

Final Report

I-71 / I-264 Interchange Study

Item No. 5-557.00

Kentucky Transportation Cabinet- District 5, Jefferson County

June 2021

In Partnership With





Executive Summary

The I-71 / I-264 Interchange Study was initiated by the Kentucky Transportation Cabinet (KYTC) to examine the need for improvements to the I-71 / I-264 interchange in conjunction with a Preliminary Design Project to improve safety and reduce congestion on I-71 from Zorn Avenue to I-265 (Item Number: 5-557.00). This study is also being completed in the context of the I-264 improvement project (Item Number: 5-804.00), which has construction funds programmed in FY 2023¹ and will widen I-264 to six lanes from KY 1447 (Westport Road) to I-71 including improvements to the US42 interchange. With these added capacity improvements to the interstate system flowing into and out of the I-71 / I-264 interchange, a need was recognized to analyze the “pinch point” this interchange presented.

Study Area Needs

The project team examined the traffic operations and safety performance of the interchange and immediately adjacent interstate segments, including the I-264 mainline between I-71 and US 42². Those analyses highlighted several primary needs (**Figure ES-1**).

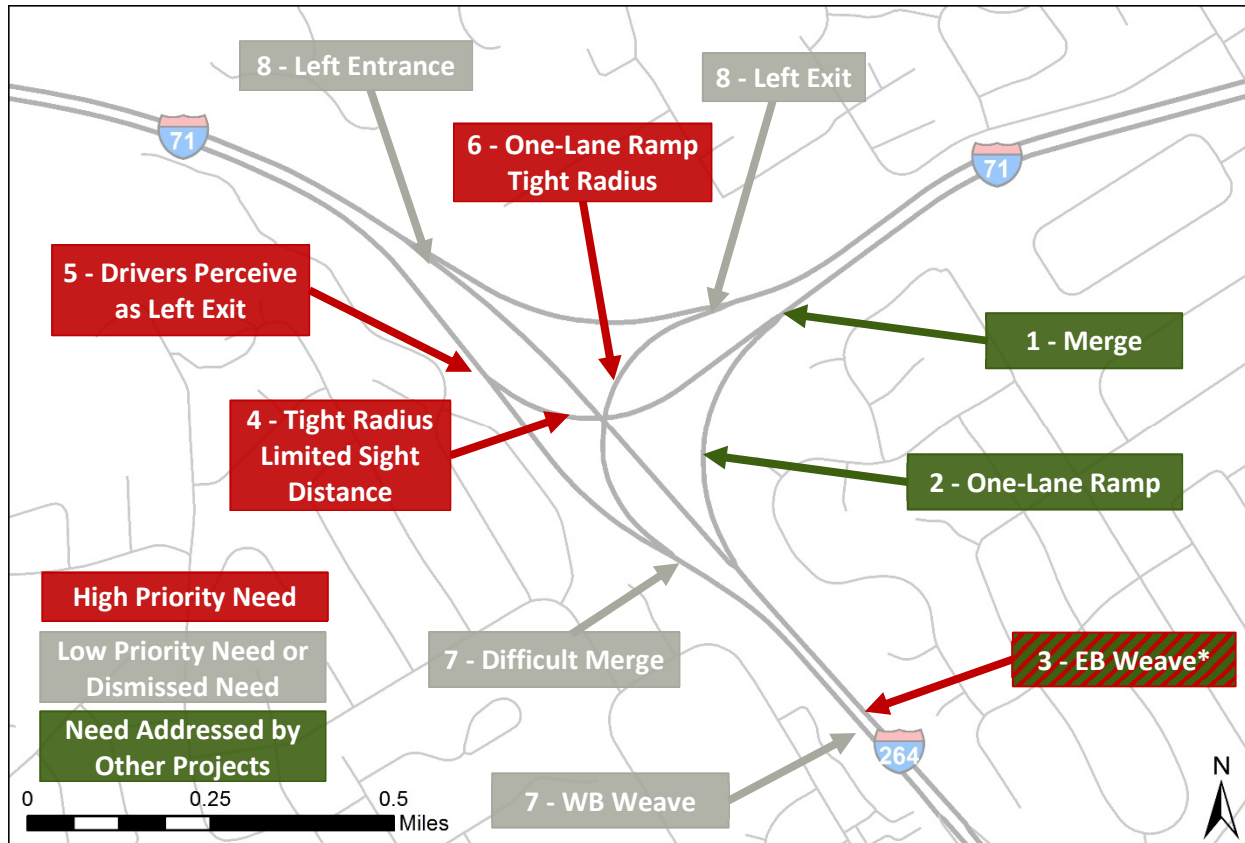
1. **I-264 Eastbound to I-71 Northbound Ramp Merge** – The merge creates a bottleneck that backs up traffic on both I-264 eastbound and to a lesser extent on I-71 northbound.
2. **I-264 Eastbound to I-71 Northbound Ramp** – This single-lane ramp is over capacity.
3. **I-264 Eastbound Weave** – The I-264 eastbound weave area operates poorly; however, the main capacity constraints are the single-lane downstream ramp (to northbound I-71) and the I-71 merge.
4. **I-71 Northbound Curve** – This tight radius horizontal curve through the interchange creates both safety issues as well as operational issues (which are made worse by the vertical upgrade and subsequent merge with vehicles coming from I-264 eastbound).
5. **I-71 Northbound Diverge at I-264 Westbound** – The design of this diverge makes remaining on I-71 northbound feel like a left-sided exit. Drivers conduct late/erratic lane changes or use the far-left lane at slow speeds. Crash data (2017-2019) supports the need for improvements to the diverge and the subsequent tight radius horizontal curve (see Item 4 above).
6. **I-71 Southbound Ramp** – The single-lane southbound ramp to I-264 westbound is a left sided exit that reaches capacity at peak times, leading to congestion and queues on southbound I-71 leading into the interchange.
7. **I-71 Northbound and I-71 Southbound Ramp Merge and Westbound Weave** – The merge where I-264 westbound begins is another difficult area for drivers to navigate, with some drivers making quick lane changes. The westbound weave was also identified as a possible issue. However, the traffic and safety analysis did not show these to be major issues. (See **Table 7** in the full report)
8. **Left Exit and Entrance Ramps** – The exit ramp from I-71 southbound to I-264 westbound and the entrance ramp from I-264 eastbound to I-71 southbound were

¹ From *Kentucky's FY 2020 – FY 2026 Highway Plan*

² See Section 7.2 for a more detailed examination of the primary needs

identified early on as possible issues but were later dismissed based on both the traffic and safety analysis.

Figure ES-1: I-71 / I-264 Interchange Needs



*Where two colors show, the high priority need is addressed by another project.

Needs 1 and 2 are addressed by the proposed widening on I-71 (Item Number: 5-557.00) and I-264 (Item Number: 5-804.00). The added lanes will make the ramp a two-lane ramp and will create a free-flow movement onto I-71 northbound, with a receiving through lane on I-71.

Study Goals and Objectives

The main goal of the I-71 / I-264 Interchange study was to develop several physically and fiscally feasible interchange improvement concepts that met the following three primary objectives:

- Improve traffic operations
- Improve safety
- Promote the reliability of the regional interstate system



Interchange Improvement Concepts and Evaluation

Many different interchange concepts were generated that addressed the identified needs. The concepts were first screened to identify the most promising. Then a detailed evaluation was conducted including simulation modeling and a predictive safety analysis. The evaluation also addressed right-of-way impacts, maintenance of traffic, environmental issues, utility impacts, and construction costs.

This analysis determined that a small number of improvements were required to meet the major identified needs in the interchange area. These improvements are needed to gain the full benefit of the widening projects (Item Numbers: 5-557.00 and 5-804.00) that are interconnected with this interchange. It was also determined that some of the proposed concepts could be implemented in future phases to further enhance the interchange after initial improvements are made.

Recommended Interchange Improvement Options

The project team recommended that four concepts be considered in the preliminary design and environmental phase for any future interchange improvements (or the improvements could be included in the preliminary design phase of the widening project for I-71 (Item Number: 5-557.00). Other concepts that did not move forward for further consideration were removed because they did not meet the project's goals and objectives or did so at a greater cost than the recommended concepts but with minor differences in improved performance. All four of these concepts would provide adequate traffic operations in the future design year of 2045. They would also offer safety improvements over the current condition. **Table ES-1** provides planning level cost estimates for each.

Table ES-1: Concept Cost Estimates

	Concept B-1	Concept A-2.2	Concept A-3.2	Concept A-3.3
Design	\$2,800,000	\$2,800,000	\$2,800,000	\$3,470,000
Right-of-Way	--	\$340,000	\$340,000	\$340,000
Utility Relocation	\$180,000	\$700,000	\$700,000	\$700,000
Construction	\$13,600,000	\$21,600,000	\$21,400,000	\$27,500,000
Total	\$16,580,000	\$25,440,000	\$25,240,000	\$32,010,000

all costs in 2020 dollars

Concept B-1 reuses the majority of the existing interchange infrastructure. The radius of I-71 northbound through the interchange is increased and the ramp from I-71 southbound to I-264 westbound is widened from a single-lane to a two-lane ramp (**Figure ES-2**). It is anticipated that this concept could be constructed within existing right-of-way, but some utility relocations would be needed. Concept B-1 meets the most critical needs identified and has the lowest estimated cost of any of the concepts at \$16,580,000.

Concept B-1 is recommended as the initial improvement for the interchange. It would address the most immediate needs in the interchange area, the curve on northbound I-71, and the single-lane southbound I-71 to westbound I-264 ramp. This concept would allow the proposed mainline widening on I-71 and I-264 to function effectively. Conversely, not making these

improvements would mean that northbound and southbound I-71 would have lingering operational and safety issues after both widening projects (Item Numbers: 5-557.00 and 5-804.00) are constructed.

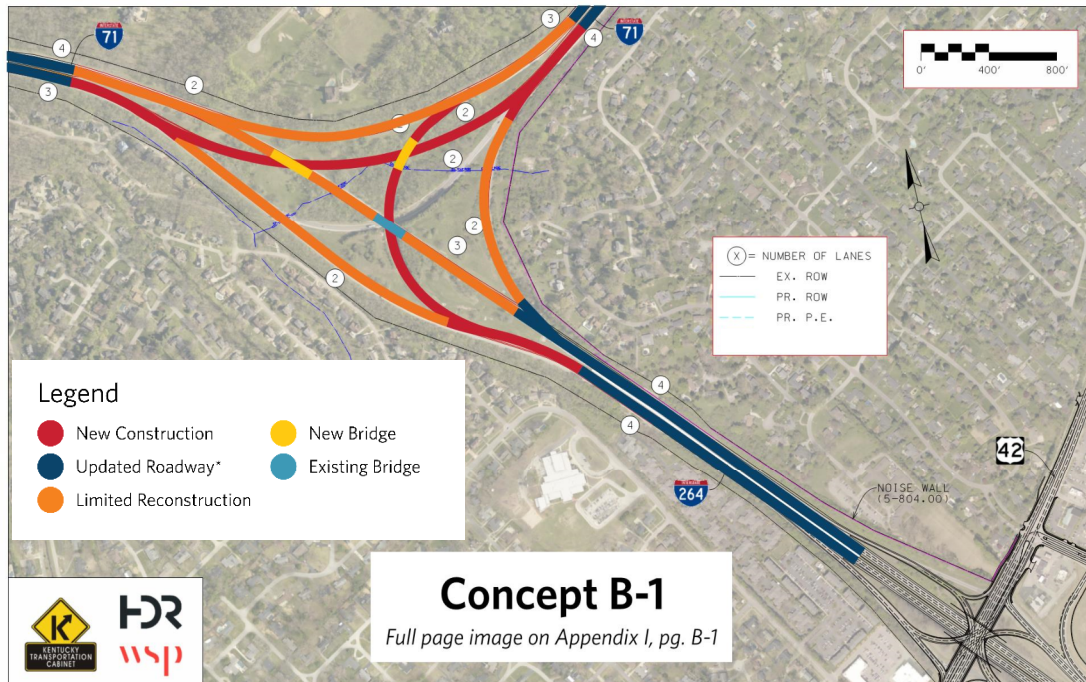


Figure ES-2: Concept B-1

**Improvements from projects 5-804.00 and 5-557.00*

Concept A-3.2 (Figure ES-3) This concept includes the improvements from Concept B-1 and also addresses the weave on I-264 eastbound by constructing a bypass ramp. Vehicles from US 42 to I-71 southbound would stay on a bypass lane, thus reducing the number of weaving vehicles. Some new right-of-way would be required. This could be a second phase after Concept B-1 is constructed.

Concept A-3.3 (Figure ES-3) This concept includes the improvements from Concepts B-1 and A-3.2 but also addresses the weave on I-264 westbound by braiding the ramps from I-71 northbound and southbound to better align traffic with its intended destination lanes on I-264 westbound.

Concept A-2.2 includes the improvements from Concept B-1 and also addresses the weave on I-264 eastbound by constructing a collector-distributor roadway. This collector-distributor roadway would take traffic from the US 42 entrance ramp and distribute it directly to the ramp to I-71 northbound and I-71 southbound, thus removing the weave. Acquisition of right-of-way is needed along I-264 to accommodate this collector-distributor ramp and additional utilities would need to be relocated. This is a competing option to B-1 and A-3.2.



Low-Cost Improvement Options

Four low-cost, short-term improvements are recommended for potential implementation.

1. **Route Shield Pavement Markings (Lane Tattoos)** – This would add interstate route shield pavement markings in advance of the major diverge points leading into the interchange. These markings would improve lane utilization and lane assignments by providing additional, digestible information to drivers in advance of lane diverges. The construction cost is estimated to be \$145,000.
2. **Vegetation Management** – This would trim vegetation, trees, and branches along the ramps in the interchange area to improve horizontal sight distance and decrease pavement drying times. It is expected this concept would be implemented under District 5's existing maintenance vegetation removal contracts and is estimated to cost \$75,000.
3. **Dynamic Message Signs (DMS)** – This would add four Dynamic Message Signs in the areas leading to the interchange to better inform drivers to make better routing decisions before they reach a decision point. The signs would fill gaps in the existing Intelligent Transportation Systems coverage. The proposed installations include an overhead DMS on I-71 northbound north of Zorn Avenue, a side mounted DMS on I-264 eastbound before the US 42 interchange, and two ground mounted DMS on US 42 approaching the I-264 interchange. The construction cost is estimated at \$750,000.
4. **Gore Extension** – This option would extend the gore area between I-71 northbound and the ramp from I-264 eastbound to move the merge further away from the interchange allowing vehicles on the ramp and the mainline to reach similar speeds. Construction cost is estimated to be \$5,000 and this could be implemented under existing pavement restriping contracts.

Study Recommendations

After extensive study and analysis, Concept B-1 has been identified as the initial recommendation. This concept meets the study's goals and objectives at the lowest cost among the analyzed concepts. This concept could be advanced with I-71 widening project 5-557.00 by including it in the ongoing environmental analysis.

Although Concept B-1 addresses the anticipated traffic needs through the design year, should traffic growth exceed expectations, a phased approach to further improve the interchange can be taken. The bypass lane on I-264 eastbound, from Concept A-3.2, could be constructed next to reduce weaving conflicts. The weave in the westbound direction of I-264 could also be addressed by implementing the ramp braiding from I-71 northbound and southbound to I-264, as described in Concept A-3.3. **Figure ES-3** presents the proposed phasing.

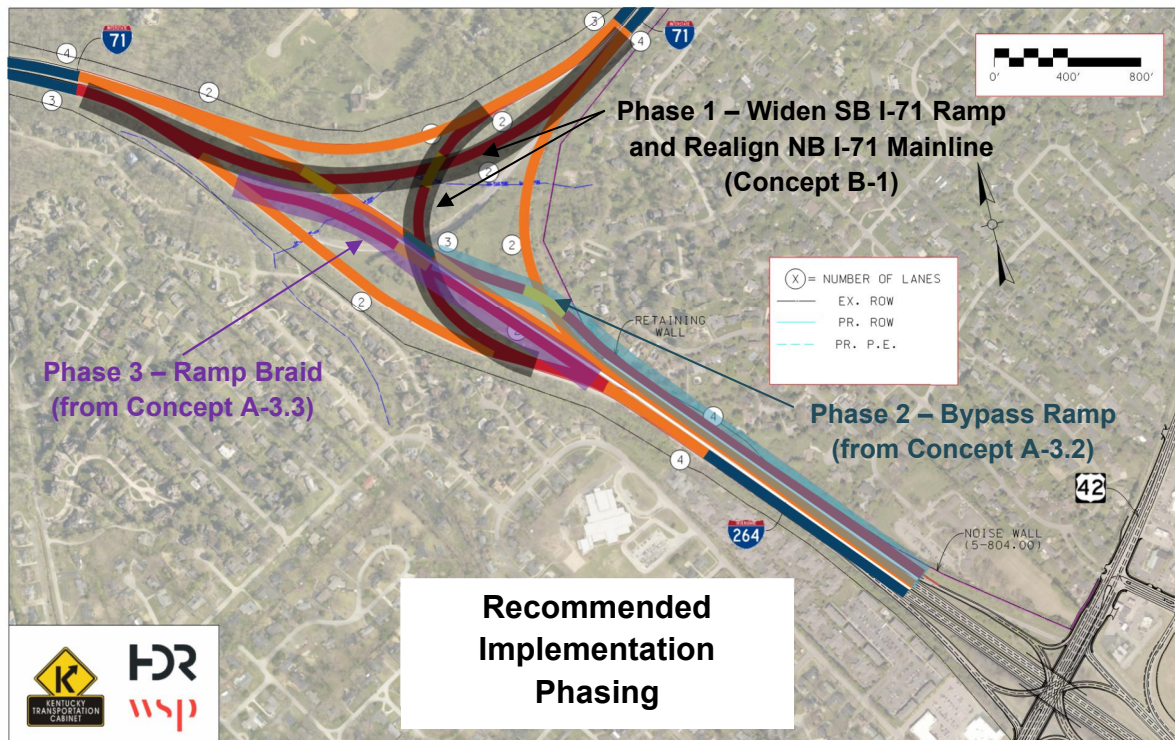


Figure ES-3: Concept B-1 With Recommended Follow-on Phases



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1 Introduction and Project Context

1.1 Project Overview

During the preliminary engineering phase to improve safety and reduce congestion on I-71 from the Zorn Avenue interchange to the I-265 interchange (Item No. 5-557.00), the Kentucky Transportation Cabinet (KYTC) initiated the I-71 / I-264 Interchange Study to evaluate the need for improvements to this interchange. Concepts developed as part of this study will be compatible with improvement configurations for mainline I-71. These interchange concepts will also tie into an adjacent project currently under development (Item No. 5-804.00) to improve the US 42 at I-264 interchange and to widen I-264 between the I-71 interchange and the KY 1447 (Westport Road) interchange. **Figure 1** shows the interchange study area and the adjacent projects.

Figure 1: Project Study Area



This document presents the Final Report for concepts to improve the I-71 / I-264 system interchange and is the sixth of six steps for studying and evaluating improvement concepts for this interchange (see **Figure 2**). Step 1 defined the current and future conditions and defined the needs of the interchange. Step 2 developed a range of improvement concepts, including low-cost short-term improvements and interchange design concepts. Step 3 provided an initial Level 1 screening of the concepts. Step 4 obtained input from the public through an online story map and survey. Additional input was gathered at a virtual Local Officials and Stakeholders meeting. Step 5 provided a more detailed assessment of the concepts that culminated in the Level 2 Concepts Evaluation. The conclusions provided in this Final Report, Step 6, are based

on the Level 2 Concepts Evaluation, input from the project team, feedback from stakeholders/local officials and the public, and follow-up technical analysis.

1.2 Project History

The 2014 I-71 Corridor Study¹ identified a need to reevaluate the I-71 / I-264 interchange and I-71 mainline between I-264 and I-265 after the Louisville Bridges Project, specifically the East End Bridge, had been open to traffic for one year. This was ranked as the sixth highest priority on I-71 between downtown Louisville and Northern Kentucky.

Funding for this project was first introduced in *Kentucky's FY 2018 – FY 2024 Highway Plan* as Item Number: 5-557.00. In addition to preliminary engineering to improve safety and reduce congestion on I-71 from the Zorn Avenue interchange to the I-265 interchange in eastern Jefferson County, the project also included studying the I-71 / I-264 interchange. The study portion of the project

kicked off in the fall of 2019 with a design

charrette where project team members examined the I-71 / I-264 interchange to brainstorm initial concepts. Several low-cost short-term improvements and five main interchange design concepts resulted from this charrette.

This project carried forward in *Kentucky's FY 2020 – FY 2026 Highway Plan* and was one of the top five scoring Statewide projects in the Strategic Highway Investment Formula for Tomorrow (SHIFT). In early 2020, the design concepts were refined, and a Level 1 screening analysis was performed that culminated in the project team meeting on this topic. Later in the summer of 2020, a more detailed Level 2 Concepts Evaluation took place. The project team met to review the Level 2 concepts and estimates in July 2020 to screen these concepts to be further refined and included in the final report.

Also, in July of 2020 a virtual Local Officials and Stakeholders meeting was held to present the study to key stakeholders and to gain feedback from them. At this time, an online survey was opened to the general public seeking input on issues they experience while traveling through the interchange. Outcomes from the Level 2 Concepts Project Team meeting, feedback from the public involvement process, and additional analysis culminated in the creation of the Final Level 2 Evaluation Report in February 2021.



Figure 2: Project Study Steps

¹ https://transportation.ky.gov/Planning/Planning%20Studies%20and%20Reports/Qk4_Final_I-71CorridorStudy_3-13-14%20-%20FINAL.pdf



1.3 Project Context

KYTC recognized the need to evaluate the I-71 / I-264 system interchange, as it is situated in the middle of the I-71 and I-264 improvement projects. There was concern that this interchange would become a “pinch point”, diminishing the benefits of the upgrades made to the mainline interstates in all three directions. Given the funding, schedule, and right-of-way challenges of improving a system interchange in a highly congested urban area, KYTC determined that the study should look at both low-cost near-term improvements as well as full interchange redesign concepts.



2 Existing Conditions and Problem Definition

2.1 Existing Conditions

Like other urban system interchanges, the I-71 / I-264 interchange in eastern Jefferson County experiences congestion during the morning (7 AM to 9 AM) and afternoon (4 PM to 6 PM) peak periods. This peak-period congestion is typically related to commuters traveling to and from their homes and places of employment. This interchange becomes a bottleneck, which results in delays, queues, and safety issues. In addition to high traffic volumes, other factors contributing to congestion include the interchange geometrics (e.g., one-lane ramps and tight-radius curves) and the proximity of the US 42 / I-264 interchange. This study identifies the major capacity, safety, and reliability challenges of the I-71 / I-264 interchange and presents concepts to address them in the near and long-term.

2.1.1 Roadway Conditions

The current configuration of the I-71 / I-264 system interchange is a Three-Legged Directional Y. This interchange is unusual in that I-71 is on the north and west legs and I-264 is on the east leg. This results in a noticeable curve for the northbound (NB) I-71 through movement, while the I-71 (NB) to I-264 westbound (WB) movement is more like a through movement. This causes issues for drivers as they approach and navigate the diverge area and the tight radius I-71 NB curve. (In fact, many drivers perceive the mainline I-71 movement to be an exit and the exit to I-264 to be the mainline.) The southbound (SB) I-71 mainline does not have the same challenges, as the mainline radius is much larger and the diverge follows a more typical design, except that a left-sided exit ramp from I-71 SB to I-264 WB and a left-sided entrance ramp from I-264 EB to I-71 SB are present. **Figure 3** highlights the key issues with the existing interchange configuration.

The mainline I-71 and I-264 approaches to the interchange have 12-foot-wide travel lanes, 6-foot-wide inside shoulders (3-foot paved) and 12-foot-wide outside shoulders (10-foot paved).

Table 1 provides geometric information for the components within the interchange.

Table 1: Existing I-71 / I-264 Interchange Mainline and Ramp Geometrics

Segment	Lane Width	Left Shoulder Width	Right Shoulder Width	Radius	Superelevation Rate
I-71 NB in Interchange	2 – 12 ft	6 ft (3 ft paved)	8 ft (6 ft paved)	819 ft	7.9%
I-71 SB in Interchange	2 – 12 ft	6 ft (3 ft paved)	8 ft (6 ft paved)	1432 ft	7.0%
I-264 EB to I-71 NB	15 ft	6 ft (4 ft paved)	8 ft (6 ft paved)	955 ft	9.3%
I-264 EB to I-71 SB	2 – 12 ft	6 ft (3 ft paved)	8 ft (6 ft paved)	1910 ft	5.4%
I-71 NB to I-264 WB	2 – 12 ft	6 ft (3 ft paved)	8 ft (6 ft paved)	1910 ft	5.4%
I-71 SB to I-264 WB	15 ft	6 ft (4 ft paved)	8 ft (6 ft paved)	654 ft	8.0%

The interchange is signed in every direction with overhead guide signs. I-71 guide signs begin two miles in advance of the interchange and I-264 guide signs begin one mile in advance of the interchange. The posted speed limit on these three approaches to the interchange is 55 mph. The I-71 Southbound (SB) to I-264 WB ramp has an advisory speed of 45 mph. I-71 NB and SB through the interchange and the I-264 Eastbound (EB) to I-71 NB ramp have advisory speeds of 50 mph.

There are utilities present near the existing interchange. Just north of the interchange on I-71, overhead electric distribution and fiber are present along with a 24-inch waterline and an 18-inch sewer force-main crossing I-71. The I-264 approach contains an underground fiber crossing and a buried phone cable that runs parallel to I-264 just outside of right-of-way on the eastern side. There are also gravity and force-main sewer facilities that run parallel to I-264 just outside of the right-of-way on the eastern side. KYTC's Traffic Response and Incident Management Assisting the River City (TRIMARC) have overhead Dynamic Message Signs (DMS) on I-71 NB before the Zorn Avenue interchange (milepoint 0.25) and on I-71 SB before the I-264 interchange (milepoint 8.20). There are traffic monitoring cameras at the US 42 / I-264 interchange and at the I-71 / I-264 interchange to aid in incident management. A full-size map of the existing conditions may be found on Page 1 of **Appendix E**.

Figure 3: I-71 / I-264 Interchange Key Issues



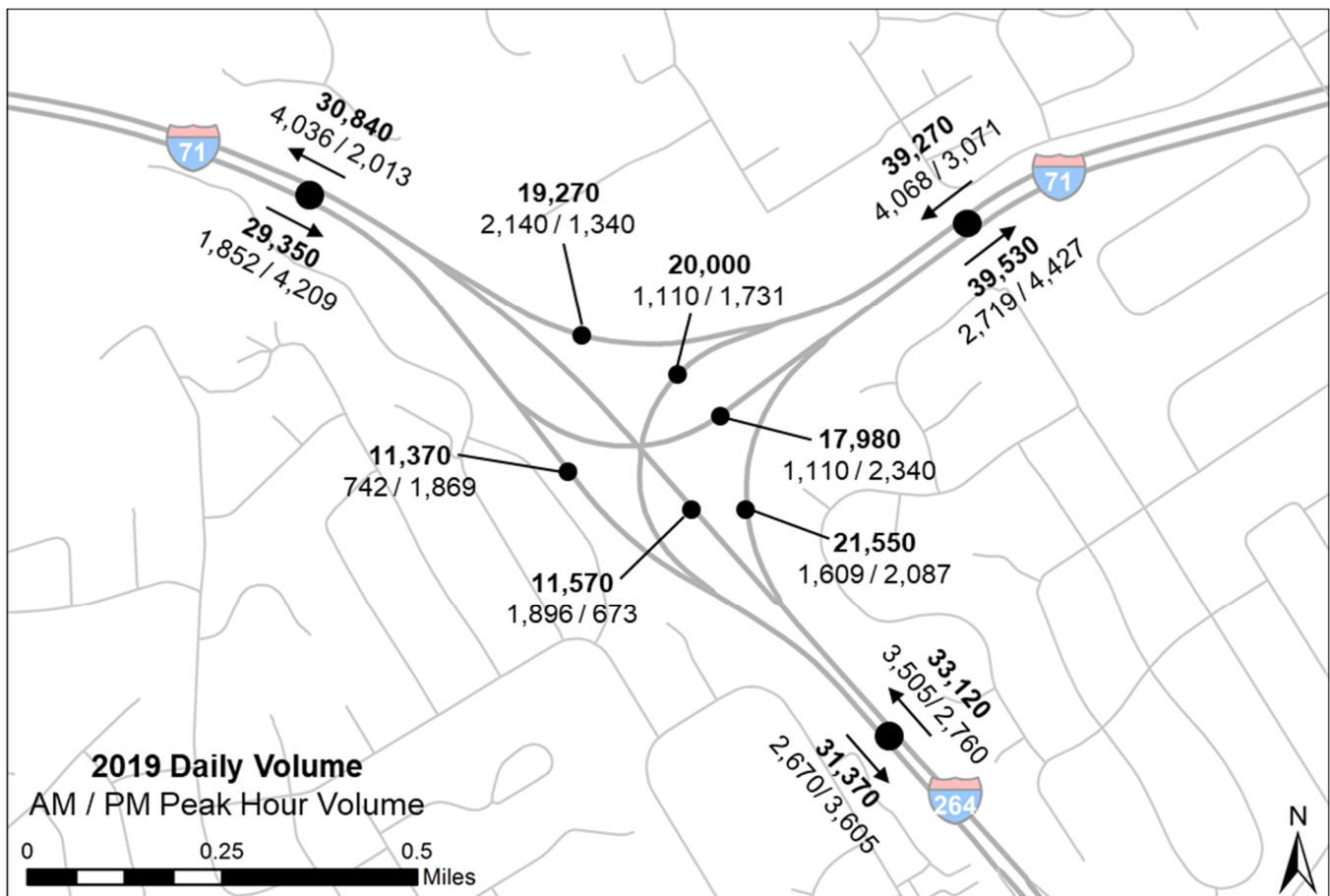
2.1.2 Traffic Operating Conditions

The interchange currently serves high volumes of traffic and has several traffic operations, safety, and reliability challenges.

TRAFFIC VOLUMES

Recent (2019, pre-COVID) traffic volume counts in the interchange study area show approximately 60,000 vehicles per day (vpd) traveling on I-71 between the Zorn Avenue interchange and the I-264 interchange, 79,000 vpd traveling on I-71 between the I-264 interchange and the I-265 interchange, and 64,500 vpd traveling on I-264 between the US 42 interchange and the I-71 interchange. **Figure 4** illustrates the 2019 volumes at the I-71 / I-264 interchange. Over 100,000 vpd enter the interchange (approximately 39,000 vpd from I-71 SB, 29,000 vpd from I-71 NB, and 33,000 vpd from I-264 EB). The AM peak hour of travel through the interchange occurs between 7:15 and 8:15 AM and the PM peak hour of travel through the interchange occurs between 4:30 PM and 5:30 PM. Daily truck percentages on the three interchange legs (for both directions combined) are 8.9% on I-71 to the south, 15.3% on I-71 to the north, and 12.1% on I-264.

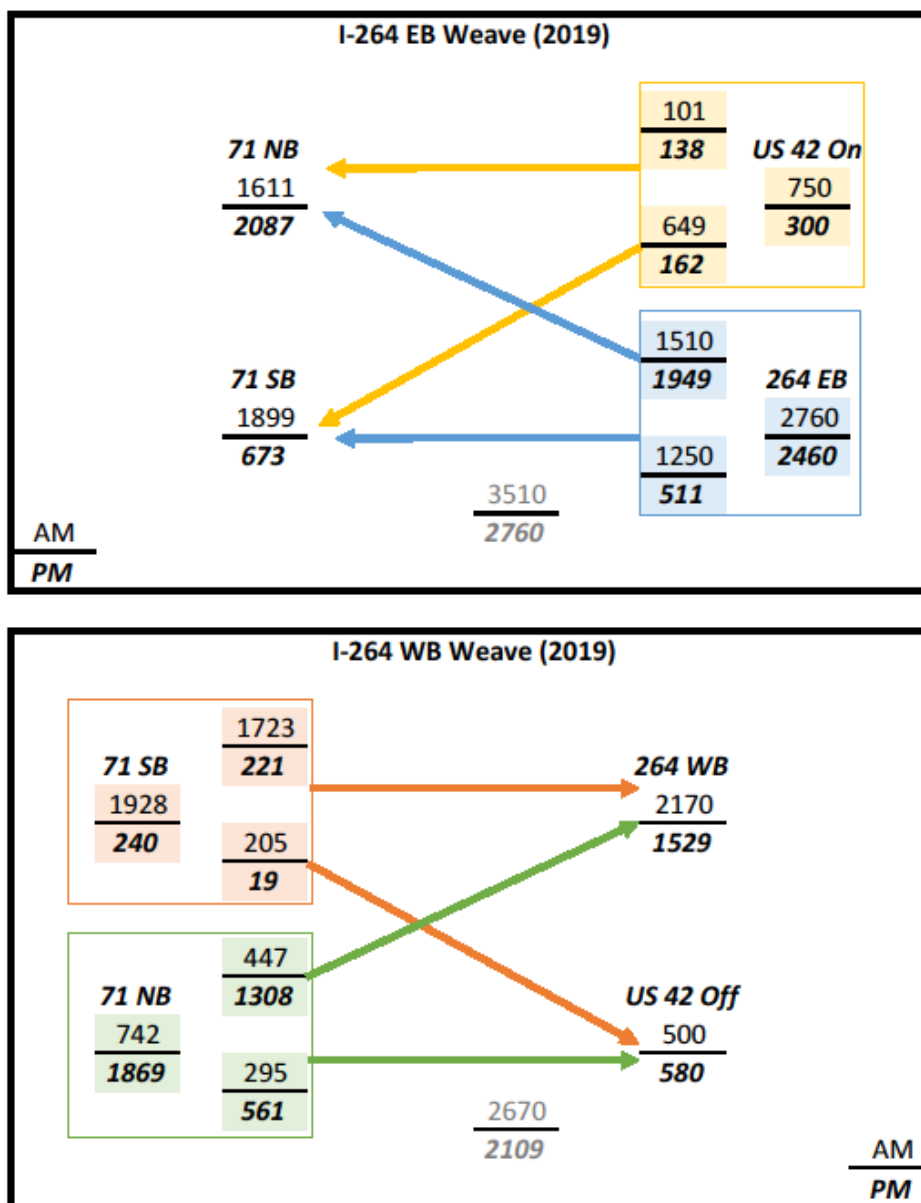
Figure 4: 2019 Traffic Volumes



WEAVING VOLUMES

The weaving areas on I-264 between the US 42 and I-71 interchanges are an integral part of studying the I-71 / I-264 interchange. Weaves create friction as many drivers must change lanes in constrained space to reach their destination, resulting in safety issues and reductions in operating speeds. StreetLight origin-destination (O-D) data was obtained for the study area to determine the proportion of vehicles utilizing specific routes through the interchange area. This data, in combination with the volume data, provided more detailed information on the weaving movements during the peak periods. The weaving volumes and O-D route choices were used in the traffic analysis, **Figure 5** presents a summary of the existing conditions weaving volumes for each direction along I-264.









Figure 5: 2019 I-264 Weaving Volumes



TRAFFIC OPERATIONS

In general, during the peak hours, operating speeds decrease as vehicles get closer to the I-71 / I-264 interchange, reach a minimum through the interchange, then begin to increase after traveling through the interchange. These speed changes can be attributed to the volume of traffic traveling through the interchange and the geometric constraints on the ramps. Existing peak hour speeds through the study area are shown in **Table 2**. As shown, AM peak speeds decrease along I-71 SB as the heavier volume is headed toward downtown. Conversely, in the PM peak, speeds along I-71 NB decrease more significantly as the volume shifts in the opposite direction. Also during the PM peak, the speeds along I-264 EB are significantly decreased due to congestion and weaving issues between the US 42 interchange and the I-71 interchange.

Table 2: Existing Peak Hour Speeds

	I-71						I-264		
	55mph – posted speed limit						55mph – posted speed limit		
Roadway Segment	S of Zorn	Zorn Interchange	Zorn to I-264	Ramp to I-264	I-264 to I-265	I-265 Interchange	I-71 to US 42	US 42 Interchange	S of US42
Travel Direction	I-71 NB						I-264 WB		
									
7:15 AM	61.57	63.65	63.34	59.92	65.11	58.70	57.34	59.95	58.17
AM 7:30 AM	59.84	62.95	60.65	58.22	62.12	65.07	56.11	60.04	60.65
Peak 7:45 AM	60.71	63.50	60.45	58.48	63.24	65.50	55.97	60.21	58.20
8:00 AM	60.50	64.45	63.00	59.42	63.16	65.06	59.59	61.47	60.64
Travel Direction	I-71 SB						I-264 EB		
									
7:15 AM	53.99	59.18	59.02		58.71	47.74	59.03	61.52	61.44
AM 7:30 AM	52.09	55.56	56.93		57.19	44.50	54.39	57.66	59.57
Peak 7:45 AM	47.52	47.71	49.82		57.42	46.42	52.67	57.67	57.74
8:00 AM	44.76	40.94	40.59		58.48	49.85	52.69	57.66	57.33
Travel Direction	I-71 NB						I-264 WB		
									
4:30 PM	54.02	54.37	54.00	40.90	45.91	57.47	57.04	58.51	58.81
PM 4:45 PM	46.12	47.37	50.81	41.01	44.50	59.16	54.82	56.45	56.44
Peak 5:00 PM	45.67	48.17	50.83	41.89	46.12	60.38	53.67	57.52	57.47
5:15 PM	44.37	43.90	50.36	45.51	52.49	56.78	54.38	55.39	54.23
Travel Direction	I-71 SB						I-264 EB		
									
4:30 PM	60.65	63.83	64.53		59.48	54.06	34.95	37.79	49.82
PM 4:45 PM	60.10	64.77	63.64		57.95	53.64	32.47	34.49	43.88
Peak 5:00 PM	60.33	64.03	65.02		59.18	55.98	29.88	26.76	38.71
5:15 PM	62.39	65.70	66.94		60.95	55.85	32.80	28.06	34.06

Speed data obtained from National Performance Management Research Data Set (NPMRDS). All speeds shown are in mph



A calibrated Vissim model was developed to replicate the existing AM and PM peak period conditions. Vissim is a traffic analysis software tool capable of performing microscopic-level analysis. Microscopic analysis is the most detailed level of traffic analysis as it provides information regarding individual vehicle interactions and the overall network performance. The Vissim analysis highlighted the current locations with speed reductions and reduced operational performance. The three metrics shown in **Table 3** below are average segment speed (mph); density (passenger cars per mile per lane); and Level of Service. Level of Service (LOS) is a qualitative measure of the performance of the highway element. It ranges from LOS A (free-flow, no congestion) to LOS F (stop-and-go traffic, heavy congestion, and delays). For urban areas, LOS A through D is acceptable. LOS E is the threshold for acceptable operations and may be viewed as acceptable for a future design year scenario; however, it is not acceptable for traffic operations in the near-term to mid-term.

The AM peak period issues include slow speeds and LOS E for the I-71 SB approach to the diverge to I-264 WB. This is due in part to the single-lane ramp, which also operates at LOS E. The I-264 EB weave operates at LOS E in the AM peak as well.

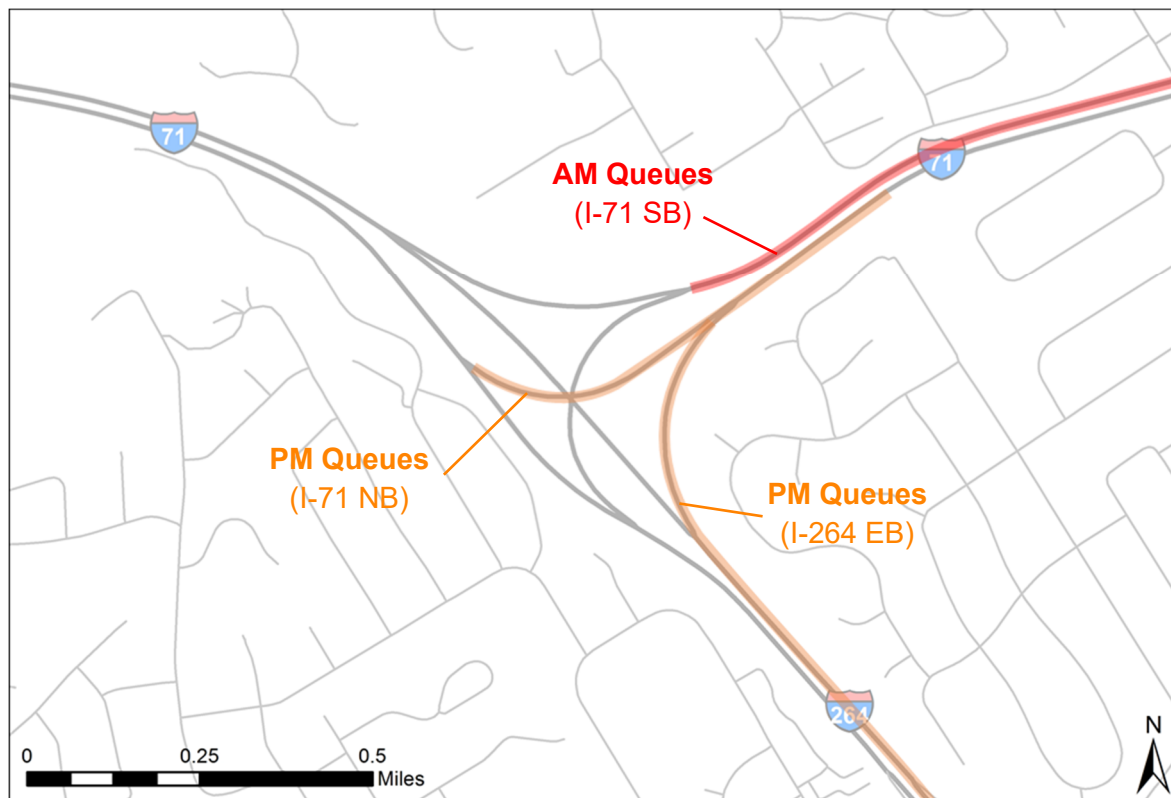
The issues in the PM peak period pertain to the I-71 SB to I-264 WB ramp (LOS E) and the I-264 EB weave (LOS F). This is related to the merge on I-71 NB, the single-lane ramp to I-71 NB, and the weave itself. The movement from I-264 EB to I-71 NB also is LOS E. The queues created from these issues are often extensive.

Table 3: Vissim Summary Results for Existing Conditions

Model Results	Existing (2019)					
	AM			PM		
Roadway Segments	Speed	Density	LOS	Speed	Density	LOS
I-71 NB before Diverge	58.19	10.65	B	55.29	25.13	C
I-71 NB Thru System	52.12	10.75	A	56.59	20.28	C
I-71 NB to I-264 WB	59.77	6.15	A	57.14	16.15	B
I-71 NB after Merge	55.41	16.05	B	53.40	25.55	C
I-71 SB before Diverge	35.37	37.79	E	40.73	26.04	C
I-71 SB Thru System	50.64	19.51	C	51.61	13.12	B
I-71 SB to I-264 WB	41.71	41.92	E	41.59	41.25	E
I-71 SB after Merge	54.13	17.26	B	53.89	9.20	A
I-264 EB Weave	30.63	41.33	E	11.37	74.25	F
I-264 EB to I-71 NB	48.32	33.02	D	46.21	39.95	E
I-264 EB to I-71 SB	57.79	15.47	B	56.00	5.44	A
I-264 WB Weave	57.65	14.42	B	55.08	21.56	C
I-264 EB On Ramp	30.82	21.73	C	31.12	8.79	A
I-264 WB Off Ramp	42.36	5.80	A	40.23	9.39	A

Queuing observations showed that this interchange creates a bottleneck situation for all three approaches (**Figure 6**). On a typical weekday, during the AM peak, queues extend back on the I-71 SB mainline as traffic backs up from the diverge point. In the PM peak, the queues on the I-264 EB approach can extend through the US 42 interchange, often reaching the Westport Road (KY 1447) entrance ramp merge area. Queues also extend on I-71 NB through the interchange to the diverge point to I-264 WB.

Figure 6: 2019 Queues



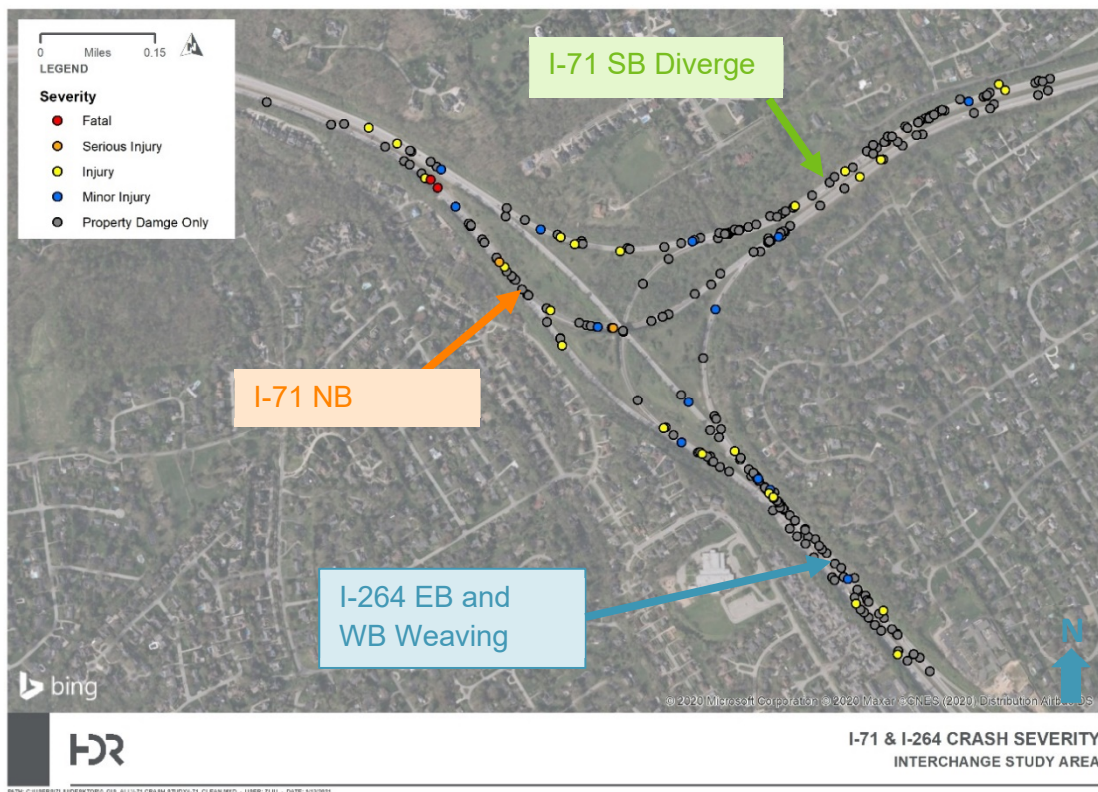
2.1.3 Traffic Safety Conditions

Crash data was obtained for the I-71 mainline, I-264 mainline, and within the I-71 / I-264 interchange². This crash analysis period included the years 2017 through 2019. During this timeframe, 278 crashes were recorded within the interchange study area.

Although crashes occurred throughout the interchange, there were some locations where a larger proportion of these crashes occurred. These locations are highlighted in **Figures 7 and 9**. The weaving areas on I-264 EB and WB between I-71 and the US 42 interchange experienced the largest number of crashes occurring with rear-end crashes representing the largest crash type in this area. The I-71 SB approach to the interchange experienced the second highest number of crashes occurring with rear-end crashes representing the largest crash type in this area. The I-71 NB approach to the interchange experienced the third highest number of overall crashes, with two fatal crashes occurring in this area. Within the interchange proper, the I-71 NB and SB through movements experienced a greater number of crashes than the four ramps connecting the interstates.

A more detailed review of the severity of these 278 crashes yields: two crashes were fatal (<1%), 41 crashes resulted in injuries (15%), and 235 crashes were property damage only (84%). Crash locations by severity within the study area can be seen in **Figure 7**.

Figure 7: I-71 / I-264 Crash Severity



² Crash data source: Kentucky State Police

The key issues experienced at the interchange are summarized by seven subareas associated with interchange features (weaving areas, merges, diverges, etc.). These subareas and the associated crashes within each are shown in **Figure 8**. A breakdown of the crash severities by subarea is also shown in **Table 4**. A detailed discussion of how these subareas were developed can be found in Section 7.1.

Figure 8: Crashes by Interchange Subarea

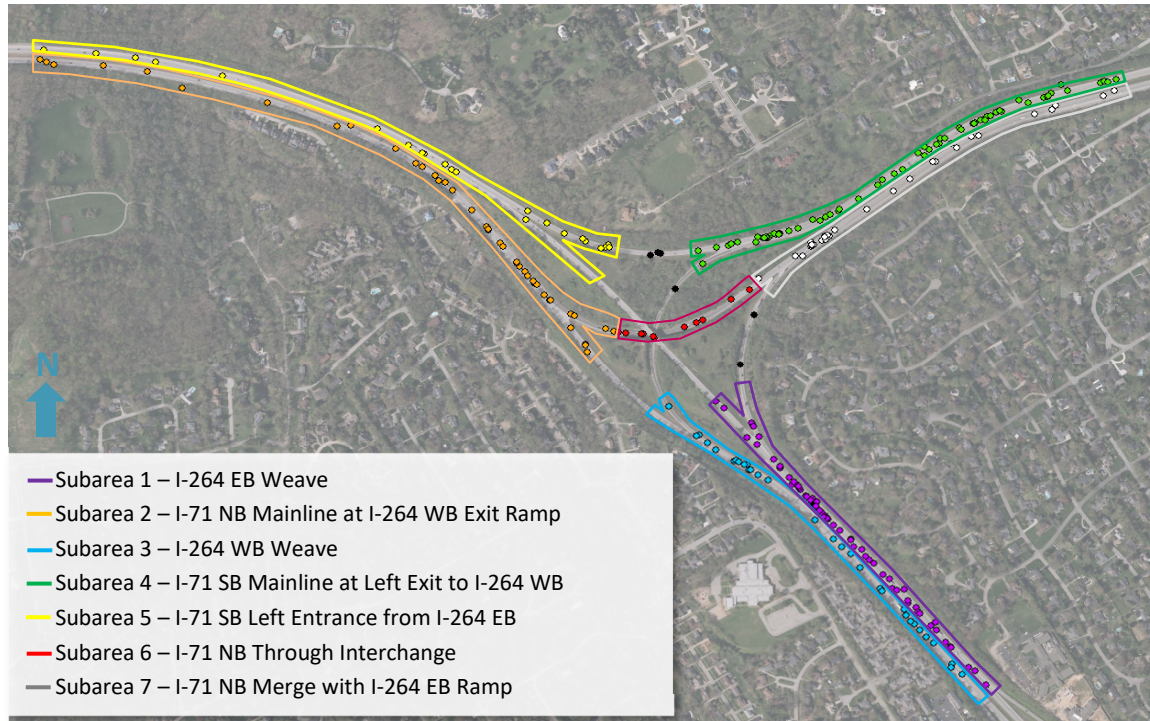


Table 4: I-71 / I-264 Interchange Crash Severity by Subarea

Crash Severity	Subarea							
	1	2	3	4	5	6	7	Other
Fatal	0	2	0	0	0	0	0	0
Serious Injury	0	1	0	0	0	1	0	0
Minor Injury	4	6	4	4	4	0	2	1
Injury Undetermined	5	1	1	2	2	1	1	1
Property Damage Only	54	34	26	60	20	10	26	5
TOTAL	63	44	31	66	26	12	29	7

A look at the manner of collision shows that there were 119 rear-end crashes (43%), 73 single vehicle crashes (26%), 72 sideswipe-same direction crashes (26%), and 14 other crashes (angle, head-on, etc.) representing 5% of total crashes. The locations shown by type of collision are shown in **Figure 9**. A breakdown of crash type by analysis subarea (see **Figure 8** for subarea locations) is shown in **Table 5**.

Figure 9: I-71 / I-264 Interchange Crash Type

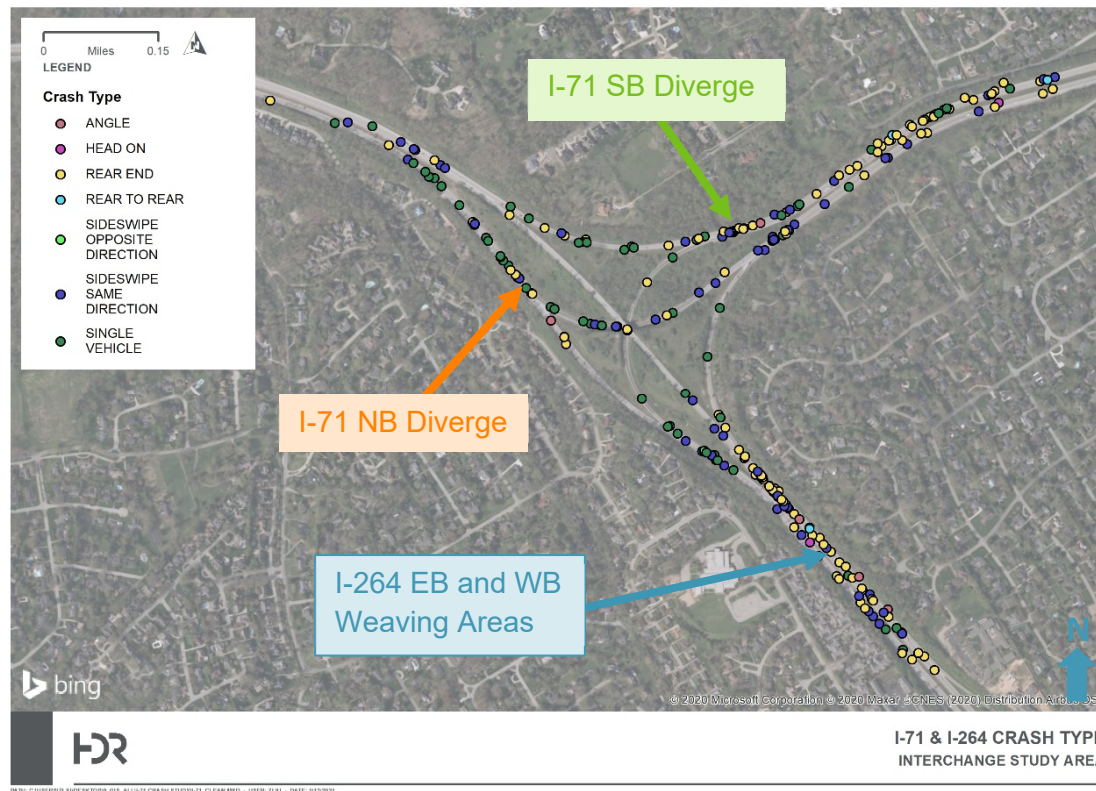




Table 5: I-71 / I-264 Interchange Crash Type by Subarea

Crash Type	Subarea							
	1	2	3	4	5	6	7	Other
Rear End	42	12	7	34	6	3	13	2
Angle	3	1	0	2	0	0	1	0
Head On	1	0	1	0	0	0	1	0
Opposing Left Turn	0	0	0	0	0	0	0	0
Single Vehicle	4	25	11	14	8	3	3	5
Sideswipe Opposite Direction	0	0	1	0	0	0	0	0
Sideswipe Same Direction	12	6	11	14	12	6	11	0
Backing	0	0	0	0	0	0	0	0
Rear to Rear	1	0	0	2	0	0	0	0
TOTAL	63	44	31	66	26	12	29	7

The frequency of crashes changed throughout a typical day, with 19 crashes occurring in the AM peak and 47 crashes occurring in the PM peak. The crash rate was found to be more pronounced in the PM, with an increased number for approximately three hours (3 PM to 6 PM). The weather effects on crashes was also reviewed. 162 crashes (58%) occurred during clear weather conditions, 57 crashes (21%) occurred under cloudy conditions, and 57 crashes (21%) occurred during rain events.

2.1.4 Reliability

Crashes and incidents that occur within the study area typically result in significant congestion and queueing. Options to reroute traffic during these incidents are limited due to interchange proximity, as the I-71/I-265 system interchange is approximately 3.75 miles to the north and the I-71/Zorn Avenue interchange is approximately 3.25 miles to the south. Any rerouting of traffic onto US 42 leads to significant additional congestion at this already congested interchange.

2.1.5 Environmental Overview

This Environmental Overview (EO) documents the environmental features currently known to exist within the study area for the I-71 / I-264 interchange planning study. Data collected for this summary is based on the review of existing GIS datasets, state and federal agency databases, literature research, archival data, and a limited windshield survey. Site reconnaissance and desktop research were performed to identify and locate areas of importance or concern within the study area. **Table 6** and **Figure 10** show the environmental categories and associated constraints within the study area.



The following information briefly summarizes potential environmental issues that may require consideration as part of the development of new alignment concepts or interchange configurations. The full EO is in **Appendix A**.

NATURAL ENVIRONMENT

The interchange area contains two unnamed intermittent and ephemeral streams that run adjacent to, perpendicular to, and through culverts underneath the existing interstate. The streams are poor quality with erosional banks and embeddedness. No mapped wetlands are present in the interchange area. The southwest portion of the study area is within a designated FEMA floodplain.

Several listed species with potential to occur in the study area were identified during early coordination with the US Fish and Wildlife Service. Species included three mammals (bats), one plant, and 10 mussel species. No critical habitats are within the study area. Known summer 1 habitat for the Indiana bat and northern long-eared bat are found in the study area. Gray bat summer foraging habitat is also found along the intermittent stream flowing along the southern extent of the study area. No other endangered species habitat is in the interchange area.

HUMAN ENVIRONMENT

The interchange study area should not create environmental concerns related to Environmental Justice, changes in land use or zoning, direct impacts to community facilities (e.g., schools, churches, parks), 6(f) resources, or farmland. Direct small-scale impacts to neighborhoods along I-264 could occur depending on a given alternative concept. Indirect, short-term impacts may occur to neighborhoods and community facilities as a result of construction activities. Improvements to existing infrastructure will occur on or adjacent to the interstate and the interchange. These activities will result in unavoidable disruption of travel to those living or working in or adjacent to the interstate and to all travelers who utilize this interstate corridor during construction activity.

The interchange improvement project is a “Project with Low Potential MSAT (Mobile Source Air Toxics) Effects” since the design year traffic is less than the 140,000 to 150,000 AADT range given in NEPA guidance. The study area is also in attainment for all transportation criteria air quality pollutants except for the 8-hour Ozone (2015) standard. Any future design project needs to be included in a conforming Transportation Improvement Program (TIP) and Statewide Transportation Improvement Program (STIP) for it to receive federal funding.

Based on the noise analysis results from the I-71 widening project (Item Number: 5-557.00) identifying noise impacts above Noise Abatement Criteria, noise impacts would be anticipated in the interchange study area. Therefore, a traffic noise analysis will likely be necessary for any potential interchange project as part of the environmental documentation necessary during the design phase of the project.



Table 6: Environmental Constraints Summary

Environmental Category	Environmental Constraint
Natural Environment	
Streams	Two intermittent and two ephemeral unnamed streams within existing right-of-way in the interchange area
Wetlands	None
Floodplains	Southwest portion of the interchange area is within a designated floodplain
Threatened & Endangered Species	Within Indiana bat and Northern Long-Eared bat Summer 1 priority habitat area, three bats, one plant, and eight mussels were listed by the USFWS for the study area; no habitat for plant or mussels
Geology	Outer Bluegrass Physiographic region underlain by limestone
Human Environment	
Air Quality	Project with Low Potential MSAT; Project would need to be included in conforming TIP and STIP
Noise	Noise impacts anticipated; traffic noise analysis to be completed in future for preliminary design alternatives
Environmental Justice	None – Minority and low-income populations low compared to state and county %
Land Use	No change in land use
Neighborhoods	Project adjacent to Indian Hills, Riverwood, Glenview, Glenview Hills, Northfield, and Glenview Manor
Community Facilities and Services	None
Farmland	None
Hazardous Materials/USTs	8 EDR sites were identified and remediated. Construction contractor should prepare contingency plan to address the removal/disposal of petroleum or hazardous contaminated soils that could be encountered during future road construction activities
Historic Structures	JF-534 - NRHP Listed; JF-2645 – NRHP Eligible
Archaeology	No Phase I archaeological survey expected (unless ground disturbance outside existing right-of-way in specified areas)
Section 4(f) Properties	No publicly owned parks or wildlife management areas Two NRHP listed and eligible sites in study area
Section 6 (f) Properties	No publicly owned parks in study area

A review of the Environmental Data Resources, Inc. (EDR) database search dated November 15, 2019 was conducted. Based on the review, eight sites are within the existing right-of-way or sufficiently close to that boundary to be of consideration. Of these sites, five are from the state spill and/or release related (SPILLS) database and three are spills recorded from the State Leads List (KY SHWS). The eight sites have been remediated. However, a construction contractor should consider preparing a contingency plan to address the removal/disposal of any petroleum/hazardous contaminated soils that could be encountered during future road construction activities. No underground storage tanks (USTs) were identified in the study area. If any bridges or other structures were to be demolished or renovated, they would require an asbestos inspection and abatement if any of the structures contain asbestos.



A cultural historic survey was completed for the I-71 widening project, which included a large portion of the interchange to determine the presence of above-ground resources within an Area of Potential Effect (APE) within the study area that may be listed in or eligible for listing in the National Register of Historic Places (NRHP). A NRHP-listed property (JF-534) (See **Figure 10**) is in the northwest portion of the study area and a NRHP-eligible site (JF-2645) is within the interchange area to the northeast. These two NRHP-listed and eligible sites would also be considered Section 4(f) resources. Neither of these sites would be expected to be adversely affected by any alternative concepts that remain within existing right-of-way. No Section 4(f) use is anticipated.

An archaeological overview was completed for the I-71 / I-264 interchange study area. It researched existing conditions pertinent to documented archaeological resources within the study area and assessed the potential for undiscovered resources. Most of the area of potential effect for the project is within disturbed right-of-way, and a full Phase I archaeological survey would not be anticipated. If future design changes require new right-of-way, an archaeological survey could be necessary, depending on the setting and conditions.

Figure 10: I-71 / I-264 Interchange Environmental Constraints





2.1.6 Geotechnical Overview

The study area is situated within the Bluegrass physiographic province of Kentucky and is depicted on the Jeffersonville Geologic Quadrangle Map (Map No. GQ-1211). This area is characterized by gently rolling hills caused by the gradual ongoing weathering of relatively thick-bedded Paleozoic limestone strata that has been structurally uplifted on a regional level by the Cincinnati Arch. The study area is immediately underlain with near-surface Silurian to Devonian-aged limestone beds of the Louisville and Jeffersonville Formations. This stratum is designated to have a medium to high karst potential by the Kentucky Geological Survey – thus the chemical dissolution of limestone can readily form sinkholes and caverns. Limestone beds are sub-horizontal, with no active or known faults or significant structural features mapped within the study area. Near-vertical rock cuts observed within the interchange, along with minor rock debris observed along the catchment areas, suggest relatively competent rock qualities.

The overlying soils within the area consist primarily of clay-like materials with sand fractions ranging from 5 to 10 feet in depth. These soils typically achieve adequate stability when constructed on 2H:1V cut slopes. A 15 foot overburden bench is typically utilized at the soil/rock interfaces. The underlying limestone appears to exhibit qualities sufficient to support 0.5H:1V pre-split cut slopes. Rock slopes less than 10 feet in depth are typically flattened to 2H:1V as preventative maintenance measure. Embankment slopes will vary depending on the quantity and quality of the materials available and heights required. Subgrade materials within this area typically require chemical stabilization be incorporated into the pavement design. Undercutting beneath areas where the pavement requires removal should be anticipated, as well as in any other low-lying areas.



2.2 Future Conditions

To develop and analyze the effectiveness of improvement options, future conditions within the study area were forecasted and modeled. This section contains information on the anticipated future conditions within the study area and the methods used to develop them.

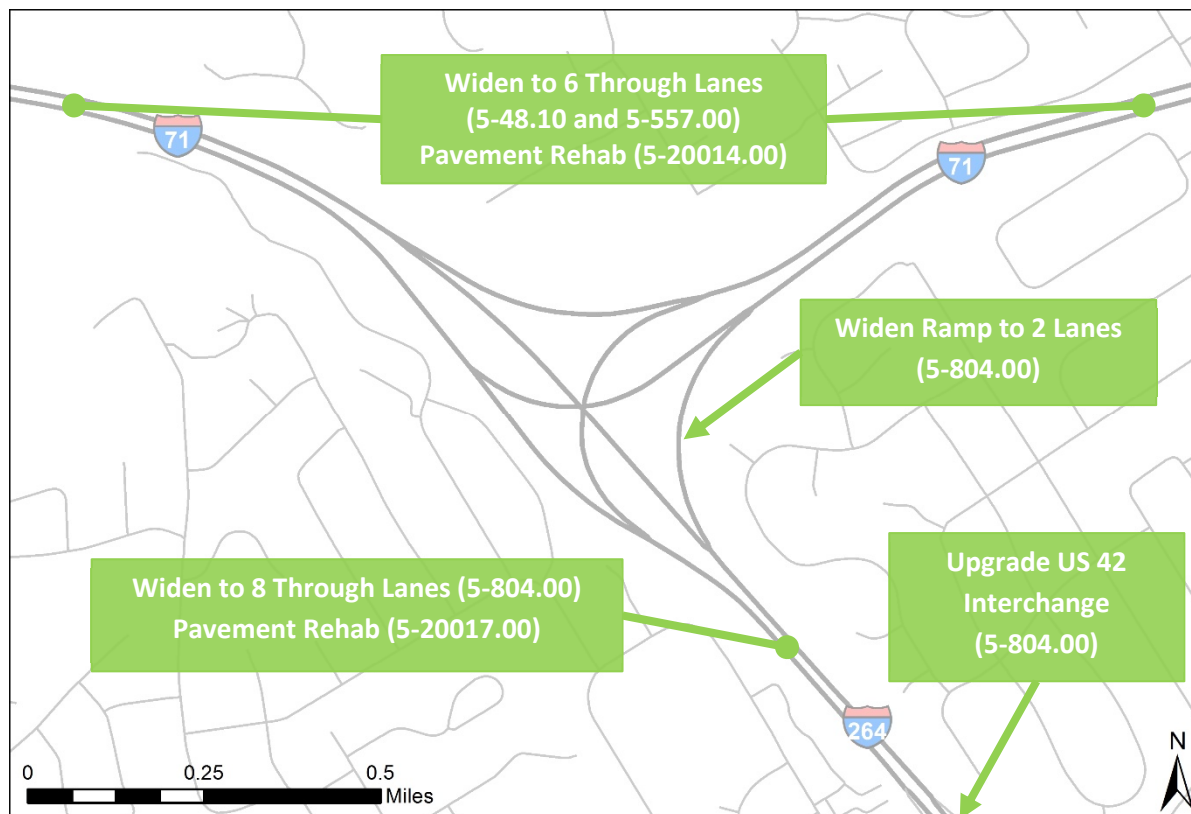
2.2.1 Planned Projects

ROADWAY PROJECTS

KYTC has several identified projects in *Kentucky's FY 2020 – FY 2026 Highway Plan* near the I-71 / I-264 interchange study area. It is anticipated that these projects will be built and open to traffic before the future analysis year of 2045 (future design year). The improvements to be made by these projects are illustrated in **Figure 11**.

- Item No. 5-48.10: This project adds a lane in each direction on I-71 from downtown Louisville near the Kennedy Interchange to the Zorn Avenue interchange and includes operational improvements to the Zorn Avenue interchange. This project is currently in the Design phase and *Kentucky's FY 2020 – FY 2026 Highway Plan* has Right-of-Way and Utility Relocation funds programmed in FY 2023 with Construction funds programmed in FY 2025.
- Item No. 5-557.00: The I-71 / I-264 interchange study is part of this project. This project is currently in the Preliminary Design Phase and proposes to add a lane in each direction of I-71 from the Zorn Avenue interchange to the I-265 interchange. Right-of-Way, Utility Relocation, and Construction funds are not identified in *Kentucky's FY 2020 – FY 2026 Highway Plan*. Improvement concepts developed as part of this study were created to be incorporated into the mainline widening of I-71.
- Item No. 5-804.00: This project adds a lane in each direction on I-264 (Watterson Expressway) from the I-71 interchange to the KY1447 (Westport Road) interchange and includes reconstructing the I-264 / US 42 interchange to a Single Point Urban Interchange (SPUI). This project is currently in the Design phase and *Kentucky's FY 2020 – FY 2026 Highway Plan* has Right-of-Way and Utility Relocation funds programmed in FY 2021, with Construction funds programmed in FY 2023.
- Pavement Rehabilitation Projects:
 - 5-20014.00: This project addresses the pavement condition of I-71 in both directions from milepoint 0.00 (Kennedy Interchange) to milepoint 11.32 (I-265 interchange) and runs through the study area. Design funds for this project have been authorized, and in *Kentucky's FY 2020 – FY 2026 Highway Plan* Construction funds are programmed in FY 2024.
 - 5-20017.00: This project addresses the pavement condition of I-264 in both directions from milepoint 20.7 (Westport Road interchange) to milepoint 22.9 (I-71 interchange). In *Kentucky's FY 2020 – FY 2026 Highway Plan*, Design funds are programmed in FY 2023 and Construction funds are programmed in FY 2024.

Figure 11: Planned Improvements in the Vicinity of the I-71 / I-264 Interchange



LAND DEVELOPMENTS

The United States Department of Veterans Affairs (VA) has been planning a new medical center to be located in the southeast quadrant of the US 42 / I-264 interchange, which is less than one mile from the study area. This medical center is set to replace the existing hospital facility currently located off Zorn Avenue near the I-71 interchange. The new medical center includes approximately 1 million gross square feet and will contain 104 full-service hospital beds. The construction schedule as of December 2020 is to have the medical facility constructed by 2025 and fully activated in 2025 and 2026³.

When fully built out, this hospital is expected to generate 10,044 daily trips. During the AM Peak Hour, it is expected that 642 (80%) vehicles will enter the facility with 161 (20%) exiting. In the PM Peak Hour, 156 (20%) vehicles are expected to enter the facility with 625 (80%) exiting.⁴ The traffic generated by this facility was considered in the traffic forecasts developed for the I-71/I-264 study.

³ <https://www.louisville.va.gov/newmedicalcenter/docs/New-Medical-Center-Presentation-Fireside-Chat-Dec-29-2020.pdf>

⁴ <https://www.louisville.va.gov/newmedicalcenter/docs/Louisville-VAMC-App-A-B-FINAL-EIS-033017.pdf>

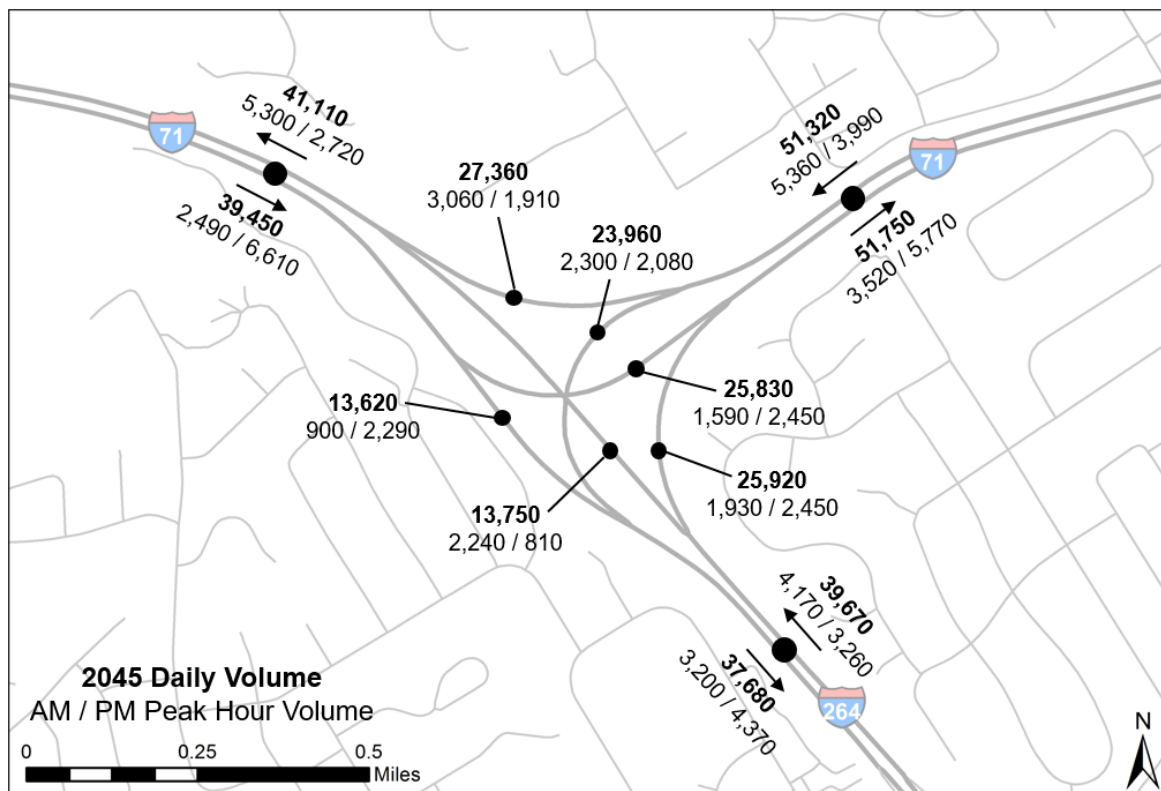
2.2.2 Future Traffic Conditions

The eastern part of Jefferson County has seen tremendous traffic growth over the past 20 years. This growth can be attributed to several factors, including residential developments in Oldham and eastern Jefferson County; high-density medical, retail, and employment centers near interchanges; and the commutes to and from these locations. Over the past 20 years, traffic has grown by approximately 20% on I-71 between I-264 and I-265 and by approximately 26% on I-264 between US 42 and I-71. Traffic on I-71 between the I-264 interchange and downtown Louisville has remained relatively constant during this time, likely due to traffic being diverted with the opening of the East End Bridge in December 2016. This bridge provided another connection to southern Indiana.

VOLUMES

A traffic forecast was developed that encompassed the I-71 corridor from downtown Louisville to the I-265 interchange and I-264 as it approaches I-71. Daily and peak-period volumes were projected for an opening-to-traffic year of 2025 and a design year of 2045. The Kentucky Statewide Model and the Kentuckiana Regional Planning and Development Agency's (KIPDA) travel demand model were used to develop the future traffic volumes. A growth rate of 1.30% was used for I-71 south of the interchange, 1.18% for I-71 north of the interchange, and 0.76% for I-264⁵. **Figure 12** shows the forecasted 2045 AM and PM Peak Hour volumes during these time periods.

Figure 12: 2045 Forecasted Traffic Volumes

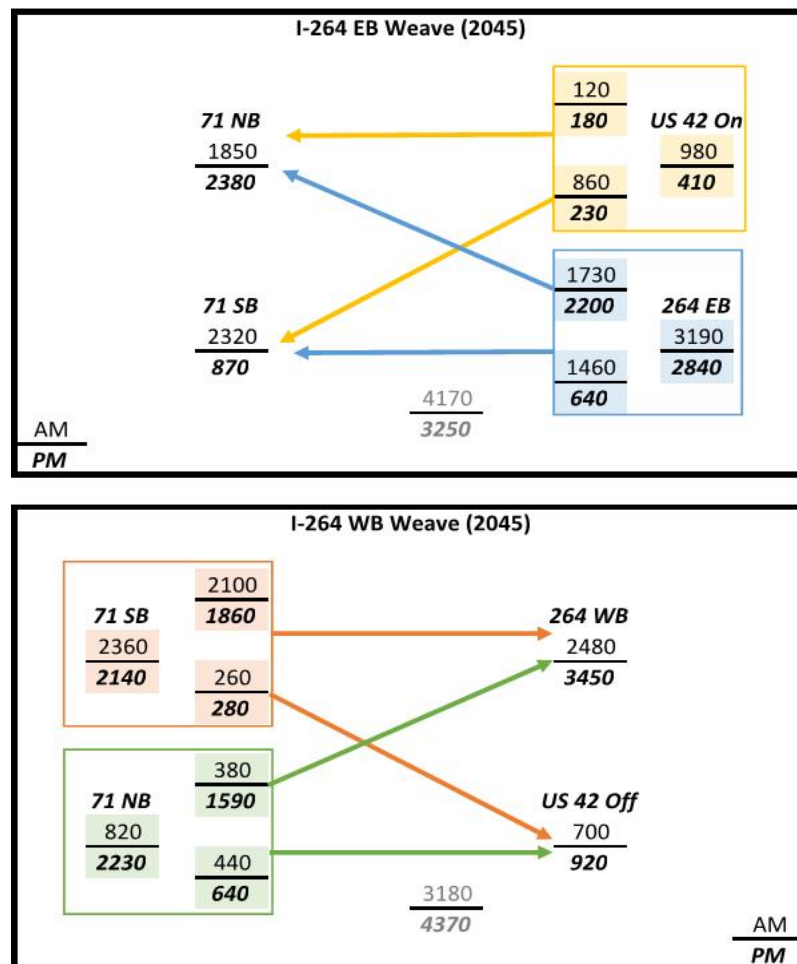


⁵ Growth rate data from October 2019 Traffic Forecast

WEAVING VOLUMES

The weaving sections on I-264 between the US 42 interchange and I-71 were looked at in further detail. Growth was applied to the weaving movements to represent the 2045 build year. A review of the weaving areas shows that during both the AM and PM peak periods more vehicles are predicted to change lanes in the I-264 EB weaving area (2,590 AM, 2,430 PM) than in the I-264 WB weaving area (640 AM, 1,870 PM). This conflicting volume is expected to reduce speeds and create the potential for safety issues. **Figure 13** gives a breakdown of the I-264 EB and I-264 WB weaving volumes in the 2045 build year.

Figure 13: 2045 Forecasted Weaving Volumes



TRAFFIC OPERATIONS (NO-BUILD)

To evaluate traffic operations in 2045, additional analysis was conducted. The analysis included using Highway Capacity Software (HCS) and FREEVAL and validating those results using Vissim microsimulation modeling. Performance metrics included AM and PM peak-hour average travel time, average speed, average delay, and average LOS.

Table 7 highlights the general network performance metrics for speed, density, and LOS based on the Vissim analysis of the No-Build AM and PM peak conditions.

Table 7: Vissim Summary Results for Existing and No-Build Conditions

Model Results	Existing (2019)						No-Build (2045)*					
	AM			PM			AM			PM		
Roadway Segments	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS	Speed	Density	LOS
I-71 NB before Diverge	58.19	10.65	B	55.29	25.13	C	58.88	16.50	B	21.52	110.70	E
I-71 NB Thru System	52.12	10.75	A	56.59	20.28	C	52.04	15.50	B	51.17	24.13	C
I-71 NB to I-264 WB	59.77	6.15	A	57.14	16.15	B	59.15	7.73	A	55.66	15.00	B
I-71 NB after Merge	55.41	16.05	B	53.40	25.55	C	66.74	20.65	C	57.46	26.17	C
I-71 SB before Diverge	35.37	37.79	E	40.73	26.04	C	55.24	87.89	E	32.41	77.89	E
I-71 SB Thru System	50.64	19.51	C	51.61	13.12	B	51.18	25.76	C	51.01	16.61	B
I-71 SB to I-264 WB	41.71	41.92	E	41.59	41.25	E	41.36	46.58	F	41.73	43.70	E
I-71 SB after Merge	54.13	17.26	B	53.89	9.20	A	53.57	15.84	B	53.69	11.18	B
I-264 EB Weave	30.63	41.33	E	11.37	74.25	F	44.47	15.84	B	55.90	22.30	C
I-264 EB to I-71 NB	48.32	33.02	D	46.21	39.95	E	51.80	19.29	C	51.40	24.50	C
I-264 EB to I-71 SB	57.79	15.47	B	56.00	5.44	A	51.00	18.57	C	59.48	6.10	A
I-264 WB Weave	57.65	14.42	B	55.08	21.56	C	59.05	18.35	B	58.49	20.24	C
I-264 EB On Ramp	30.82	21.73	C	31.12	8.79	A	16.52	16.46	B	16.51	17.64	B
I-264 WB Off Ramp	42.36	5.80	A	40.23	9.39	A	39.51	11.44	B	39.31	10.82	A

*Includes widening I-71 to 6 mainline lanes north and south of the interchange. Also includes the 5-804 project with additional lanes on I-264 and a 2-lane ramp.

As shown in **Table 7**, it is anticipated that the interchange performance (speed, density, and LOS) would still be an issue even with the adjacent widening projects.

Where performance metrics improve from Existing to the No-Build conditions, this is likely attributable to either the additional capacity provided by the widening (I-71 and/or adjacent 5-804.00 project) or the lack of volume processing through the network due to bottlenecks. The density and LOS decline in several places between the Existing and No-Build conditions, illustrating the importance of additional improvements. These improvements are necessary for the interchange to maintain operational conditions as several key interchange components are anticipated to experience poor LOS. In particular, the I-71 SB to I-264 WB ramp is anticipated to exceed available capacity without additional capacity as shown by the LOS F conditions and lower speeds in the No-Build conditions.

SAFETY

To compare improvement options to a baseline, a future No-Build (2045) predictive safety analysis was developed using the Highway Safety Manual's (HSM) Interchange Safety Analysis Tool enhanced (ISATe) Excel spreadsheet. This future No-Build scenario assumed that project 5-557.00 was completed by widening I-71 to six lanes from the Zorn Avenue interchange to the I-265 interchange, and that project 5-804.00 was implemented by adding additional lanes to I-264 between I-71 and the US 42 interchange, replacing the US 42 interchange, and adding an additional lane to the I-264 EB to I-71 NB ramp. Geometry of the other ramps remained the same. The results of



this analysis predicted that over a period of 20 years (2026-2045), 1,412 total crashes would occur, averaging 70.6 crashes per year. The undiscounted total crash cost is estimated to be \$171.1 million over the 20-year period. See **Sections 7.2.1, 7.2.2, and 7.2.3** in the report for the predictive safety analysis comparing future concepts to this baseline.



3 Goals and Objectives

The main goal of the I-71 / I-264 Interchange Study is to develop several physically and fiscally feasible interchange improvement concepts that meet the following three primary objectives:

1. Improve traffic operations
2. Improve safety
3. Promote reliability of the regional interstate system

The I-71 / I-264 system interchange in Jefferson County, KY is a critical piece of infrastructure serving and connecting Louisville, Southern Indiana, and the rest of Kentucky. The current I-71 / I-264 interchange cannot adequately support current or future traffic demands and has been identified for improvements.

As noted previously, widening projects for I-71 and I-264 that tie into this interchange are currently in the project development phase. These projects should improve traffic operations and safety by adding capacity to the existing system (new lanes) and upgrading key interchange elements (ramps and intersections) to adequately move people and goods. Traffic delays, congestion, and safety issues at the I-71 / I-264 interchange are already evident and are projected to become more significant in the future.

The primary objective of the study is to improve the interchange to better accommodate peak-period traffic volumes, while improving safety at this interchange. Crashes within the interchange have caused fatalities, serious injuries, and significant traffic delays. Safety enhancements are also needed to reduce severe crashes and to promote the reliability of the interstate traffic flow.



4 Initial Concept Development

The development of the initial interchange improvement concepts began with a conceptual design charrette including members of the project team. The purpose of holding this charrette was to brainstorm initial improvement concepts, which would be used to develop a priority list of ideas to further investigate with this interchange planning study. These initial concepts included a wide range of scope, ranging from large complete interchange rebuilds, to medium-sized improvements that could be constructed in phases or included in I-71 mainline widening, to smaller low-cost, short-term improvements.

Constructability and budget friendliness were two factors that came into play when developing these initial concepts. These concepts needed to focus on improving traffic operations while minimizing any right-of-way acquisitions to build the improvement. Other concerns that were factored in when developing these initial concepts included safety performance, design constraints, and the phasing of construction of these concepts.

The charrette attendees were split into two groups for this brainstorming effort. Section 4.1 and Section 4.2 provide a summary of the initial concepts this group developed and of additional concepts that were developed shortly after the meeting.

4.1 Interchange Concepts

Five interchange concepts were developed by the project team at the charrette, and soon after an additional three concepts were developed. Below is a brief summary of each of these concepts. A more detailed description and concept drawings can be found in **Appendix B**.

- Concept Bombardier-A: This concept requires the reconstruction of the majority of the interchange and also addresses the weave with the adjacent US 42 interchange in both the EB and WB directions. All exit ramps diverge on the right side. Through the interchange, the I-71 NB radius is increased to run parallel to I-71 SB, thus making this the main movement through the interchange. Collector-Distributor (C-D) lanes replace the weave on I-264 in the EB and WB directions. This concept requires five new bridges to be constructed.
- Concept Bombardier-B: This concept requires the reconstruction of the majority of the interchange and also addresses the weave with the adjacent US 42 interchange in both the EB and WB directions. This concept is similar to Concept Bombardier-A except that the radius for I-71 SB is decreased to run parallel to I-71 NB. This concept requires three new bridges at the interchange and also a new bridge at the ramp from US 42 to I-264 EB to accommodate the C-D lane.
- Concept Bombardier-C: This concept focuses on the merge between the I-71 NB through movement and the I-264 EB to I-71 NB ramp. The ramp from I-264 EB to I-71 NB is made the major movement with I-71 NB moved to merge from the right. One new bridge is needed for this concept (**Figure 14**).
- Concept Hume-A: This concept increases the radius of I-71 NB in the interchange area. The weaves between US 42 and I-71 in both directions remain and the left-sided exits and entrances remain. The I-71 SB to I-264 WB ramp is widened to become a two-lane

ramp. This concept provides lane balance for each merge and diverge point at the interchange. There are two new bridges and one bridge is widened for this concept.

- Concept Kinzel-A: This concept requires the reconstruction of a portion of the interchange and does not address the I-264 EB and WB weave. This concept would convert the interchange into a turbine-like facility that leaves some left-sided merges and diverges. Three new bridges would be constructed with this concept (**Figure 15**).
- Concept Davis-A (Post Charette): This concept looks to increase ramp radius while remaining within the existing right-of-way footprint. Lane balance at the diverge points is created and the I-71 SB to I-264 WB ramp is made into a two-lane ramp. The concept requires the construction of three new bridges.
- Concept Matheny-A (Post Charette): This concept moves I-71 NB and SB to the center of the interchange and creates right sided entrances and exits on I-71. The weave on I-264 EB and WB remains and the ramp from I-71 SB to I-264 WB is made into a two-lane ramp. This concept requires three new bridges to be constructed.
- Concept Matheny-B (Post Charette): This concept is similar to Matheny-A, except that the geometry of I-71 through the interchange is slightly different. This concept also requires three new bridges, and these bridges are slightly longer than those in Concept Matheny-A.

Figure 14: Concept Bombardier-C

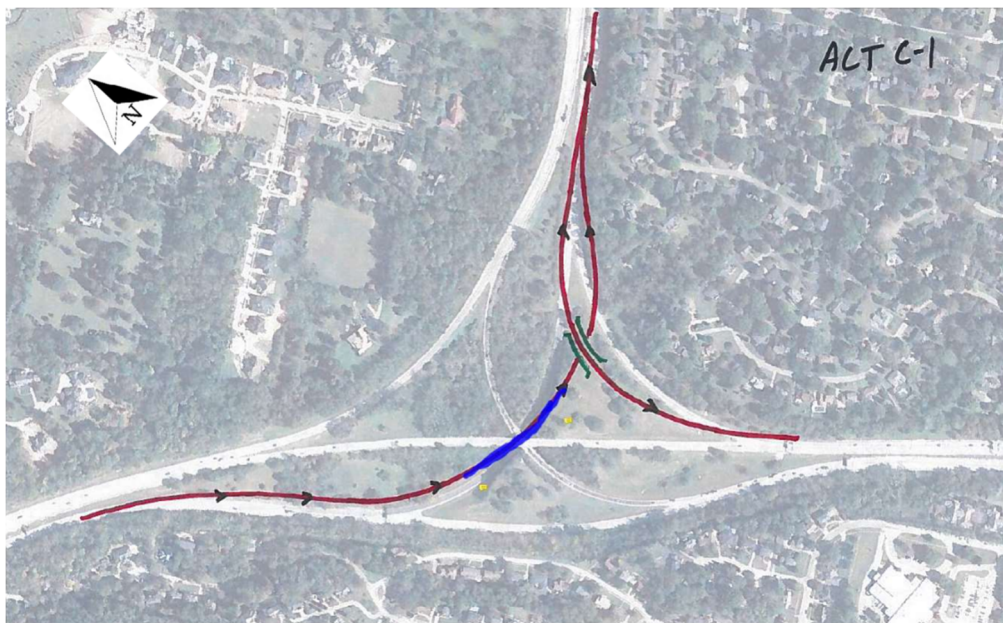




Figure 15: Concept Kinzel-A



4.2 Low-Cost, Short-Term Improvements

Eight lower-cost improvement concepts were initially developed that were smaller in scale than the full interchange concepts but could be implemented more immediately to address spot improvement needs. Below is a summary of these improvement options. A more detailed description and concept drawings can be found in **Appendix J**.

- Extend Third I-71 NB Lane Under Lime Kiln Lane Bridge: The extension of this lane lengthens the merging distance (approximately by 1000 feet) on the I-264 EB to I-71 NB ramp and was expected to improve safety and capacity.
- Add Median Barrier Gates: The installation of these gates to provide emergency access through a median barrier is expected to improve emergency response time and could improve system reliability. The segment of I-71 between I-264 and I-265 is a candidate for this installation.
- Lane Tattoos: These thermoplastic route shields can help motorists better understand lane assignments and aid them in getting into the proper lane sooner, thus reducing last-minute weaves and increasing decision-making times. These pavement markings are helpful in advance of diverge points, such as the I-71 NB diverge.
- Guide Signing Improvements: This low-cost option looks to improve the existing overhead guide signs in advance of the I-71 NB diverge. This option would remove the



diagrammatic signs on I-71 NB in advance of the interchange and replace them with arrow-per-lane overhead signing.

- Vegetation Management: This option would remove trees, foliage, and brush around curves that restrict sight distance. The most notable example at this interchange is the I-71 NB curve in the middle of the interchange. Improving this sight distance is expected to have a positive impact on reducing rear-end collisions with stopped traffic.
- Dynamic Congestion Warning Signs: This option would install dynamic signs that would be triggered by queued traffic within the interchange. This information would warn drivers approaching the interchange of the slow or stopped traffic, thus decreasing the potential for rear-end collisions.
- Barrier and Shoulders through Rock Cut: This low-cost option would widen the shoulder through the I-71 NB curve within the interchange and add a barrier at the outside of the shoulder.
- I-71 NB and I-264 EB Ramp Gore Extension: This low-cost option extends the gore area, thus encouraging a merge further downstream. This could give drivers more time to plan the merge and increase safety. This extended gore area could be accomplished with increased striping or with physical delineators.



5 Level 1 Screening

The Level 1 Screening process evaluated the initial interchange concepts that were developed as part of the design charrette and immediately afterward. The purpose of the screening was to remove concepts that did not meet the study's goals and objectives. It thereby identified concepts for further refinement and analysis, including more detailed traffic, safety, and cost-estimating work. The decisions that were made at the Level 1 Screening meeting were documented in the Level 1 Screening Meeting Minutes which are available in **Appendix D**.

5.1 Concept Families (A-H)

There were fifteen (15) interchange concepts developed for the Level 1 Screening process. Concepts with similar attributes, such as the alignment of I-71 through the interchange, were grouped into eight (8) concept families (A, B, C, D, E, F, G, H). Below is a description of each of the concept families that were presented for Level 1 Screening, and **Figure 16** shows some examples of these concepts (red is new construction; blue is existing to remain). More detailed concept drawings are provided in **Appendix E**.

5.1.1 A Family Concepts

The A family of concepts (**A-1**, **A-2**) address the tight horizontal curvature of I-71 NB through the interchange by increasing this radius and bringing both I-71 NB and SB together onto a shared alignment. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. The diverge from I-71 SB to I-264 WB is changed from a left-sided exit to a right-sided exit and the merge from I-264 EB to I-71 SB is changed from a left-sided to a right-sided entrance to better meet driver expectations.

Differences between these two concepts are focused on I-264 between I-71 and US 42. These EB and WB weaves on I-264 remain in place in Concept A-1, whereas concept A-2 removes the weaves to address issues that can occur in weaving sections by providing bypass ramps in the EB and WB direction. By addressing the possible weave issues, Concept A-2 requires four additional bridges to be constructed and minor right-of-way acquisitions, whereas Concept A-1 requires only two new bridges with no anticipated right-of-way impacts. Concept A-2 also braids the I-71 SB to I-264 WB ramp with the ramp from I-71 NB to better align traffic with its intended destination.

5.1.2 B Family Concepts

The B family of concepts (**B-1**, **B-2**) both bring the I-71 SB alignment in line with the existing I-71 alignment, but address sight distance issues that exist by providing a wider inside shoulder through the curve. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. The diverge from I-71 SB to I-264 WB is changed from a left-sided exit to a right-sided exit and the merge from I-264 EB to I-71 SB is changed from a left-sided to a right-sided entrance to better meet driver expectations.

Differences between these two concepts are focused on I-264 between I-71 and US 42. These EB and WB weaves remain in place in Concept B-1, whereas Concept B-2 removes the weaves to address issues that can occur in weaving sections by providing bypass ramps in the EB and



WB directions. By addressing the possible weave issues, Concept B-2 requires five additional bridges to be constructed and minor right-of-way acquisitions, whereas concept B-1 requires only three new bridges with no anticipated right-of-way impacts. Concept B-2 also braids the I-71 SB to I-264 WB ramp with the ramp from I-71 NB to better align traffic with its intended destination.

5.1.3 C Family Concepts

The C family only contains one concept, **C-1**. The majority of the I-71 / I-264 interchange is left intact with this concept. I-71 NB through the interchange diverges further to the west and braids under the ramp from I-264 EB entering on the right side of this ramp, thus increasing the radius of I-71 through the interchange. The ramp from I-264 EB to I-71 NB is realigned to enter I-71 mainline on the left side. One new bridge is required, and no additional right-of-way acquisitions are anticipated.

5.1.4 D Family Concepts

The D family concepts (**D-1**, **D-2**) address the tight horizontal curvature through the interchange on I-71 NB by increasing the radius and moving the diverge point further west. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. Other common characteristics include retaining the existing left-sided entrance and exit ramps on I-71 SB and also retaining the weaving sections on I-264 in the EB and WB direction.

The distinguishing difference between the D family concepts is in the area where the ramps from I-71 SB and I-71 NB merge into I-264 WB. Concept D-1 keeps the existing configuration with the exception of an added lane. Concept D-2 braids the ramp from I-71 NB over the ramp from I-71 SB before they merge into I-264 WB to better align traffic with its intended destination. Concept D-1 would require the construction of two new bridges whereas Concept D-2 requires three new bridges. Both concepts are anticipated to not need any additional right-of-way.

5.1.5 E Family Concepts

The E family only contains one concept, **E-1**. Concept E-1 has characteristics similar to a turbine type interchange. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. Merges are changed to added lanes for each entrance ramp in this concept to improve traffic flow. The I-264 WB weave distance increases by approximately 875 feet to allow for better weaving operations. Three new bridges are required, but no additional right-of-way acquisitions are anticipated.

5.1.6 F Family Concepts

The F family only contains one concept, **F-1**. To improve the horizontal curvature through the interchange, I-71 NB and SB are brought closer together but stay on separate alignments. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. The diverge from I-71 SB to I-264 WB is changed from a left-sided exit to a right-sided exit to better meet driver expectations. This concept also braids the I-71 NB to I-264 WB ramp over the ramp from I-71 SB to better align traffic with its intended destination. A slip lane is created from I-71 NB to I-264 WB to better align traffic exiting with an ultimate destination to the US 42 exit to improve the operations of this weaving section. Three new bridges would be needed, but no additional right-of-way acquisitions are anticipated.



5.1.7 G Family Concepts

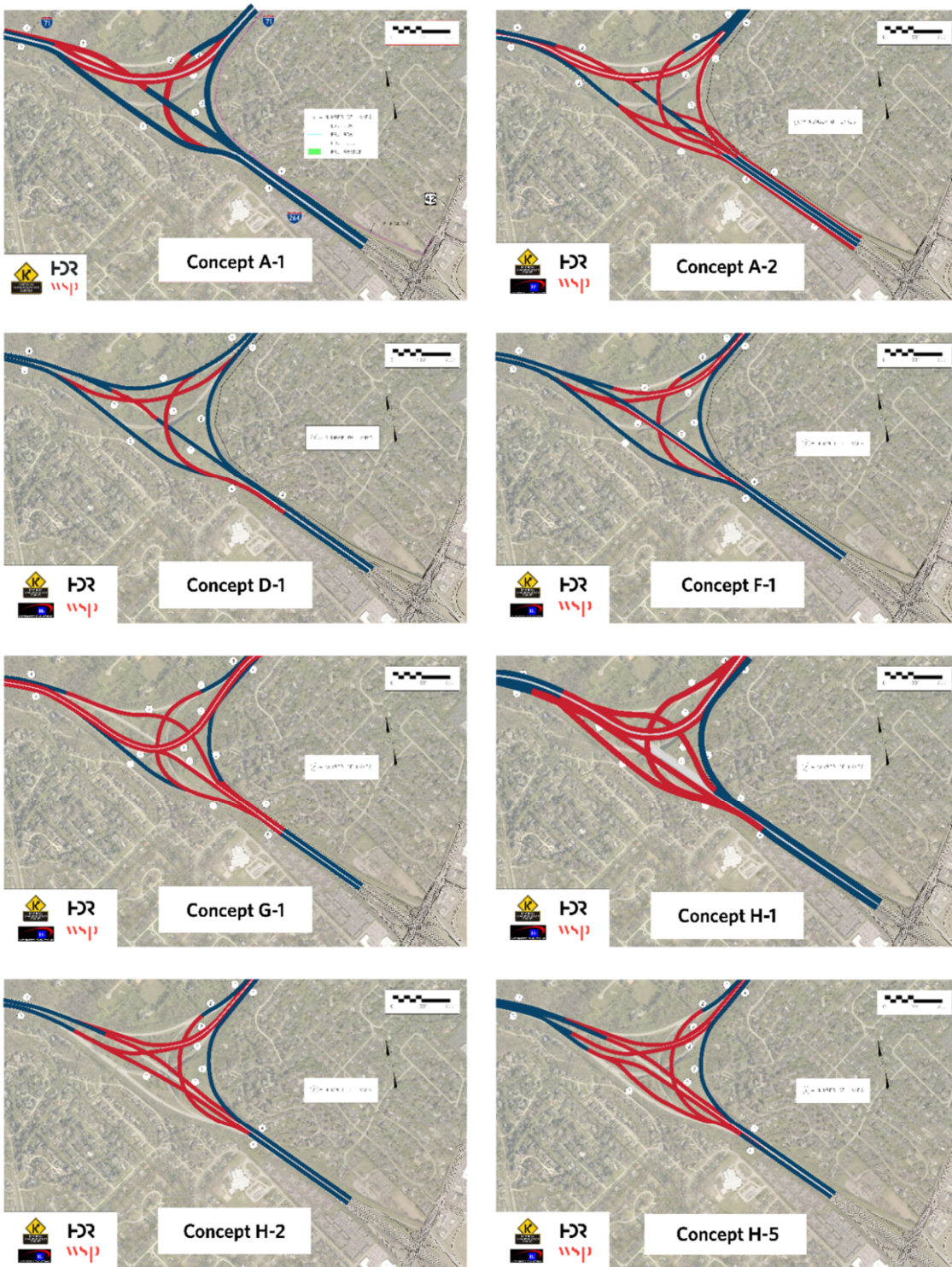
The G family contains only one concept, **G-1**. I-71 SB through the interchange is moved onto the same alignment as I-71 NB, thus not improving the radius of I-71 NB through the interchange. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. The diverge from I-71 SB to I-264 WB is changed from a left-sided exit to a right-sided exit and the merge from I-264 EB to I-71 SB is changed from a left-sided to a right-sided entrance to better meet driver expectations. This concept also braids the I-71 NB to I-264 WB ramp under the ramp from I-71 SB to better align traffic with its intended destination. A slip lane is created from I-71 NB to I-264 WB to better align traffic exiting with an ultimate destination to the US 42 exit to improve the operations of this weaving section. Three new bridges would be needed, but no additional right-of-way acquisitions are anticipated.

5.1.8 H Family Concepts

The H family of concepts (**H-1**, **H-2**, **H-3**, **H-4**, **H-5**) address the tight horizontal curvature of I-71 NB through the interchange by increasing the radius. The ramp from I-71 SB to I-264 WB is widened from one to two lanes to address capacity concerns. The diverge from I-71 SB to I-264 WB is changed from a left-sided exit to a right-sided exit to better meet driver expectations.

The main differences between the concepts are that H-1 also changes the merge from I-264 EB to I-71 SB from the left to the right side to improve driver expectations, while the other H concepts retain the left-sided entrance. In all of these concepts, the weaves on I-264 in the EB and WB direction are retained, but ramps from I-71 SB and I-71 NB to I-264 WB are braided in H-2 and H-5 to better align traffic with its intended destination. For concept H-1 and H-5, a slip lane is created from I-71 NB to I-264 WB to better align traffic exiting with an ultimate destination to the US 42 exit to improve the operations of this weaving section. Concepts H-1, H-3, and H-4 all would require three new bridges, and concepts H-2 and H-5 would require four new bridges. All concepts are not anticipated to need additional right-of-way.

Figure 16: Example Level 1 Concepts



Full page drawings of each concept are included in **Appendix E**. Above: Red = New Construction, Blue = To Remain



5.2 Evaluation Criteria Matrix

An evaluation matrix was used to more easily show the benefits and challenges of each of the Level 1 Analysis concepts. At this stage of analysis, a higher-level look was taken to compare attributes among the concepts. **Table 8** presents a summary of the evaluation matrix, showing how the concepts scored comparatively (+, 0, -) in seven evaluation categories. It highlights those that were recommended for further evaluation in Level 2. **Appendix H** contains the full Level 1 Screening Evaluation Matrix. The attributes used to screen and select concepts for further analysis are summarized below.

5.2.1 Major Elements

The major areas of improvement that each concept was to address were listed, including realigning I-71, changing left-sided to right-sided exit and entrance ramps, the inclusion of C-D or braided lanes, and changes in ramp radius.

5.2.2 Concept Cost

A qualitative description of concept cost was included by showing very high, high, or moderate costs. The number and size of new bridges was a major contributing factor for this metric.

5.2.3 Right-of-Way Impacts

A general observation of the need for additional right-of-way was made for each concept, and concepts were rated based on the anticipated need for additional right-of-way.

5.2.4 Design Challenges

Each concept presents its own unique challenges. These challenges included the need to construct additional bridges, design speeds, and maintaining vertical clearance between existing structures.

5.2.5 Maintenance of Traffic (MOT)

The ability to maintain traffic while interchange improvements are being constructed was another major screening criterion. Much like project costs, maintenance of traffic was looked at qualitatively at this stage, with each concept ranging from moderate to difficult. It was also noted if temporary roads or ramps were needed as part of construction.

5.2.6 Environmental Constraints

The environmental impacts and constraints for each concept were minimal.

5.2.7 Mobility Improvements

This criterion recognizes key improvements to traffic flow through the interchange. Some of these key improvements included removing weaving, creating ramp braiding or C-D lanes, and increasing weaving distance.

5.2.8 Safety Improvements

Each concept was reviewed and graded on whether it was expected to provide safety benefits or not. An ISATe analysis was used predict future crashes.



5.2.9 Benefits and Drawbacks

A review of the above-mentioned criteria was made to show the potential benefits and drawbacks of each concept.

Table 8: Level 1 Evaluation Table

ALT	NAME	COST	RIGHT-OF-WAY	DESIGN CHALLENGES	MOT	ENVIRONMENT	MOBILITY	SAFETY	BENEFITS	DRAW BACKS	DISPOSITION
Ex	Existing	0	0	0	0	0	0	0	0	0	Ex Baseline
Fut. NB	No-Build w/ US 42 & I-71 Imp	0	0	0	0	0	0	0	0	0	Fut. Baseline
A-1	2-Level T	--	0	+	--	+	+	+	0	0	Carry Forward
A-2	2-Level T w/ CDs	--	--	+	--	+	+	+	0	0	Carry Forward
B-1	2-Level W/ I-71 in Curve	--	0	--	--	+	+	--	0	0	Dismiss
B-2	2-Level W/ I-71 in Curve & CDs	--	--	--	--	+	+	--	0	0	Dismiss
C-1	I-71 NB Right-Handed	0	--	+	--	+	0	0	0	0	Dismiss
D-1	Upgraded Existing w/Switch	+	+	+	--	+	+	+	0	0	Carry Forward
D-2	Upgraded Existing	--	+	+	--	+	+	+	0	0	Dismiss
E-1	Turbine Style Design	--	+	0	--	+	+	--	0	0	Dismiss
F-1	2-Level T w/US 42 Ramp	--	+	+	+	+	+	+	0	0	Carry Forward
G-1	I-71 On Existing NB Alignment	--	+	--	--	+	+	--	0	0	Dismiss
H-1	2-Level T w/ New SB to WB Ramp	--	+	+	--	+	+	--	0	0	Carry Forward
H-2	2-Level T w/ 4 Bridges	--	+	+	+	+	+	--	0	0	Carry Forward
H-3	2-Level T w/ off-align 264WB	--	+	+	+	+	+	--	0	0	Carry Forward
H-4	2-Level T w/ Exist 264WB	--	+	+	--	+	+	--	0	0	Carry Forward
H-5	2-Level T w/ New SB to WB Ramp	--	+	+	--	+	+	--	0	0	Carry Forward

0 = equal; -- = scored less; + = scored better

5.3 Level 1 Screening Results

Each of the fifteen (15) Level 1 Screening concepts was compared to the study goals and objectives. The concepts that best met the study goals and objectives were chosen to carry forward for further review and analysis at the Level 2 stage. These included the A-family of concepts (**A-1** and **A-2**), concept **D-1**, concept **F-1**, and the H-family of concepts (**H-1**, **H-2**, **H-3**, **H-4**, **H-5**). The concepts that did not meet screening criteria were removed from further analysis and included the B-family of concepts (**B-1** and **B-2**), concept **C-1**, concept **D-2**, concept **E-1**, and concept **G-1**.

The low-cost improvement concepts were also screened as part of the Level 1 analysis. All of the low-cost improvement concepts were retained for further analysis except for the installation of median gates to aid in emergency response times. This type of improvement would be located along mainline freeway segments, and therefore fell outside the limits of this study.



6 Public and Stakeholder Engagement

Input was solicited from the public and stakeholders to better understand their views on the issues in the interchange area. This input was helpful for confirming and further documenting key traffic operations and safety issues. This engagement process was conducted in coordination with the I-71 widening projects. Public involvement for these projects was combined because the majority of the users of these facilities are the same, and many of the stakeholders are similar.

6.1 Stakeholder Meeting

A virtual stakeholder meeting was held on July 27, 2020 that included local and state elected officials, emergency services, education representatives, major stakeholders, and the project team. The meeting provided attendees with an overview of the project, including a description of the goals and objectives, environmental constraints, and key project background information. In addition to the I-71 / I-264 Interchange study, the meeting covered I-71 widening from Zorn Avenue to I-265 (associated with this study – 5-557.00) and also covered widening from the Kennedy interchange to the Zorn Avenue interchange along with improvements to the Zorn Avenue interchange (project 5-48.10).

During the meeting there was an explanation of the planning effort underway at the I-71 / I-264 interchange. This included a discussion of the traffic and safety benefits of the projects adjacent to the interchange (5-557.00 and 5-804.00). It also included a discussion of the remaining traffic and safety challenges in the interchange.

The attendees brought up their concerns, including traffic generated by the proposed VA Hospital near the US 42 interchange. The traffic generated by this site, along with other regional projects, was considered in the traffic forecast, and a sensitivity analysis has since been performed to test a range of growth assumptions. There was concern about the tight radius on I-71 northbound through the interchange, even with the recent addition of lighting and high friction surface. It was also noted that short-term solutions will be considered in this planning study along with larger longer-term improvements.

6.2 Public Outreach and Survey

Public input for the interchange planning study was obtained using an on-line survey available during July and August of 2020. In addition, an online StoryMap⁶ was created to present the project goals and objectives, environmental constraints, and other important project information. A link to the survey was posted on the KYTC Highway District 5 project webpage⁷ and was also promoted through KYTC Highway District 5 social media accounts. A review of Facebook analytics has shown that the post reached approximately 10,000 individuals. Close to 900 individuals provided a response to the online survey.

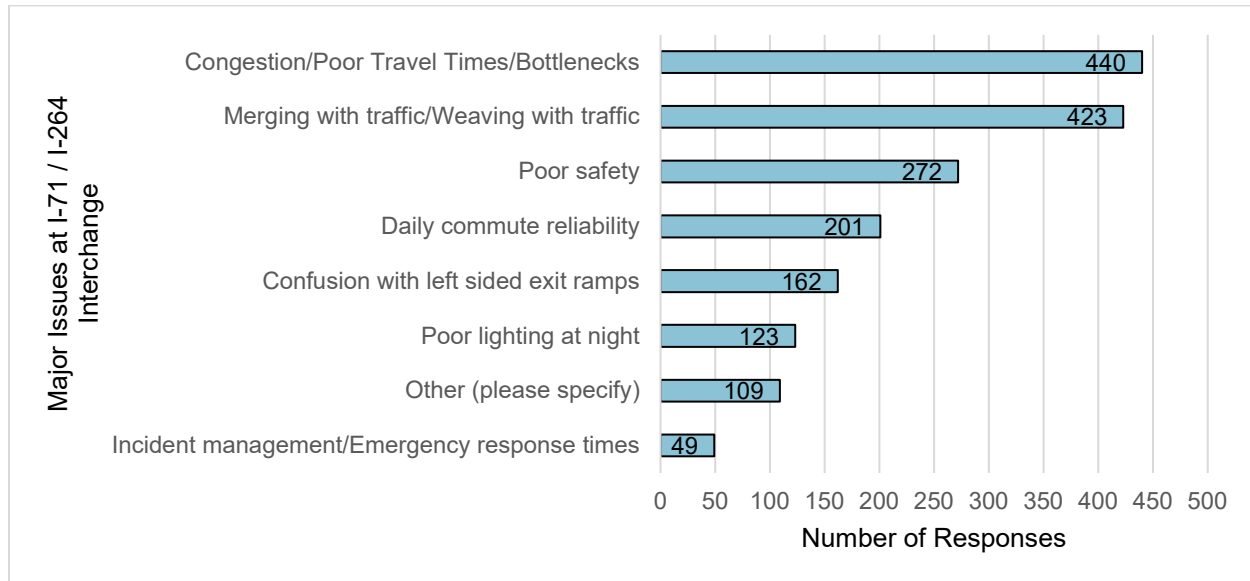
The public was asked ten questions in the survey, with three of these focused on the I-71 / I-264 interchange. The first question sought input on major issues the public experienced while

⁶ <https://storymaps.arcgis.com/stories/44b0199d28b64e8398ed861181359b5f>

⁷ <https://transportation.ky.gov/DistrictFive/Pages/I-71-Widening-from-Downtown-Louisville-to-I-265.aspx>

traveling through the interchange. The most frequent three responses were: Congestion/Poor Travel Times/Bottlenecks, Poor Safety, and Merging/Weaving with Traffic. **Figure 17** presents the survey results (Respondents selected their top three issues experienced at the interchange).

Figure 17: Survey Responses for Major Issues at the Study Interchange



The second question regarding this interchange asked the public to select the top three locations they see as problem areas. The top three responses were:

- EB I-264 weave between the US 42 interchange and the I-71 interchange (341 responses)
- Merge between NB I-71 traffic and the ramp from EB I-264 (297 responses)
- WB I-264 weave between the I-71 interchange and the US 42 interchange (226 responses)

The third question about this interchange asked if the public had any additional comments or concerns. The majority of responses repeated concerns from the problem area question. These additional comments and a summary of the Local Officials Meeting can be found in **Appendix F**.



7 Level 2 Evaluation

The purpose of the Level 2 Evaluation was to perform a more in-depth review of the concepts retained from the Level 1 Analysis to further narrow down the number of concepts for a final recommendation. A future year traffic operations analysis was conducted, and a predictive safety performance analysis was completed to better compare each interchange concept. Cost estimates, including Design, Right-of-Way, Utility Relocation, and Construction costs were completed for each of the concepts retained from the Level 1 screening.

The method of analysis used began with investigating problem areas within the interchange and grouping these into three main areas. Within these main areas the interchange was broken down even further into subareas by component (ramp, diverge, weave, etc.). The next sections provide an overview of this process.

7.1 Interchange Area and Primary Issues

Based on the evaluation of the retained and eliminated concepts from the Level 1 screening process, the project team dissected the interchange to identify the major independent issues. These issues were prioritized and isolated to be analyzed independently. This would allow for right-sized options to be considered to adequately address each of the major issues. These major issues were grouped into three primary areas (I, II, III), which were further broken down into seven subareas (listed below) that represent independent issues.

- 1 EB I-264 Weave (US 42 to I-71)
- 2 I-71 NB Mainline at I-264 WB Exit Ramp
- 3 WB I-264 Weave (I-71 to US 42)
- 4 I-71 SB Left Exit to I-264 WB
- 5 I-71 SB Left Entrance from I-264 EB
- 6 I-71 NB Horizontal and Vertical Alignment
- 7 I-71 NB Merge with I-264 EB Ramp

Operational and safety analyses were conducted for potential options within each of the seven subareas. Costs were developed for potential options at the area level (i.e., costs were developed for Area I, II, and III separately) as it was possible to maintain independence between the three areas – the solutions for each area can be mixed and matched. However, it was not possible to separate options for each of the five subareas in Area III as they are too interrelated. Instead, Area III concepts were developed to address a set of applicable issues as

opposed to addressing each issue individually, and the costs were developed accordingly. The three main areas (I, II, and III) and seven subareas at the interchange are shown in **Figure 18**.

Figure 18: I-71 & I-264 Interchange – Focus Areas and Subareas



7.1.1 Area I – I-264 EB

EB I-264 WEAVE (US 42 TO I-71) 1

The EB weave on I-264 is a primary concern for the interchange operations based on the existing congestion patterns, anticipated growth and development along US 42, and the future origin-destination patterns through the area. The existing configuration between US 42 and I-71 is a short (approximately 1,400 foot) Type-A weave with an auxiliary lane between the US 42 entrance ramp and the I-71 NB exit ramp. The Type-A weave specifies

that a lane change is required for both directions of weaving traffic (ramp-to-freeway and freeway-to-ramp). There is typical peak congestion for this weave area with the existing traffic volumes (See **Figures 4 and 5**).

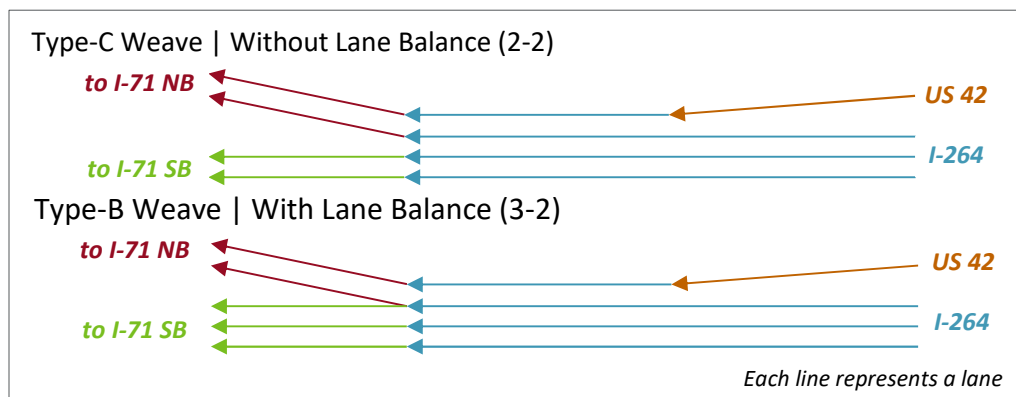
Several considerations influenced the potential future improvement options developed for Area I:

- Future development along the US 42 corridor
- Adjacent project, Item Number: 5-804.00, including US 42 interchange improvements, a two-lane exit from I-264 EB to I-71 NB, and conversion of the Type-A weave to a Type-B weave (Type-A weaves require one-lane change for any weaving vehicle, whereas the proposed Type-B weave allows for mainline-to-ramp traffic to exit without changing lanes, while the ramp-to-mainline traffic requires one-lane change.)
- The proposed widening of I-264 between the Westport Road interchange and I-71
- Available weaving length

Based on these factors and the previously developed concepts within this area, the following options were analyzed and considered from an operations, safety, and cost perspective.

1. **Traditional Weave** – This option is similar to the existing configuration with the addition of a through lane along I-264, creating a four-lane weaving area instead of the existing three lanes. Within this configuration, two weaving conditions were analyzed. The I-71 NB ramp will require two lanes based on the volume projection (project 5-804.00 will widen this ramp to two lanes), so that was held constant in both conditions. The first configuration is a Type-C weave that does not maintain lane balance. This Type-C weave allows mainline-to-ramp traffic to exit without changing lanes, but the ramp-to-mainline traffic must make two-lane changes. The second option is a Type-B weave, which does maintain lane balance and has a three lane, two-lane diverge at the interchange (the design proposed by the 5-804.00 project). Basic line diagrams of these configurations are shown in **Figure 19**. The concept with lane balance is also shown in **Figure 20**.

Figure 19: I-264 EB Weave Configuration Options

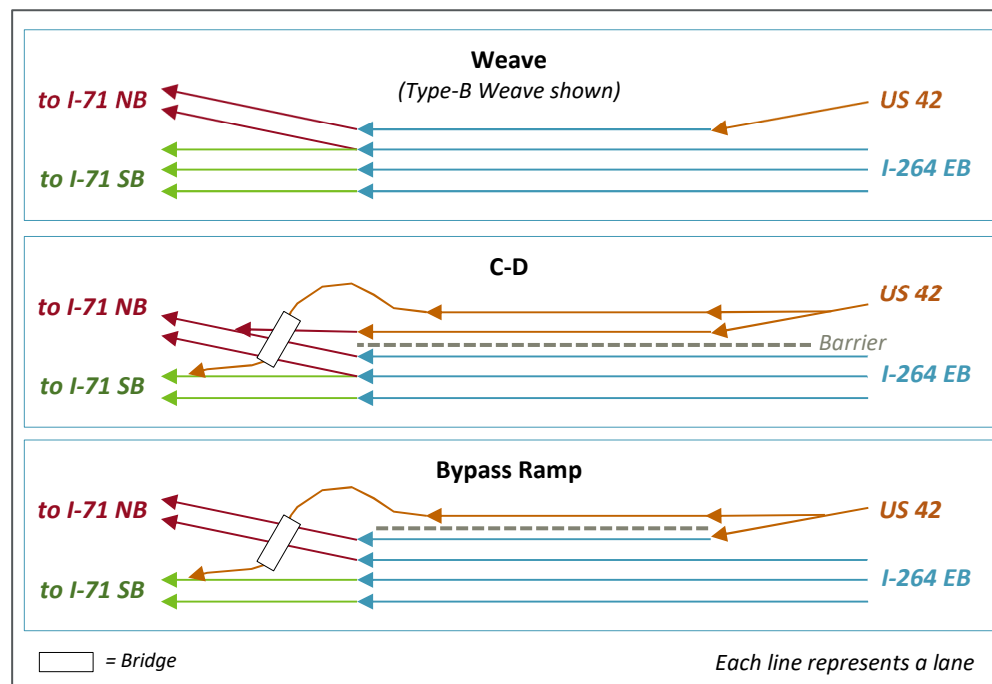


Similar configurations were considered with regard to maintaining lane balance in the subsequent options; this illustration should provide an indication as to the various configurations for those options as well.

2. **Collector-Distributor (C-D) Road** – This option completely removes the weaving interaction from I-264 by separating the traffic movements and providing a C-D road which would run parallel to mainline I-264 between US 42 and the system interchange (see **Figure 20**). The US 42 entrance ramp volume would feed into the C-D road and avoid interaction with the I-264 mainline volume until the interchange ramps. The C-D road would branch off to connect with the I-71 NB ramp, accessing it along the curve on the right-hand side and would connect with the I-71 SB ramp via a flyover ramp (over the I-71 NB ramp) prior to the bridge over the I-71 SB to I-264 WB ramp.
3. **Bypass Ramp** – This option falls somewhere between the weave and C-D road options as it removes the weaving interaction but also maintains some of the existing access (see **Figure 20**). The Bypass Ramp concept would feature a second lane on the US 42 entrance ramp which would diverge to the right of the entrance ramp to run adjacent to and parallel with the mainline and flyover the I-71 NB ramp and access the I-71 SB ramp beyond the diverge point. This would eliminate the weaving interaction as it would provide immediate access to I-264 for vehicles which would utilize the I-71 NB ramp (merge and then diverge with I-264 traffic) and the traffic bound for I-71 SB would bypass the weave area and merge beyond the diverge point.

Each of the Area I concepts are shown in **Figure 20**.

Figure 20: Area I Configuration Options





7.1.2 Area II – I-264 WB 3

WB I-264 WEAVE (I-71 TO US 42) (See **Figure 18**)

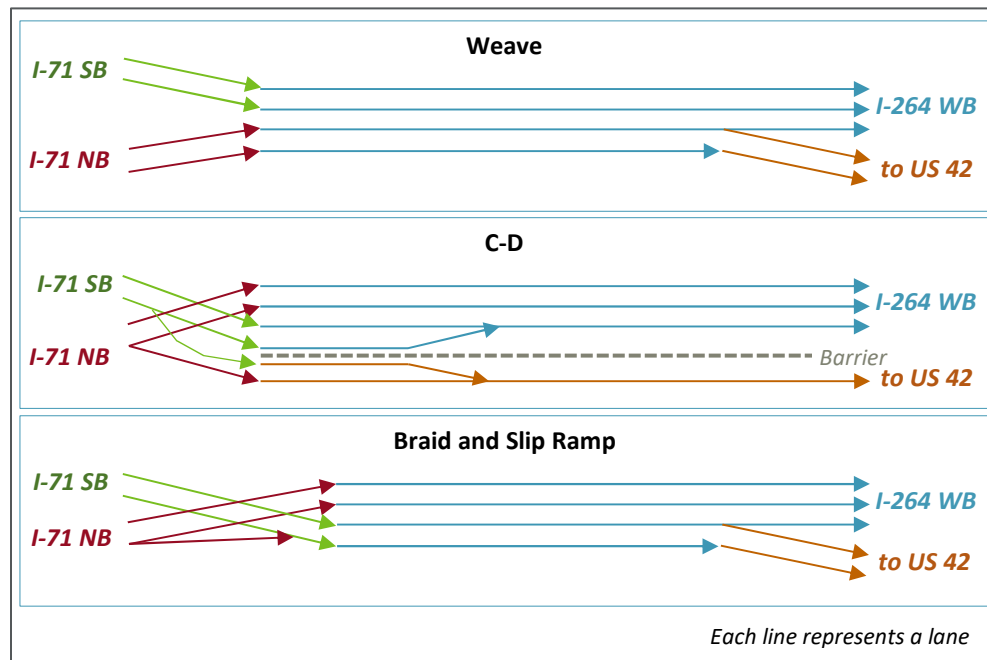
The WB weave on I-264 was also a focal concern for the interchange. This area is similar to the EB direction in that it is anticipated to experience significant traffic volume growth, see a potential shift in travel patterns, and may be changed or impacted by the adjacent projects. Opposite to EB, this direction serves volumes leaving the I-71 / I-264 system interchange, but if not adequately accommodated it could serve as a major bottleneck to the system interchange.

Based on the anticipated traffic growth, adjacent projects, and concepts developed during the Level 1 screening phase, the following options were analyzed in this area.

1. **Traditional Weave** – This option is similar to the existing configuration with the addition of another travel lane, creating a four-lane weave as opposed to a three-lane weave as it exists today (see **Figure 21**). The exit ramp to US 42 is a two-lane ramp with a choice lane (maintaining lane balance) in the existing condition and is anticipated to continue as such with the proposed KYTC 5-804.00 project; therefore, it was maintained in this concept. Additionally, it is anticipated that the mainline segments feeding this weave would both require two lanes (coming together as four lanes). To accommodate the ramp requirements and the addition of a through lane, one weave configuration was proposed, which includes three through lanes and a two-lane diverge at the US 42 ramp (maintaining lane balance).
2. **C-D Road** – Similar to the EB direction, a C-D road was considered for the WB I-264 direction to eliminate weaving movements throughout the area (see **Figure 21**). This option would separate the incoming movements from I-71 SB and I-71 NB, providing braided ramps between each to allow for movements without weaving near the existing connection point for the two system ramps. The I-71 NB ramp would braid over the existing I-71 SB ramp to enter on the left (instead of the right) and would have a one-lane slip ramp following the existing alignment to enter the C-D road serving traffic bound for US 42. The I-71 SB ramp would primarily maintain its current alignment and enter to the right of the NB ramp. It would have a right-sided slip ramp to the C-D road for US 42 traffic. This configuration has a four-lane I-264 section which tapers to three lanes to tie-in to the proposed expansion and a two-lane C-D road tying to the two-lane US 42 exit.
3. **Braid and Slip Ramp** – This concept utilizes the flipping of the incoming I-71 ramps and the I-71 NB slip ramp without the C-D road (see **Figure 21**). This concept alleviates much of the weaving interaction but does not eliminate it. Braiding and splitting the I-71 NB movements allows for I-264 traffic volume to enter on the left and avoid the weaving lanes and the US 42 bound volume to use the slip ramp and enter on the right, eliminating the need for weaving. The I-71 SB ramp would tie in between these two ramps and have access to both I-264 and US 42 with no major lane changing or weaving required. This configuration creates a series of merges and diverges but eliminates the primary weaving interaction.

Each of the Area II concepts are shown in **Figure 21**.

Figure 21: Area II Configuration Options



7.1.3 Area III – System Interchange Area

Area III features the I-71 mainline movements as well as the system ramps between I-71 and I-264. Within this area, five key issues were identified. Area III includes the I-71 mainline, the system interchange ramps, and the related merge / diverge points. Examining the entire area and all five issues together allowed for the development of more cohesive options than examining each issue separately. The five subareas representing these key issues are detailed below.

I-71 NB MAINLINE AT I-264 WB EXIT RAMP 2 (See **Figure 18**)

The existing I-71 NB diverge is a three-lane diverge with two lanes following the I-71 NB mainline and two exiting to the right to access I-264 WB. The diverge itself follows proper design and lane balance requirements; however, the configuration makes the I-71 NB movement feel like the exit ramp as opposed to the mainline movement. The mainline diverges on the left into a significant curve with a reduced speed advisory. This configuration may contribute to driver discomfort and driver confusion through the interchange as it is atypical to follow the mainline through a reduced speed curve into a rock cut. In addition to the configuration of the diverge, the location also creates issues as it is within a large curve of I-71. As the roadway traverses the curve, it expands from two lanes to three lanes for the diverge, which creates issues with lane changing, lane selection, and potential for high-speed differentials between lanes and/or passenger cars and heavy vehicles as they navigate the diverge. All of these factors likely contribute to the safety issues and crash history, as the area of the diverge and I-71 NB curve has the most significant grouping of crashes through the interchange.

Based on the concepts developed and discussions from the Level 1 screening, it was determined that the re-alignment of the I-71 NB mainline is a high priority for the interchange



improvement concepts. In developing re-alignment concepts, the I-71 NB diverge was a focal point to provide options which addressed the current issues.

I-71 SB LEFT EXIT TO I-264 WB 4 (See **Figure 18**)

The existing configuration of the I-71 SB exit to I-264 WB is a single lane left sided exit ramp which is accessed by a tapered deceleration lane from the left lane of the I-71 SB mainline. This is an atypical design for exit ramps, but left-sided ramps are more common at system interchanges as opposed to service interchanges. Based on traffic volume projections, it is anticipated that the ramp from I-71 SB to I-264 WB will need to be expanded to a two-lane ramp and the I-71 mainline leading to the diverge will need to be widened to three lanes, which would impact the existing configuration of the diverge⁸. Based on this configuration and the future changes due to the widening this was identified as an issue.

I-71 SB LEFT ENTRANCE FROM I-264 EB 5 (See **Figure 18**)

The existing configuration of the I-71 SB and I-264 EB merge is a left-sided entrance ramp from I-264 EB to I-71 SB. Similar to the left-sided exit ramp for the I-71 SB diverge, the left-sided entrance is an atypical configuration. The existing merge requires the I-71 SB traffic to merge with the I-264 EB traffic as the lanes drop from the right from four to three and from three to two. Based on the existing and future volumes, this merge configuration requires the heavier volume (I-71 SB) to merge with the lower volume (I-264 EB) movement. It should be noted that the 5-804.00 project will maintain the current configuration as the I-264 EB to I-71 SB ramp and will drop from three lanes to two-lane prior to the merge with I-71 SB mainline.

I-71 NB HORIZONTAL AND VERTICAL ALIGNMENT 6 (See **Figure 18**)

In addition to the concerns about the diverge for I-71 NB, the alignment of the I-71 mainline in the current condition is a major concern for the interchange. The current alignment is a sharp horizontal curve (radius of approximately 815 feet) which has an advisory speed warning and reduces the speeds to 50 mph. Additionally, there is a significant vertical grade throughout the curve as it is located in a large rock cut section and has to climb to meet the elevation of the I-71 NB mainline and entrance ramp north of the interchange.

I-71 NB MERGE WITH I-264 EB RAMP 7 (See **Figure 18**)

The I-71 NB merge between I-71 NB mainline and the ramp from I-264 EB was identified as a concern area for the interchange based on current congestion and projected traffic growth. The current merge condition is a three-lane merge (two lanes from I-71 NB and one-lane from I-264 EB) which tapers to two lanes from the right. The existing merge point is a bottleneck location during peak periods under the existing conditions and with the proposed expansion of the I-264 ramp to two lanes (by project 5-804.00) it could become a focal point for future congestion. The proposed I-71 widening would expand the through lanes north of the interchange to three lanes leading away from this merge location. The connecting 5-804.00 project will tie in at this merge location and as part of the project will expand the I-264 EB ramp to I-71 NB to two lanes. Prior to the implementation of the I-71 widening, these two lanes will both merge into the two-lane mainline. After the I-71 widening, only the right ramp lane will merge, with the left ramp lane

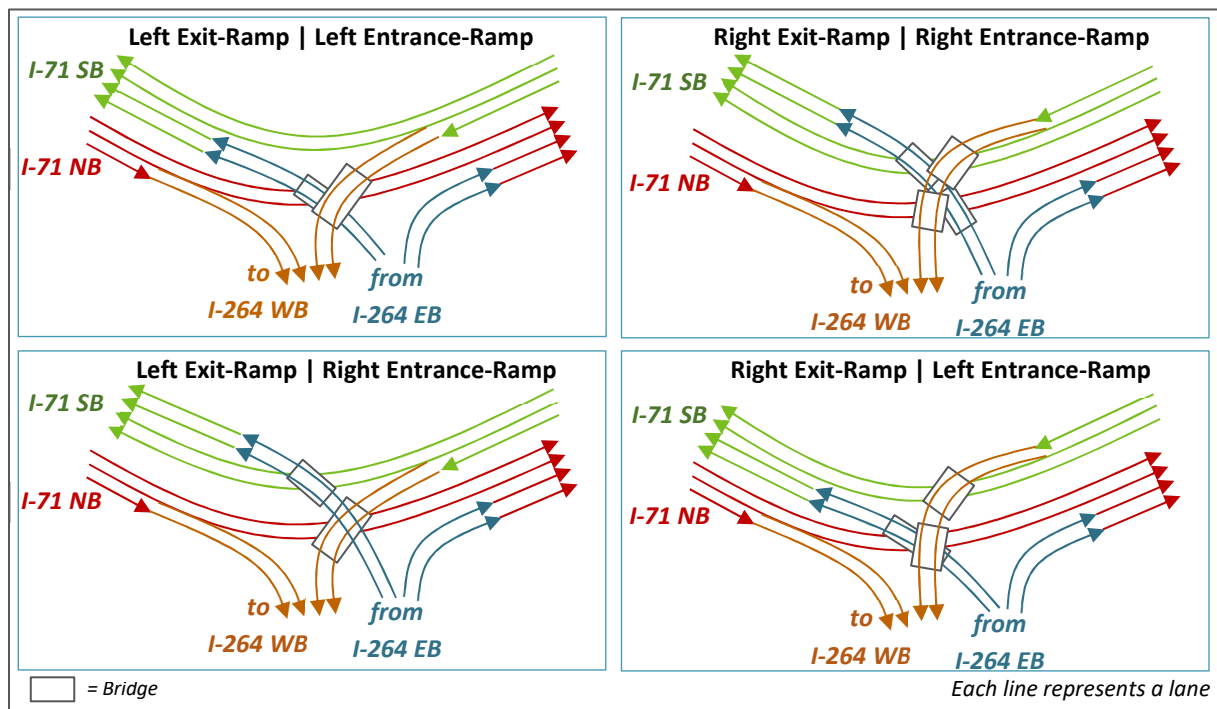
⁸ I-71 mainline to be widened to six lanes as part of 5-557.00 project.

being an add-lane to I-71. The proposed 5-804.00 design is not anticipated to impact the merge location. The options for this area were to assess if three or four lanes would be necessary for merge conditions, and if four lanes were required what length would be sufficient to taper the fourth lane back to three lanes.

7.1.4 Area III Concepts

The development of concepts for this area was primarily based on the ramp configurations for I-71 SB (subareas four and five) as those were the main discussion points for consideration, while the other area associated issues were determined to be addressed by features included within each concept. These features include the realignment of I-71 NB through the interchange (which includes subareas two and six) and accommodating a four-lane merge on I-71 NB departing the interchange (subarea seven). Based on that, there were four different configurations of I-71 SB ramps which were considered. These are shown in **Figure 22**.

Figure 22: Area III (I-71 SB and Connecting Ramps) Concepts



7.2 Component Analysis

The options for each of the areas were analyzed for operations, predictive safety performance, and project costs. The operational analysis was conducted based on the design year (2045) peak period volume projections using deterministic tools (HCS and FREEVAL) and then ultimately validated with microsimulation (Vissim). The predictive safety analysis was conducted via the implementation of the AASHTO Enhanced Interchange Safety Analysis Tool (ISATe) spreadsheet tools using the proposed geometry and projected Average Daily Traffic (ADT).



7.2.1 Area I – I-264 EB

The Area I options were evaluated for future operational performance, predicted safety performance, and project costs. The results of the analysis are shown for each Area I option in **Table 9**. The Area I options are illustrated in **Figure 20**.

Table 9: Area I (I-264 EB) Analysis Results

Area I: I-264 EB Analysis Results		Operational Analysis		Predictive Safety		Cost (\$ in millions)**			
		AM Peak LOS	PM Peak LOS	Avg. Crashes per year	Total Crashes	Const. Cost	Right of Way Cost	Utility Cost	Total Cost
Option 1: Weave	Weave – Type-B (3-2 diverge)	C	B	15.1	302.1	\$0*	N/A	N/A	\$0*
	Weave – Type-C (2-2 diverge)	F	F	Eliminated based on traffic operational analysis					
Option 2: C-D Road	C-D Road (2-2 diverge)	C	C	14.6	291.2	\$8M	\$0.3M	\$0.7M	\$9.0M
	C-D Road (1-2 diverge)	D	D	Eliminated based on traffic operational analysis					
Option 3: Bypass Ramp	Bypass Ramp (3-2 diverge)	C	B	15.6	312.3	\$7.8M	\$0.3M	\$0.7M	\$8.8M
	Bypass Ramp (2-2 diverge)	C	B	15.6	312.3	\$7.8M	\$0.3M	\$0.7M	\$8.8M

*To be completed as part of the KYTC 5-804.00 project, therefore no assumed additional cost **in 2020 dollars

OPERATIONAL ANALYSIS

Based on the results from **Table 9**, all of the proposed options are anticipated to operate with LOS of B or C during peak periods with the exception of the weave and C-D options without lane balance (Weave – Type-C (2-2 diverge) & C-D Road (1-2 diverge) options in **Table 9**). Therefore, these two options were eliminated from further consideration. The Bypass ramp option without lane balance, however, was retained as operationally there is little impact since it would feature an additional lane of traffic and eliminate weave movements.

PREDICTIVE SAFETY ANALYSIS

Based on the results from **Table 9**, there is negligible difference in safety performance between the three concepts (resulting in four options). The safety analysis showed that each of the options is anticipated to average approximately 15 crashes per year, resulting in approximately 300 crashes over the 20-year analysis period. The C-D option is anticipated to result in the fewest crashes as it fully eliminates the weaving interactions (but adds additional roadside/ median barrier). The Weave option crash results fall between the C-D and Bypass Ramp options. The Bypass Ramp option has a slightly higher crash prediction than the weave option (0.5 crashes more per year). This is likely because while weaving is



minimized with that option, it is not prevented, and the ISATe model is not able to accurately account for that specific situation. In addition, the Bypass Ramp option has a long ramp and ramps typically have slightly higher crash rates than mainline sections.

COST ANALYSIS

The Weave option is assumed to have no cost as it is anticipated to be constructed as part of the adjacent KYTC 5-804.00 project and is assumed to require no additional right-of-way. The C-D and Bypass Ramp options have comparable construction costs with the C-D road being slightly more costly. It is also anticipated that these options will require some right-of-way and the relocation of utilities due to the additional width and buffers required for the separated lane(s).

7.2.2 Area II – I-264 WB

The Area II options were evaluated for future operational performance, predictive safety performance, and project costs. The results from the analysis are shown in **Table 10**. The Area II options are illustrated in **Figure 21**.

Table 10: Area II (I-264 WB) Analysis Results

Area II: I-264 WB Analysis Results	Operational Analysis		Predictive Safety		Cost (\$ in millions)**		
	AM Peak LOS	PM Peak LOS	Avg. Crashes per year	Total Crashes	Const. Cost	Right of Way Cost	Total Cost
Weave – Type B (3-2 diverge)	B	C	16.3	325.9	\$1.9M	N/A	\$1.9M
C-D Road	B	C	<i>Eliminated based on traffic operational analysis</i>				
Mainline Braid + Slip (3-2 diverge)	C	C	19.7	393.4	\$9.9M	N/A	\$9.9M

**in 2020 dollars

OPERATIONAL ANALYSIS

Based on the HCS/ FREEVAL 2045 peak period analysis, all three options in Area II are anticipated to operate with LOS in the B to C range as shown. Since the C-D road option and the Weave option are anticipated to operate with similar performance it was deemed unnecessary to move the C-D road option forward as it would be a substantial cost increase and differ significantly from the design proposed by the KYTC 5-804.00 project. While the Mainline Braid + Slip concept differs from the proposed 5-804.00 design, the tie-ins would fit closely with the proposed weave area and was therefore carried forward for further consideration.

PREDICTIVE SAFETY ANALYSIS

The ISATe results indicate that the Weave option has fewer predicted crashes than the Braid + Slip option, averaging approximately 16.3 crashes per year compared against 19.7. Over the 20-year analysis period this results in an increase in crashes from 325.9 to 393.4.



Both options leave a weaving interaction, and while the Braid + Slip changes the functionality of the weave by dividing the traffic stream, this is not fully captured by the ISATe analysis methods. ISATe is able to consider the presence, proximity, and volumes of the ramps but does not consider the weaving volumes, which for the Braid + Slip concept may cause an over-estimation of crashes. Additionally, the presence of the slip ramp in the Braid + Slip concept may account for some of the increase in predicted crashes as it provides an increase in traffic exposure compared to the Weave option. Based on the ISATe results and limitations of analysis for the weave, it is not anticipated that the Braid + Slip concept will show a safety improvement over the Weave option.

COST ANALYSIS

It is anticipated that the weave option would require approximately \$1.9M to construct in addition to what is proposed by the KYTC 5-804.00 project. The Braid + Slip concept is significantly more costly at approximately \$9.9 million. Neither option is anticipated to require right-of-way or utility relocations, resulting in a cost difference of \$8 million.

7.2.3 Area III – System Interchange Area

The Area III options were analyzed for predictive safety and project costs. An initial operational analysis was conducted; however, the difference in performance between the options (using both deterministic and microsimulation tools) was negligible. Therefore, no further operational analysis was conducted. The results of the predictive safety and project cost analysis are shown in **Table 11**.

Table 11: Area III Analysis Results

Area III: System Interchange Analysis Results (See Figure 22 for Images)		Predictive Safety		Cost (\$ in millions)**		
		Avg. Crashes per year	Total Crashes	Const. Cost	Right of Way Cost	Total Cost
Left Exit-Ramp	Left Entrance-Ramp	37.9	757.9	\$11.7M	N/A	\$11.7M
Right Exit-Ramp	Right Entrance-Ramp	39	779.5	\$25.0M	N/A	\$25.0M
Left Exit-Ramp	Right Entrance-Ramp	-*	-*	\$22.8M	N/A	\$22.8M
Right Exit-Ramp	Left Entrance-Ramp	-*	-*	\$20.6M	N/A	\$20.6M

**Based on the cost calculations, it was determined that the left-off, right-on and right-off, left-on options were only marginally less costly than the right-off, right-on option and were deemed unnecessary and therefore safety analysis was not conducted. ** in 2020 dollars*

PREDICTIVE SAFETY ANALYSIS

The ISATe analysis indicates that the two concepts will function with relatively similar safety performance. While left-side ramps are generally associated with lower safety performance, in this case the curvature and length of the right-sided ramps appears to offset the benefits associated with changing the layout. It is important to mention again, that for major diverges and major merges at system interchanges, left side ramps can be acceptable.



7.3 Level 2 Concepts

The independent component analysis resulted in multiple options for each area (I, II, and III) that would address the identified concerns and would function adequately with respect to traffic operations, safety, and cost. Options for each area were combined to develop the final Level 2 concepts. Several of these were modifications to the retained Level 1 concepts.

7.3.1 Development of Level 2 Concepts

Table 12 shows the options for each area that were used in the Level 2 concepts (e.g., Concept B-1 uses a weave in Area I). **Figure 23** provides a thumbnail illustration for each concept. The concepts are discussed further in the subsequent sections and conceptual sketches are provided in **Appendix I**.

Table 12: Level 2 Concept Components

Improvement Concepts		B-1	A-1.1	A-2.1	A-2.2	A-3.1	A-3.2
AREA I		Weave	Weave	C-D	C-D	Bypass Ramp	Bypass Ramp
AREA II		Weave	Weave	Weave	Weave	Weave	Weave
AREA III	Exit Ramp	Left	Right	Right	Left	Right	Left
	Entrance Ramp	Left	Right	Right	Left	Right	Left

7.3.2 Concept B-1

Concept B-1 features weaves in Areas I and II (#1 in **Figure 23**) and retains the left-sided ramp configuration in Area III (#2). This concept is the closest to the No-Build scenario as the only major change within the interchange is the realignment of I-71 NB through the interchange (#3) and the widening of the I-71 SB to I-264 WB ramp from one to two lanes (#4). The I-264 EB to I-71 NB ramp will be widened from one to two lanes (#5) as part of project 5-804.00. This concept will require two new bridges to be constructed and one bridge to be widened (if no design variance can be obtained).

7.3.3 Concept A-1.1

Concept A-1.1 features weaves in Areas I and II (#1 in **Figure 23**) and switches the ramp configuration in Area III to right-sided ramps for both the entrance and exit ramps on I-71 SB to and from I-264 (#2). Switching of the ramp configuration requires the realignment of both directions of I-71 through the interchange, bringing them together (#3). By bringing these alignments of I-71 together through the interchange the radius of I-71 NB is improved. This concept will require two new bridges to be constructed and one bridge to be widened (if no design variance can be obtained).

7.3.4 Concept A-2.1

Concept A-2.1 features the C-D road in Area I (#1 in **Figure 23**), weave in Area II (#2), and switches both Area III ramps to right-sided for both the entrance and exit ramps on I-71 SB to and from I-264 (#3). This concept significantly changes the interchange as it switches the ramps



causing a realignment of I-71 mainline in both directions through the interchange (#4). By bringing these alignments of I-71 together through the interchange, the radius of I-71 NB is improved. I-264 EB would also be reconfigured for the C-D road separating the mainline from the US 42 ramp to eliminate weaving movements. This concept will require three new bridges to be constructed and one bridge to be widened (if no design variance can be obtained). The acquisition of right-of-way is also needed for this concept.

7.3.5 Concept A-2.2

Concept A-2.2 features the C-D road in Area I (#1 in Figure 23), weave in Area II (#2), and retains the left-sided ramp configuration in Area III (#3). This concept is similar to Concept A-2.1 in Areas I and II, but it leaves the I-71 SB entrance and exit ramps in the existing configuration. The radius of I-71 NB through the interchange is increased. This concept will require three new bridges to be constructed and one bridge to be widened (if no design variance can be obtained). The acquisition of right-of-way is also needed for this concept.

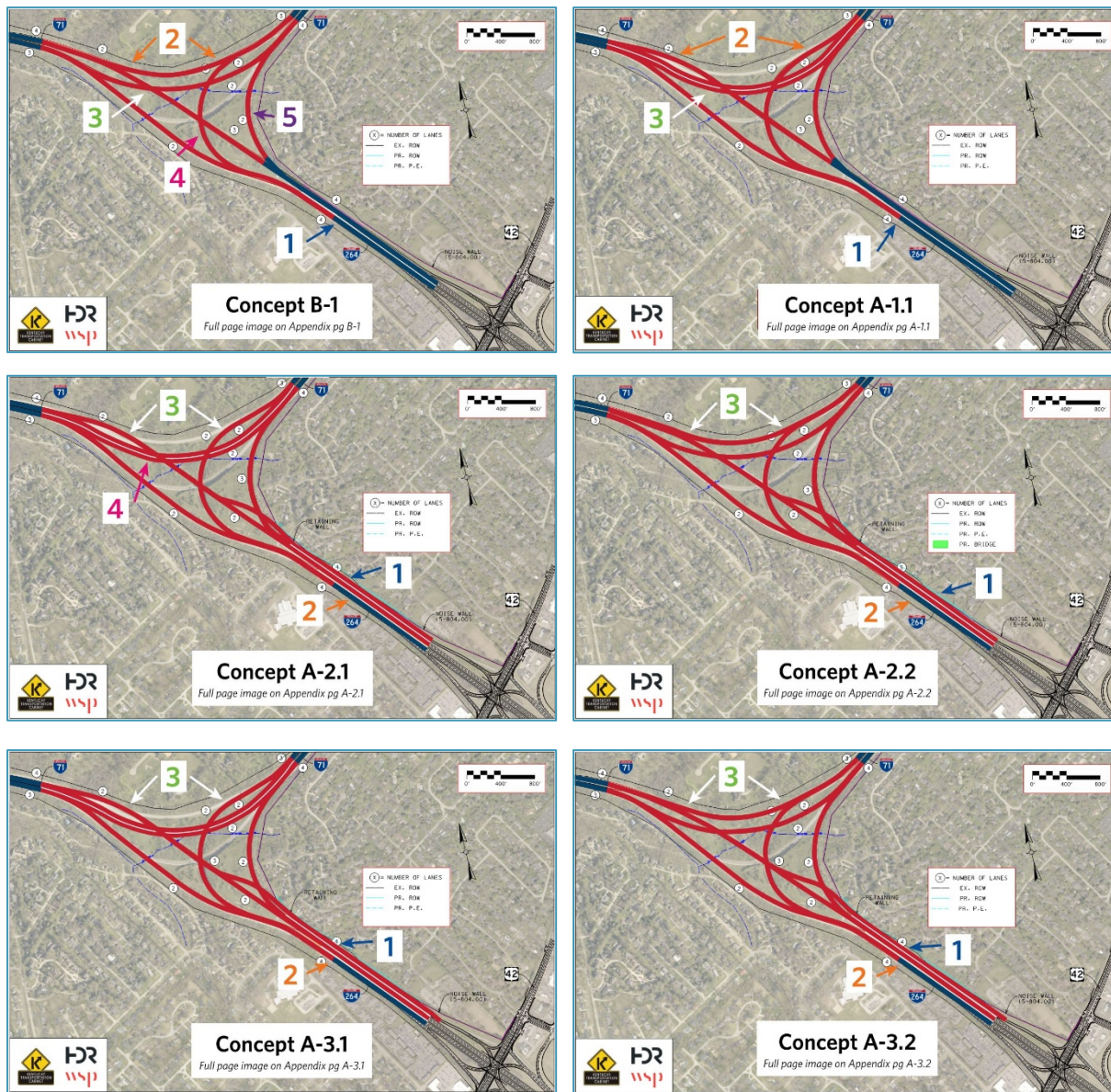
7.3.6 Concept A-3.1

Concept A-3.1 features the bypass ramp option in Area I (#1 in Figure 23), weave in Area II (#2), and switches the ramp configuration in Area III to right-sided ramps for both the entrance and exit ramps on I-71 SB to and from I-264 (#3). Similar to Concept A-2.1, it substantially changes the interchange, affecting the I-264 EB area and realigning I-71 in both directions. This concept has the potential to be a second phase of Concept A-1.1 as the only difference is the branched bypass ramp from the US 42 entrance ramp and this ramp could be added in the future when conditions degrade. This concept will require three new bridges to be constructed and one bridge to be widened (if no design variance can be obtained). The acquisition of right-of-way is also needed for this concept.

7.3.7 Concept A-3.2

Concept A-3.2 features the bypass ramp option in Area I (#1 in Figure 23), weave in Area II (#2), and retains the left-sided ramp configuration in Area III (#3). This concept has the potential to be a second phase of Concept B-1 as the only difference is the branched bypass ramp from the US-42 entrance ramp. The additional bypass ramp could be constructed as needed after the initial B-1 construction. This concept will require three new bridges to be constructed and one bridge to be widened (if no design variance can be obtained). The acquisition of right-of-way is also needed for this concept.

Figure 23: Level 2 Concepts



Full page drawings of each concept are included in **Appendix I**. Above: Red = New Construction, Blue = To Remain

7.4 Low-Cost, Short-Term Improvements

The low-cost, short-term improvement options were carried forward from the Level 1 screening process for further analysis and refining. This evaluation during the Level 2 screening process further polished the cost and expected benefits to implement the improvement.

7.4.1 I-71 NB Lane Extension

This improvement option would extend the third I-71 NB lane from the merge point with the I-264 EB ramp to beyond the Lime Kiln Road bridge. The extension of the lane would provide additional length for the I-71 NB and I-264 EB merging traffic. There is potential for the



extension of this third lane to improve safety and capacity in the merge area where a significant volume of traffic comes together. It is anticipated that this improvement would require additional right-of-way, utility relocations, and a design exception for outside shoulder width under the Lime Kiln Road bridge. The estimated cost, including right-of-way and utility relocations, is \$1.66 million.

While some benefits can be expected, it is not anticipated that the travel time benefits would be significant enough to outweigh the cost of the improvement. This improvement would also be unnecessary with the widening of I-71 mainline, as this would create a continuous three-lane section. Based on this, it was not recommended that this concept be carried forward for additional consideration.

7.4.2 Lane Tattoos (Route Shield Pavement Markings)

Lane tattoos are thermoplastic pavement markings that provide the driver with an indication of lane assignment at the approaches to major interchanges or significant junction points. These route shields help motorists better understand lane assignments, which have been shown to reduce last-minute lane changes leading to better lane utilization and improved safety.

Figure 24 shows two example applications of lane tattoos.

Figure 24: Lane Tattoo Applications



This low-cost, short-term improvement option would install lane tattoos on the three approaches to the I-71 / I-264 interchange to provide motorists with advanced warning of the movements and to allow them to make lane changes more in advance of the interchange. The cost of applying lane tattoos to the pavement is approximately \$145,000 and could be implemented as part of the existing maintenance program for the interchange.

7.4.3 Guide Signing

Additional guide signing improvements were suggested during the initial project screening process to better direct the driver to the appropriate lanes. Lane change maneuvers would occur further from the diverge, thus splitting decision making for the driver into separate tasks. The approximate cost for this improvement is approximately \$500,000 to \$750,000 depending on the signage required. After the initial screening it was determined that District 5 was already in the process of ordering and installing updated signage for the I-71 NB approach to the

interchange, which would address several of the concerns for this low-cost option. Because of this, it was recommended that additional guide sign improvements would not be implemented in the short-term but would be a part of the ongoing widening projects currently in planning and design.

7.4.4 Vegetation Management to Improve Sight Distance

Some areas of the I-71 / I-264 interchange have obstructed sight lines due to foliage and excessive vegetation. The most impacted area is I-71 NB just past the NB diverge in the curve. These sight obstructions have potential safety impacts as drivers may have less warning time if they cannot see slower or stopped traffic ahead. This vegetation could also impact driver comfort as foliage encroaches onto the travel lanes making the roadway feel more closed in and narrow, which could impact speeds and behavior through the interchange and along the ramps. Pavement drying times can also be affected by excessive vegetation creating extending periods of time for wet or icy pavement conditions. It was assumed that this low-cost option could be addressed as part of the ongoing maintenance efforts at the interchange.

Figure 25: Existing Vegetation Condition



7.4.5 Dynamic Congestion Warning Signs

Throughout the I-71 and I-264 corridors near the I-71 / I-264 interchange there is some existing Intelligent Transportation Systems (ITS) infrastructure present. This ITS architecture includes traffic cameras and Dynamic Message Signs (DMS). The intent of this low-cost improvement would be to supplement the existing DMS coverage and to work in conjunction with the rest of the ITS system to improve interchange operations. The goal of the DMS signs would be to provide advanced warning of congestion, traffic incidents, road and lane closures, and other various warning messages prior to the system interchange to allow drivers ample time to make decisions about their route choice and downstream traffic impacts.

A series of potential locations for additional DMS signs were identified within the study area from the Level 1 screening. The I-264 EB approach to the I-71 / I-264 interchange and the US 42 approaches to the I-71 interchange were also identified in the 2014 I-71 Corridor Study as potential locations to install DMS.⁹ Further analysis occurred to narrow down and prioritize locations to install DMS signs along the I-71, I-264, and US 42 corridors. Four locations were

⁹ <https://transportation.ky.gov/Planning/Pages/Project-Details.aspx?Project=I-71%20Corridor%20Study>

selected from this prioritization that would provide information to drivers in advance of key decision points. The cost of implementing this short-term low-cost option is \$750,000. The locations and sign type are listed and shown below in **Figure 26**.

- Arterial DMS on US 42 in the EB direction approaching the I-264 interchange
- Arterial DMS on US 42 in the WB direction approaching the I-264 interchange
- Side mounted DMS on I-264 EB in advance of the US 42 interchange
- Overhead DMS (on truss) on I-71 NB adjacent to the existing I-71 SB DMS just north of the Zorn Avenue interchange



Figure 26: DMS Sign Locations

7.4.6 Barrier and Shoulders Through Cut Section

This low-cost improvement provides shoulder protection along the outside of the I-71 NB curve through the interchange within the rock cut section. The existing shoulder in this section is narrow and drops off into a roadside ditch then to the rock cut face. The proposed improvement would widen the shoulder and add a concrete barrier which would improve safety and driver comfort. The increase in paved shoulder width and the presence of concrete barrier would create a more reliable condition from a safety perspective, provide additional refuge, and provide a barrier of known crash performance as opposed to an exposed rock wall. An example of this improvement is shown in **Figure 27**.



Figure 27: Existing and Example Barrier

This improvement will cost approximately \$395,000 to construct. If any of the Level 2 analysis concepts are implemented (See Section 7.3), I-71 NB will be realigned and negate the need for this improvement. After further review, based on the construction cost, impact to traffic under construction, and effectiveness with the proposed interchange concepts it is recommended that this option be dismissed from further consideration, unless project 5-557.00 is anticipated to be open to traffic greater than 10 years into the future or no full interchange improvement option is chosen.

7.4.7 Gore Extension at I-71 NB Merge

The existing merge between I-71 NB and the ramp from I-264 EB is a traditional right sided parallel type merge that provides some distance for merging traffic from I-264 to run parallel to I-71 NB traffic before merging. This acceleration lane runs for approximately 2,500 feet from the painted gore until it fully merges with I-71 NB traffic. During the existing peak period, congestion often occurs through this area as vehicles do not fully utilize the available acceleration lane and often merge earlier than is necessary creating turbulence in the traffic stream.

As traffic volumes increase throughout the study area, it is anticipated that this issue will only get worse causing more congestion for longer periods of time. The proposed improvement would extend the gore for this merge with striped or physical separation. The extension would promote later merges by focusing these merge interactions with vehicles at a predictable area beyond the existing 2,500 feet currently available. This gore extension would allow vehicles on the ramp, and on I-71 mainline coming out of the slower speed curve to accelerate to similar speeds, thus decreasing speed differentials and creating a smoother merge condition. **Figure 28** shows an example of a gore extension.



Figure 28: Existing and Example Delineation

7.5 Evaluation of Improvement Concepts

An evaluation matrix was developed to assess the Level 2 interchange concepts. The key interchange aspects and performance criteria were used to develop a matrix to compare the No-Build scenario and each of the Level 2 improvement concepts. The matrix provided the opportunity for quickly and concisely comparing the concepts to each other and to the No-Build. The major elements of the matrix include: components of each concept (by area), cost (design, utilities, construction, and right-of-way), maintenance of traffic (description and level of difficulty), environmental impact, operational performance (travel time, average speed, average LOS), safety performance, and overall benefits and drawbacks. The Level 2 evaluation matrix is shown in **Table 13**.



Table 13: Level 2 Evaluation Matrix

		No-Build	B-1	A-1.1	A-2.1	A-2.2	A-3.1	A-3.2
PROJECT ELEMENTS	AREA I (I-264 EB)	Weave	Weave	Weave	C-D	C-D	Bypass Ramp	Bypass Ramp
	AREA II (I-264 WB)	Weave	Weave	Weave	Weave	Weave	Weave	Weave
	AREA III (System Ramps)	Left Exit, Left Entrance	Left Exit, Left Entrance	Right Exit, Right Entrance	Right Exit, Right Entrance	Left Exit, Left Entrance	Right Exit, Right Entrance	Left Exit, Left Entrance
PROJECT COST	Design	N/A	\$2,800,000	\$2,800,000	\$2,800,000	\$2,800,000	\$2,800,000	\$2,800,000
	Right-of-way		-	-	\$340,000	\$340,000	\$340,000	\$340,000
	Utilities		\$180,000	\$180,000	\$700,000	\$700,000	\$700,000	\$700,000
	Construction		\$13,600,000	\$26,900,000	\$34,900,000	\$21,600,000	\$34,700,000	\$21,400,000
	Total Project Cost		\$16,580,000	\$29,880,000	\$38,740,000	\$25,440,000	\$38,540,000	\$25,240,000
DESIGN CHALLENGES		N/A	I-71 SB to I-264 WB ramp: Design variance for inside shoulder					
MOT	Short Description	N/A	No long-term closures	Wknd closures of 2 ramps	Wknd closures of 3 ramps & lane shifts	Wknd closure of 1 ramp & lane shifts	Wknd closure of 3 ramps & lane shifts	Wknd closure of 1 ramp and lane shifts
	Level of Difficulty		Moderate	Moderate	Most Difficult	Difficult	Most Difficult	Difficult
RIGHT-OF-WAY	RW (acres) PE (acres)	N/A	-	-	0.25 0.75	0.25 0.75	0.25 0.75	0.25 0.75
	Impacted Parcels		-	-	11 14	11 14	11 14	11 14
ENVIRONMENT	Stream Impacts (ft)	N/A	<300	>400	>400	<300	>400	<300
	Bat Habitat Impt. (acres)		1.18	3.07	3.57	1.68	3.57	1.68
	Existing Noise Wall Impacts		N/A	N/A	1844'	1844'	1844'	1844'
MOBILITY [2045 Analysis Results]	Avg Travel-Time AM PM (s)	131 181	76 76	76 76	78 75	81 76	79 78	80 78
	Avg Speed AM PM (mph)	49 42	53 53	54 54	51 52	50 51	51 52	50 51
	Avg Delay AM PM (s)	30 41	21 21	20 21	20 19	21 20	18 20	20 20
	Avg AM LOS	D	C	C	C	C	B	C
	Avg PM LOS	E	C	C	C	C	C	C
SAFETY [ISATe Results]	Total Crashes (20 year)	1412	1386	1408	1397	1375	1418	1396
	Avg Crashes per year	70.6	69.3	70.4	69.9	68.8	70.9	69.8
	Total Crash Cost (20 year)	\$171,055,500	\$166,444,400	\$169,598,800	\$165,229,100	\$162,074,700	\$170,729,600	\$167,575,200
BENEFITS		-	Low Cost; Simplest to construct; Could be constructed with widening; A-3.2 could be a future phase	Improve Driver Expectancy; A-3.1 could be a future phase	Eliminates I-264 EB Weave; Improve Driver Expectancy - Right Side Ramps	Eliminates I-264 EB Weave	Can be a Phased Alt to A-1.1; Eliminates I-264 EB Weave; Improve Driver Expectancy	Can be a Phased Alt to B1; Eliminates I-264 EB Weave
DRAWBACKS / LIMITATIONS		Does not meet the Purpose & Need	Weaves remain, does not separate movements	Weaves remain, does not separate movements	Difficult to construct; Large Cost Increase; Requires right-of-way	Requires right-of-way	Difficult to construct; Significant Cost Increase; Requires right-of-way	Requires right-of-way



7.5.1 Project Elements

The project elements for each concept were discussed previously but are included in the table for quick reference. Note that Concept A-3.1 could be a phased addition to Concept A-1.1 and Concept A-3.2 could be a phased addition to Concept B-1. Concepts A-2.1 and A-2.2 are stand-alone concepts.

7.5.2 Project Cost

Project cost was separated into design, right-of-way, utilities, construction, and total project cost to better show the differentiation between the concepts. The concepts which do not require right-of-way (B-1 and A-1.1) do not have any associated cost for that, while it was assumed that the other concepts would require approximately the same amount of right-of-way resulting in an estimated cost of \$340,000. The concepts that required right-of-way were also assigned a higher estimated cost associated with utility relocations of \$700,000, whereas B-1 and A-1.1 have a utility relocation cost of \$180,000. This difference is attributed to the additional utility impacts associated with the widening along I-264 EB to accommodate the C-D and Bypass Ramp configurations associated with those concepts.

The main contributor to total project cost for all concepts is construction. Construction costs vary between \$13.6 million and \$38.7 million depending on the extent of the required reconstruction. The most significant difference in construction cost is the reconfiguration of the I-71 SB ramps to be right-sided. This option (included in A-1.1, A-2.1, and A-3.1) increases the construction cost by approximately \$13.3 million. Additionally, the cost for constructing the C-D and Bypass Ramp components along I-264 EB represent an additional cost over the weave options of approximately \$8 million and \$7.8 million, respectively.

7.5.3 Design Challenges

While design issues are an important consideration, they are not a differentiator. All concepts are expected to require a design variance for the inside shoulder width for the I-71 SB to I-264 WB ramp to utilize the existing structure. This variance may be eliminated depending on the selected concept as the bridge may not be necessary if the I-71 NB alignment is shifted. It should be noted that a review of archive plans for the existing structure indicate that it was designed to accommodate two lanes of future ramp traffic based on design standards in place at the time of initial construction (mid-1960s). If this bridge is widened, further review of vertical clearance between the I-71 SB to I-264 WB ramp and the I-264 EB to I-71 SB ramp that is above would be needed.

7.5.4 Maintenance of Traffic (MOT)

The MOT requirements for each concept were examined in detail, and all six concepts appear constructible, assuming that weekend closures are permitted for various ramps as needed. Concepts A-2.1 and A-3.1 would be the most difficult for MOT as they require the closure of three ramps and lane shifts through the interchange due to reconfiguring both directions of the I-71 mainline and I-264 EB weave. The concepts which impact only the northbound I-71 mainline and the I-264 EB configuration (A-2.2 and A-3.2) are the next most difficult due primarily to the impacts to the I-264 weaving area during construction.



7.5.5 Right-of-way

As discussed under project cost, the need for right-of-way is another differentiating factor. For the improvement concepts that have been proposed the only area where right-of-way would be required is along I-264 EB. Therefore, the concepts which leave I-264 EB as a weave do not require right-of-way, while the C-D and Bypass Ramp concepts are anticipated to impact 11 parcels (approximately 0.25 acres total).

7.5.6 Environment

The examination of the natural environment showed that the concepts have generally similar potential impacts. Each concept would impact two streams, have six stream crossings, and could impact approximately 200 to 500 feet of stream. Each concept would also impact known bat habitat in the study area. With regard to the human environment, all six concepts would require a noise analysis to determine if additional noise walls are needed. One factor present for some, but not all, concepts is the potential for impacting existing noise walls. Concepts B-1 and A-1.1 are not expected to impact the existing noise walls, but the other four could impact approximately 1,800 feet of existing noise wall.

7.5.7 Mobility

The mobility metrics highlight the performance of each concept with regard to travel time, speed, delay, and level of service (LOS). Since improving traffic operations is part of the goals and objectives, it was a main aspect of the independent component analysis process for each of the three interchange areas (I, II, and III). The six concepts identified through that process all provide acceptable design year traffic operations. Additionally, the concepts do not have high levels of variability with regard to travel-time, average speed, delay, or LOS amongst them. All are anticipated to function within the typically accepted thresholds, perform in a comparable manner, and show a significant improvement compared to the No-Build 2045 conditions.

Based on the operational analysis, there is no indication that either of the I-71 SB ramp configurations (right-side ramps or left-side ramps) provides substantial mobility benefits over the other (as shown in the comparison of A-2.1 to A-2.2 or A-3.1 to A-3.2). Similarly, the different configurations of I-264 do not indicate that one option is substantially better than another (as shown by the comparison of A-1.1, A-2.1, and A-3.1). This is because all the proposed configurations can accommodate the 2045 design year volumes at acceptable levels of service.

7.5.8 Safety

Similar to mobility, improving safety is an important part of the objectives and goals of the study and is a main driver behind the development of several of the improvement concepts. Using ISATe to analyze the predictive safety of the various components and concepts made it possible to develop 20-year predictive crash metrics. The results of the ISATe analysis indicate a variance in total crashes between 1,375 and 1,418 for the concepts (or a fluctuation in annual crashes from 68.8 to 70.9). The anticipated performance of the No-Build is 1412 total crashes and 70.6 crashes per year; which is less than Concept A-3.1, but more than the other concepts. It is important to note that the HSM method does not specifically consider or have Crash Modification Factors (CMFs) for three important elements present in the interchange: left side



system ramps, Type-A or Type-C weaves, and over-capacity conditions. The analysis included research-based adjustments for the left-side ramps, but the other two items may explain the low crash predictions for the weave conditions. Adding factors for these second two items would increase the No-Build crashes the most and the weave concept crashes to a lesser degree. These factors would have little impact on the C-D road or ramp braid concepts, making them look more attractive. The net result of this sensitivity analysis is that the predicted build crash numbers are all better than the no-build and they are in the same range when compared to each other. This result favors lower capital cost concepts since the higher cost concepts do not necessarily yield significant safety benefits over the lower cost concepts.

When crash severity is taken into account (e.g., the number of fatal and serious injury crashes compared to property damage only crashes), it is predicted that the No-Build would be the most costly of the concepts with an undiscounted societal crash cost of \$171 million. The total societal crash costs of the Build concepts vary from \$162 million to \$170 million – all of which fall below the No-Build cost.

While the safety performance differs between the build concepts, they remain relatively similar based on the level of accuracy associated with a predictive crash analysis. The annual crash variance across the concepts is approximately two crashes/year, which is likely within the margin of error for the analysis.

7.6 Post-Level 2 Analysis

Following the completion of the Level 2 Analysis, additional analysis and review occurred. This section documents these activities.

7.6.1 Sensitivity Analysis

To evaluate the longevity of the developed concepts a sensitivity analysis was conducted for each of the concepts carried forward beyond the Level 2 Evaluation. The purpose of this sensitivity analysis was to estimate the lifetime of the proposed improvement concepts by testing volume increases beyond the design year analysis volumes. As each of the concepts is anticipated to work in the design year conditions, this will provide an additional indication of benefit of the concepts. Additionally, this testing will help validate the concepts if the future traffic growth or development growth exceeds the assumptions used to generate the traffic projections.

The traffic forecast volumes were grown at a consistent rate beyond the provided 2045 projections for all of the improvement concepts. For the purposes of the analysis, traffic was grown in increments of five years and each improvement concept was tested for failure. **Table 14** highlights the volume growth percentages both from 2019 existing volume and beyond the 2045 forecasted volume for each sensitivity analysis year.

Table 14: Sensitivity Analysis Volume Growth

	AM		PM		Average of AM & PM	
	% Growth from 2019	% Growth from 2045	% Growth from 2019	% Growth from 2045	% Growth from 2019	% Growth from 2045
2045	27%	-	29%	-	28%	-
2050	32%	4%	35%	4%	33%	4%
2055	36%	8%	40%	8%	38%	8%
2060	41%	11%	45%	12%	43%	12%
2065	46%	15%	51%	16%	49%	16%
2070	51%	19%	56%	20%	54%	20%
2080	61%	27%	67%	28%	64%	27%

The growth percentages are average growth throughout the Vissim model inputs weighted by volume. As the growth rate varied across input areas this provides a general growth estimation across the inputs.

The weaving areas along I-264 are assumed to be the most sensitive to increased volumes and were examined most critically during this process as the other links and merge or diverge areas have adequate capacity with all proposed concepts. Based on the analysis, it is anticipated that the I-264 EB weave proposed as part of Concept B-1 will reach an operational threshold with approximately 12% of additional traffic growth beyond the 2045 projections and 43% of total traffic growth beyond existing conditions. This is assumed to approximate 2060 traffic volume conditions. At this increase in volume the weaving area is anticipated to function with a density bordering the LOS D/ LOS E conditions. Several proposed concepts provide additional capacity to I-264 EB by eliminating the weaving movement with a C-D road (A-2.2) or Bypass Ramp (A-3.2 and A-3.3) which could be implemented as a later phased improvement should the traffic approach the additional growth in the future.

The I-264 WB weave proposed as part of Concept B-1 did not reach the LOS D/ LOS E density threshold and is anticipated to function with LOS D or better beyond the 27% of additional growth and 64% of total traffic growth tested as part of the sensitivity analysis (or the assumed 2080 traffic conditions). Should traffic exceed the anticipated growth within this area the proposed concept A-3.3 provides additional capacity along I-264 WB as it eliminates the majority of the weaving movement by braiding the I-71 ramps and providing a slip ramp from I-71 NB.

7.6.2 Concept A-3.3

After the Level 2 Analysis Report and sensitivity analysis were completed, Concept A-3.3 was created that could be constructed in phases as needs arise in Areas I, II, and III. The phasing of this new concept, supported by the sensitivity analysis, would be flexible and allow improvements to be made as the weaves on I-264 began to function unacceptably.

For example, Concept B-1 could be constructed first to address the most immediate needs of the interchange, with these being to improve I-71 NB through the interchange to address the horizontal curvature in this area and to widen the ramp from I-71 SB to I-264 WB from one to two lanes to address capacity concerns. If at such point in the future the I-264 EB weave began to break down and function at an unacceptable level of service, the bypass ramp could be

Figure 29: Concept A-3.3



8 Recommendations and Next Steps

This report section summarizes the I-71 / I-264 Interchange Study recommendations and potential next steps. The recommended interchange concepts should be carried forward into a Preliminary Engineering and Environmental phase where the project team would make the final design decisions. This section also identifies low-cost, short-term concepts for potential near-term implementation.

8.1 Potential Concepts for Preliminary Engineering

After evaluating and comparing the six Level 2 concepts, the project team recommended Concept B-1 as the base improvement concept to be carried forward for further analysis and more immediate implementation (possible inclusion with the I-71 widening project). It is the lowest cost concept that meets the identified project needs. The team also recommended Concepts A-3.2 and Concept A-3.3 to be implemented as two potential future phases that would further improve capacity and safety in the interchange area by removing the weaves in both directions. These concepts provide more capacity than would be needed in the design horizon, so they were not recommended for immediate implementation, but they could be constructed as follow-on phases when warranted (See **Figure 30**) Concept A-2.2 is recommended as an option to Concept B-1 and Concept A-3.2. It provides a collector-distributor road along eastbound I-264 between US 42 and I-71. Each of the recommended concepts is presented below.

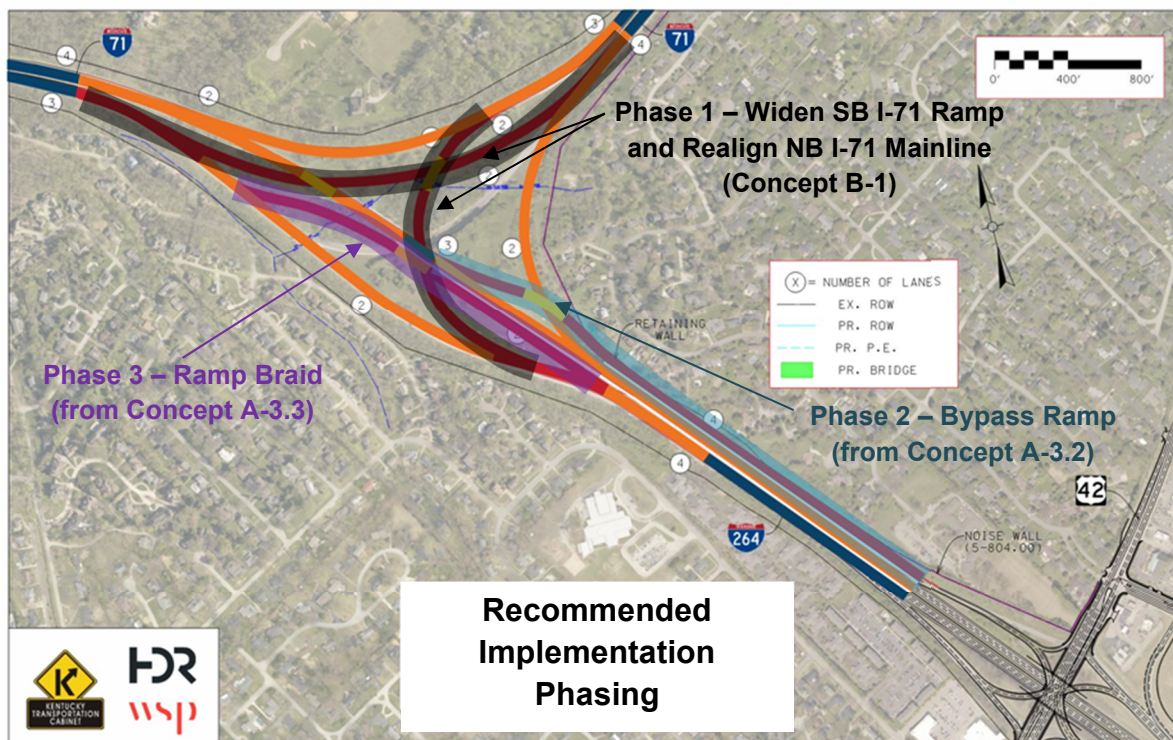


Figure 30: Concept B-1 With Recommended Follow-on Phases



8.1.1 Concept B-1 – Realign NB I-71 and Widen SB to WB Ramp to Two Lanes

Concept B-1 (**Figure 31**) is recommended as the initial improvement for the interchange to be implemented as soon as practicable. It would address the most immediate needs in the interchange area, the curve on I-71 NB through the interchange and the single-lane SB I-71 to WB I-264 ramp. This concept would allow the proposed mainline widening on I-71 and I-264 to function effectively. Conversely, not making these improvements would mean that northbound and southbound I-71 would have lingering operational and safety issues even after the widening construction was complete.

While Concept B-1 meets the most critical needs it also has the lowest cost of any of the improvement options and it does not require any additional right-of-way. The total estimated cost for this concept including design, utility relocations, and construction is \$16,580,000 (2020 dollars).

One facet of Concept B-1 would increase the radius of I-71 NB through the interchange. This improvement is projected to reduce crashes on this portion of the mainline by 15% or about 2.5 crashes per year. Flattening the curve would also allow for an improved design of the diverge of NB I-71 traffic to WB I-264. The proposed geometry would better meet driver expectations in the diverge area, which would reduce last minute lane changes and the current use of the far-left lane by lower speed traffic, allowing I-71 through traffic to move more freely in that lane and reducing the potential for speed differentials.

Concept B-1 would also widen the I-71 SB to I-264 WB ramp to two lanes. This would improve the ramp and SB I-71 approach area traffic flow to acceptable levels of service during the AM and PM peak hours. The 2019 peak hour traffic demand exceeds the capacity of the single-lane ramp, resulting in delays and queues (LOS E). If not addressed, the level of service during the highest demand hour will drop to LOS F by 2045 and the delays and queues will get longer.

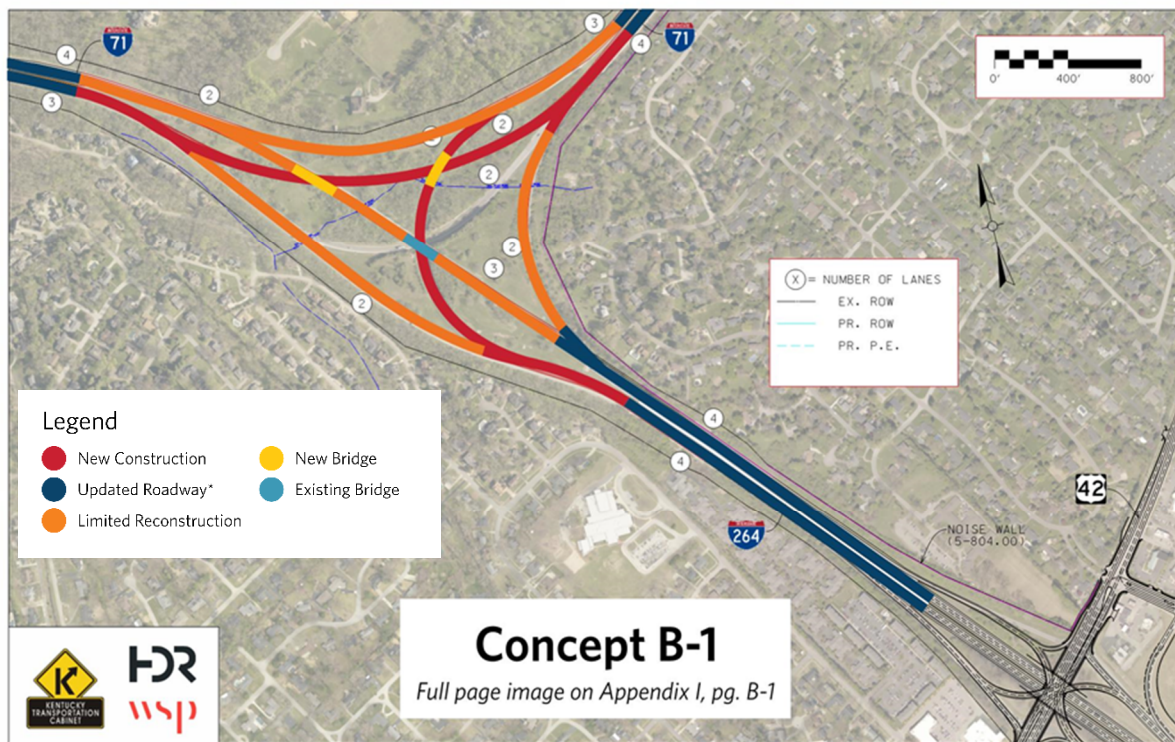


Figure 31: Concept B-1

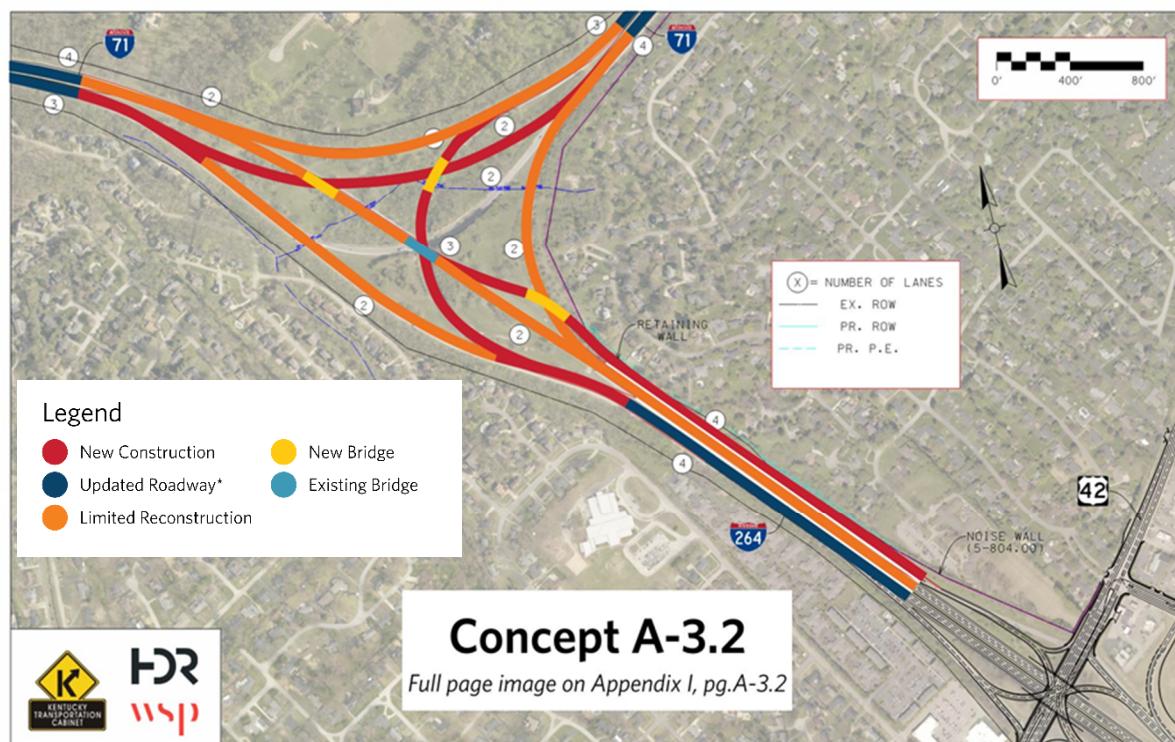
**Improvements from projects 5-804.00 and 5-557.00*

8.1.2 Concept B-1 - Future Phases

The two concepts shown in this section could be constructed either with Concept B-1 or as future phases of Concept B-1. They would eliminate the weaves on I-264.

CONCEPT A-3.2 – ADD BYPASS RAMP ALONG EB I-264

Concept A-3.2 (**Figure 32**) would add a bypass ramp from the US 42 on-ramp to the I-264 EB to I-71 SB ramp. This bypass ramp would eliminate the need for weaving on I-264 EB between the US 42 on-ramp and I-71. Drivers could still make the weaving movement if they did not use the bypass ramp, so clear signage would be needed if this concept was implemented. The bypass ramp could be constructed as a follow-on phase to Concept B-1.



*Improvements from projects 5-804.00 and 5-557.00

Figure 32: Concept A-3.2

Removing this weave was not shown to be needed in the design year (2045) once the I-71 mainline, I-264 mainline, and I-264 EB to I-71 NB ramp widening was all complete. However, the sensitivity analysis indicated that a 12% increase over the projected 2045 volumes would trigger a need for the bypass ramp. Therefore, it is recommended that this future phase improvement be advanced either with Concept B-1 (if funding allows) or traffic volumes be monitored at this interchange so that this improvement could be included as a follow-on phase when needed. If advanced with Concept B-1 the ramp would improve traffic flow (even before it is required by a level-of-service threshold) by minimizing weaving friction. It would also reduce potential conflict points, which is expected to improve safety on the mainline; however, the long bypass ramp with added barrier will increase the number of ramp crashes.

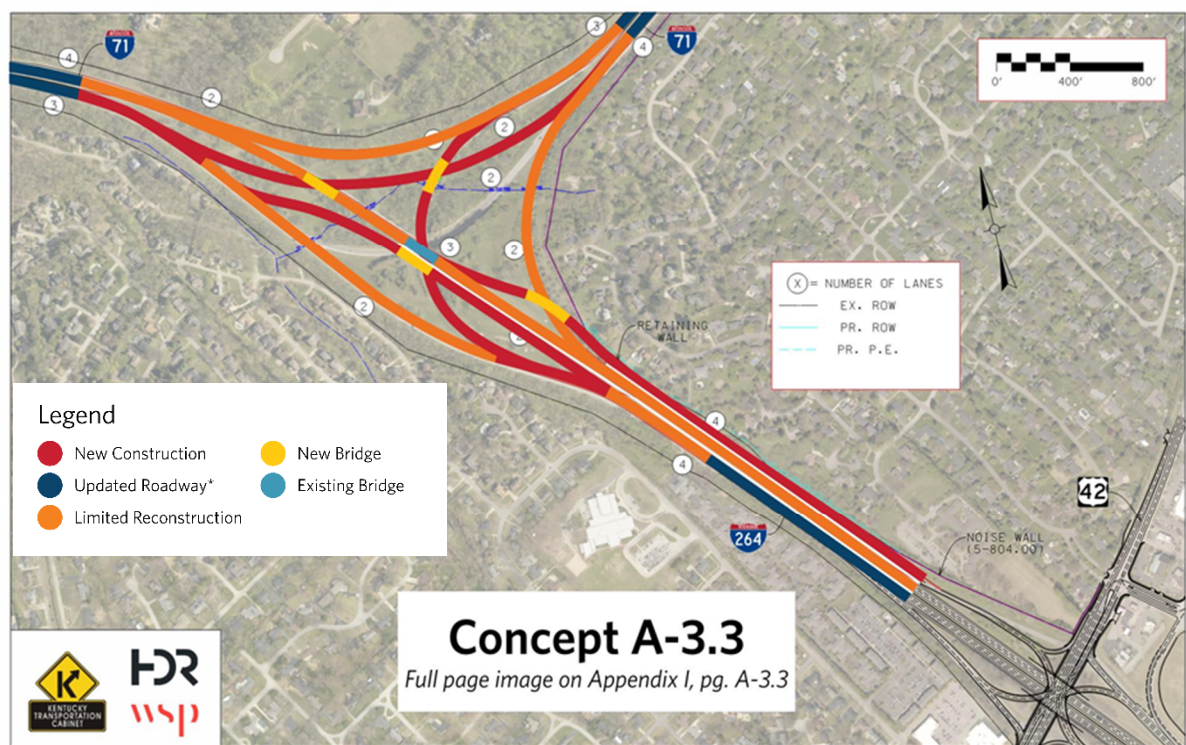
The construction of the bypass ramp would result in the need for additional right-of-way along the backs of several residential properties. It will also require additional utility relocations. This concept would also present additional MOT challenges but is expected to be more easily constructed than Concept A-2.2. The total estimated cost for this concept (both phases - Concept B-1 and the bypass ramp) including design, right-of-way acquisition, utility relocations, and construction is \$25,240,000 (2020 dollars).

CONCEPT A-3.3 – BRAID RAMP APPROACHES TO WB I-264

Concept A-3.3 (**Figure 33**) would build on the improvements of Concept B-1 and Concept A-3.2 to remove the I-264 WB weave. It would braid the ramp approaches from

I-71 NB and SB to I-264 WB such that no weaving is required for any WB I-264 drivers heading toward US 42.

Although the I-264 WB weave is predicted to operate acceptably throughout the design horizon, the current merge point is challenging for drivers due to the curvature of the ramps leading into the merge and the potential for drivers from SB I-71 to quickly switch lanes to the right after the merge. This concept would eliminate that issue. Additionally, while the proposed VA hospital traffic was taken into account in the forecasts, if weave traffic grows more than predicted it may be beneficial to remove the weave. A sensitivity test showed the level of service of this movement to be LOS D even with 27% traffic growth beyond the 2045 projections, so this concept is not viewed as a high priority compared to eliminating the I-264 EB weave.



*Improvements from projects 5-804.00 and 5-557.00

Figure 33: Concept A-3.3

The construction of the new ramp braid would not require additional right-of-way (right-of-way is required for the EB I-264 bypass ramp as noted above). The ramp braiding could create some new MOT challenges, but it also presents some important MOT opportunities. For example, it may be possible to construct this phase of the project with Concept B-1 in such a way that it helps maintain traffic on I-264 EB to I-71 SB. No long-term lane closures are expected to construct the ramp braid elements. The total estimated cost for this concept (all three phases – Concept B-1, bypass ramp from

US 42 to EB I-264, and ramp braid) including design, right-of-way acquisition, utility relocations, and construction is \$32,010,000 (2020 dollars).

8.1.3 Concept A-2.2 – CD Road Alternative to Concept B-1 and A-3.2

Concept A-2.2 (see **Figure 34**) would build on the improvements in Concept B-1 by adding a Collector-Distributor (C-D) Road on I-264 EB between US 42 and I-71. The C-D road would eliminate weaving on EB I-264 because it would directly connect the US 42 on-ramp to the I-71 NB and SB ramps. This would improve traffic flow by eliminating weaving friction, potentially resulting in higher speeds and smoother flows through the interchange. One challenge is how to best merge traffic onto the ramp to NB I-71. This would require additional pavement width and taper length. Concept A-2.2 would also reduce conflicts and improve safety on the freeway mainline, but new crashes could potentially occur on the C-D road, which will have additional barrier to separate it from the mainline. However, a net safety benefit is expected.

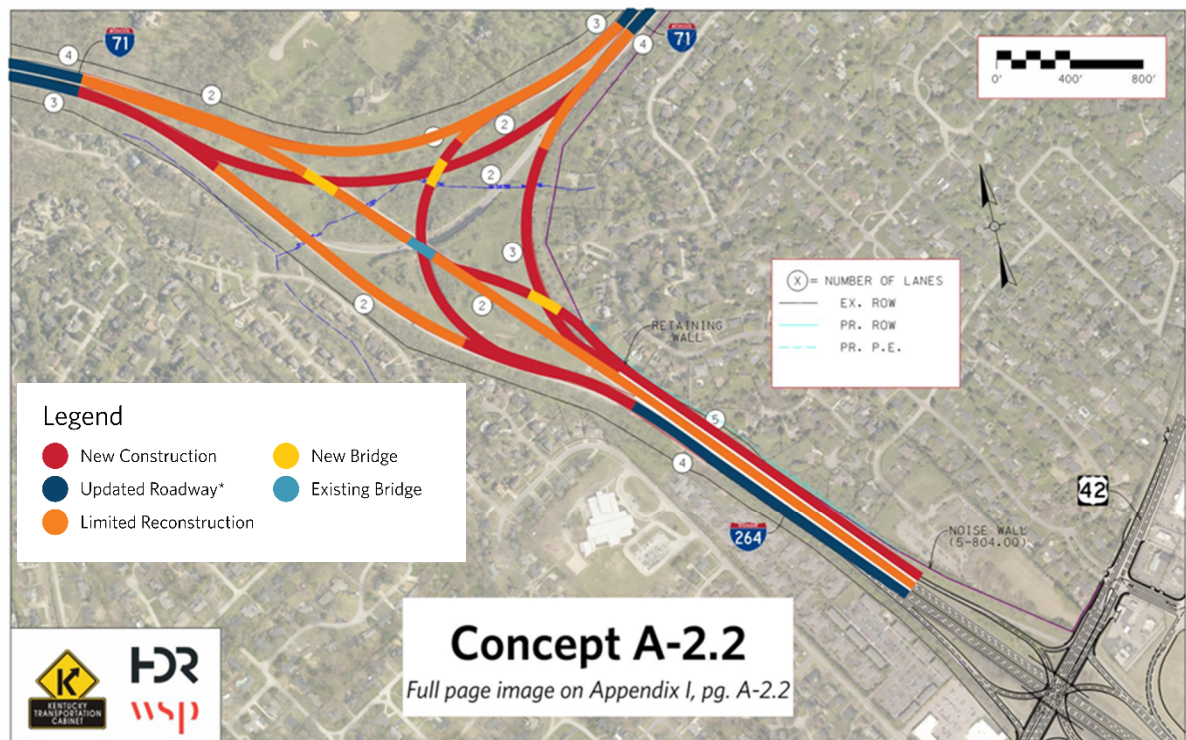


Figure 34: Concept A-2.2

**Improvements from projects 5-804.00 and 5-557.00*

The construction of the C-D roadway would result in the need for additional right-of-way and utility relocations. It should be noted that it would be more difficult to maintain traffic during construction with this concept. The total cost for this concept including design, right-of-way acquisition, utility relocations, and construction is \$25,440,000 (2020 dollars). This is approximately the same cost as Concept A-3.2, which includes the Concept B-1 improvements plus a proposed bypass ramp from US 42.



8.1.4 Left Sided Ramps

The left side entrance and exit ramps on I-71 SB were examined in detail. The analysis did not identify substantial operational or safety benefits to changing the ramps to be right side entrance and exit ramps. Converting these to right side ramps would require tighter radii along I-71 SB mainline which may potentially result in negative safety impacts due to a predicted increase in crashes associated with the curvature change. Given the lack of identified needs or benefits for these changes and the high cost, the concepts that switched the ramps to right side ramps were dismissed from consideration.

8.2 Low-Cost, Short-Term Improvements

Of the low-cost, short-term improvements evaluated as part of the Level 2 screening process, four were recommended for implementation and have been prioritized in order as listed below.

1. **Route Shield Pavement Markings (Lane Tattoos)** - This would add interstate route shield pavement markings in advance of the major diverge points leading into the interchange. These markings would improve lane utilization and lane assignments by providing additional, digestible information to drivers in advance of the diverges. With 60% of all crashes occurring in the approaches and diverge areas this option is expected to improve safety. The construction cost is estimated to be \$145,000.
2. **Vegetation Management** - This would trim vegetation, trees, and branches along the ramps in the interchange area to improve horizontal sight distance and decrease pavement drying times. Of the 278 total crashes that occurred in the study area between 2017 and 2019, 30 crashes occurred during rain events and 41 crashes occurred with wet pavement conditions. It is expected this option would be implemented under District 5's existing maintenance vegetation removal contracts and is estimated to cost \$75,000.
3. **Dynamic Message Signs (DMS)** - This would add four Dynamic Message Signs in the area around the interchange to better inform drivers headed toward the interchange so that they can make better routing decisions before they reach the interchange. The signs would fill gaps in the existing ITS coverage. The DMS would inform drivers of incidents and traffic congestion prior to entering the interchange and would give them the opportunity to select other routes. The proposed installations include an overhead DMS on I-71 NB north of Zorn Avenue, a side mounted DMS on I-264 EB before the US 42 interchange, and two ground mounted DMS on US 42 approaching the I-264 interchange (one on each side of the interchange). These installations offer the potential to improve system reliability and decrease rear-end and secondary crashes. The construction cost is estimated at \$750,000.
4. **Gore Extension** - This option would extend the gore area between I-71 NB and the ramp from I-264 EB to move the merge further away from the interchange allowing vehicles on the ramp and the mainline to reach similar speeds. Due to maintenance concerns the physical delineators may present, this option moved forward with only including additional striping to separate mainline and ramp traffic. This option is intended to address the 21



crashes that occurred in this merge area between 2017 and 2019. Construction cost is estimated to be \$5,000 and could be implemented by using existing pavement striping contracts.

8.3 Next Steps

No future funds have been programmed to improve the I-71 / I-264 Interchange beyond the planning funds designated for this study. Funding for Preliminary Engineering and Environmental work would need to be secured, whether as a standalone project or as part of the ongoing project to reduce congestion and improve safety along I-71 mainline (5-557.00) currently in preliminary engineering.

There are considerable advantages to including the improvements identified in Concept B-1 with the ongoing I-71 mainline project (5-557.00). It achieves the primary operational and safety goals for the interchange (and the widening projects), can be integrated with both project 5-557.00 and 5-804.00, has the lowest estimated construction costs, and allows for future phased construction of the interchange. Other advantages include eliminating a critical bottleneck that would be present after I-71 mainline is widened if ramp improvements were not included, reducing impacts to the traveling public by having only one construction project, and providing fiscal efficiency by having a unified construction effort. If proposed improvements from Concept B-1 are included in the 5-557.00 effort, the NEPA analysis would need to be updated accordingly to include the interchange improvements.

No funding sources for the recommended low-cost, short-term improvements have been identified, but the use of maintenance funds should be explored to accomplish as much of these as possible – examples being to include Route Shield Pavement Markings with pavement rehabilitation/resurfacing projects, extending the striped gore at the I-71 NB merge from I-264 EB, and vegetation management using existing maintenance contracts.

Written requests for additional information should be sent to Mikael Pelfrey, P.E., Director, KYTC Division of Planning, 200 Mero Street, Frankfort, KY 40622. Additional information regarding this study can also be obtained from the KYTC District 5 Project Manager, Pat Matheny, P.E., (Ph. 502-210-5400); email Patrick.Matheny@ky.gov