
Audubon Village	2.8	A	4.6	A
Watson Lane	76.5	E	80.2	F

Table 3: Existing Peak Delay and LOS at Signalized Intersections

3.6 2030 NO-BUILD TRAFFIC

The Evansville Metropolitan Planning Organization (MPO) provided output from its Regional Travel Demand Model to assist Stantec in developing year 2030 traffic forecast volumes for this study. Based on the model output and investigation of historic traffic volume trends, a one percent annual growth rate was assumed along US 41 for the 2030 No-Build (Existing plus Committed network without a new I-69 bridge). This growth comes from the construction of I-69 north and south-east of Henderson, which currently funnels traffic through the US 41 study area. Stantec used the annual growth rate to calculate future year AM and PM peak traffic volumes for the 2030 No-Build scenario without a new I-69 bridge.

As shown in **Table 4**, under this scenario, US 41 between US 60 and Watson Lane will be operating above design capacity by year 2030, with a V/C greater than 1.0. US 41, between Watson Lane and Wolf Hills Road, will be operating just below capacity by year 2030 with a V/C of 0.99.

Begin Segment	Begin MP	End Segment	End MP	2030 Average Daily Traffic (VPD)	2030 Level of Service (LOS)	2030 Volume to Capacity (V/C) Ratio
US 60	16.386	Marywood Dr	16.807	44,000	E	1.05
Marywood Dr	16.807	Watson Ln	17.407	47,000	F	1.12
Watson Ln	17.407	Wolf Hills Rd	18.538	45,000	C	0.99

Table 4: US 41 2030 Volume-to-Capacity Ratios without a New I-69 Bridge

The completion of the I-69 corridor between Kentucky and Indiana will affect future demand along US 41. Therefore, model runs were also conducted for the Existing plus Committed network with a new I-69 bridge between Evansville and Henderson, shown in **Figure 1**. Results show a 15 to 20 percent reduction in traffic along US 41 compared to the 2030 No-Build volumes without a new I-69 bridge, essentially resulting in traffic volumes equivalent to the existing 2015 traffic volumes. Thus additional through lanes are not warranted on US 41 if a new I-69 river crossing is constructed. The completion of the I-69 corridor is a regional priority in Kentucky and Indiana as well as a national priority. A detailed traffic forecast report is included in **Appendix A**.

3.7 CRASH HISTORY

To quantify safety concerns, a crash analysis was performed for the study portion of US 41. Historical crash data were collected along the study area for a three-year period between January 1, 2012 and December 31, 2014. The crash records and locations are included in **Appendix B**.

3.7.1 Crash Severity

Over the analysis period, there were 433 reported crashes along the 2.152-mile corridor. Of these, no crashes resulted in fatalities but 86 resulted in injuries. **Figure 11** demonstrates the distribution of crashes by severity.

The percentage of injury collisions along US 41 is slightly above average when compared to similar roads in Kentucky. Based on the most recent statewide crash data from the Kentucky Transportation Center research report *Analysis of Traffic Crash Data in Kentucky (2009-2013)*[4], injury crashes along urban principal arterials generally compose 18 percent of total crashes; but along the study portion of US 41, injury crashes compose 20 percent of the total reported crashes.

[4] http://uknowledge.uky.edu/cgi/viewcontent.cgi?article=2446&context=ktc_researchreports

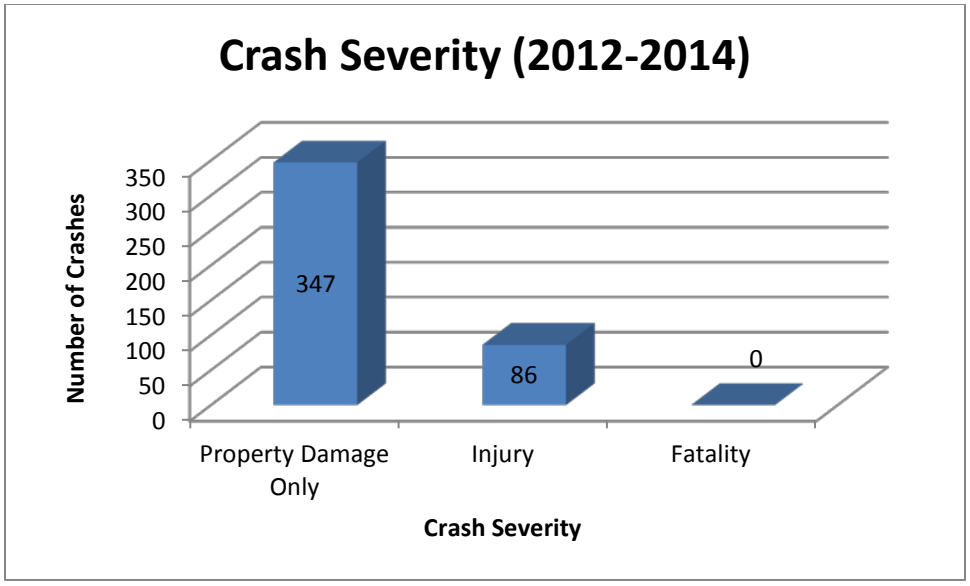


Figure 11: Distribution of Crashes by Severity

3.7.2 Crash Type

Rear end vehicle crashes were the most commonly reported crash type (178 crashes, 41 percent) followed by angle crashes (102 crashes, 24 percent) and sideswipe crashes (72 crashes, 17 percent). Rear end collisions, angle collisions, and opposing left turn collisions total 70 percent of all the crashes along the study area portion of US 41. These types of crashes are indicative of congested roadways with poor access management. **Figure 12** and **Figure 13** demonstrate the distribution of crashes by crash type.

3.7.3 Critical Crash Rate Factors

Crashes were geospatially referenced and compared to statewide data to identify locations experiencing above average crash rates. The methodology is defined in the Kentucky Transportation Center research report *Analysis of Traffic Crash Data in Kentucky (2009-2013)*. As defined in the methodology report, segments vary in length and are divided along roadways where geometry or traffic volumes change. For each segment, analysts looked at the number of crashes, traffic volume, rural/urban, number of lanes, and segment length to determine the critical rate factor (CRF). The CRF is one measure of the safety of a road, expressed as a ratio of the crash rate at the location compared to the average crash rate for roadways of the same functional classification throughout the state. If the CRF is 1.00 or greater, it is unlikely that the crashes can be attributed to random occurrence.

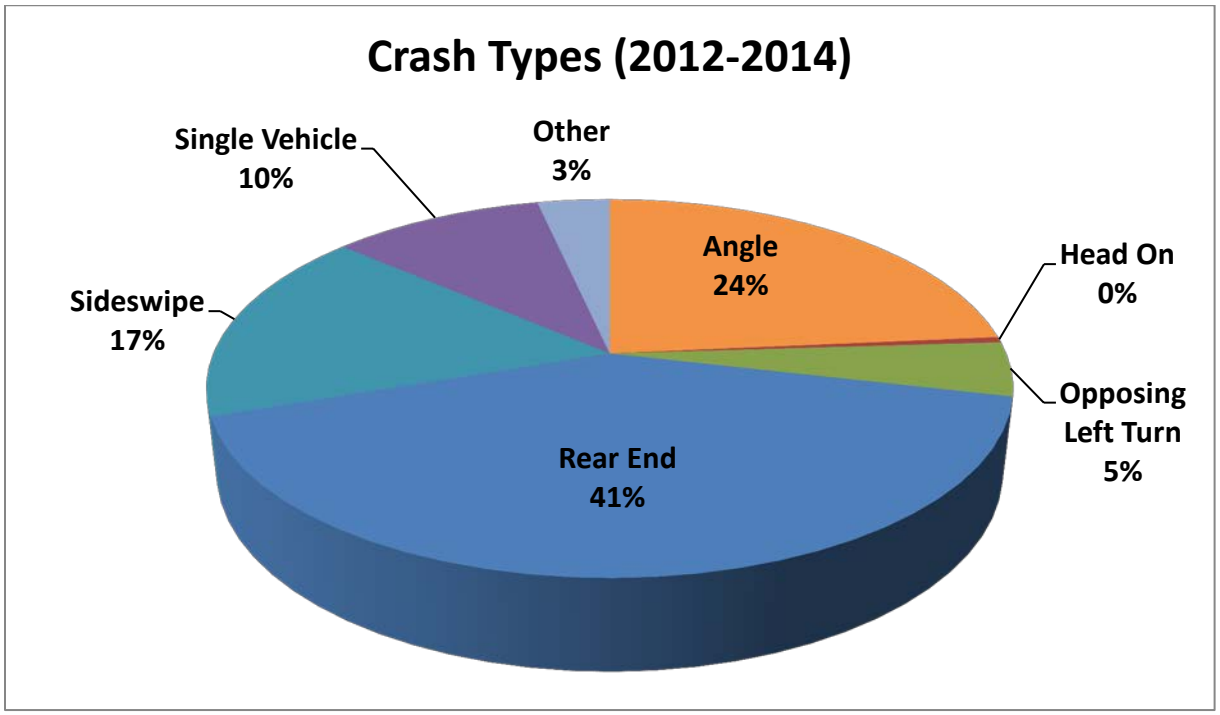


Figure 12: Distribution of Crashes by Type

Analysts also conducted a spot analysis along US 41. Spots were defined by observing 3/10 mile sections where crashes were concentrated. Crashes were again geospatially referenced and compared to statewide data to identify locations experiencing above average crash rates. The CRF was again used as a measure of the safety of a particular spot.

Table 5 and **Figure 14** show the results of the segment analysis with statistics on each segment. CRF's along the study corridor range from 0.53 to 1.67. Two segments along the study route were found to have a CRF over 1.00. Segment 1 between the US 60 interchange and Marywood Drive (0.421 miles) has a CRF of 1.67 and Segment 2 between Marywood Drive and Watson Lane (0.600 miles) has a CRF of 1.41. In Segment 1, there were 144 crashes including 32 crashes resulting in injuries. Rear end collisions were the predominant crash type (36 percent), followed by angle collisions (29 percent) and sideswipe collisions (19 percent). In Segment 2 there were 177 crashes including 32 crashes resulting in injuries. Rear end collisions were the predominant crash type (55 percent), followed by sideswipe collisions (16 percent) and angle collisions (15 percent).

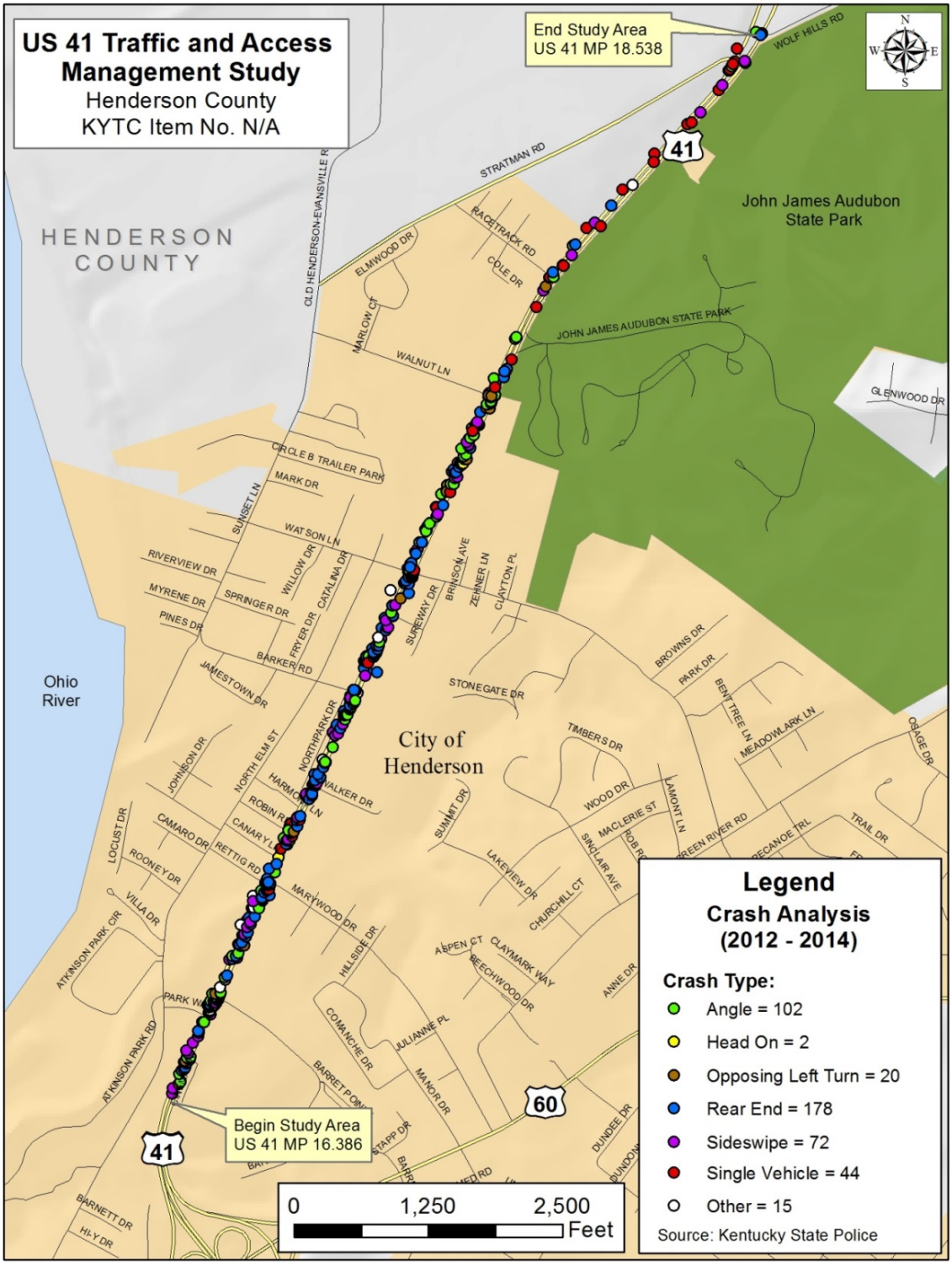


Figure 13: Distribution of Crashes by Location and Type

Segment	Route	Beginning MP	Ending MP	Number of Crashes	Number of Fatal Crashes	Number of Injury Crashes	Number of PDO Crashes	ADT	CRF
1	US 41	16.386	16.807	144	0	32	112	37,700	1.669
2	US 41	16.807	17.407	177	0	32	145	40,400	1.411
3	US 41	17.407	18.538	112	0	22	90	38,415	0.526

* Source: KTC Analysis of Traffic Crash Data in Kentucky (2009-2013): Table B-2

Table 5: Crash Rate Analysis by Segment (2012 to 2014)

Along the study corridor, five 3/10 mile spots were found to have a CRF greater than 1.00, as shown in **Figure 15**. Spot 1 between milepoint 16.386 and 16.686 has a CRF of 4.47 with 107 crashes including 27 crashes resulting in injuries. Angle collisions were the predominant crash type (38 percent), followed by rear end collisions (29 percent) and sideswipe collisions (19 percent). Spot 2 between milepoint 16.686 and 16.986 has a CRF of 3.46 with 83 crashes including 11 crashes resulting in injuries. Rear end collisions were by far the predominant crash type (60 percent), followed by sideswipe collisions (13 percent) and angle collisions (10 percent). Spot 3 between milepoint 16.986 and 17.286 has a CRF of 3.24 with 82 crashes including 15 crashes resulting in injuries. Rear end collisions were the predominant crash type (49 percent), followed by angle collisions (20 percent) and sideswipe collisions (20 percent). Spot 4 between milepoint 17.286 and 17.586 has a CRF of 3.33 with 81 crashes including 15 crashes resulting in injuries. Rear end collisions were the predominant crash type (51 percent), followed by angle collisions (25 percent) and sideswipe collisions (12 percent). Spot 5 between milepoint 17.638 and 17.938 has a CRF of 1.36 with 33 crashes including 7 crashes resulting in injuries. Angle collisions were the predominant crash type (33 percent), followed by rear end collisions (24 percent) and single vehicle collisions (21 percent).

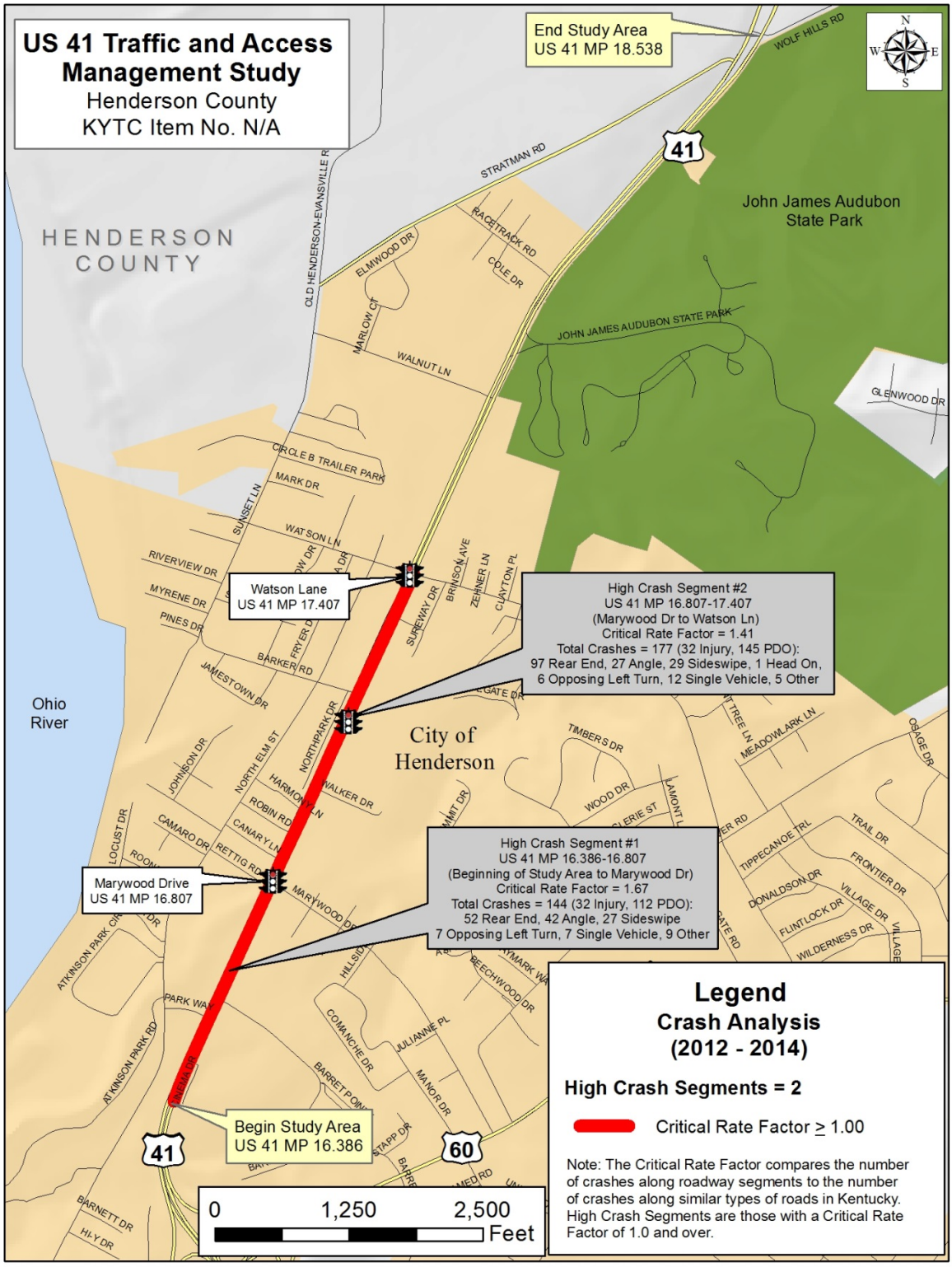


Figure 14: Critical Crash Rate Factors (CRF) Segments

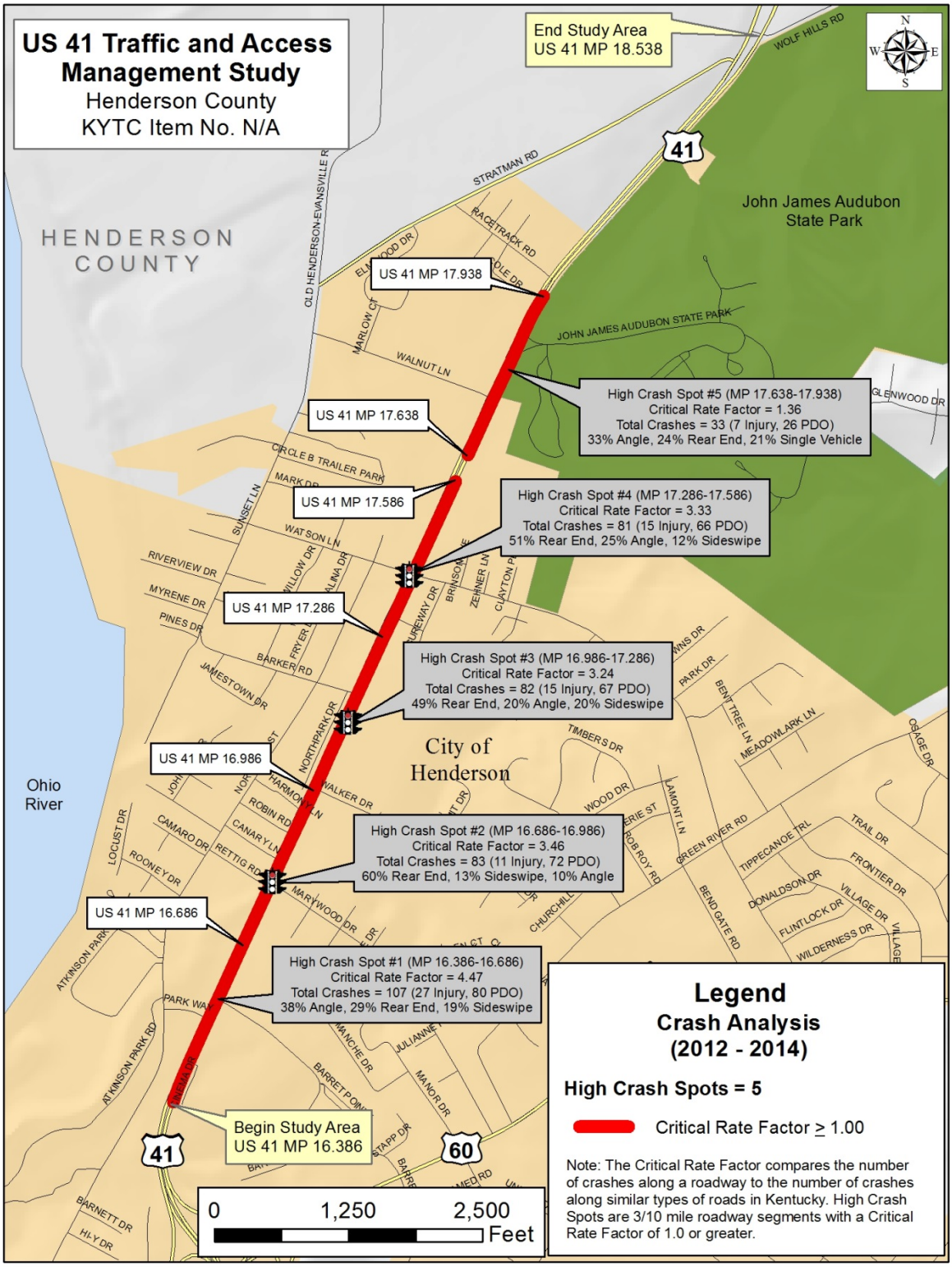


Figure 15: Critical Crash Rate Factors (CRF) Spots

3.8 EXISTING ACCESS ISSUES

Access and mobility are often competing needs, as described on **Figure 16**. Arterial roadways are generally intended to provide high levels of mobility, the capability of traveling from one place to another, but lower levels of access to adjacent land uses. Local streets typically provide higher levels of access but are not intended to serve higher volumes of faster moving traffic. Problems arise when the intended function of a roadway does not correlate with the demands that are placed upon it.

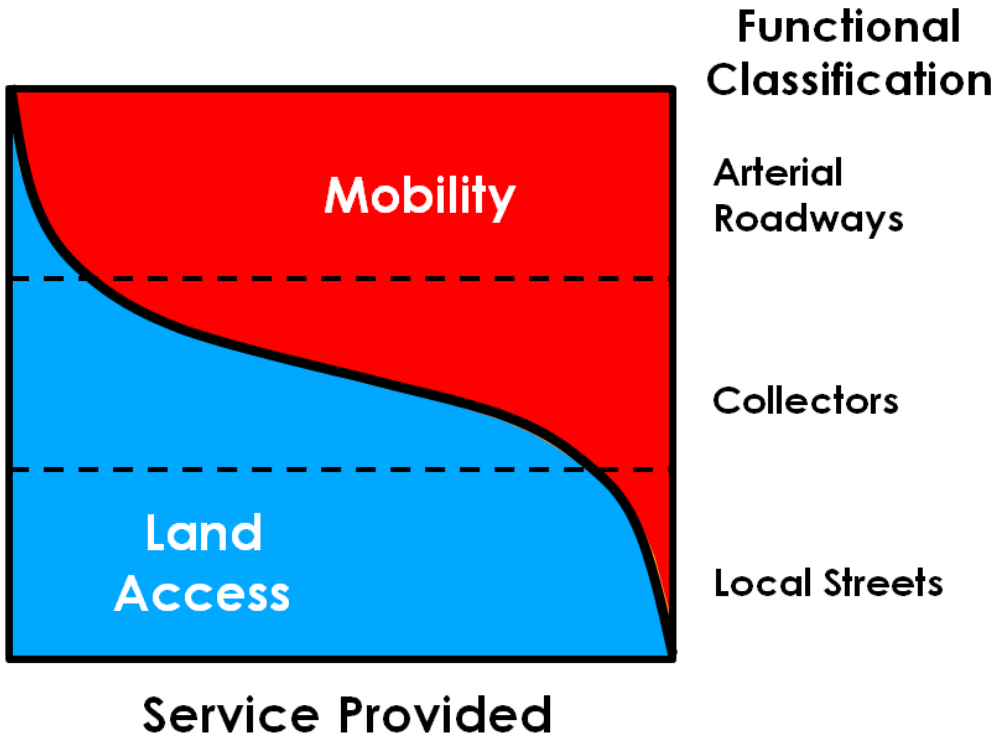


Figure 16: Roadway Functional Classification by Service Provided

Roads are an important public resource and are costly to build, improve, or replace. Allowing closely spaced curb cuts, median openings, driveways near major intersections, and poorly coordinated traffic signals, places a heavy burden on the roadway, which in turn leads to unsafe and congested conditions. By managing access, government agencies can extend the life of these roads, improve traffic safety, decrease congestion, improve traffic flow, and improve air quality, which helps preserve long-term property values and provides an improved quality of life.

Figure 17 includes a summary of the existing access points along the study portion of US 41. Along the 2.152-mile study area portion of US 41 there are approximately 119 access points (55 per mile). Most of those access points are south of Watson Lane (70 access points per mile). Increasing the spacing between access points improves arterial flow and increases safety.

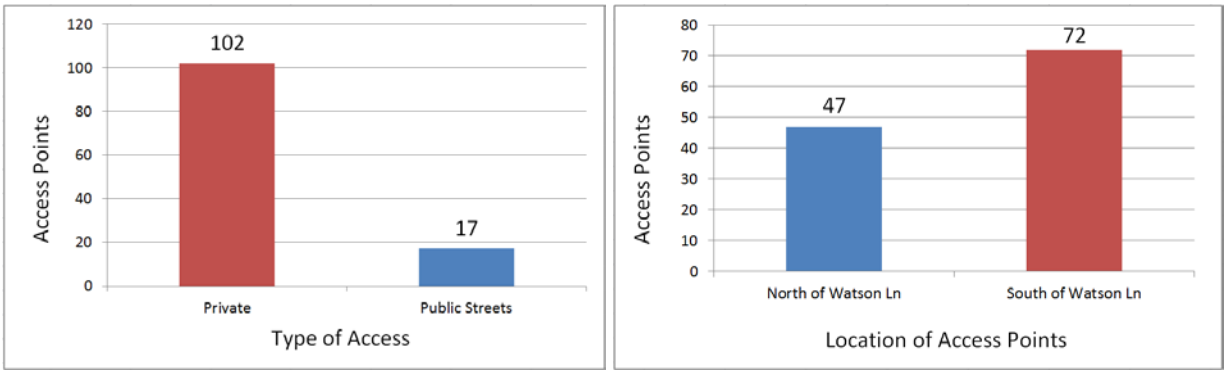


Figure 17: Existing Access Points along US 41

Access problems result from inadequate coordination between land use and transportation. When best access management practices, discussed in more detail in **Chapter 6**, are not used, both the function and character of a road can deteriorate rapidly, resulting in less efficient traffic operations, a higher than average rate of crashes, and in many cases adverse impacts to businesses and residential areas as traffic attempts to avoid poorly managed arterials. In an ideal situation, a roadway such as US 41 would be a "highly access-managed arterial" because of its high traffic volume and importance in the context of the regional transportation network. Highly access-managed arterials are generally characterized as having physical medians, access limited to ½ mile intervals, most left-turn access prohibited, and right-turn access provided at ¼ mile intervals. Such measures result in about 40% of the crash rate of well access managed arterials.

4.0 ENVIRONMENTAL OVERVIEW

An abbreviated environmental overview was performed to determine the potential impacts of the proposed project. The complete document is included in **Appendix C**. The following sections discuss both natural and human environmental resources present within the study area. This information was assembled from readily available data sources, a field survey, and some correspondence with resource agencies; additional, detailed investigations should be undertaken as part of any future project development phases. If a project is federally-funded, the National Environmental Policy Act (NEPA) requires that potential environmental impacts with regard to jurisdictional wetlands, archaeological sites, cultural historic sites and federally endangered species must be avoided if at all possible. If not, then minimization efforts are required. Mitigation for the impacts, if unavoidable may also be necessary.

4.1 NATURAL ENVIRONMENT

Natural environment resources include streams; floodplains; wetlands; ponds; water supplies; threatened, endangered and special concern species and habitat; woodland and terrestrial areas; and parks located within the study area. Natural environment resources present in the study area are shown on **Figure 18**.

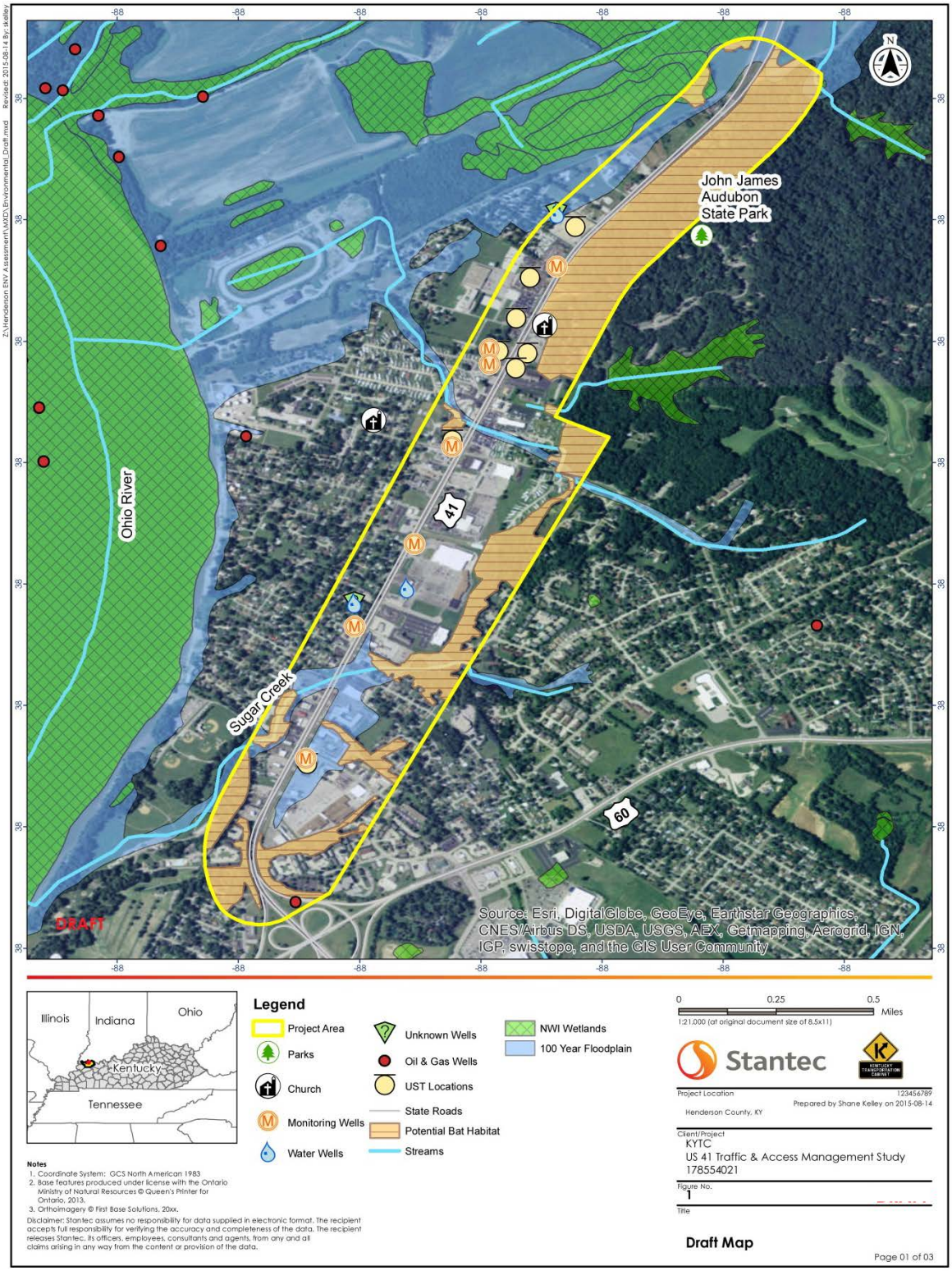


Figure 18: Environmental Footprint

4.1.1 Surface Streams

Based on a review of the Kentucky Geonet online database and the National Wetlands Inventory (NWI) there are three USGS streams located within the study area. These include Sugar Creek, an un-named tributary to the Ohio River, and an un-named stream that feeds Scenic Lake (large pond located in John James Audubon State Park). Based on topographic and aerial map reviews, no potential non-USGS streams appear to be located within the study area. Comprehensive wetland surveys and impact assessments, including evaluation of avoidance and minimization measures, may be required during subsequent project phases.

4.1.2 Floodplains

Based on review of Flood Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), 100-Year floodplain occurs within the study area along Sugar Creek, an unnamed tributary to the Ohio River, and from the Ohio River itself in the Northeastern section of the study area, just west of John James Audubon State Park. Coordination for transportation projects in mapped 100-year floodplain areas will be required with the Henderson County Floodplain Administrator and the Kentucky Division of Water (KDOW), Surface Water Permits Branch, Floodplain Management Section to determine limitations on construction activities in these areas, as well as local and state permit requirements.

4.1.3 Wetlands and Ponds

A review of National Wetlands Inventory (NWI) data indicates that one NWI wetland is located within the study area, near the northeastern end of the study area. Two pond areas also appear to be outside of the study area (Scenic Lake and an un-named pond) within two miles of the study boundary. Comprehensive wetland surveys and impact assessments, including evaluation of avoidance and minimization measures, may be required during subsequent project phases. Efforts will be made to avoid or minimize stream and wetland impacts.

4.1.4 Groundwater Resources

Water well information from the Kentucky Geologic Survey (KGS) and KDOW was reviewed for the study area. Review of Kentucky Geologic Survey data indicate there are 11 water wells registered in the study area. Of these, seven (64 percent) are monitoring wells below underground storage tanks, three (27 percent) are domestic use wells, and one (9 percent) is unknown.

4.1.5 Public Parks – Section 4(f) and Section 6(f) Facilities

Based on a data request from the Kentucky Heritage Council, Kentucky Office of State Archaeology (KOSA) and available aerial mapping, John James Audubon State Park, a Section 4(f) and 6(f) resource, and one cemetery, a Section 4(f) resource that is not mapped as it is also an archaeological resource, are located within the study area. Further coordination with the owners will determine if impacts would result from future transportation improvement projects.

4.1.6 Threatened and Endangered Species

Information concerning federal and state endangered, threatened, and special concern species and unique habitats in the project vicinity was obtained from the United States Fish and Wildlife Service (USFWS), the USFWS Ecological Services Kentucky Field Office, the Kentucky Department of Fish and Wildlife Resources (KDFWR), and the Kentucky State Nature Preserves Commission (KSNPC).

Federal-Listed Species

The Indiana bat, purple catspaw pearlymussel, fanshell, fat pocketbook, pink muckett, and ring pink freshwater mussels, are all listed by USFWS as endangered and are known to occur in Henderson County. The northern long-eared bat is listed by USFWS as threatened and known to occur in Henderson County. The orangefoot pimpleback, sheepnose, clubshell, and rough pigtoe freshwater mussels are all listed by USFWS as endangered and are listed as potentially occurring in Henderson County.

The Sheepnose and fat pocketbook freshwater mussels, and the Indiana bat are listed by USFWS as federally endangered and are known to occur within five miles of the study area. Potential summer roost and foraging habitat for the Indiana bat is found within the study area. American Burying Beetle, listed by USFWS as federally endangered, is known to historically occur within five miles of the study area but is considered extirpated from the site. Rabbitsfoot freshwater mussel, listed by USFWS as federally threatened, is known to occur within five miles of the study area. The pyramid pigtoe freshwater mussel, listed by USFWS as a species of management concern, is known to occur within one mile of the study area. Impacts to these areas should be avoided to the extent practical. See **Appendix C** for additional detail.

State-Listed Species

The small-flower baby-blue-eyes, lake chubsucker, great egret, bald eagle are all listed by KSNPC as state threatened. The little spectaclecase and longsolid freshwater mussels, fish crow and cinereus shrew are all listed as state species of special concern. The pocketbook freshwater mussel is listed as state endangered. All are known to occur within 1 mile of the study area. Impacts to these areas should be avoided to the extent practical. See **Appendix C** for additional detail.

4.2 HUMAN ENVIRONMENT

Human environment is defined as what we live in and around and what we have built. Through review of secondary source information and field reconnaissance, potentially sensitive resources that affect the human environment were identified in the study area, are discussed in the following sections, and shown in **Figure 18**.

4.2.1 Social and Economic Resources

- Cemeteries – Based on a review of USGS topographic maps and field survey, there is one cemetery located in the study area. The Kentucky Office of State Archaeology (KOSA)

indicated this cemetery is also an archaeological resource; therefore, it is not shown on Figure 18.

- Churches/Houses of Worship – Based on review by field reconnaissance, there is one house of worship located in the study area, Covenant Baptist Church.
- Schools, Institutions, and Learning Centers – No schools, institutions, or learning centers are mapped within the study area.
- Fire Departments and Emergency Services – There are no fire departments located in the study area, and no emergency operations centers.
- Law Enforcement – No law enforcement facilities are mapped within the study area or were observed during the field reconnaissance.
- Industrial Parks – No industrial parks are mapped within the study area.
- Golf Courses – No golf courses are located in the study area.
- Potential Relocations – The number of potential relocations are unknown at this time. Every effort will be made to avoid home and business relocations. In Phase I design, alignments will be developed, where feasible, to avoid relocations.

4.2.2 Environmental Justice

Issues pertaining to minority, elderly, disability and low income (persons living in poverty) populations in the project study area were evaluated and documented by the Green River Area Development District (GRADD) in an April 2015 report entitled *US 41 Traffic and Access Management Study Socioeconomic Study*. A copy of the report is found in **Appendix D**.

The Socioeconomic Study concluded that, based on evaluation of data obtained from the U.S. Census Bureau, there are small concentrations of Environmental Justice (EJ) and socioeconomic sensitive populations of minorities, populations below poverty level, and disabled persons in the Census Track (CT) 201 of the study area. CT 206.01 in the study area shows the percentage of minorities, persons with Hispanic or Latino origin, and persons with limited English proficiency are higher than the county and state percentages.

During future phases of project development a more detailed and robust analysis will be required for the NEPA documentation when assessing the potential for adverse and disproportionate impacts to poverty status, and minority populations. EJ issues will be addressed further in accordance with KYTC Policy in Phase 1 Design.

4.2.3 Historic Properties

No properties are listed on the National Register of Historic Places (NRHP) within the study area. However, there are two Nationally Registered listed properties within John James Audubon State Park, including Tea House and Memorial Museum. The full records review report is provided in **Appendix C**.

4.2.4 Archaeology

A Kentucky Office of State Archaeology (KOSA) preliminary site check listed three previously recorded archaeology sites within the study area, including: open habitation without mounds

(site not assessed for National Register Status), a workshop (does not presently meet National Register criteria), and a cemetery (listed as a National Register Property). Further study may be required, once the proposed improvements are more defined.

4.2.5 UST and Hazardous Waste Sites

No Resource Conservation and Recovery Act (RCRA) generators occur within the study area. There are two Federal RCRA generators that occur within 1.25 miles of the study area. These are located at 1195 Barret Boulevard and 1205 North Elm Street.

Properties with hazardous material concerns were identified through review of readily available state and federal database records. Federal and state regulatory database records research was provided in part by the Environmental Data Resources, Inc. (EDR, 2015), in addition to a review of the Kentucky Statewide Underground (UST) Database. Records found eight Underground Storage Tank/Leaking Underground Storage Tank (UST/LUST) sites located within the study area.

Any potential impacts will be handled per all local, state, and federal laws and in accordance with KYTC policy. All solid wastes generated by any future construction activities must be disposed of at a permitted facility.

4.2.6 Oil and Gas Wells

Based on a review of the Kentucky Geonet online database, one oil well is located within the study area, on its southern end near US 60 and the US 41interchange.

5.0 INITIAL PROJECT TEAM AND STAKEHOLDER COORDINATION

Over the course of the study, the project team held three in-person project team meetings to coordinate on key issues; project team meeting summaries are presented in **Appendix E**. The project team consisted of representatives of the Kentucky Transportation Cabinet (KYTC) Central and District 2 offices, representatives of the Green River Area Development District (GRADD), representatives of the Evansville Metropolitan Planning Organization (MPO), and the consultant team Stantec. The project team also reached out to stakeholders and local officials for input. Detailed summaries of each are presented in **Appendix E**.

5.1 PROJECT TEAM MEETING #1

Staff from the KYTC Central Office, KYTC District 2 Office, GRADD, Evansville MPO, and Stantec met at the Audubon State Park in Henderson, Kentucky on May 11, 2015. The purpose of the meeting was to discuss the project purpose and history, the results of the existing conditions analysis, design considerations, access management, and early feedback from the project team before developing improvement alternatives. Key discussion items included the following:

- KYTC District 2 will implement a separate improvement project to add turn lanes at the US 41 intersection with Wolf Hills Road.
- Rear end collisions, angle collisions, and opposing left turn collisions total 70 percent of all the crashes along the study area portion of US 41. These types of crashes are indicative of congested roadways with minimal access management.
- The high crash segments correlate to areas with a high density of access points.
- Safety appears to be the major concern along US 41 with isolated pockets of congestion such as Watson Lane.
- Improvements to Watson Lane will likely be one of the proposed projects. Significant improvements at this location will be expensive because of utility relocations and right-of-way costs.
- Non-traversable medians will be considered with U-turns provided at signalized intersections.
- Frontage/Backage roads should be considered to control access on US 41 and provide access to adjoining properties. This will separate local and through traffic and facilitate traffic circulation. It will also provide access for larger delivery trucks.
- Adding traffic lanes will be examined along US 41. The completion of the I-69 corridor through Henderson could affect future demand along US 41.
- Proposed improvement costs will need to be evaluated against future needs, with the anticipated completion of the I-69 corridor through or around Henderson, which will lower future traffic volumes along US 41.

5.2 LOCAL OFFICIALS/STAKEHOLDER MEETING #1

The project team reached out to a number of local government representatives and other community groups early in the planning process. The following organizations were invited to participate as key stakeholders in the US 41 Traffic and Access Management Study:

- United States Legislators
- State Legislators
- Henderson County Judge Executive
- City of Henderson
- City of Henderson, Public Works
- Green River Area Development District (GRADD)
- Henderson Area Rapid Transit (HART)
- Henderson City-County Planning Commission
- Henderson County Emergency Management
- Henderson County Sheriff Department
- Henderson Police Department
- Henderson Fire Department
- Kentucky State Police
- Henderson County Schools
- Henderson Water Utility
- Evansville Metropolitan Planning Organization
- Audubon State Park
- Green River Area Development District

The project team met with key stakeholders and local officials on May 11, 2015. The purpose of the meeting was to discuss the project purpose and history, the results of the existing conditions analysis, design considerations, access management concepts, and get feedback before

developing improvement alternatives. Key comments received at the meeting include the following:

- This mix of high density access and high traffic volumes is a common problem on arterials that pass through larger cities. US 231 in Bowling Green, US 31W in Elizabethtown, and US 27 between Nicholasville and Lexington are examples. Similar studies are being conducted or have already been completed at these locations.
- A suggestion was made to relocate the Audubon Village signal to align with Barker Road. Elm Street functions as backage road to most of the businesses on the west side of US 41. This would relieve congestion at Watson Lane by providing another signalized location for vehicles to turn left onto US 41.
- Consider a backage road on the east side of US 41, similar to Elm Street.
- The existing four lanes along US 41 should adequately accommodate future traffic if the new I-69 bridge is constructed.
- The US 60 interchange needs better signage to direct trucks and vehicles to the correct lane prior to the interchange.
- If suggested improvements result in additional traffic demand along Elm Street, improvements to Elm Street should be considered.
- In urban areas, utility and right-of-way costs can be more expensive than construction costs.
- All businesses along the west side of US 41, south of Watson Lane, have access to Elm Street except Pizza Hut.
- Locals use Elm Street, US 60, and Wolf Hills Road to avoid US 41.

6.0 ALTERNATIVES DEVELOPMENT

The project team decided the focus of the US 41 Traffic and Access Management Study would be to identify small projects that can be implemented quickly and independently as well as a long-term improvement plan that can be implemented if funding becomes available. Conceptual projects were identified that address operational and safety issues that result from the combination of heavy traffic volumes, signalized and unsignalized intersections, and access concerns.

6.1 ACCESS MANAGEMENT

According to the Federal Highway Administration (FHWA), an ideal roadway is one that connects to our driveways (access) and at the same time leads to interruption-free drives to our destinations (mobility). To accomplish this, roadways are planned and designed differently based on their intended function. Local roads are chiefly to provide access, while mobility is the primary function of arterials such as US 41.

Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. It also involves roadway design applications, such as median treatments and auxiliary lanes, and the

appropriate spacing of traffic signals. The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system.

Everyone benefits from access management:

- Motorists face fewer decision points and traffic conflicts, experience fewer traffic delays, and arrive more quickly at their destinations.
- Pedestrians, Bicyclists, and Bus Riders face fewer conflicts with vehicles, making for a safer walking environment, simplifying the cycling task, and providing safer and more convenient access to bus stops. Henderson Area Rapid Transit (HART) stops at every intersection along northbound US 41 between Barret Boulevard and Watson Lane.
- Businesses are served by a more efficient roadway system that captures a broader market area, which produces more stable property values and a more predictable and consistent development environment.
- Government Agencies use access management as a strategy to save highway improvement dollars by preserving the function and capacity of roadways and thereby extending the useful life of those roadways.
- Communities receive a safer transportation system, less need for widening and displacement of businesses and homes, and benefit from more attractive roadway corridors.

6.1.1 KYTC's Access Management Guidelines

US 41 is functionally classified as an arterial, yet it provides a significant level of access to adjacent properties. The 2.152-mile study area portion of US 41 includes approximately 119 access points (55 per mile). The highest density of access is south of Watson Lane (70 access points per mile). An effective access management program can reduce crashes by as much as 50 percent, increase roadway capacity by 23 to 45 percent, and reduce travel time and delay by as much as 40 to 60 percent[5].

For US 41, an existing urban principal arterial with high volume (ADT > 24,000 VPD) and high access point density (> 10 approaches/mile and < 85 approaches/mile), KYTC recommends the following access management controls[6]:

- Non-Traversable ("non-mountable") Median
- Median Opening Spacing:
    - 2,400 feet for Full Median Opening
    - 1,200 feet for Directional Median Opening
- Signalized Intersection Spacing = 2,400 feet

[5] TRANSPORTATION RESEARCH BOARD (TRB) Access Management Manual
[6] Kentucky's Proposed Access Management Program – Executive Summary: http://transportation.ky.gov/Planning/Documents/Exec%20Summary%20AM%202006.pdf

6.1.2 Safe Access Is Good For Business

There are economic impacts that should be considered as part of an unmanaged access system. These impacts may include a reduced desire to travel to congested areas or reluctance to develop an area without proper access structure. On the other hand, improved safety and traffic operating conditions translate into significant reductions in travel time, which may allow businesses to attract customers from a greater distance and have a positive impact on the economy of the area.

In addition to the impacts access management may have on businesses, it has been shown that access control can increase property values. It is widely accepted that the development potential of land is closely tied to the efficiency of the transportation system that serves it. In a Texas study, an 18 percent increase in property values was shown along corridors where access control was implemented[7]. In a Florida study, more than 70 percent of the businesses impacted by a project involving several median opening closures reported no change in property value, while 13 percent reported some increase in value[8].

In spite of the many benefits of properly managed access, regulating driveway access on an existing roadway is often controversial. Owners of abutting businesses often feel that their business will be adversely impacted. Before-and-after studies of businesses in Florida, Iowa, Minnesota, and Texas along highways where access has been managed found that the vast majority of businesses do as well or better after the access management projects are completed[9]. The majority of customers and truck drivers surveyed in the before-and-after studies reacted positively to access management projects as improving both safety and traffic flow. Business customers surveyed about access management projects in Iowa, Texas and Florida overwhelmingly supported the projects because their drive became quicker, easier, and safer[10].

6.2 INITIAL IMPROVEMENT CONCEPTS

A range of concepts was developed based on the existing conditions analysis and input received from the project team and stakeholders/local officials. The proposed improvement concept locations are shown in **Figure 19** with general descriptions included below. It should be noted that these improvements are purely conceptual and that ultimate details must be examined in subsequent project phases.

No Build: This concept serves as a baseline for comparison of other alternatives. The No Build assumes regular maintenance activities would be conducted but does not include widening or other construction to improve capacity and safety. The No Build alternative does not meet the project purpose.

[7] Giguere, R.K., Driveway And Street Intersection Spacing. Transportation Research Circular, TRB, Washington, DC Number 456 (1996).
[8] Vargas, F.A. and Y. Guatam, Problem: Roadway Safety vs. Commercial Development Access, ITE, Compendium of Technical Papers, 1989.
[9] http://ops.fhwa.dot.gov/publications/amprimer/access_mgmt_primer.htm
[10] Iowa State University, Iowa Access Management Research and Awareness Project, CTRE, 1997.

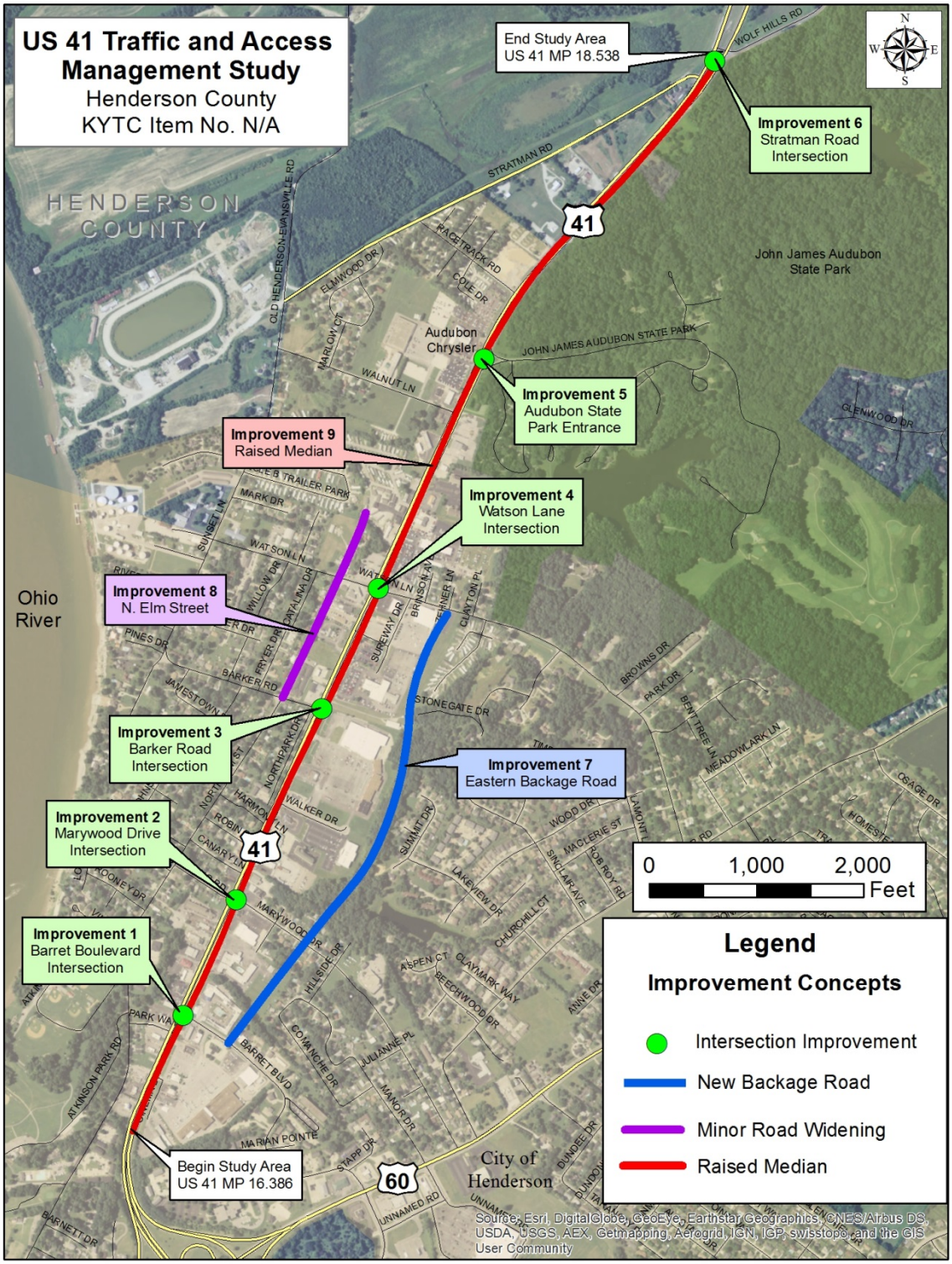


Figure 19: Improvement Concepts

6.2.1 Intersection Improvements

- **Improvement 1 – Barret Boulevard Intersection**: Add a signal and extend Barret Boulevard to N. Elm Street west of US 41. Elm Street functions as backage road to most of the businesses on the west side of US 41. This would relieve congestion at the other signalized intersections, providing another location for vehicles to turn left on and off US 41. Widen Barret Boulevard to accommodate a left-turn lane and improve capacity at the signal. Allow passenger vehicle U-turns on US 41 at the signal and consider adding crosswalks. Consider a jughandle in the adjacent shopping center to accommodate U-turns for southbound semi-trucks. Some safety concerns were expressed at the project team meeting about adding a traffic signal at Barret Boulevard because of its proximity to the high speed US 60 interchange. As a result, two concepts were developed for the Barret Boulevard intersection:

    - **Option 1 – Full Signal**: This concept, shown on **Figure 20**, adds an outside lane on northbound US 41 for the interchange ramp. Terminate the extra lane at Barret Boulevard. Remove the mainline lane drop on northbound US 41.

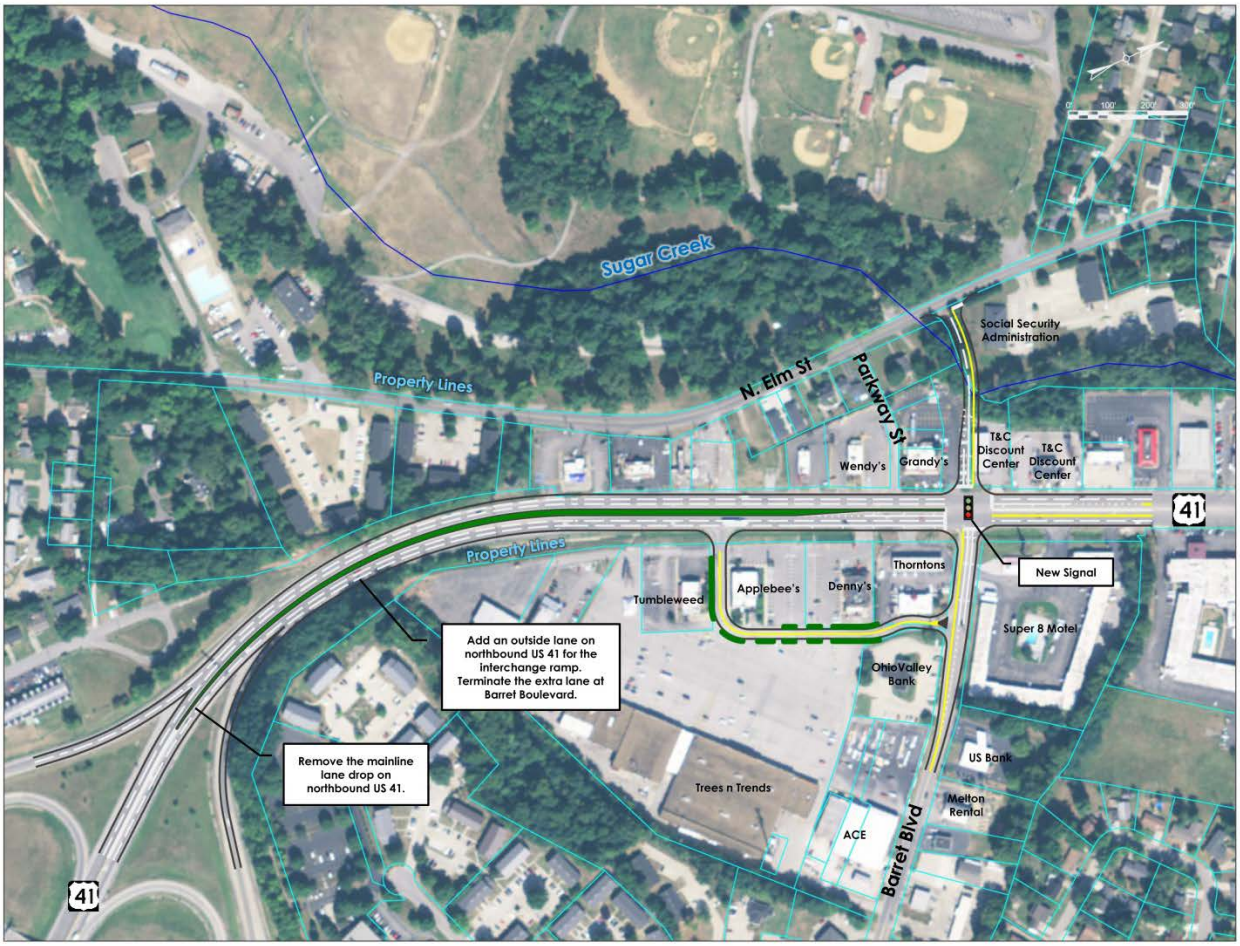


Figure 20: Improvement 1 – Barret Boulevard (Option 1)

- **Option 2 – "3/4 Signal"**: A second option, shown in **Figure 21**, provides a new Elm Street connector west of US 41 that provides left-in and right-in/right-out movements protected by a traffic signal. Barret Boulevard will be converted to a right-in/right-out. This would allow northbound traffic to flow freely through the intersection. This configuration is similar to the "Green T" or "Continuous Green T" intersection concept[11].

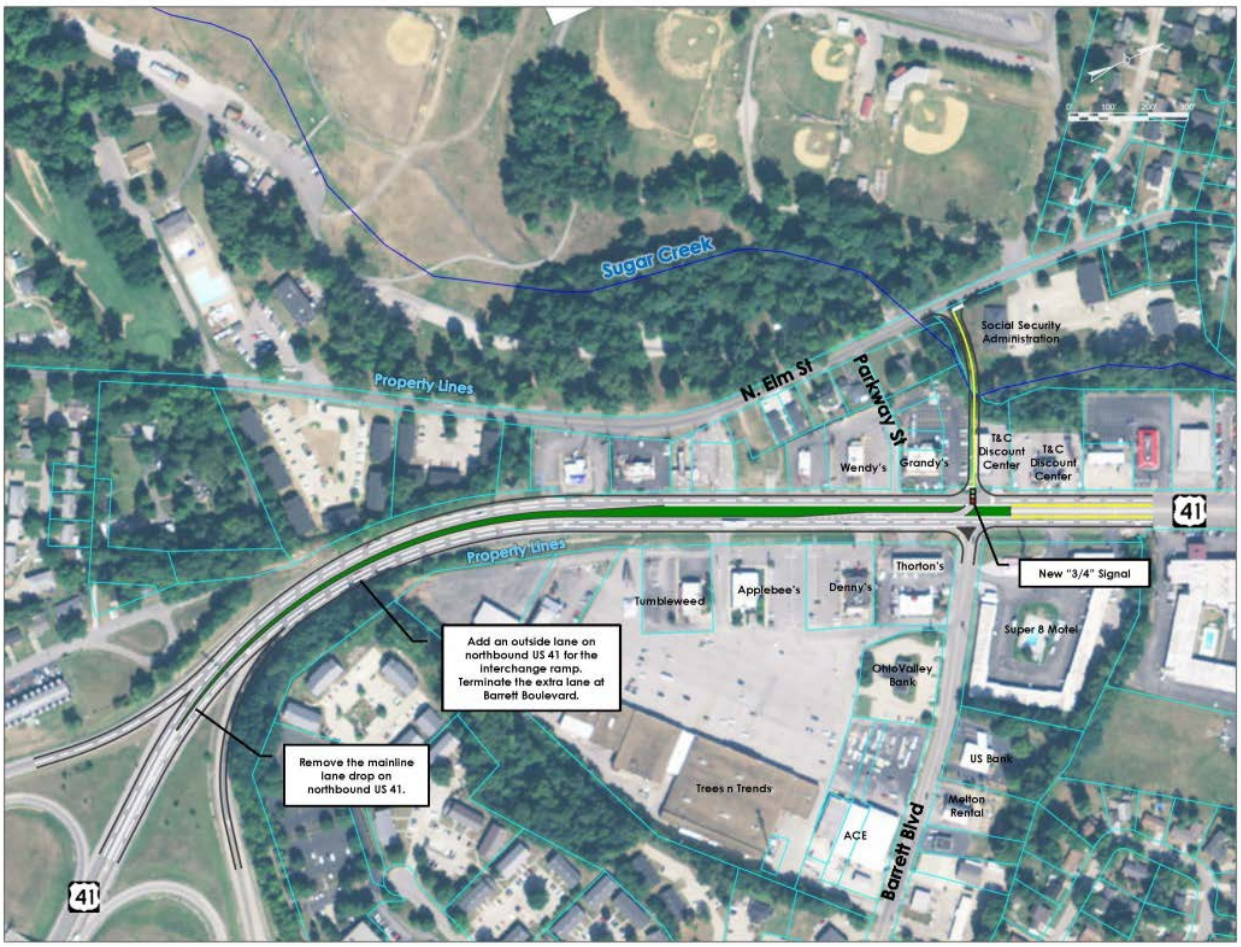


Figure 21: Improvement 1 – Barret Boulevard (Option 2)

[11] http://safety.fhwa.dot.gov/intersection/resources/casestudies/fhwasa09016/fhwasa09016.pdf

- **Improvement 2 – Rettig Road / Marywood Drive Intersection**: Align Rettig Road and Marywood Drive. Widen each road to accommodate additional turn lanes and improve capacity at the signal. Allow passenger vehicle U-turns on US 41 at the signal and consider adding crosswalks. A conceptual layout is shown in **Figure 22**.

Figure 22: Improvement 2 – Rettig Road / Marywood Drive Intersection

- **Improvement 3 – Barker Road Intersection**: Move the signalized entrance at the Audubon Village Shopping Center north to Barker Road. Elm Street functions as backage road to most of the businesses on the west side of US 41. This would relieve congestion at Watson Lane by providing another signalized location for vehicles to turn left onto US 41. Design the new Audubon Village Shopping Center entrance and widen Barker Road to accommodate left-turn lanes and improve capacity at the signal. Allow passenger vehicle U-turns on US 41 at the signal. Consider adding crosswalks at the new signal. A conceptual layout is shown in **Figure 23**.

Figure 23: Improvement 3 – Barker Road Intersection

- **Improvement 4 – Watson Lane Intersection:** Watson Lane is by far the most congested intersection in the study area. Based on the traffic analyses, southbound dual left turn lanes are needed on US 41. This will require widening Watson Lane to accommodate dual receiving lanes. The limits of this widening project should be determined in the design phase, but the lane drop is currently shown at Stonegate Drive. Comments from the local officials/stakeholders suggest extending the project to US 60 should be considered. There are also heavy delays during peak hours for westbound vehicles turning right from Watson Lane to US 41. The existing right-turn bay can be extended and a right-turn overlap phase can be implemented within the signal timing to increase capacity. Dual right turn lanes may also be considered during future phases of the project. Also consider adding crosswalks at the signal. A conceptual layout is shown in **Figure 24**.

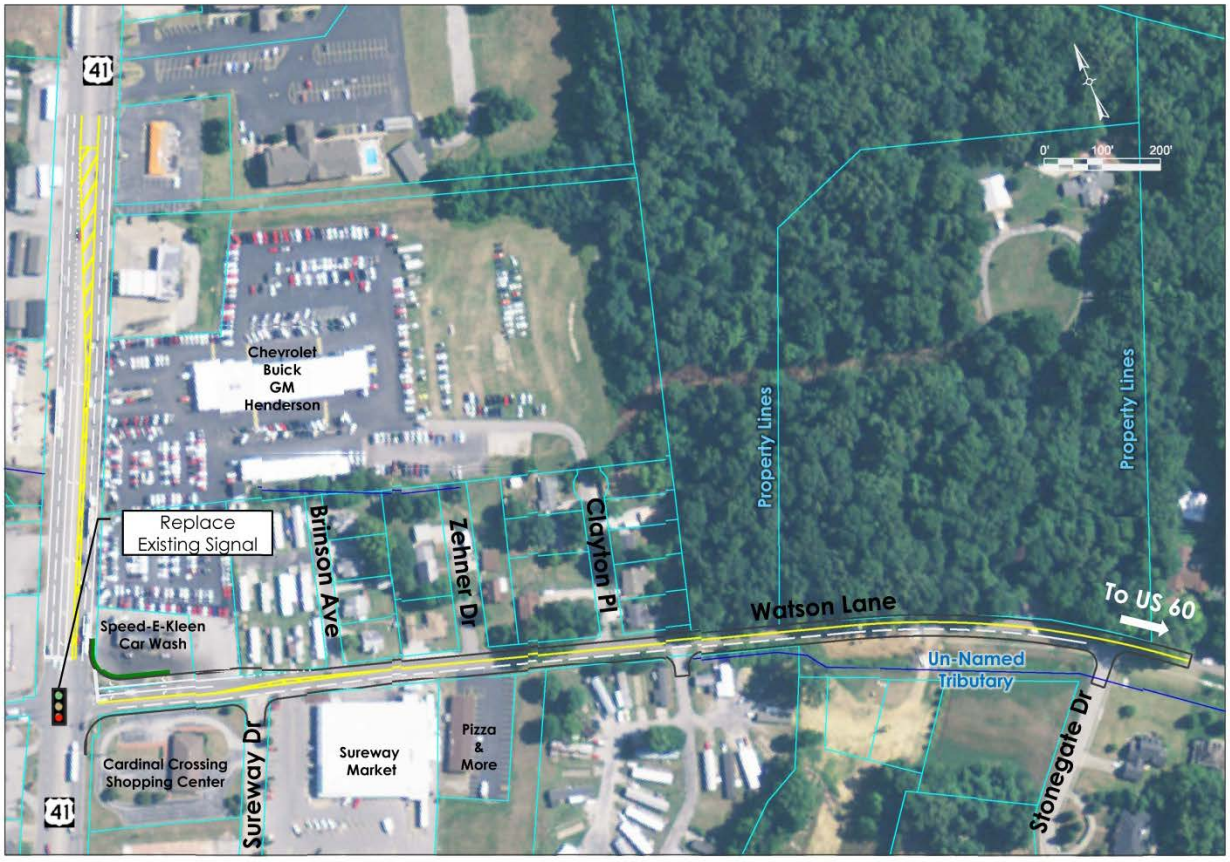


Figure 24: Improvement 4 – Watson Lane Intersection

- **Improvement 5 – Audubon State Park Entrance**: Reconfigure the skewed "Y" shape entrance to a single point entrance perpendicular to US 41. In the event a raised median is constructed along US 41 consider aligning the new Audubon State Park entrance with the Audubon Chrysler entrance. A conceptual layout is shown in **Figure 25**.

Figure 25: Improvement 5 – Audubon State Park Entrance

- **Improvement 6 – Stratman Road / Wolf Hills Road Intersection**: Reconstruct the Stratman Road and Wolf Hills Road offset approaches to a single intersection to accommodate U-turns and potentially add a signal. Widen each road to accommodate additional turn lanes and improve capacity at the signal. In the event a raised median is constructed, provide a jughandle off Stratman Road to accommodate U-turns for northbound semi-trucks. Two conceptual layouts are shown in **Figure 26** and **Figure 27**. From a survey distributed at the second local officials/stakeholders meeting, Option 1 was determined to be the preferred alternative.

Figure 26: Improvement 6 – Stratman Road / Wolf Hills Road Intersection (Option 1)

Figure 27: Improvement 6 – Stratman Road / Wolf Hills Road Intersection (Option 2)

6.2.2 Backage Roads

Backage roads were considered to control access on US 41 and provide access to adjoining properties. This will separate local and through traffic and facilitate traffic circulation. It will also provide access for larger delivery trucks. Elm Street functions as backage road to most of the businesses on the west side of US 41. There is no backage road on the east side of US 41.

- **Improvement 7 – Eastern Backage Road:** Construct a new backage road on the east side of US 41 between Barret Boulevard and Watson Lane. Provide connections to the existing shopping centers along US 41 and the proposed new/relocated signal at Barker Road. A conceptual layout is shown in **Figure 28**. The Eastern Backage Road can be designed and constructed in segments as funding becomes available. During the design phase, the construction of sidewalks, bicycle lanes, and/or a shared use path should be considered. Currently, there are few facilities for pedestrians and bicyclists on the east side of US 41. Also consider having the Eastern Backage Road line up with the Audubon State Park parcel off Watson Lane, a potential location for a new park entrance. Constructing the Eastern Backage Road at this location would require right-of-way acquisition at a mobile home park.

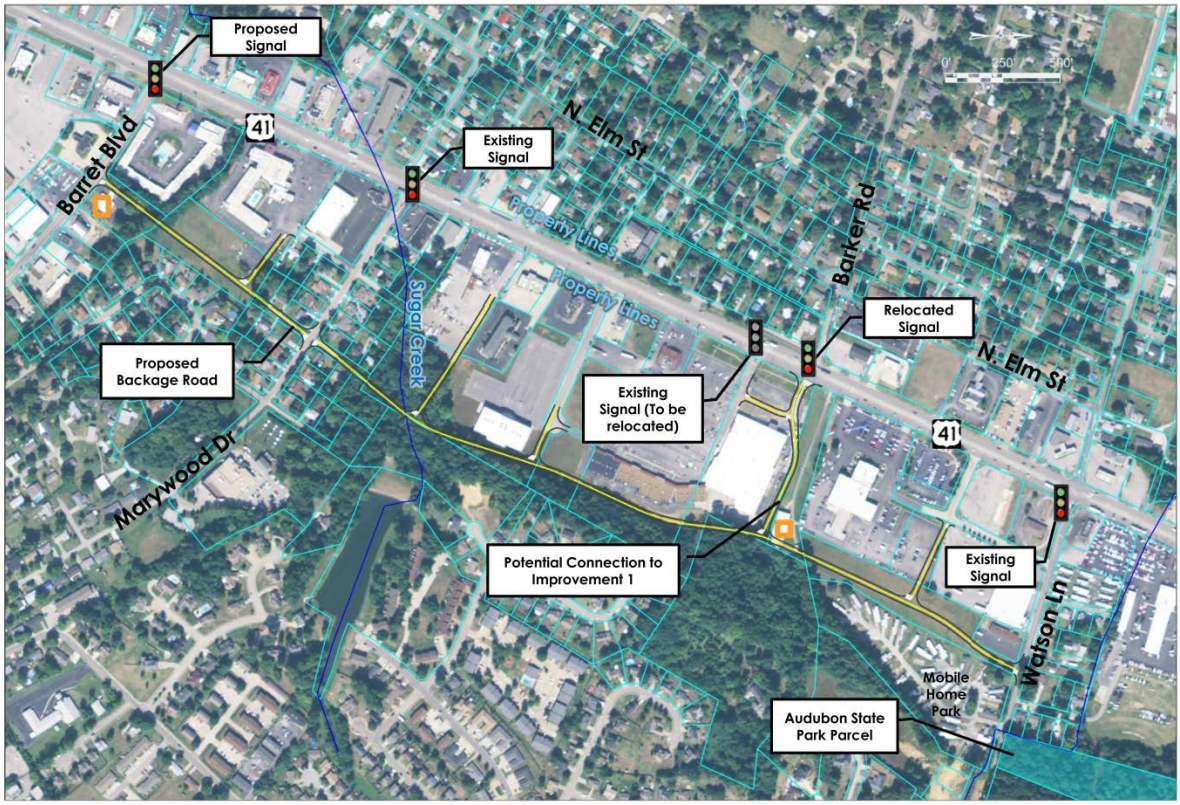


Figure 28: Improvement 7 – Eastern Backage Road

- **Improvement 8 – N. Elm Street:** Add shoulders on N. Elm Street between Barker Road and Watson Lane. Add turn lanes at the Barker Road and Watson Lane intersections to increase capacity. During the design phase, the construction of sidewalks, bicycle lanes, and/or a shared use path should be considered. In the event a raised median is constructed along US 41, consider extending N. Elm Street north of Watson Lane to provide a connection to the mobile home park. A conceptual layout is shown in **Figure 29**.

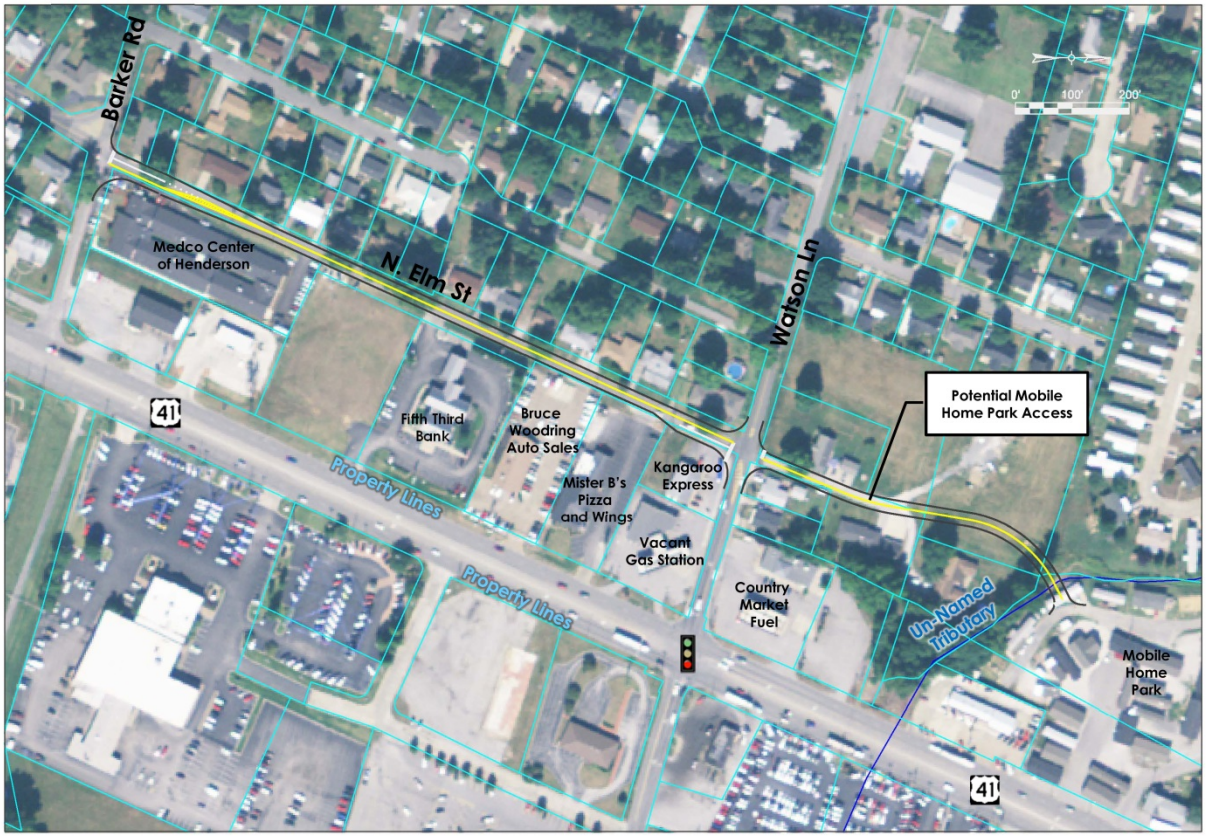


Figure 29: Improvement 8 – N. Elm Street

6.2.3 Raised Median

Adding a non-traversable median can reduce crashes by as much as 35 percent, increase roadway capacity by 30 percent, and reduce travel time and delay by as much as 30 percent[12].

[12] TRB Access Management Manual

- **Improvement 9 – Raised Median**: A proposed raised median is shown extending the entire length of the corridor with median openings at the signalized intersections and the Audubon State Park entrance. The conceptual typical section for the raised median is shown in **Figure 30**. The proposed typical section would not require additional right-of-way along US 41. The limits of the raised median and the typical section will ultimately be determined during future project phases.

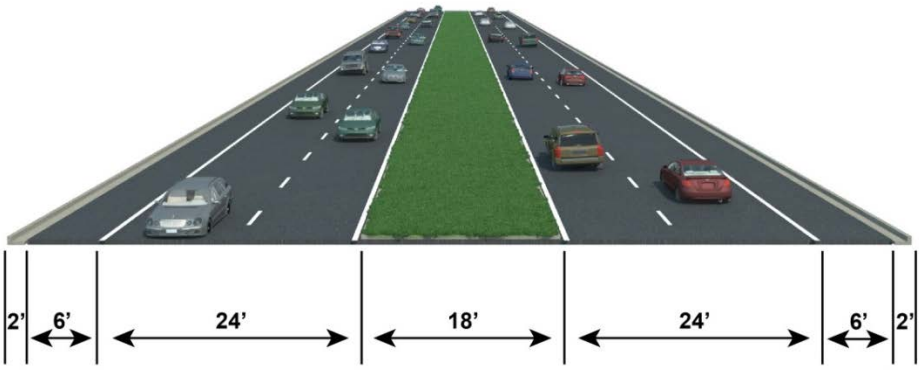


Figure 30: Conceptual Typical Section for the US 41 Raised Median Improvement

6.2.4 Safety and Mobility Improvement Plan

In addition to short-term, "quick-win" improvements that can be implemented quickly and independently, the project team was also tasked with developing a long-term improvement plan that can be implemented as funding becomes available. The Safety and Mobility Improvement Plan combines improvements 1 through 9, as described above. The conceptual layout is presented in **Appendix F**.

6.2.5 Six-Lane Widening

US 41 between US 60 and Watson Lane will operate above design capacity by year 2030 if a new I-69 Ohio River bridge is not built connecting Evansville and Henderson. US 41 between Watson Lane and Wolf Hills Road will be operating just below capacity by year 2030 with a V/C of 0.99. Thus, in the event a new I-69 bridge is not built, a six-lane widening concept was considered.

- **Improvement 10 – Six-Lane Widening**: Widen US 41 to three through lanes in each direction. Construct a raised median, which is currently shown extending the entire length of the corridor with median openings at the signalized intersections and the Audubon State Park entrance. The conceptual typical section is shown below in **Figure 31** and the conceptual layout is presented in **Appendix G**. At a minimum, the proposed typical section would require 12 feet of additional right-of-way along US 41, but drainage requirements would likely increase the needed right-of-way. The limits of the raised median and the typical section will ultimately be determined during future phases of the project.

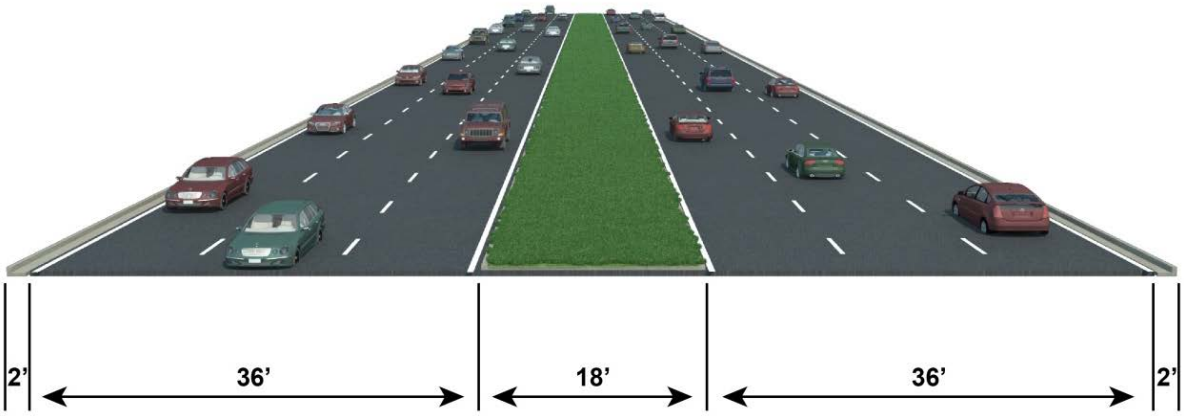


Figure 31: Conceptual Typical Section for the US 41 Six-Lane Widening Improvement

6.3 TRAFFIC ANALYSIS AND COMPARISON OF ALTERNATIVES

In an effort to further identify existing traffic issues and to evaluate improvement scenarios, a traffic simulation model was developed to replicate existing peak hour traffic conditions and estimate future travel conditions throughout the study area. The Evansville MPO regional travel demand model was utilized to develop traffic forecasts for this project, and portions of the travel demand model network were extracted to create the simulation model.

Models initially were developed to simulate typical weekday AM and PM peak hour traffic conditions for the 2015 base year. These were calibrated based on traffic count data and queues to the point where the models accurately reflected known traffic conditions. In the AM peak hour, which is typically somewhere between the hours of 7:00 AM and 9:00 AM, the model includes approximately 3,700 trips. In the PM peak hour, which typically occurs somewhere between 4:00 PM and 6:00 PM, the model includes approximately 4,600 trips.

A simulation model was developed to replicate the improvements in the Safety and Mobility Improvement Plan concept and the Six-Lane Widening concept. Traffic demand for the design year 2030 was estimated by inflating the existing demand by one percent per year, or just over 16 percent to 2030. The Existing, 2030 No-Build, and 2030 Concept models were run and average performance measures were extracted from the output. The traffic signal phasing was optimized for the each scenario. When compared to the Existing and No-Build conditions, all measures of effectiveness show that the conceptual improvement alternatives will result in considerable improvements in traffic operations.

Figure 32 depicts throughput, a comparison of the completed trips over a one-hour model run to the demand for the period. While 100 percent throughput is not achievable, higher percentages indicate an alternative is better able to accommodate traffic demand. The Safety and Mobility Improvement Plan and the Six-Lane Widening concepts result in significantly higher throughput compared to the 2030 No-Build. The Safety and Mobility Improvement Plan provides throughput very similar to the existing.

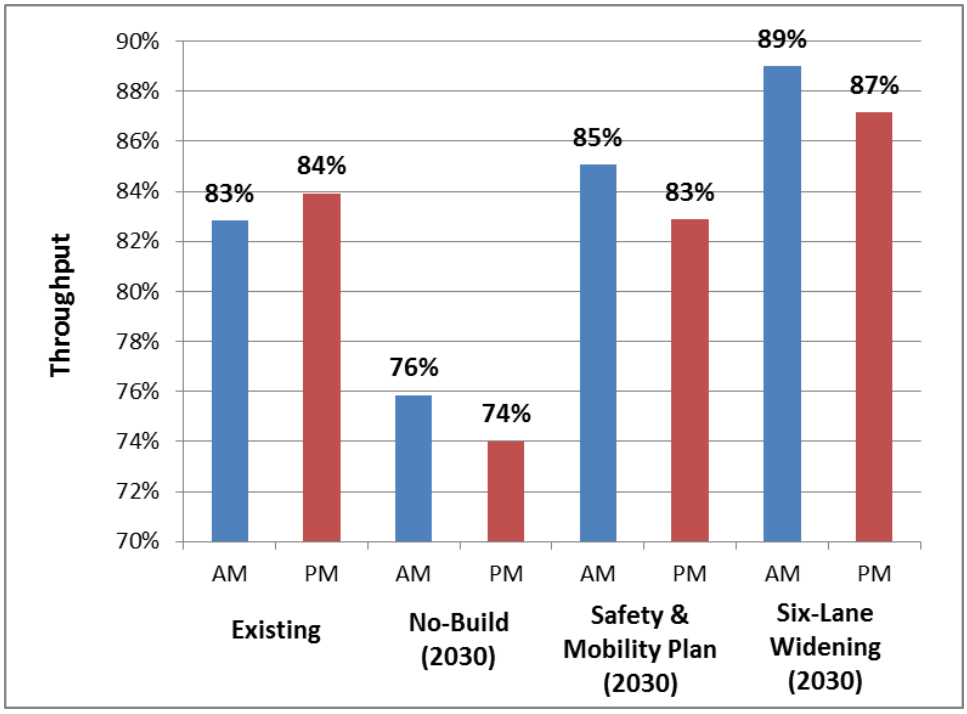


Figure 32: Traffic Simulation Model Throughput

Figure 33 shows the total system delay (in hours), the total difference between the experienced travel time and free-flow (i.e., unencumbered) travel time, summed for all vehicles traveling in the network. The Safety and Mobility Improvement Plan and the Six-Lane Widening concepts result in significantly lower overall delay compared to the No-Build.

Figure 34 and **Figure 35** show the AM and PM Peak Hour Intersection Delay (respectively), the average delay experienced by each vehicle passing through an intersection during a one-hour model run. In most cases, the Safety and Mobility Improvement Plan and the Six-Lane Widening concepts result in significantly lower intersection delay than the No-Build. The exceptions are where additional traffic is funneled through an intersection, such as at the proposed Barker Road intersection.

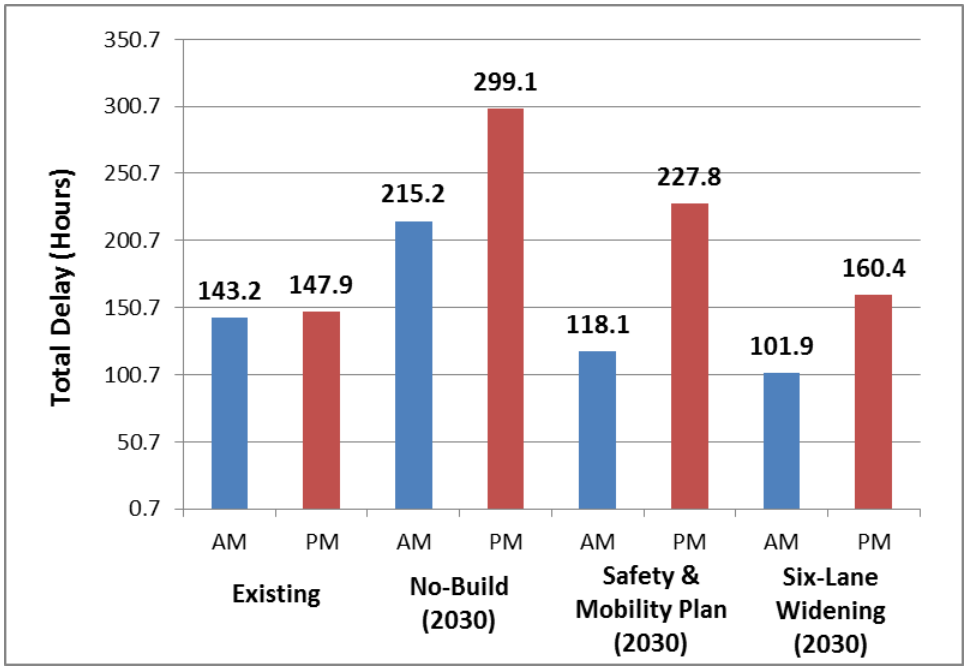


Figure 33: Total System Delay

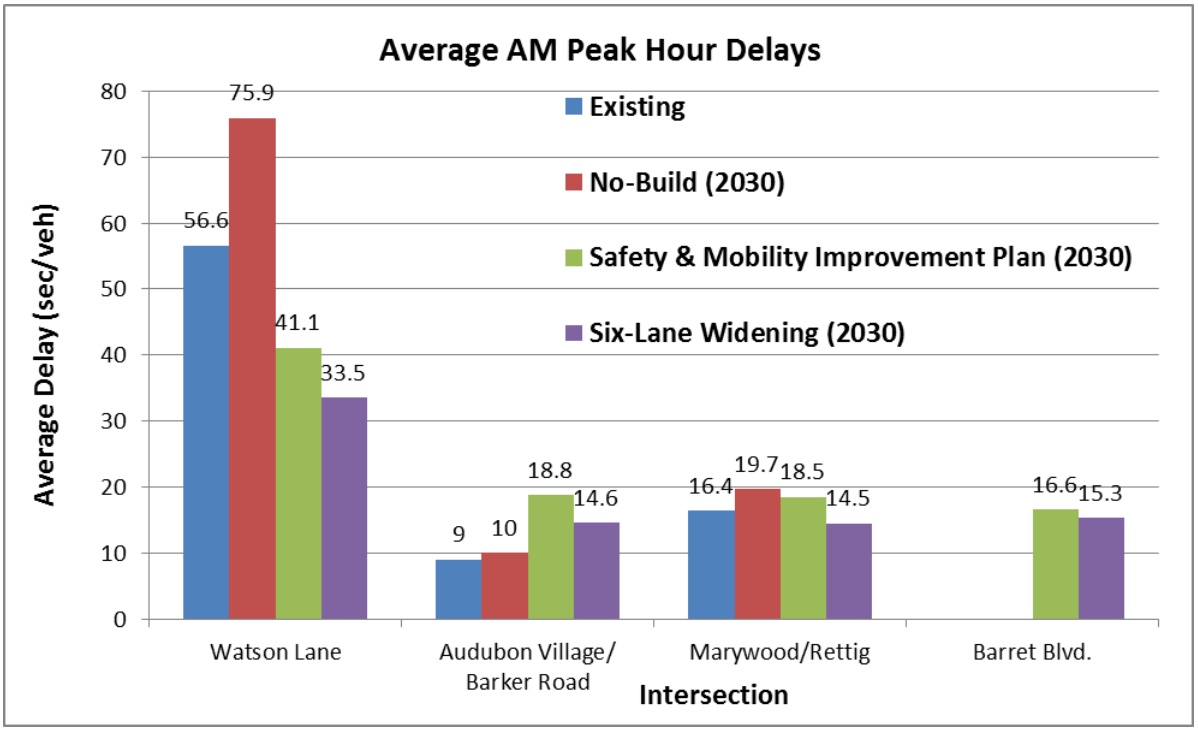


Figure 34: Average AM Peak Hour Delay at Signalized Intersections

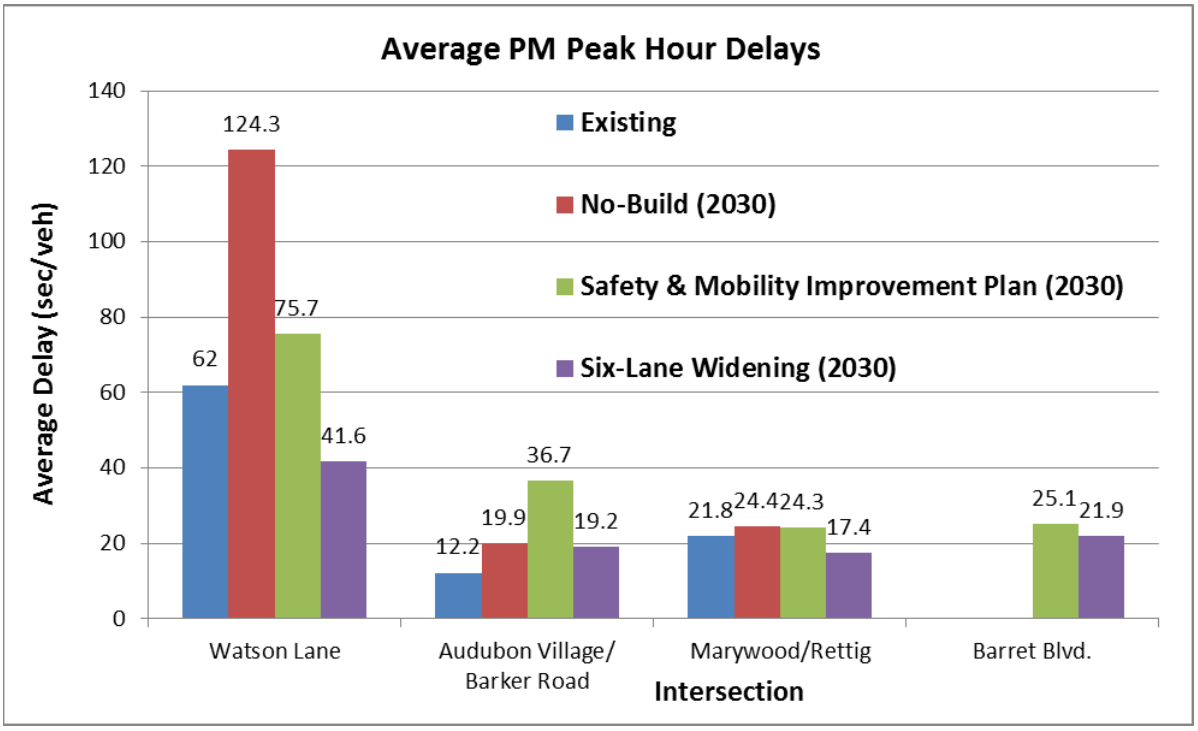


Figure 35: Average PM Peak Hour Delay at Signalized Intersections

7.0 SECOND PROJECT TEAM AND STAKEHOLDER MEETINGS

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

7.1 PROJECT TEAM MEETING #2

Staff from the KYTC Central Office, KYTC District 2 Office, GRADD, Evansville MPO, and Stantec met at the Audubon State Park in Henderson, Kentucky on August 6, 2015. The purpose of the meeting was to discuss the initial improvement concepts and get feedback from the project team on changes that should be considered. Key discussion items included the following:

- There is some concern with adding a signal at Barret Boulevard. The US 60 Interchange is high speed and less than 2,000 feet south of this intersection and there are weaving patterns associated with the mainline US 41 lane drop and the interchange ramps.
- Based on the traffic analyses, southbound dual left turn lanes are needed on US 41 at Watson Lane. This will require widening Watson Lane to accommodate dual receiving lanes. Stonegate Drive is the nearest logical intersection for the lane drop on Watson

Lane.

- During heavy rain events, Stratman Road is often overtopped by flood water.
- The Eastern Backage Road could be built in segments, and some of the proposed intersection improvements would be recommended for implementation first to better accommodate traffic flow between the backage road and US 41.
- The raised median does not have to span the entire corridor. The ultimate limits should be considered during future project phases.

7.2 LOCAL OFFICIALS/STAKEHOLDER MEETING #2

The project team met with key stakeholders and local officials on August 6, 2015. The purpose of the meeting was to discuss the initial improvement concepts and to solicit feedback on changes that should be considered. Attendees were asked to complete a questionnaire to help the project team understand priorities from a local perspective.

The first question asked respondents to rank the importance of seven transportation goals in order from 1 to 7 where 1 is the highest importance. Improving safety (1.5) and reducing congestion (2.0) were the highest ranked goals. Accommodating trucks (5.9), ensuring compatibility with the future I-69 (5.4), and minimizing impacts to residents and businesses (5.0) were the lowest ranked goals. Complete results are shown in **Figure 36**.

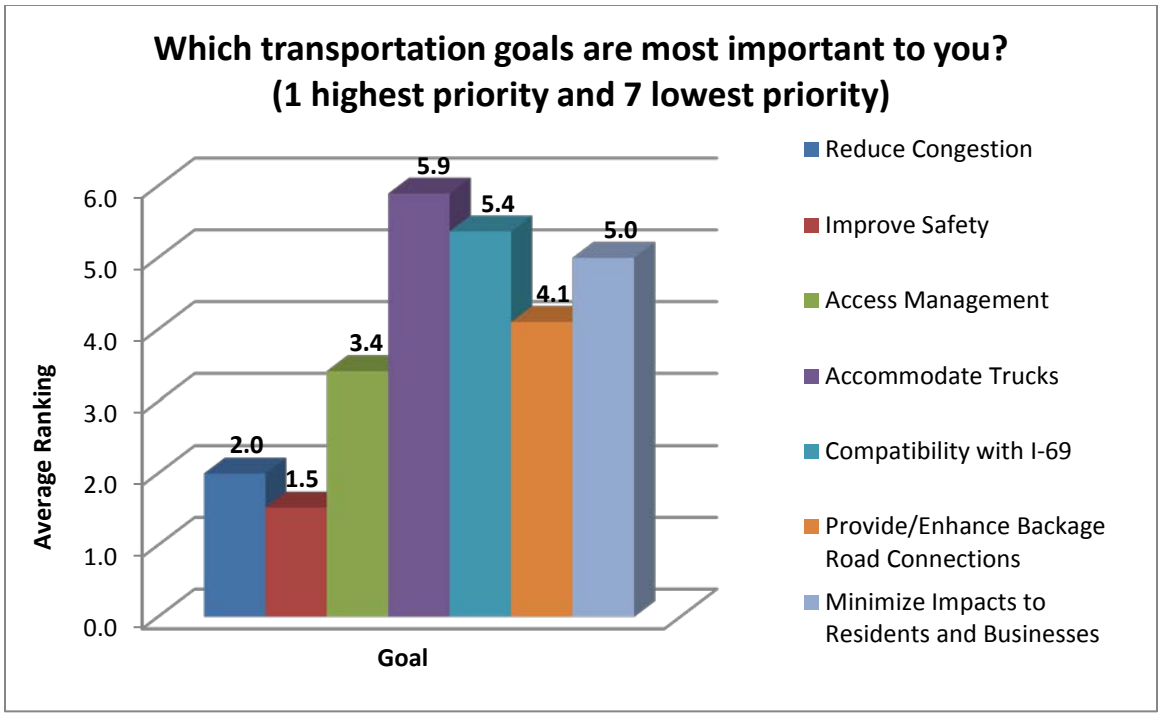


Figure 36: Stakeholder Questionnaire (Question 1)

The second question asked the respondents to rate the importance of the conceptual improvement projects on a scale from 1 to 5, where 1 indicates the project is not important and 5 indicates very important. Improvements to Watson Lane scored the highest (4.6) followed by the construction of an Eastern Backage Road (3.9). Relocating the traffic signal at Audubon Village Shopping Center to Barker Road and improvements to Elm Street were both rated high (3.7). Complete results are shown in **Figure 37**.

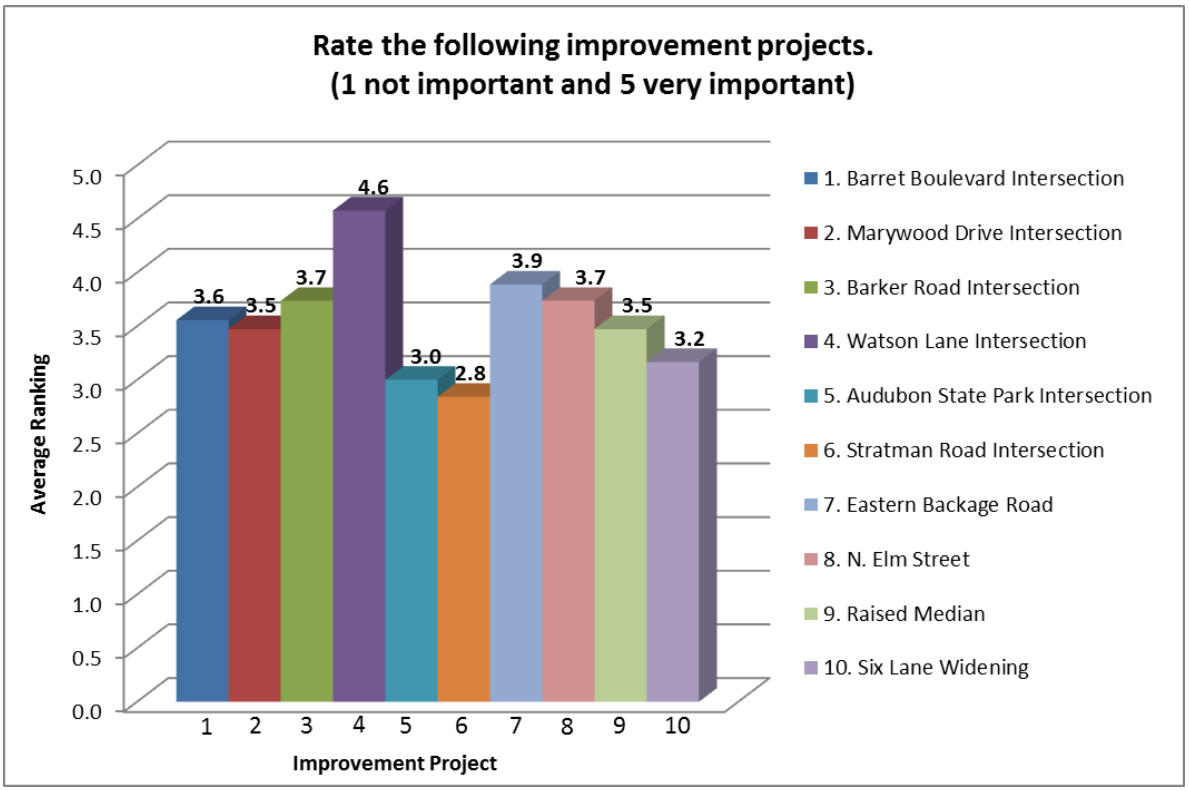


Figure 37: Stakeholder Questionnaire (Question 2)

8.0 CONCLUSIONS AND RECOMMENDATIONS

This section provides recommendations for the US 41 Traffic and Access Management Study. Recommendations are built upon technical analyses, stakeholder input, and engineering judgment.

8.1 COST ESTIMATES

Planning level cost estimates were prepared for each improvement concept, shown in **Table 6**, based on unit costs plus additional costs for special features such as culverts and traffic signals. KYTC District 2 assisted in this effort by providing approximate right-of-way and utility cost estimates.

Improvement	Description	Design	Right-of-Way	Utilities	Construction	TOTAL
1	Barret Boulevard Intersection (Option 1)	$ 290,000	$ 1,000,000	$ 600,000	$ 2,900,000	$ 4,790,000
1	Barret Boulevard Intersection (Option 2)	$ 240,000	$ 1,000,000	$ 600,000	$ 2,400,000	$ 4,240,000
2	Marywood Drive Intersection	$ 120,000	$ 350,000	$ 850,000	$ 800,000	$ 2,120,000
3	Barker Road Intersection	$ 170,000	$ 350,000	$ 300,000	$ 1,100,000	$ 1,920,000
4	Watson Lane Intersection	$ 350,000	$ 1,000,000	$ 1,200,000	$ 3,500,000	$ 6,050,000
5	Audubon State Park Entrance	$ 110,000	$ 250,000	$ 200,000	$ 700,000	$ 1,260,000
6	Stratman Road Intersection (Option 1)	$ 380,000	$ 300,000	$ 400,000	$ 3,800,000	$ 4,880,000
6	Stratman Road Intersection (Option 2)	$ 430,000	$ 400,000	$ 400,000	$ 4,300,000	$ 5,530,000
7	Eastern Backage Road	$ 330,000	$ 4,000,000	$ 750,000	$ 3,800,000	$ 8,880,000
8	N. Elm Street	$ 150,000	$ 750,000	$ 750,000	$ 1,000,000	$ 2,650,000
9	Raised Median	$ 1,060,000	$ 3,350,000	$ 3,550,000	$ 10,300,000	$ 18,260,000
--	Safety & Mobility Improvement Plan	$ 1,460,000	$ 8,050,000	$ 5,050,000	$ 16,300,000	$ 30,860,000
10	Six-Lane Widening	$ 1,740,000	$ 6,500,000	$ 4,500,000	$ 19,100,000	$ 31,840,000

Table 6: 2015 Cost Estimates

8.2 EVALUATION MATRIX

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

- All improvement concepts met the purpose and need of the project.
- Improvement concepts at Barret Boulevard, Barker Road, Audubon State Park, Stratman Road, Raised Median, Safety and Mobility Improvement Plan and Six-Lane Widening would decrease access density which will decrease travel delay and improve safety.
- All improvement concepts provide truck access and are compatible with the I-69 Preferred EIS Corridor.
- Improvement concepts at Barret Boulevard (Option 2), Audubon State Park, Stratman Road, Raised Median, Safety and Mobility Improvement Plan and Six-Lane Widening would reduce the number of conflict points which will improve safety.
- Improvement concepts at Barret Boulevard, Watson Lane, Eastern Backage Road, N. Elm Street, Raised Median, Safety and Mobility Improvement Plan and Six-Lane Widening could potentially have a high amount of right-of-way and utility impacts.
- Improvement concepts at Barret Boulevard, Watson Lane, Eastern Backage Road, N. Elm Street, Raised Median, Safety and Mobility Improvement Plan and Six-Lane Widening could impact an existing stream, creek, or tributary.
- Improvement concepts at Barret Boulevard, Eastern Backage Road, Safety and Mobility Improvement Plan and Six-Lane Widening could impact existing UST sties.

A summary of the complete evaluation matrix is shown in **Table 7**.

US 41 Traffic & Access Management Study Evaluation Matrix												
Improvement	Purpose & Need	Traffic			Safety		Community Impacts			Environmental Impacts		Average Local Officials Ranking (5 = Very Important)
	Does the improvement relieve congestion and improve safety along the US 41 corridor?	Decrease Access Density which Decreases Delay	Provide Truck Access	Compatibility with the I-69 Preferred EIS Corridor	Decrease Access Density	Reduce Conflict Points	Right-of-Way	Utilities	Parks (Audubon Sate Park)	Streams	UST Sites	
No Build	No	No	Yes	Yes	No	No	None	None	No	None	No	N/A
1. Barret Boulevard Intersection (Option 1)	Yes	Yes	Yes	Yes	Yes	No	High	High	No	Sugar Creek	Yes	3.6
1. Barret Boulevard Intersection (Option 2)	Yes	Yes	Yes	Yes	Yes	No	High	High	No	Sugar Creek	Yes	3.6
2. Marywood Drive Intersection	Yes	No	Yes	Yes	No	No	Medium	Medium	No	None	No	3.5
3. Barker Road Intersection	Yes	Yes	Yes	Yes	Yes	No	Medium	Medium	No	None	No	3.7
4. Watson Lane Intersection	Yes	No	Yes	Yes	No	No	High	High	No	Un-Named Tributary	No	4.6
5. Audubon State Park Entrance	Yes	Yes	Yes	Yes	Yes	Yes	Low	Low	Yes	None	No	3.0
6. Stratman Road Intersection (Option 1)	Yes	Yes	Yes	Yes	Yes	Yes	Medium	Low	Yes	None	No	2.8
6. Stratman Road Intersection (Option 2)	Yes	Yes	Yes	Yes	Yes	Yes	Medium	Low	Yes	None	No	2.8
7. Eastern Backage Road	Yes	No	Yes	Yes	No	No	High	High	No	Sugar Creek	Unknown	3.9
8. N. Elm Street	Yes	No	Yes	Yes	No	No	High	High	No	Un-Named Tributary	No	3.7
9. Raised Median*	Yes	Yes	Yes	Yes	Yes	Yes	High	High	Yes	Un-Named Tributary	No	3.5
Safety & Mobility Improvement Plan (Includes Concepts 1-9)	Yes	Yes	Yes	Yes	Yes	Yes	High	High	Yes	Sugar Creek & Un-Named Tributary	Yes	N/A
10. Six Lane Widening* (Does not include eastern backage road)	Yes	Yes	Yes	No	Yes	Yes	High	High	No	Sugar Creek & Un-Named Tributary	Yes	3.2

* Includes intersection improvements at Barrett Boulevard, Barker Road, Watson Lane, Audubon State Park Entrance, and Stratman Road.

Table 7: Evaluation Matrix

8.3 BENEFIT-TO-COST RATIO

A 15-year benefit-to-cost ratio was calculated for the Safety and Mobility Improvement Plan. Benefits related the crash reduction and congestion relief were compared to the design, right-of-way, utility, and construction cost. The benefit-to-cost ratio is 1.05, meaning the project will more than pay for itself after 15 years based on the parameters shown below in **Table 8**.

Benefits	Crash Reduction*	$ 19,922,400	**$32,449,235**	**Benefit-to-Cost (B/C)**
	Congestion Relief**	$ 12,526,835		
Costs* **	Design	$ 1,460,000	**$30,860,000**	**1.05**
	Right-of-Way	$ 8,050,000		
	Utilities	$ 5,050,000		
	Construction	$ 16,300,000		

*Assumes 30% reduction in overall crashes along US 41.

**Based on reduction in average delay for AM and PM peak hours between 2015 and 2030 and average hourly rate of $17.72 per hour (source: Bureau of Labor Statistics)

***Does not include improvements to Elm Street

Table 8: 15-Year Benefit-to-Cost Ratio for the Safety and Mobility Improvement Plan

8.4 FINAL PROJECT TEAM MEETING

The project team met for the final time on August 24, 2015. The purpose of the meeting was to prioritize the improvements, using input from the stakeholders and local officials, and determine which improvements have the greatest benefit and are most economical. A detailed summary of the final project team meeting is included in **Appendix E**.

The group had an open discussion about the improvements:

- Extending the Watson Lane widening east to US 60 may be considered in future project phases.
- The raised median does not have to be built through the entire study area. The limits of the raised median will be determined during future phases of the project.
- The Eastern Backage Road can be designed and constructed in segments as funding becomes available.
- There have been concerns about limiting connections and access to the proposed Eastern Backage Road. The terrain will limit access to development on the east side of the road and there is not much open space for development on the west side of the road.
- The six-lane widening concept would not be warranted if a new I-69 bridge is built connecting Evansville and Henderson. As long as I-69 is a regional priority, this improvement should not be recommended.

- The improvements at Watson Lane should be the top priority.

8.5 RECOMMENDATIONS

This study has been undertaken to seek feasible strategies to more effectively manage access along the corridor in order to improve the efficiency and safety of US 41. The completion of the I-69 corridor between Kentucky and Indiana will affect future demand along US 41. The six-lane widening concept would not be warranted if a new I-69 bridge is built between Evansville and Henderson. Therefore, the costs of proposed improvements were evaluated against future needs. In light of the technical data, comments from stakeholders, and results of the survey, the project team worked together to prioritize each of the improvements.

- **High Priority (in order)**
    - I**mprovement 4 – Watson Lane Intersection**
    - **Improvement 3 – Barker Road Intersection**
    - **Improvement 7 – Eastern Backage Road**
- **Medium Priority (in no particular order)**
    - **Improvement 1 – Barret Boulevard Intersection**
        - **Option 1 – Full Signal**
        - **Option 2 – "3/4 Signal":** This appears to be the preferred alternative of the project team and stakeholders.
    - **Improvement 2 – Rettig Road / Marywood Drive Intersection**
    - **Improvement 5 – Audubon State Park Entrance**
    - **Improvement 6 – Stratman Road / Wolf Hills Road Intersection**
    - **Improvement 8 – N. Elm Street**
    - **Improvement 9 – Raised Median**
- **No Priority**
    - **Safety and Mobility Improvement Plan:** The project team has estimated the Safety and Mobility Improvement Plan to cost $30.86 million, which will likely make such an undertaking infeasible as a single project.
    - **Improvement 10 – Six-Lane Widening:** The six-lane widening concept would not be warranted if a new I-69 bridge is built between Evansville and Henderson.

8.6 NEXT STEPS

The next phase for the US 41 Traffic and Access Management Project would be Phase 1 Design (Preliminary Engineering and Environmental Analysis) for one or more of the high priority projects. Further funding will be necessary to advance an improvement to the design phase.

9.0 CONTACTS/ADDITIONAL INFORMATION

Written requests for additional information should be sent to John Moore, Director, KYTC Division of Planning, 200 Mero Street, Frankfort, KY 40622. Additional information regarding this study can also be obtained from the KYTC District 2 Project Manager, Nick Hall, at (270) 824-7080 (email at Nick.Hall@ky.gov).