

EAST//WEST CoNNECTION

North
29 35 71 ONLY

NöRTH
: KANSAS CiTY
: *Virtually Urban. Supremely Suburban.*

MARC
MID-AMERICA REGIONAL COUNCIL

East/ /West Connection Plan

Final
November 2022

Prepared for:



600 Broadway, Suite 200
Kansas City, MO 64105

Project Sponsor:



2010 Howell St
North Kansas City, MO 64116

Prepared by:



300 Wyandotte, Suite 200
Kansas City, MO 64105

Table of Contents

- Table of Contents3
- Executive Summary.....5
- Introduction.....11
- Public Engagement Summary14
 - Focus Group #1.....14
 - Public Online Survey.....16
 - Survey Question Responses.....17
 - Focus Group #2.....26
 - City Council Presentation.....30
- Safety Analysis32
 - Recommended Countermeasures.....34
 - Crash Data Analysis.....35
 - Crash Locations.....35
 - Crash Types.....38
 - Bicycle and Pedestrian Crashes.....42
 - Highway Ramp Crashes.....43
- Traffic Analysis47
 - Proposed Options47
 - Traffic Operations Summary49
 - Traffic Operations Modeling.....49
 - Existing Traffic Operations.....51
 - Proposed Options Traffic Operations.....52
- MoDOT Coordination55
 - Coordination Meetings55
 - Coordination Meeting #1.....55
 - Coordination Meeting #2.....55
 - Coordination Meeting #357
- Design Criteria Review58
 - Engineering Policy Guide Design Information.....60
 - Additional Engineering Guidance.....61
- Concept Layouts64

Non-Geometric Recommendations.....	65
Crosswalk Improvements.....	65
Lighting Under Bridge.....	65
Maintenance and Cleaning of Sidewalks.....	66
Landscaping & Trees.....	66
Geometric Recommendations.....	67
Construct Shared Use Path Under I-35.....	68
Construct Shared Use Path Near Levee.....	71
Fill in Sidewalk Gaps in Area.....	72
Re-align High Speed Right-Turn Lanes onto I-35 Ramps.....	73
Recommended Concept.....	74
Conclusion.....	82

Executive Summary

The East/ /West Connection Plan was initiated in response from the North Kansas City (NKC) Bicycle Master Plan to provide detailed planning and coordination for the Armour Road bike/pedestrian crossing under I-35 between Ozark Street and Taney Street as seen in Figure 1. This plan's location of interest was identified as an infrastructure barrier that divides NKC into east and west during the Bicycle Master Plan's public engagement process. Additionally, the location was determined as the community's top priority for potential improvement.



Figure 1: East/ /West Connection Study Area

Throughout this project, the public was asked to participate in the decision-making process. Two focus group meetings were convened, a public survey was conducted, and a public open house was held in conjunction with a City Council meeting. The results of these meeting are highlighted in this section. Traffic safety was identified as a top concern by the public. To determine what safety issues exist on the corridor, a comprehensive crash analysis was conducted. Over the nine-year study period from 2012 - 2020, there were 369 crashes in the study area. 56 of these crashes resulted in a minor injury and 9 resulted in a serious injury.

The bicycle and pedestrian crashes accounts for approximately 6% of the minor and serious injury crashes. One of the serious injury crashes involved a cyclist, which represents approximately 11% of the serious injury crashes. Bicyclists and pedestrians likely represent approximately 0.5% of the traffic volume through the study area. This means that a bicyclist or pedestrian is approximately 12 times more likely to be injured and 22 times more likely to be seriously injured than a driver travelling through the interchange area.

Other items were identified by the public for improvement besides safety including:

- Improve Crosswalks
- Improve Lighting
- Widen Sidewalks/Trails
- Improve Maintenance
- Construct Levee Trail

Each of these was pursued except the levee trail. The levee trail was deemed to be a potentially positive improvement for the community but was outside the scope of this project. The following sections detail these concept recommendations and options.

Almost the entire study area for this project resides within the MoDOT right of way. Because of this, any proposed options will need to comply with MoDOT design standards. This section provides an overview of the controlling design standards for this project that were considered in the design options. MoDOT was engaged throughout this project process. Three meetings were held throughout the process and they were a vital partner in refining the concepts.

The recommendations detailed in this study include:

- Constructing a new barrier protected 12' wide shared use path on both the north and south sides of Armour Road
- Improving lighting levels under the bridge
- Identifying who is responsible for maintenance and cleaning of the paths and providing continuous maintenance
- Improving landscaping in the area
- Provide further study for a levee trail, other safety improvements at the interchange, and infill sidewalk projects in the area

This concept design is depicted in the following renderings. Additional renderings and videos can be viewed on the project website:

<https://www.nkc.org/government/community-development/armour-road-east-west-connection>

It is recommended this concept move forward into the final steps of coordination with MoDOT to develop final designs and begin construction. The expected cost for this project is approximately \$2.5 million, a breakdown of which can be seen below. It should be noted that this cost estimate includes shared use paths on both sides of Armour Road. This project could be phased with the shared use path constructed on just the north or just the south side initially.

Table 1: Estimated Project Costs

Estimated Cost Item	Estimated Cost
Barrier Protected 12' Wide Shared Use Path (North and South sides, incl. landscaping)	\$1,870,000
Improve lighting under bridge	\$330,000
Professional Services for Shared Use Path and Lighting	\$320,000
Estimated Total Cost	\$2,520,000



Figure 2: Overview rendering of recommended concept



Figure 3: Rendering view of improved pedestrian crossing of ramp from eastbound Armour Road to southbound I-35 (looking east)



Figure 4: Rendering view of new pedestrian crossing across ramp from eastbound Armour to northbound I-35 (looking east)



Figure 5: Rendering view of shared use path under the I-35 bridge on the south side of Armour Road (looking west)



Figure 6: Rendering view of improved crosswalk across northbound I-35 off-ramp (looking east)



Figure 7: Rendering view of improved pedestrian crossing of ramp from westbound Armour Road to northbound I-35 (looking west)



Figure 8: Rendering view of shared use path under the I-35 bridge on the north side of Armour Road (looking west)



Figure 9: Rendering view of shared use path on north side of Armour Road east of Ozark Street (looking east)

Introduction

The East/ /West Connection Plan was initiated in response from the North Kansas City (NKC) Bicycle Master Plan to provide detailed planning and coordination for the Armour Road bike/pedestrian crossing under I-29/35 between Ozark Street and Taney Street as seen in Figure 10. This plan's location of interest was identified as an infrastructure barrier that divides NKC into east and west during the Bicycle Master Plan's public engagement process. Additionally, the location was determined as the community's top priority for potential improvement.



Figure 10: East/ /West Connection Study Area

Figure 12 and Figure 13 show the current cyclist paths around NKC in green and the desired cyclist paths in blue. It is clear to see that most of the cyclists attempt to avoid the Armour Road and I-29/35 interchange, and that most cyclists would prefer utilizing Armour Road if safe and comfortable facilities existed. Exact counts are not currently available for usage, but counts were available for the Armour Road and Iron Street intersection where bicycle and pedestrian traffic only accounted for 0.9% of the daily traffic. It is assumed that at Armour and I-29/35, the bicycle and pedestrian traffic would account for even less than this. For this analysis, it is assumed that bicycle and pedestrian traffic account for 0.5% of daily traffic at the interchange.

The NKC Bicycle Master Plan recommended a network through NKC based on three principles: (1) safe and comfortable routes for all ages and abilities, (2) direct and continuous routes, and (3) connecting important destinations. The NKC Bicycle Master Plan determined that from 1.1% to 2.4% of people in NKC ride a bike daily. If NKC implemented the details of the NKC Bicycle Master Plan, then the number of adults bicycling daily could increase from 2.5% to 15% during a 20-year period, resulting in a high benefit to society. However, this increase is contingent on implementation of facilities comfortable for low-stress cyclists.

In addition to cycling, pedestrian improvements are also highly desired. There are several large employers and residential areas existing and planned on the east side of I-29/35, which are somewhat isolated from downtown NKC for pedestrians. Sidewalk improvements have been implemented during preceding years so that there are now continuous sidewalks on both the north and south side of Armour Road. However, these sidewalks have a constrained width of four to five feet wide with barriers on both sides of the sidewalk for much of the distance. Pedestrians must cross several uncontrolled high-speed, right-turn lanes, some with limited sight distance.



Figure 11: Photos from the Study Area.

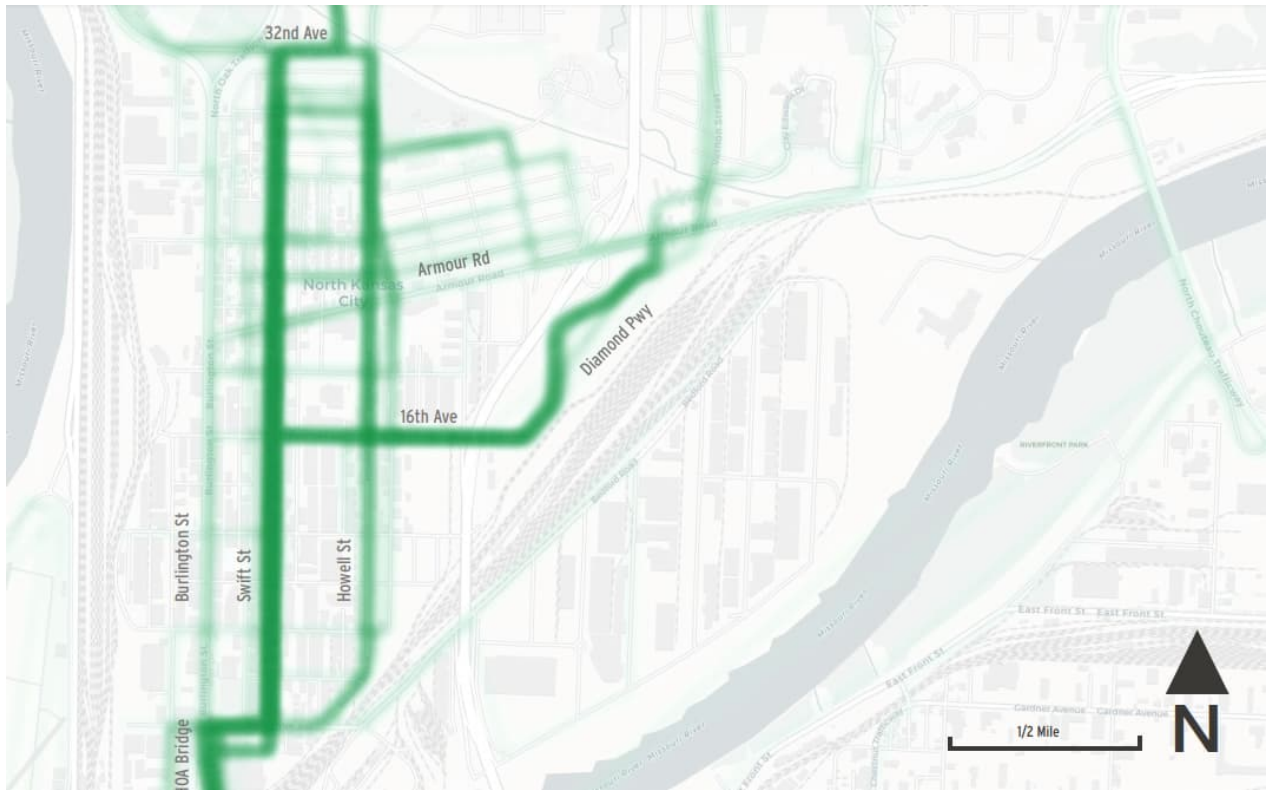


Figure 12 - Current Cyclist Paths through North Kansas City (Taken from NKC Bicycle Master Plan)

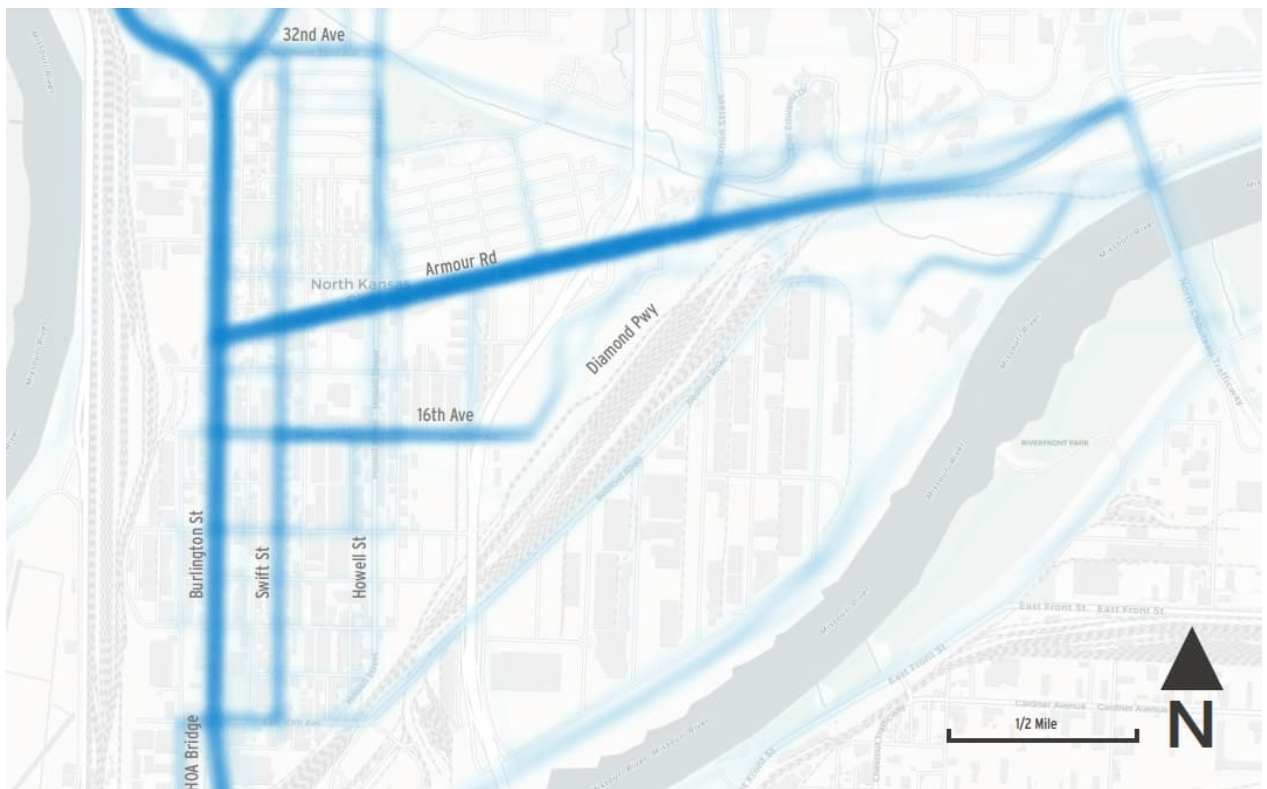


Figure 13 - Desired Cyclist Paths through North Kansas City (Taken from NKC Bicycle Master Plan)

Public Engagement Summary

Throughout this project, the public was asked to participate in the decision-making process. Two focus group meetings were convened, a public survey was conducted, and a public open house was held in conjunction with a City Council meeting. The results of these meetings are highlighted in this section.

Focus Group #1

The first focus group meeting was held on July 21, 2021, and attendees included:

- Ryan Shafer - Clay County Public Health Department and Resident
- Valerie Swearingen - Parks Board
- Amie Clarke - Ward Four
- Adam DeGonia - Parks Board
- Bryant DeLong - Mayor
- Victoria Ressler - Parks and Recreation Department
- Linda Black - Resident
- Delaney Brown - Clay County Health Intern
- Dave Wood - Planning Commission
- Kathy West - Resident

Focus group members were polled to help identify potential improvement options and prioritize those improvements. In general, focus group attendees shared their belief that I-29/35 divides NKC, and they would like to be able to walk/bike between the west and east sides of the city much more easily. Focus group attendees were asked to respond to the question, "If you have walked/biked under I-29/35, describe your experience." Their responses are shown in Figure 14. Larger words show consensus.

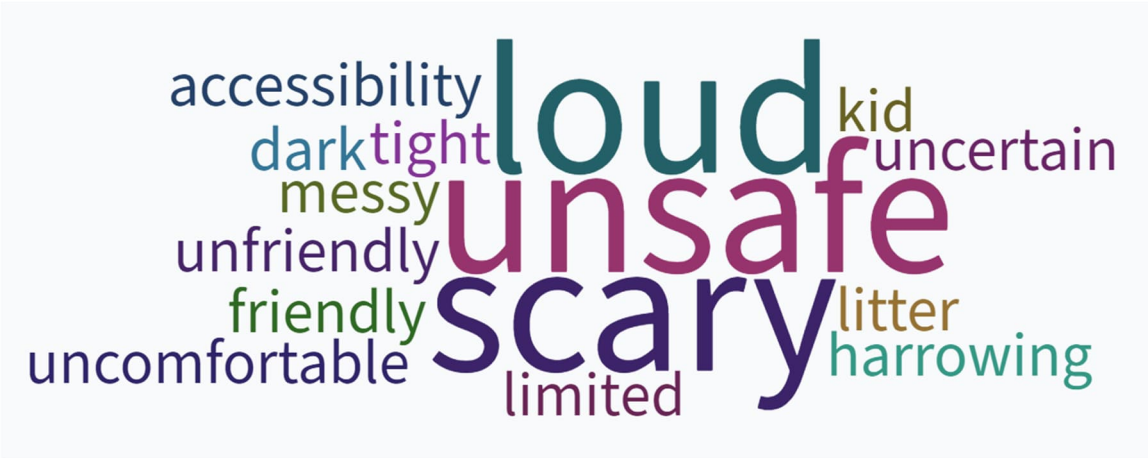


Figure 14: Focus group responses to the question, "If you have walked/biked under I-29/35, describe your experience."

Most focus group attendees felt that safety was the top priority. This included both traffic safety and personal safety. Traffic safety concerns were primarily related to having to cross the right-turn lanes for the on-ramps and the high speed of traffic through the area.

Personal safety concerns were related to the constrained environment and low lighting levels. Figure 15 shows the focus group responses to the question, "What is the greatest opportunity?"



Figure 15: Focus group responses

The group felt that improved lighting would be a good first-implementation project and then more intensive safety work to upgrade pavement marking, provide wider bike/pedestrian paths, and improved crosswalks. An important, but longer-term goal would be to beautify the area as well. Other ideas included improving maintenance (including trash cleanup), exploring an elevated crossing across I-29/35 in line with the levee north of Armour Road, and improving visibility of pedestrians and cyclists.

Figure 16 shows the focus group responses to the question, “What can be done to make walking or biking in that vicinity safe, comfortable, and appealing?”



Figure 16: Focus group responses

Public Online Survey

A public survey was conducted after gathering focus group input. The survey was open from September 21 to October 21, 2021 and gathered 229 total responses. Most comments characterized this section of Armour Road as uninviting and dangerous. Respondents had safety concerns both from a traffic safety and a personal security perspective.

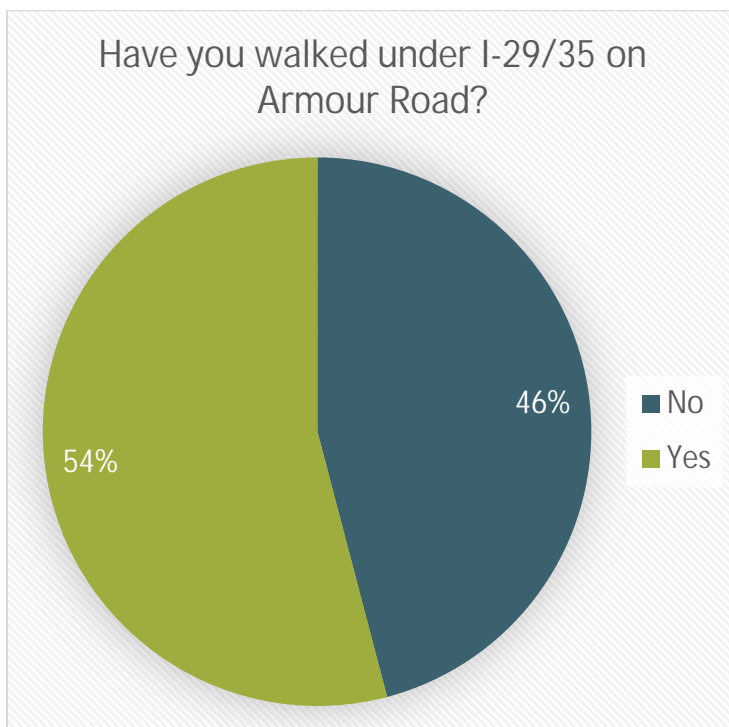
Comments from the public survey closely mirror feedback gathered in Focus Group #1 and throughout the Bicycle Master Plan public engagement process.

- Respondents primarily disliked:
 - Narrow sidewalks
 - Having to cross high-speed, right-turn on-ramps to I-29/35
 - Lack of lighting—dark under bridge and difficult to see when entering or emerging into sunlight
 - Lack of maintenance, trash clearing
- Respondents primarily liked:
 - Barrier between sidewalk and cars
 - Areas with separation between sidewalk and cars with grass
- Respondents were most in support of:
 - Improving crosswalks with flashing warning lights for drivers, pavement marking, and signs
 - Widening sidewalks
 - Improving lighting under the bridge
 - Improving maintenance/clearing trash
 - Exploring a levee trail with bridge/tunnel over/under I-29/35

The following sections detail the responses to the survey questions.

Survey Question Responses

Question 1: The project area being studied includes the area along Armour Road between Ozark Street and Taney Street under I-29/35. Have you ever walked or biked under the highway on Armour Road?

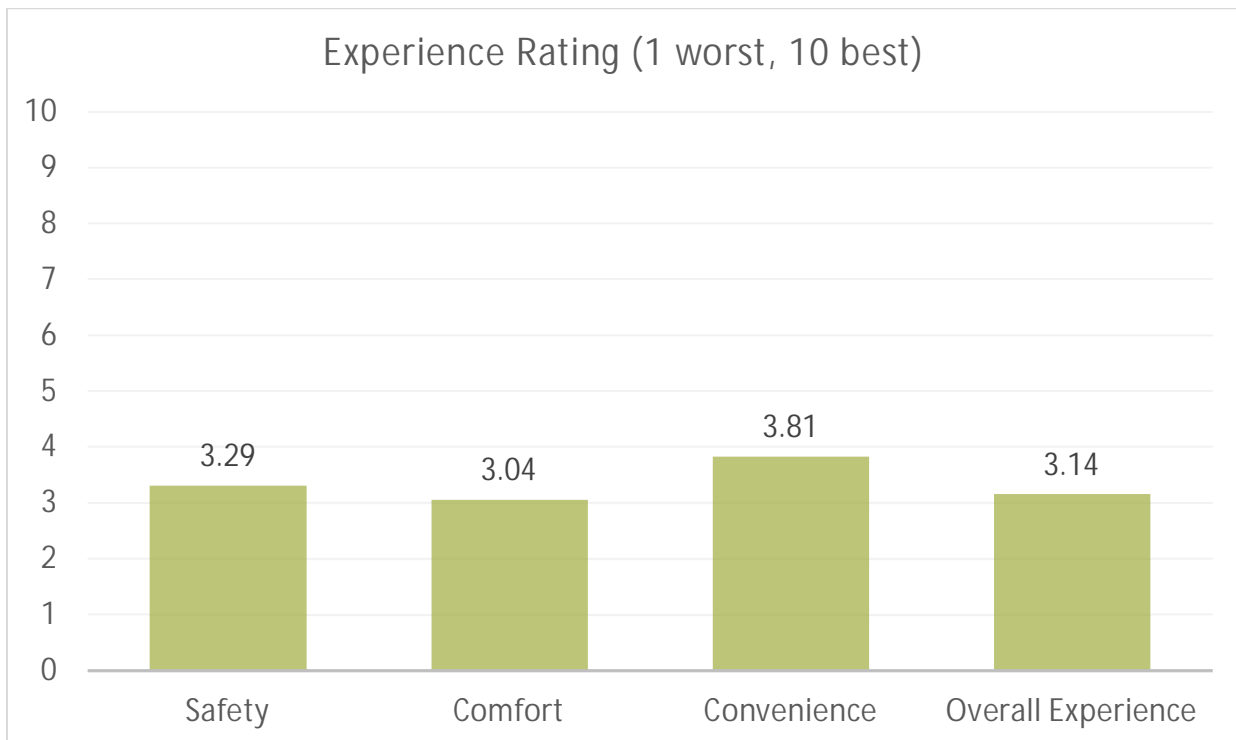


Question 2: If you have walked or biked under I-29/35, please describe your experience. If you have not walked or biked under I-29/35, please say why not.

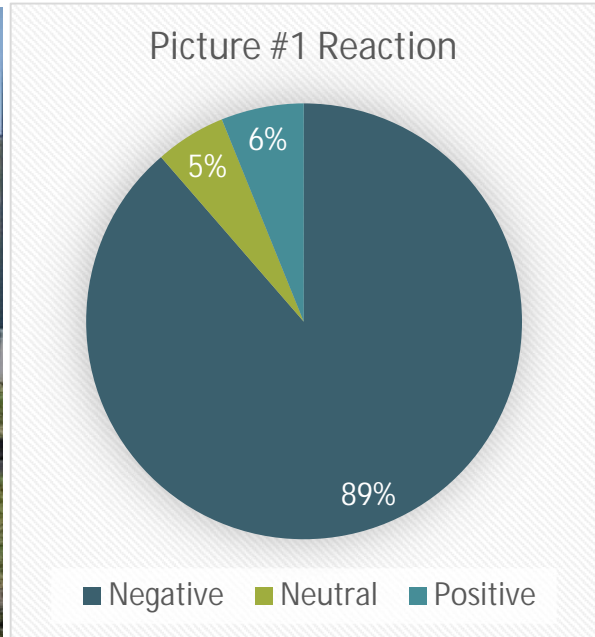
- What was your experience walking or biking under I-29/35?
 - Unpleasant & loud
 - Scary
 - Stressful
 - Drivers don't yield to pedestrians/cyclists
 - Area is dirty and filled with trash
- Why haven't you walked or biked under I-29/35?
 - Unsafe to walk/bike there
 - More convenient to drive
 - Dirty and uninviting

Question 3 - 6: On a scale of 1 to 10, rate:

- Your overall experience walking or biking under I-29/35 on Armour Road with 1 being terrible and 10 being great.
- The convenience of walking or biking under I-29/35 on Armour Rd. with 1 being least convenient and 10 being most convenient.
- Your comfort level walking or biking under I-29/35 on Armour Road with 1 being most uncomfortable and 10 being most comfortable.
- How safe would you rate the Armour Road corridor under I-29/35 with 1 being least safe and 10 being extremely safe?



Question 7: This is a picture from the south side of Armour Road west of I-29/35. Is your reaction to this picture positive or negative? Are there things you like or dislike in the picture? Please elaborate.



What respondents liked:

- Open space

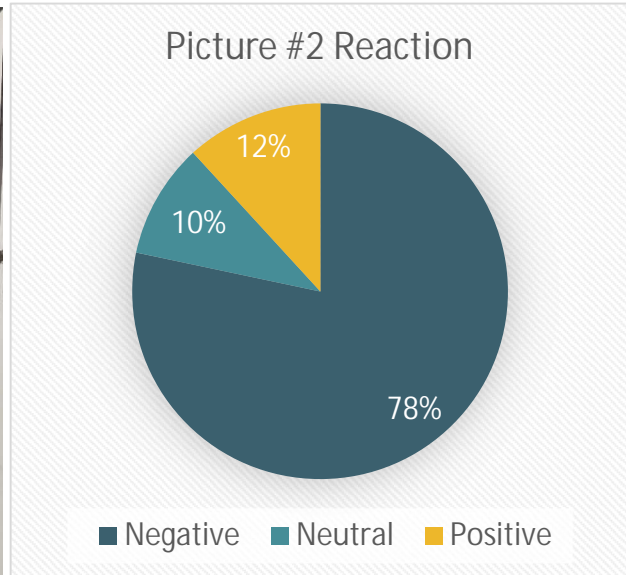
What respondents didn't like:

- Narrow sidewalk
- Crossing high speed traffic
- Drivers don't yield
- No warning device for pedestrians

Respondent Quotes:

- "Only somebody with no other option would walk through here."
- "Having to cross on-ramps like that with traffic coming from behind is always dangerous and difficult. Drivers are never watching for pedestrians or bikers."
- "My reaction... I am going to get hit!!!"
- "This area was obviously built to steer people away from walking or biking."
- "The only good thing is that the sidewalk is a little separated from the road. However, there's zero barrier keeping a car from swerving over. The gentle curve promotes high speeds, and it was clearly designed with disregard for pedestrians. The crosswalk needs to be more visible."

Question 8: This is a picture from the north side of Armour Road underneath I-29/35. Is your reaction to this picture positive or negative? Are there things you like or dislike in the picture? Please elaborate.



What respondents liked:

- Barrier between pedestrians and cars

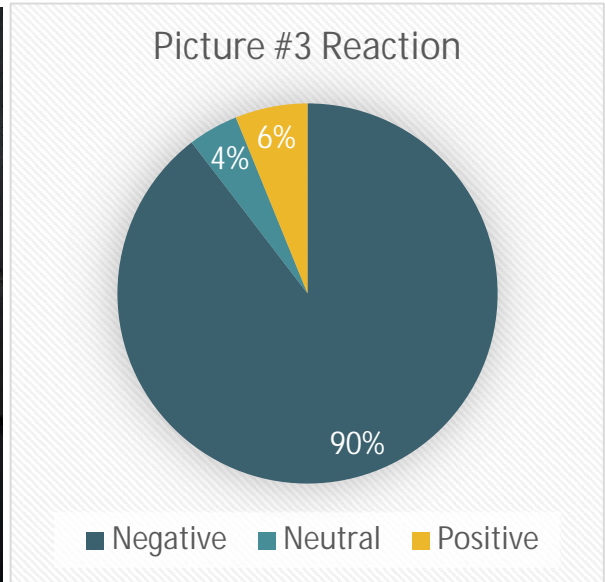
What respondents didn't like:

- Narrow width
- Dark under bridge
- Trash

Respondent Quotes:

- "I'm a woman and wouldn't walk under this at night."
- "As a 6' 210lb male I'd be uncomfortable at night. Ridiculous."
- "Dirty, narrow, loud, entrapped. Does not encourage walking."
- "Positive as I feel it provides a safe barrier between the car traffic and sidewalk. It functions in a positive way but can be improved."
- "Good protection for pedestrians. Not enough space for two people in opposite directions."

Question 9: This is a picture from the south side of Armour Road under I-29/35. Is your reaction to this picture positive or negative? Are there things you like or dislike in the picture? Please elaborate.



What respondents liked:

- Barrier between pedestrians and cars

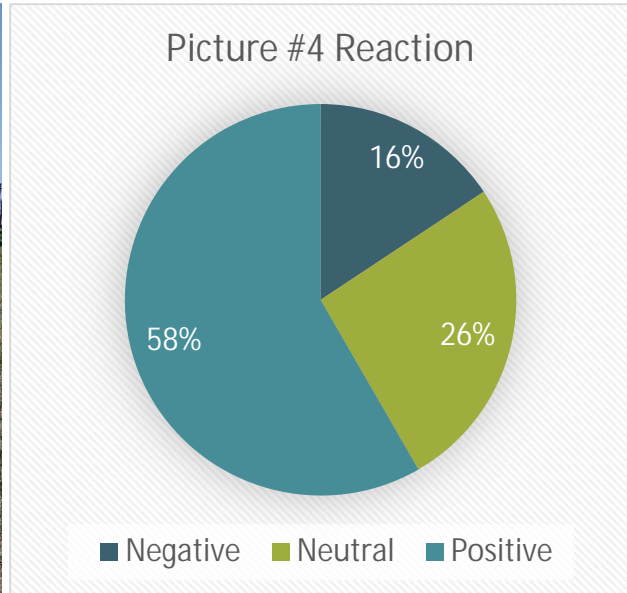
What respondents didn't like:

- Narrow width
- Dark under bridge
- Crossing high speed traffic
- Poor visibility
- Trash

Respondent Quotes:

- "I do like that there is a crosswalk marking but entering from the dark passage is dangerous. Too narrow"
- "Poor lighting and cars are transitioning from street to highway speeds."
- "Its protected"
- "Such a car centric design. And not even comfortable to drive through"
- "Where on earth and in what planet does one think it is safe to ride, or walk with children through this intersection?"

Question 10: This is a picture from the south side of Armour Road east of I-29/35. Is your reaction to this picture positive or negative? Are there things you like or dislike in the picture? Please elaborate.



What respondents liked:

- Buffer area from traffic
- Grass
- Well maintained

What respondents didn't like:

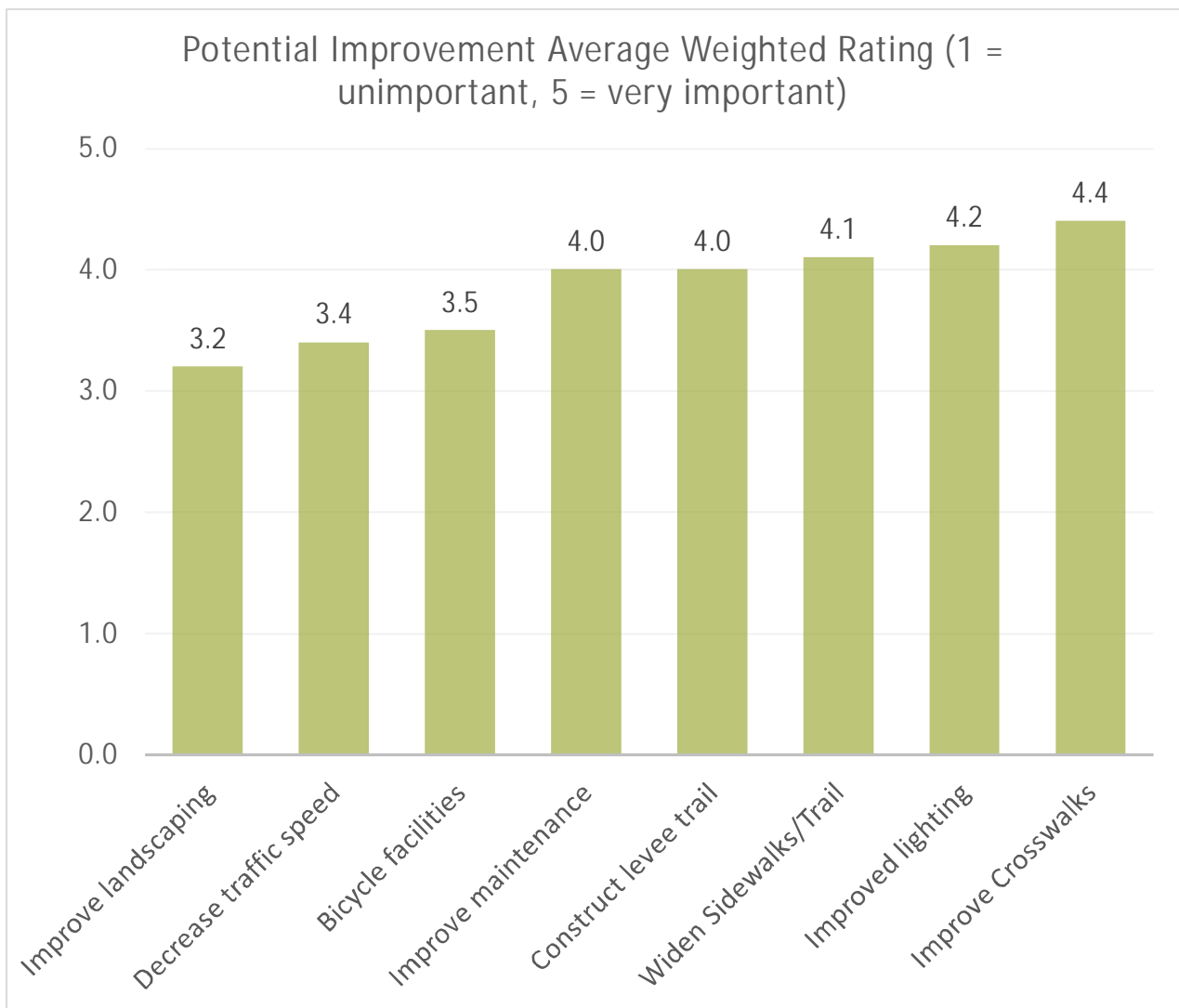
- Narrow width
- No shade/trees
- Lack of character

Respondent Quotes:

- "I like the sidewalks being further from the roadway, it is more inviting for pedestrians."
- "This sidewalk is too narrow for two people to walk side by side; it should be wider. But I appreciate that it is oriented further from the highway, making it more comfortable to utilize."
- "For walking, it is nice that the sidewalk is away from the road. What about bikes? Do they have a safe spot to ride? Would be nice to see some trees/shade to make this an encouraging place to walk."
- "Very pretty. Could use some trees, though."

Question 11: Rate the importance of potential improvements that could be made to Armour Road in the study area. Ranking from Unimportant to Very Important.

- Improve Crosswalks with signs, pavement marking, and warning lights
- Improved lighting under the bridge
- Widen Sidewalks or construct shared use trail through area
- Improve maintenance of area under the bridge
- Construct trail along flood levee north of Armour Road with a crossing over/under I-29/35
- Add dedicated bicycle facilities
- Decrease speed of traffic and speed limit
- Improve landscaping and streetscaping aesthetics



Question 12: Do you have any other ideas that would make walking or biking in the vicinity more safe, comfortable, and appealing?

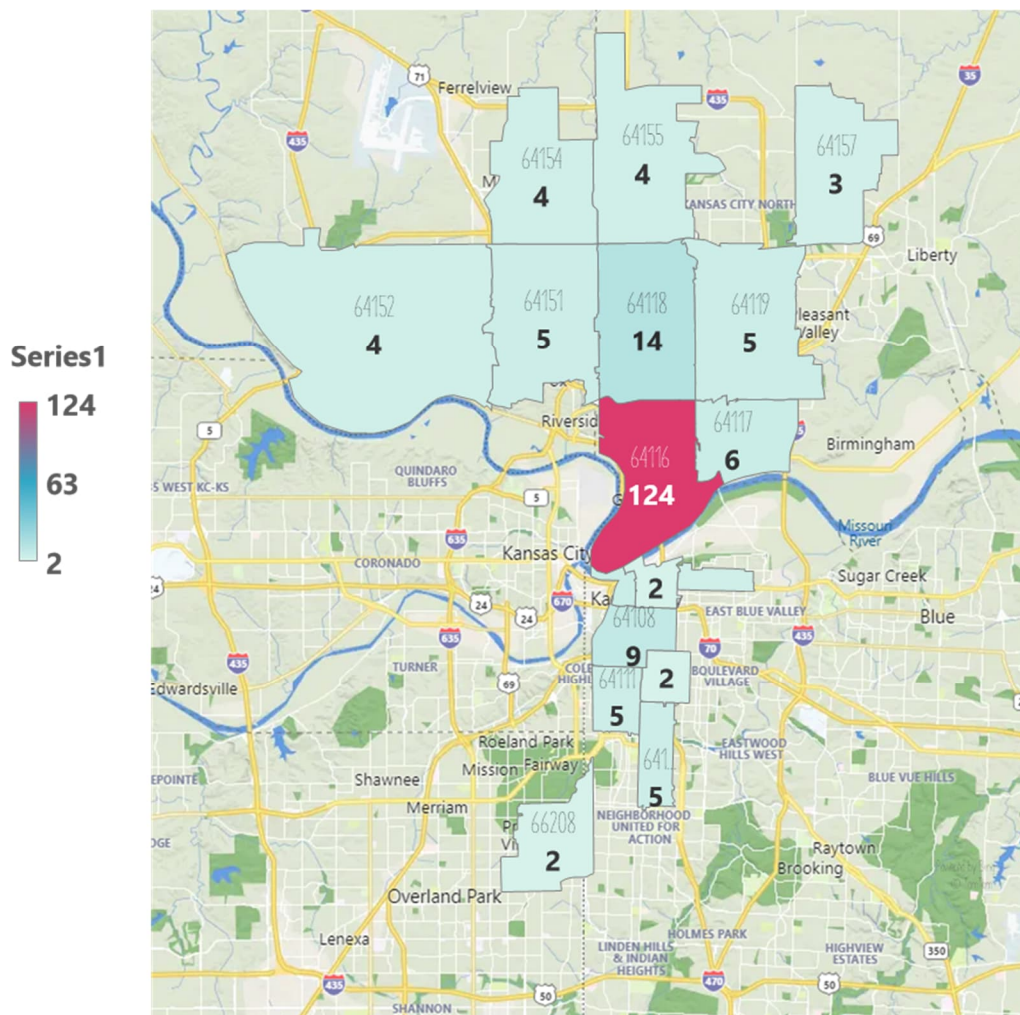
Majority of comments further support improvement ideas presented in question #11

Question 13: Do you have any other comments or concerns that you would like to share with project staff?

- Consider additional connections at 16th Avenue & 14th Avenue
- Concerned for cost of project and if benefit outweighs the cost
- Concern project will increase traffic congestion

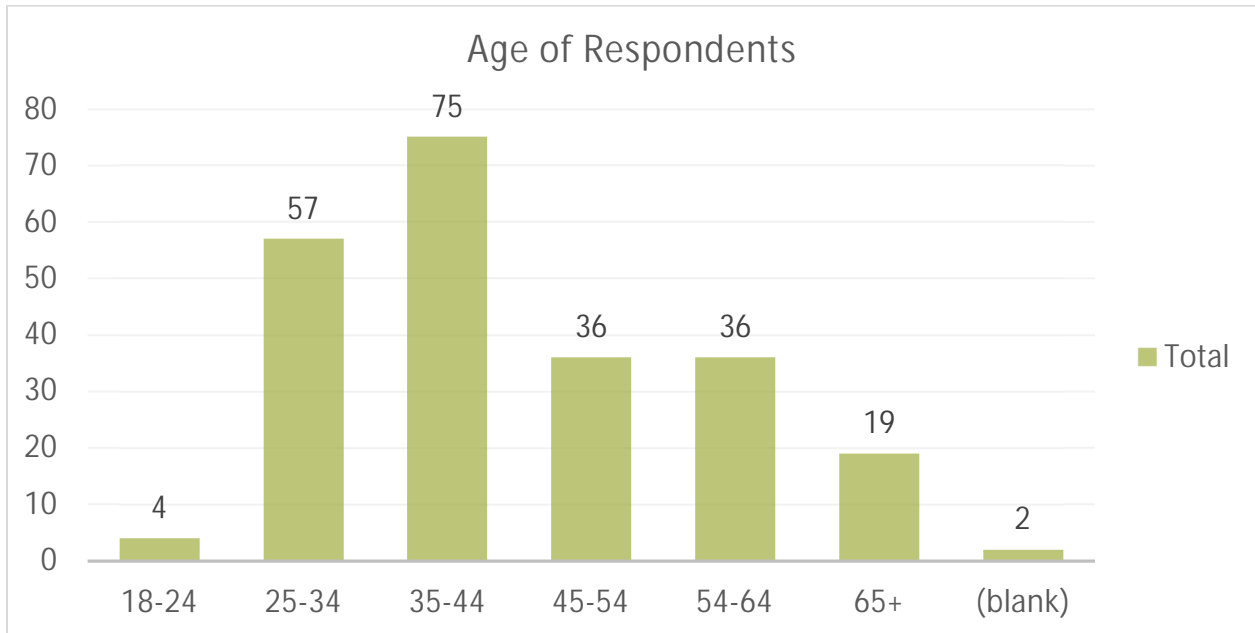
Question 14: What is your home zip code?

- Majority of respondents (56%) lived in zip code 64116, which encompasses North Kansas City.
- Some respondents lived in the immediate surrounding area in the Northland and in Downtown Kansas City, MO.
- The remainder lived throughout the metro area.



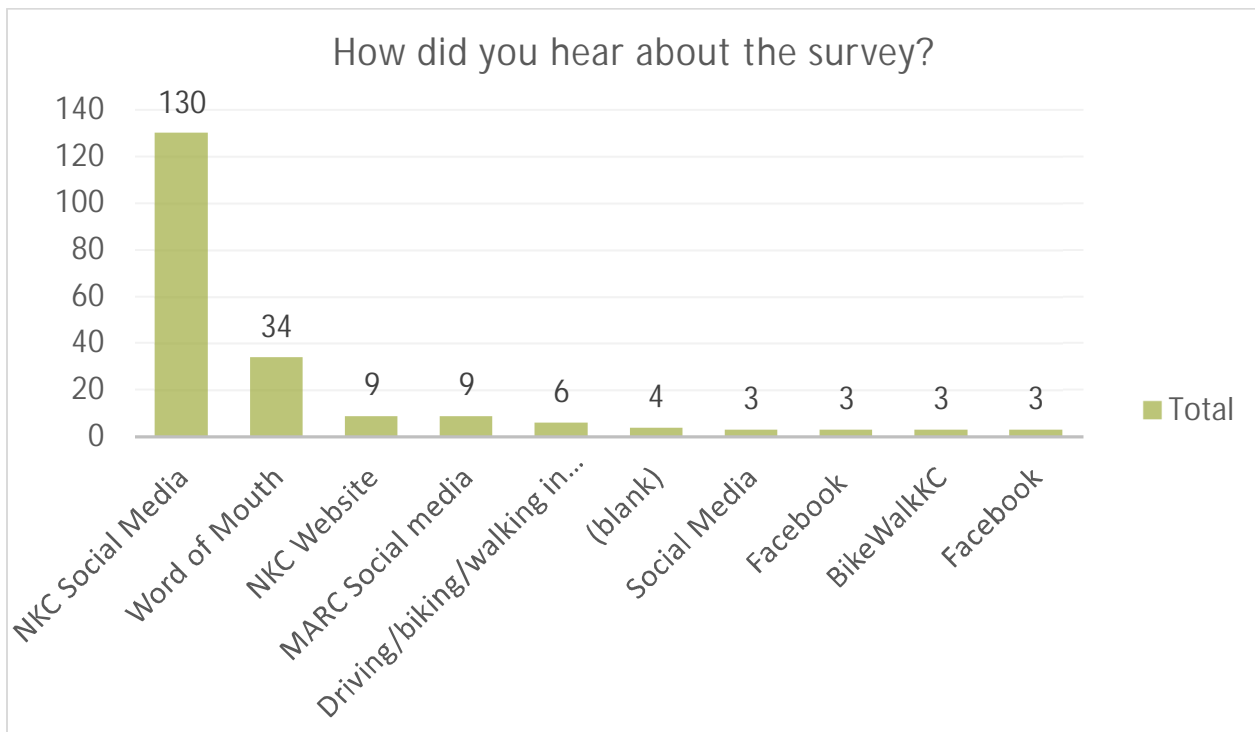
Question 15: What is your age?

- Distribution of ages is like distribution of ages of residents in the area.
- Largest age group was 25 - 44 (57%) followed by 45 - 64 (31%)



Question: How did you hear about this survey?

- Most heard about survey on NKC social media accounts / word of mouth (80%)



Focus Group #2

The second focus group meeting was held on January 25, 2022. Attendees included:

- Valerie Swearingen - Parks Board
- Amie Clarke - Ward Four
- Adam DeGonia - Parks Board
- Bryant DeLong - Mayor
- Linda Black - Resident
- Delaney Brown - Clay Co. Health Intern
- Byron Spencer
- Jack Fry

Project team members shared information on project background, project location, and photos from the virtual walking tour, as well as a brief recap of Focus Group #1 and highlighted results from the Public Online Survey. Focus group members were polled to understand what surprised them about the public survey results, and general comments included the following observations:

- "The popularity of a levee trail option"
- "Bicycle trail being lower priority"
- "Not surprised rankings were low. I like that were four to five top ideas to choose from on how to improve."
- "No real surprises. It seems as if the public is in agreement. I would like to see more of the levee idea."
- "Lighting doesn't seem like as big a deal as ramps "

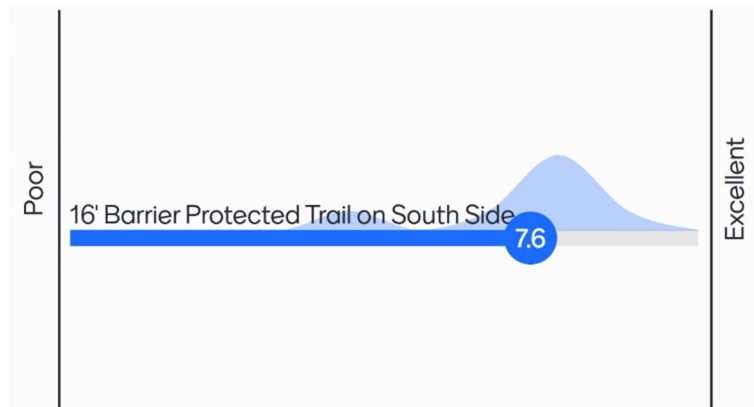
The project team then shared proposed options and concept layouts with focus group attendees and polled them to gauge their reactions. The team provided information on non-geometric recommendations, including crosswalk improvements, lighting under the bridge, and maintenance and cleaning up sidewalks, as well as geometric recommendations where most of the discussion revolved. These geometric proposed options and recommendations included:

- Constructing a trail near the levee (reviewed this option preliminarily)
 - 12-foot-wide trail and pedestrian tunnel under I-29/35
 - Appears to be feasible although likely expensive
 - City considering a separate planning study
- Widening Sidewalks / Building Trails (reviewed these options primarily)
 - Challenging as space is limited under the bridge
 - Changes to driving lanes would be necessary to expand sidewalks
 - Traffic simulation was created with videos (<https://bit.ly/3qXDqf3>) and these videos were uploaded to our FTP site and share with attendees
 - Team reviewed Table 2: Overall Network Performance & Travel Time Comparison and Table 3: Intersection Levels of Service Comparison from the Traffic Operations Summary on p. 42 of this report

The team then shared details with focus group members on three proposed options.

1. 16-foot-wide, barrier-protected trail on south side of Armour behind columns (p. 55)
2. 10-foot-wide trail on south side of Armour (p. 56)
3. 10-foot-wide trail on north side of Armour (p. 57)

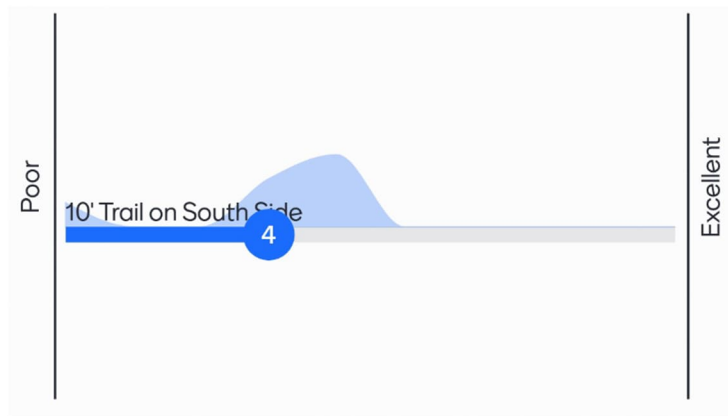
Focus group members were polled about **how they would rate the 16-foot-wide, barrier-protected trail on the south side of Armour** behind the bridge columns, rating between poor and excellent, and their responses are below:



Respondent Quotes:

- "I like the idea of using the bridge columns as "bonus" protections of pedestrians from motorists."
- "I have concerns about people obeying the no right on red as well as crossing the two right turn lanes from the southbound ramp off I-35 where cars frequently pull too far forward to see oncoming traffic"
- "It might make the car travel easier actually in that as that turn is tight and intimidating being squeezed in as it is. I'm curious about the public opinion cost of trying to retrain so many drivers that are used to it now."
- "The path under the bridge is nicer but the Interstate access crossing still seem unphased unsafe - if your goal is for a kid on a tricycle is safe."
- "I like this, BUT I'm more concerned about access from the NORTH side of Armour since that's where there are a large number of residents and businesses on that side... i.e., hospital and Cerner. If there were a SAFE way to cross Armour from the North to the South, it would be more attractive."
- "You still have issues crossing the southbound ramp as people are accelerating to get up to fast speeds while you are trying to cross."
- "I think it solves several of the issues other than crossing that right turn, that could still be an issue, especially for anyone on a bike."
- "Benefit of increasing (ped/bike) options that connects to the new grocery store."
- "Great opportunity for art installation just to the west of the southbound on-ramp. A metal sculpture of a few cyclists and someone walking. Would catch attention and bring more awareness. Like the metal cows in the median at 435 and K10 in JoCo."

Next, focus group members were polled about **how they would rate the 10-foot-wide trail on the south side of Armour**, ranking between poor and excellent, and their responses are below:



Respondent Quotes:

- "I think this configuration would likely not improve pedestrian comfort level over the existing condition."
- "Glad we have two options, but this is scary. Walking in the new lane but have cars / trucks speeding by on BOTH sides now is terrifying."
- "It would just make it too close to traffic and loud between two lanes of traffic. Overall, still have concern with image of "taking away a lane away."
- "Seems like a lot of trade-offs with no net improvement."
- "Not a fan of this option. Can't think of anything that could be improved."
- "I feel like it would need to be barrier protected, and still would feel more scary I think for pedestrians."
- "Glad that you considered it."
- "I'd rather focus on the southside, BUT a better, safer crossing from the NORTH side of Armour to the SOUTH side."
- "Has anybody watched those big trucks turn? They already have trouble with the existing lanes. If you reduce a lane, it's going to make it even worse. I'm not seeing that as a really viable instance right there. I see a lot more danger there than I see safety. I'm talking about where they come south off the Interstate and turn left onto eastbound Armour, that's where you see a lot of scraping of the barriers and traffic on the other side having to back up to allow a truck to get around. I would be very concerned about walking on a non-barriered sidewalk right there. I could see them bouncing up across a curb in a heartbeat."
- "I also have neighbors that have already been complaining based on the bike trails or bike path that, 'We don't have enough lanes anymore.' 'They shut our lanes down.' You can't walk in my neighborhood without somebody complaining about it, so taking another lane is not going to help my neighbors' attitudes."

Next, focus group members were polled about **how they would rate the 10-foot-wide trail on the north side of Armour**, ranking between poor and excellent, and their responses are below:



Respondent Quotes:

- "The improved crosswalk placement is a huge win."
- "Unprotected walk undesirable and not worth the minimal addition in width by adding barrier."
- "The line of sight to cross the southbound ramp helps, but we'd have to have the barrier."
- "If there is a public campaign to teach motorists on looking for pedestrians. Hopefully they would also be more aware in the north-south crossing by Starbucks."
- "The barrier is a requirement through there, so it seems like a trade-off."
- "With all of the heavy truck traffic, a barrier would still be a needed safety feature."
- "I think you see very few people using it [the existing sidewalk on the north side] at all because of the danger of it and the unsavoriness of it. I know a lot more people would if it were better, but I don't believe it's being used hardly at all now."
- "When I see this, I immediately see a net zero, but I'd have to look at a bit longer, I just don't see a strong benefit, especially when you associate the cost to do the work. I'm struggling to see a great improvement here, but I'm not an engineer."

Focus group members were polled about **how they would rank all the proposed improvements in order of priority**, and their responses are below:



Finally, focus group attendees were asked to share **what other general feedback they had for the project team as concepts and recommendations are finalized**, and one participant shared that they were grateful our team was gathering public input. Another attendee noted it was that "modeling needs to update for the large number

of new residents and people staying at the hotels," and there was a request of "can this work [from this study] be part of a published 'trail' to increase bike adoption."

Another attendee asked, "With the development on One North by Diamond Parkway with more housing coming, do we see more roads or traffic where the south side [of Armour] becomes an issue on crossover versus the north side and usage on those two paths? Does that kind of change our long-term thoughts on where people need to walk to access a lot of what NKC has to offer on the west side?" The project team facilitated a brief discussion with the group on where people will travel, where do we want them to travel, and how best to make walking and biking safer in the future.

One attendee clearly summarized, "The City is going to be promoting a lot more use of facilities that are added to the Diamond Parkway area, and people are definitely going to want to be coming to the grocery store, and if you can walk to it, even better. I do think that if it were safer, our residents will no longer feel a barrier of NKC only being on the west side of the Interstate."

There was additional conversation about how better to connect the avenues and being able to cross Armour on both the east and west. One remark was, "We already have people coming, and if you're building a community that welcomes people and provides the open pathway and walkway to get to every direction, then they're more encouraged to abandon their vehicle, or not even bother with their vehicle to get around and to get through the avenues. Make it streamlined and make it feel like it's an open connection that doesn't feel so cloak and dagger, grab your flashlight!"

Another comment was, "We need better transportation opportunities, aside from big trucks and more and more cars, and I would encourage us to look at alternatives and be able to say, 'Look at where we're providing benefits, ease of use and connectivity,' so that it feels like a connected community, which is a big driving force for us."

Another remark was, "Of the options shared tonight, I would rather focus on the south side, as we need to get a safer way to cross from the north side of Armour to the south side and to the Diamond Parkway area. The crosswalks don't work, and people get stuck in the middle. It's not safe. I think that's where some of the disconnect will be, when we feel we can't get across Armour to the new development. While we can't do everything, we do have to focus on what's going to get the biggest usage and I really do feel like we need to do something about the crossing of Armour."

At the conclusion of the Focus Group #2, the project team shared with attendees next steps for the project. Coordination with MoDOT, development of detailed concept and renderings, and a Public Open House and City Council work session were discussed.

City Council Presentation

The recommended concept design was presented before the city council on September 20th, 2022. The presentation focused on the benefits addressed by the proposed design concept as brought forward by the focus group specifically:

- Increased safety for pedestrians and cyclists
- Safer Route to Helens
- Enhanced Accessibility
- Adding lighting to increased comfort to vulnerable users

The presentation began with a demonstration of the project area and the project history and challenges that needed to be solved. Specifically, safety, accessibility, and lighting. Next a general overview of the model of traffic for all the various concepts using VISSIM was presented to the council which concluded that regardless of concept chosen there was to be a of an insignificant nature on the overall traffic operations in the area. All concepts as well as the various issues were then reviewed, including two 10' unprotected paths on the north and south side of Armour Road, a 16' barrier protected path, and finally the recommended design concept of a 12' barrier protected path on both sides of Armour Rd.

The benefits and costs of the recommended concept was presented to the council and public to overwhelming approval. Questions regarding truck turning were addressed as the truck turning had been reviewed by MoDOT and noted that MoDOT would not approve any final design that curtailed truck accessibility at the interchange. The City Council expressed an interest in decorative fencing on top of the barriers adjacent to the shared use paths to avoid trash and debris being thrown out by cars on to the shared use path. Further points about the maintenance of the project were raised but it was found to be under the purview of the council, and therefore an already existing expense. Overall, the council was extremely pleased with the benefits and the reasonable price tag of the project, with some members commenting about how pleasantly surprised they were. A video of the presentation can be viewed here: [City Council Presentation](#).

Safety Analysis

Traffic safety was identified as a top concern by the public. To determine what safety issues exist on the corridor, a comprehensive crash analysis was conducted. Over the nine-year study period from 2012 - 2020, there were 369 crashes in the study area. 56 of these crashes resulted in a minor injury and 9 resulted in a serious injury. Four crash types account for 85% of the injury crashes. These crash types are shown in Figure 17.

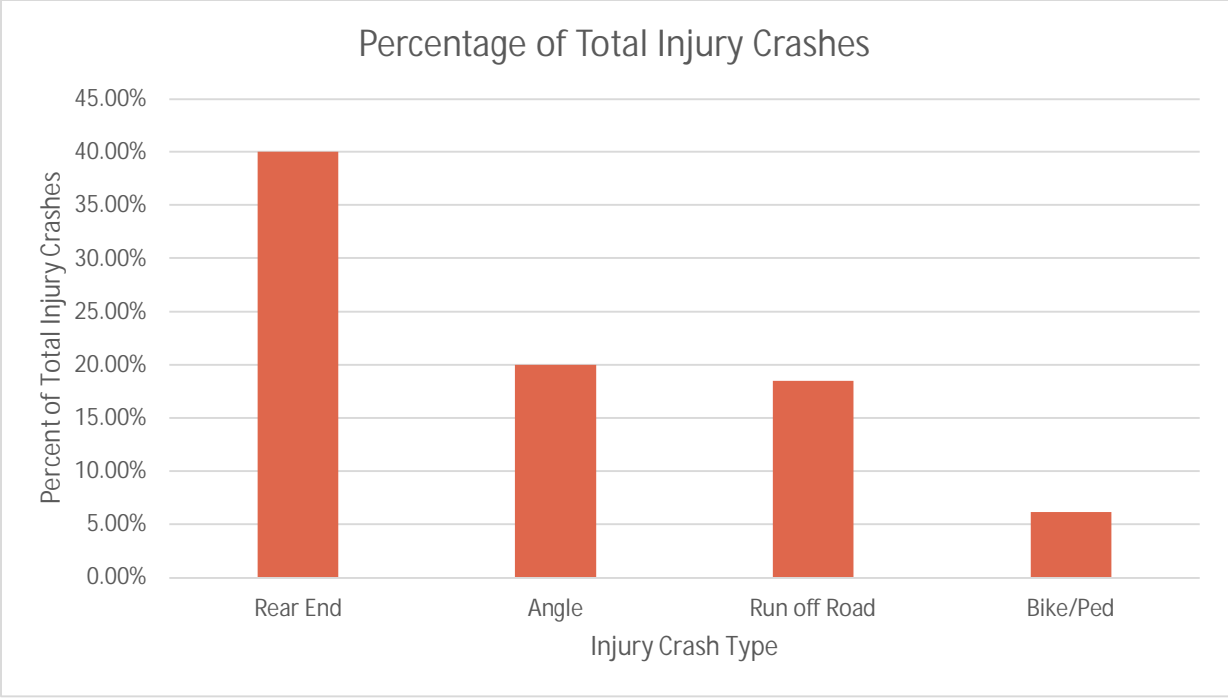


Figure 17: Injury Crash Types (2012-2020)

Four of these crashes involved a bicyclist or pedestrian, which accounts for approximately 6% of the minor and serious injury crashes. One of the serious injury crashes involved a cyclist, which represents approximately 11% of the serious injury crashes. Bicyclists and pedestrians likely represent approximately 0.5% of the traffic volume through the study area. This means that a bicyclist or pedestrian is approximately 12 times more likely to be injured and 22 times more likely to be seriously injured than a driver travelling through the interchange area. The bicyclist and pedestrian crashes happened at Ozark, the I-29/35 southbound ramps, and the I-29/35 northbound ramps. Safety issues exist for drivers as well. The predominant types of crashes seen at the interchange are typical for signalized intersections in urban areas. The injury crashes are relatively evenly dispersed between the four intersections with Ozark having the fewest injury crashes as shown in Figure 18.

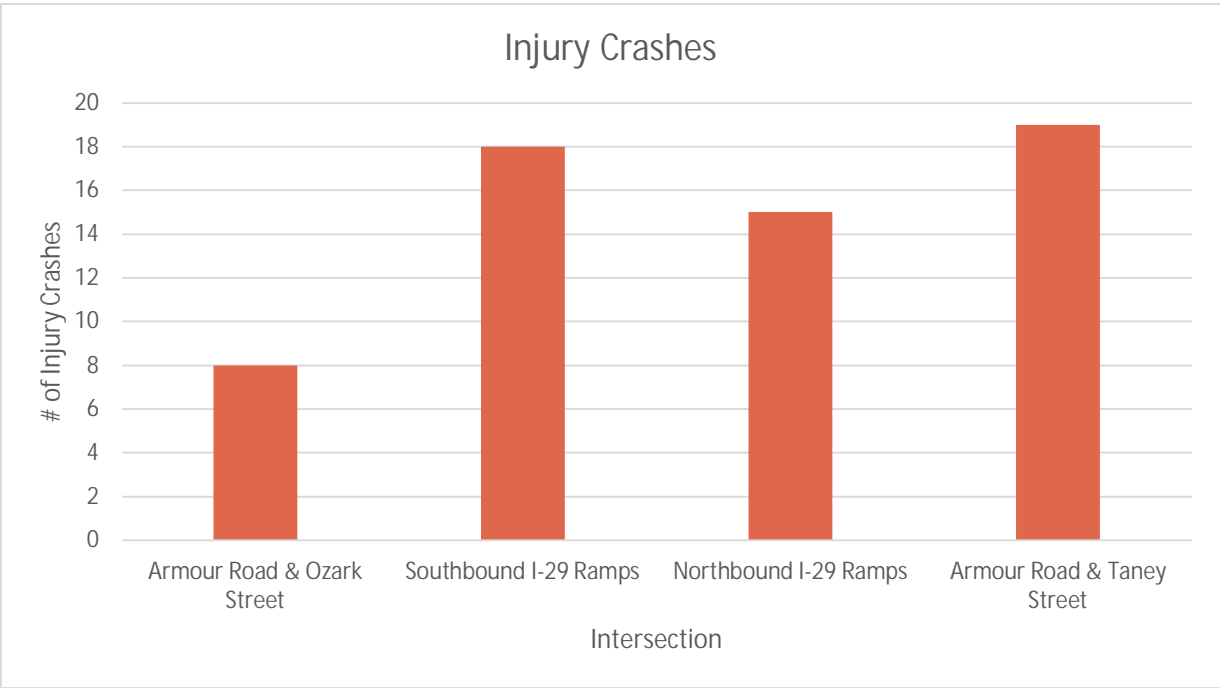


Figure 18: Location of Crashes along Armour Road by Intersection (2012-2020)

No discernable yearly trend can be identified with an increase or decrease in crashes over the study period. Figure 19 displays the number of injury crashes by year. However, it should be noted that in 2020 traffic volumes were substantially reduced due to the COVID-19 pandemic. Injury traffic crashes at the interchange were slightly lower than 2019 but were not significantly lower than previous years. This indicates that the injury crash rate was elevated at the interchange through the COVID-19 pandemic. This may indicate that the roadway design led to riskier driver behavior such as speeding and distracted driving in the absence of other traffic. This was seen across the nation where streets with excess capacity showed an increase in injury and fatal crash rates through the COVID-19 pandemic.

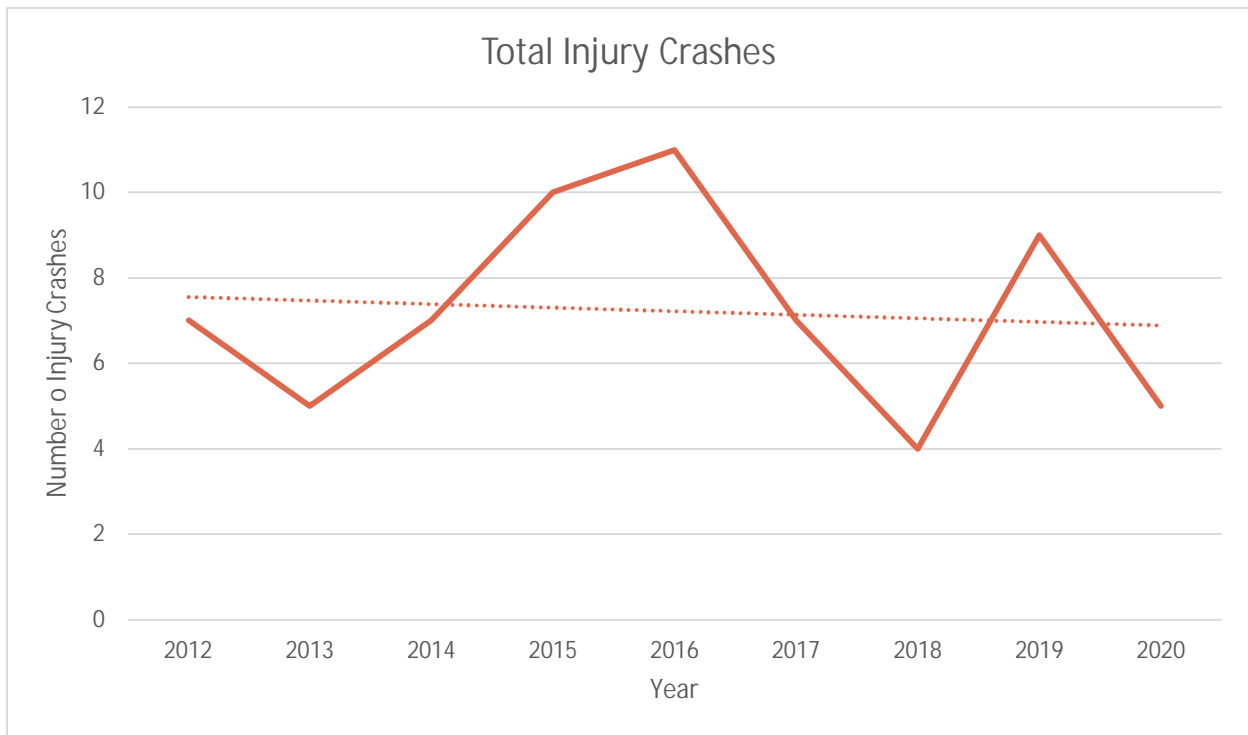


Figure 19: Number of Injury Crashes by Year (2012-2020)

Recommended Countermeasures

To address the safety issues identified with this project, improvements should be considered. These improvements should include bicycle and pedestrian safety improvements and signalized intersection safety improvements. Preliminary countermeasure recommendations to be investigated with this project include:

- Provide dedicated/separated facilities for cyclists/pedestrians protected from motor vehicle traffic
- Provide high visibility crossing locations for cyclists/pedestrians
- Review of the signal timing including yellow and all-red clearance intervals, cycle lengths, pedestrian phasing, and left-turn phasing
- Provide retroreflective back-plates on signal back plates
- Reduce speeds through the area by reducing capacity of roadway to match traffic demand
- Reduce speed limits
- Review design of high speed free right turn lane geometry for I-29/35 on-ramps

It should be noted that these are preliminary recommendations. Each of these recommendations will be explored through the project progress. Countermeasures will be evaluated based on their ability to improve safety for all users and to avoid significant detrimental impacts to traffic operations. Of particular concern with operations would be to avoid any possibility of queuing on the off-ramps to reach the mainline lanes of I-29/35.

Crash Data Analysis

Crash data from the most recent nine years (January 1, 2012 to December 31, 2020) were obtained from the Missouri Department of Transportation (MoDOT) Safety Data Zone Crash Tool for Armour Road from Ozark Street to Taney Street. This data was reviewed at intersections and roadway segments along Armour Road to determine if any crash patterns are present. During this review period, there were 369 total crashes including 304 property damage only (PDO), 56 minor injury, and 9 serious injury. There were no fatal crashes identified during this period. In order to analyze the crashes from a Vision Zero perspective, only injury crashes were analyzed from this dataset. The Vision Zero approach is useful for understanding and determining possible pedestrian and/or biking issues within the study area.

Crash Locations

Of the 65 total crashes, it was determined that 92% occurred at intersections or were intersection related. Table 4 through Table 8 detail where and when the crashes occurred along the Armour Road corridor. The general location of crashes along the corridor showing the severity is shown in Figure 20.

Table 4: Number of Crashes by Year, Location (Intersection vs. Non-Intersection) and Severity - Armour Road from Ozark Street to Taney Street

	Non-Intersection Crashes			Intersection Crashes			Grand Total		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	1	0	1	3	3	6	4	3	7
2013	0	0	0	5	0	5	5	0	5
2014	3	0	3	4	0	4	7	0	7
2015	1	0	1	8	1	9	9	1	10
2016	0	0	0	9	2	11	9	2	11
2017	0	0	0	7	0	7	7	0	7
2018	0	0	0	2	2	4	2	2	4
2019	0	0	0	9	0	9	9	0	9
2020	0	0	0	4	1	5	4	1	5
Total	5	0	5	51	9	60	56	9	65

Table 5: Number of Crashes by Year, Location (Intersection and Intersection-Related) and Severity - Armour Road from Ozark Street to Taney Street

	Armour Road & Ozark Street			Armour Road & Taney Street		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	0	1	1	1	1	2
2013	1	0	1	1	0	1
2014	0	0	0	3	0	3
2015	3	0	3	4	0	4
2016	0	0	0	3	0	3
2017	0	0	0	3	0	3
2018	0	1	1	1	0	1
2019	2	0	2	1	0	1
2020	0	0	0	1	0	1
Total	6	2	8	18	1	19

Table 6: Number of Crashes by Year, Location (Interchange Ramp and Interchange Ramp-Related) and Severity - Armour Road & Northbound I-29/35 On/Off-Ramps

	NB I-29/35 Off-Ramp			WB to I-29/35 NB On-Ramp			EB to I-29/35 NB On-Ramp		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	1	1	2	0	0	0
2016	3	0	3	1	1	2	0	0	0
2017	0	0	0	1	0	1	0	0	0
2018	1	1	2	0	0	0	0	0	0
2019	1	0	1	0	0	0	0	0	0
2020	3	1	4	0	0	0	0	0	0
Total	8	2	10	3	2	5	0	0	0

Table 7: Number of Crashes by Year, Location (Interchange Ramp and Interchange Ramp-Related) and Severity - Armour Road & Southbound I-29/35 On/Off-Ramps

	SB I-29/35 Off-Ramp			WB to I-29/35 SB On-Ramp			EB to I-29/35 SB On-Ramp		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	1	1	2	1	0	1	0	0	0
2013	1	0	1	1	0	1	1	0	1
2014	1	0	1	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
2016	2	1	3	0	0	0	0	0	0
2017	2	0	2	1	0	1	0	0	0
2018	0	0	0	0	0	0	0	0	0
2019	3	0	3	1	0	1	1	0	1
2020	0	0	0	0	0	0	0	0	0
Total	10	2	12	4	0	4	2	0	2

Table 8: Number of Crashes by Year and Severity - Armour Road Corridor

	Armour Road Segment Crashes		
	Minor Injury	Serious Injury	Total
2012	1	0	1
2013	0	0	0
2014	3	0	3
2015	1	0	1
2016	0	0	0
2017	0	0	0
2018	0	0	0
2019	0	0	0
2020	0	0	0
Total	5	0	5



Figure 20: General Location of Crashes along Armour Road by Crash Severity (2012-2020)

Crash Types

The frequency of crashes by type and severity along Armour Road from Ozark Road to Taney Street are shown in Table 9, while the general location is shown in Figure 21. Most of the crashes were rear-end crashes occurring near the intersections and interchange on/off-ramps. Angle crashes were the second most common injury crash type and most common serious injury crash type, mostly occurring near the intersections and interchange on/off-ramps. Bicycle and pedestrian crashes were fourth highest. These four crash types account for approximately 85% of all injury crashes. These crash types are typical at signalized intersections within proximity of an urban interchange.

Table 9: Number of Crashes by Type and Severity for Armour Road (2012-2020)

	Armour Road			
	Minor Injury	Serious Injury	Total	Percentage
Rear-end	25	1	26	40%
Angle	10	3	13	20%
Run off Road	10	2	12	18%
Ped/Bike	3	1	4	6%
Changing Lane/Passing	3	0	3	5%
Left/Right Turn	1	1	2	3%
U-turn	2	0	2	3%
Fixed Object	1	0	1	2%
Head-on	1	0	1	2%
Sideswipe	0	1	1	2%
Total	56	9	65	100%



Figure 21: General Location of Crashes along Armour Road Corridor by Crash Type (2012-2020)

For further analysis, the area of interest was divided into three different sections (western, central, and eastern) to determine frequency of crash types and severity in those locations. The western section includes Armour Road & Ozark Street and the EB to I-29/35 SB on-ramp. The central section includes SB I-29/35 off-ramp, WB to I-29/35 SB on-ramp, NB I-29/35 off-ramp, and EB to I-29/35 NB on-ramp. The eastern section includes Armour Road & Taney Street and WB to I-29/35 NB on-ramp.

The frequency of crashes by type and severity for the western intersection are shown in Table 10, while the general location is shown in Figure 22. The western intersections experienced 10 (17%) of all intersection crashes within the study area. Most of the crashes were angle, run off road, and collisions with pedestrians.

Table 10: Number of Crashes by Type and Severity for Armour Road & Ozark Street and EB to I-29/35 SB On-Ramp (2012-2020) - Western Intersections for Area of Interest

	Armour Road & Ozark Street and EB to I-29/35 SB On-Ramp			
	Minor Injury	Serious Injury	Total	Percentage
Angle	2	0	2	20%
Run off Road	2	0	2	20%
Pedestrian Collision	2	0	2	20%
Changing Lane/Passing	1	0	1	10%
Head-on	1	0	1	10%
Left/Right Turn	1	0	1	10%
Sideswipe	0	1	1	10%
Total	9	1	10	100%



Figure 22: General Location of Crashes Near Armour Road & Ozark Street and EB to I-29/35 On-Ramps (2012-2020) - Western Intersections for Area of Interest

The frequency of crashes by type and severity for the central intersections are shown in Table 11, while the general location is shown in Figure 23. The central intersections experienced 26 (43%) of all intersection crashes within the study area. Most of the crashes at this location are rear-end collisions, followed by angle collisions. These results are anticipated near interchange ramps especially when traffic signals are present. The 8% of crashes involving bicyclists and pedestrians at this location is alarmingly high considering bicycle/pedestrian volume likely only accounts for approximately 0.5% of daily traffic.

Table 11: Number of Crashes by Type and Severity for SB I-29/35 Off-Ramp, WB to I-29/35 SB On-Ramp, NB I-29/35 Off-Ramp, and EB to I-29/35 NB On-Ramp (2012-2020) - Central Intersections for Area of Interest

	SB I-29/35 Off-Ramp, WB to I-29/35 SB On-Ramp, NB I-29/35 Off-Ramp, and EB to I-29/35 NB On-Ramp			
	Minor Injury	Serious Injury	Total	Percentage
Rear-end	11	0	11	42%
Angle	7	3	10	38%
Run off Road	3	0	3	12%
Pedestrian/Bike Collison	1	1	2	8%
Total	22	4	26	100%



Figure 23: General Location of Crashes Near SB I-29/35 Off-Ramp, WB to I-29/35 SB On-Ramp, NB I-29/35 Off-Ramp, and EB to I-29/35 NB On-Ramp (2012-2020) - Central Intersections for Area of Interest

The frequency of crashes by type and severity for the eastern intersections are shown in Table 12, while the general location is shown in Figure 24. The eastern intersections experienced 24 (40%) of all intersection crashes within the study area. Most of the crashes at this location are rear-end collisions. In addition, a majority of these rear-end collisions occurred at Armour Road & Taney Street. A large percentage of these rear-end collisions appear to have some relation to the right-turn lane accessing the I-29/35 northbound on-ramp. Crashes on the ramp are run off road crashes and crashes directly in advance of the ramp are rear-end crashes. This is likely partly a result of the proximity of the right turn lane to the Taney traffic signal.

Table 12: Number of Crashes by Type and Severity for Armour Road & Taney Street and WB to I-29/35 NB On-Ramp (2012-2020) - Eastern Intersections for Area of Interest

	Armour Road & Taney Street and WB to I-29/35 NB On-Ramp			
	Minor Injury	Serious Injury	Total	Percentage
Rear-end	12	1	13	54%
Run off Road	4	2	6	25%
Changing Lane/Passing	2	0	2	8%
Angle	1	0	1	4%
Left Turn	1	0	1	4%
U-Turn	1	0	1	4%
Total	21	3	24	100%

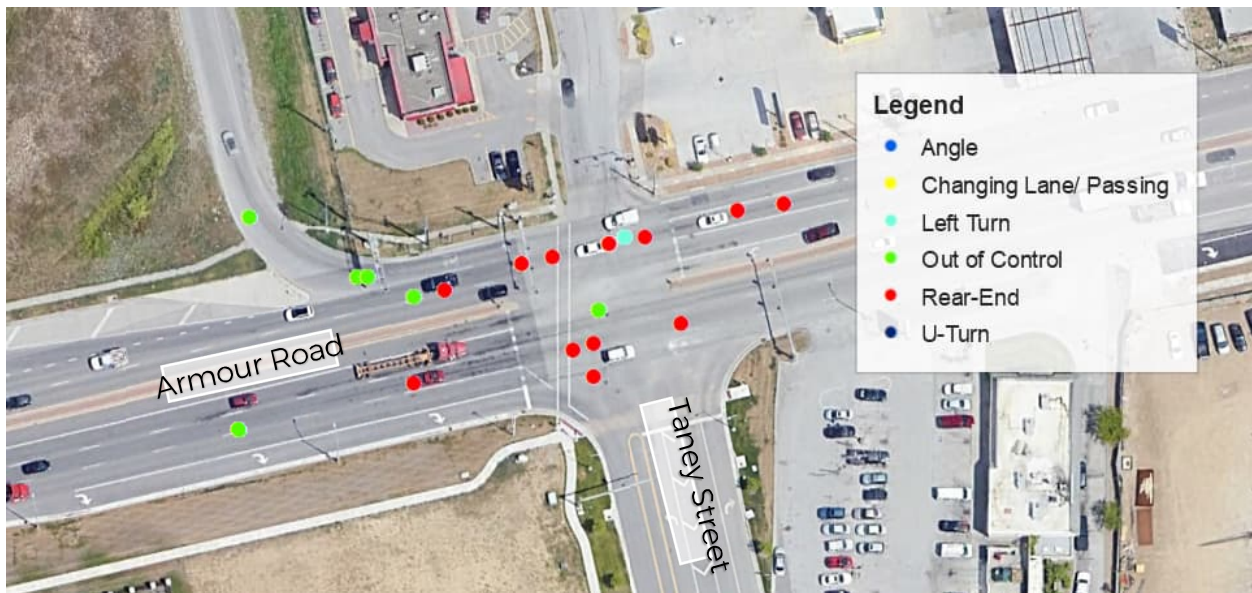


Figure 24: General Location of Crashes for Armour Road & Taney Street and WB to I-29/35 NB On-Ramp (2012-2020) - Eastern Intersections for Area of Interest

Bicycle and Pedestrian Crashes

A major goal of this study was to analyze the bicycle and pedestrian crashes that have occurred along Armour Road. Figure 25 displays the general location of these crash types along the area of interest. As shown in Table 13, the bicycle crash resulted in a serious injury and also occurred near the southbound I-29/35 off-ramp. There were three other pedestrian crashes that occurred along Armour Road; these crashes were flagged as intersection-related and one occurred near the northbound I-29/35 off-ramp. Both crashes occurring near the interchange ramps were located at the off-ramps. In addition, the other two crashes were located at Armour Road & Ozark Street. Individual crash reports were not provided by MoDOT for additional details regarding the primary reason for these crashes or other specific information.

The bicycle and pedestrian crashes accounts for approximately 6% of the minor and serious injury crashes. One of the serious injury crashes involved a cyclist, which represents approximately 11% of the serious injury crashes. Bicyclists and pedestrians likely represent approximately 0.5% of the traffic volume through the study area. **This means that a bicyclist or pedestrian is approximately 12 times more likely to be injured and 22 times more likely to be seriously injured than a driver travelling through the interchange area.**

Table 13: Number of Pedestrian and Bike Crashes by Severity along Armour Road Corridor (2012-2020)

	Armour Road Ped/Bike Crashes		
	Minor Injury	Serious Injury	Total
Bike	0	1	1
Pedestrian	3	0	3
Total	3	1	4

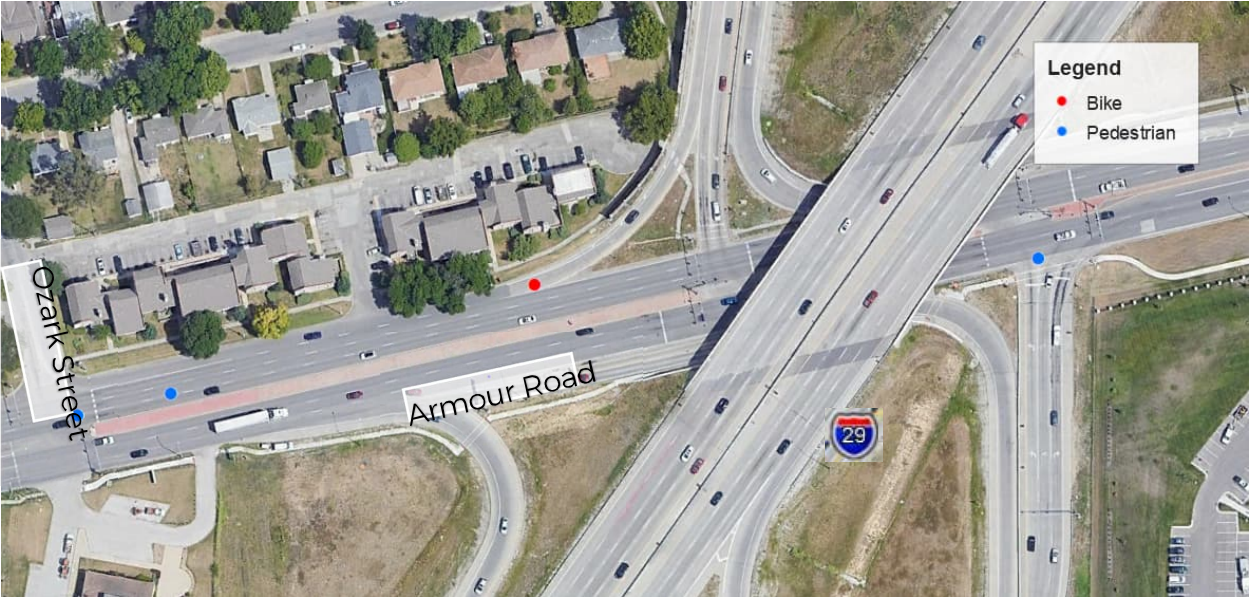


Figure 25: Pedestrian and Bicycle Crash Locations along Armour Road Corridor (2012-2020)

Highway Ramp Crashes

Additional analysis was done to crashes that occurred on the ramps themselves to determine frequency of crash types and severity in those locations. The five on/off ramps which there was crash data where; I-29/35 NB to WB, I-29/35 SB to EB, I-29/35 SB to WB, I-29/35 WB to NB, and I-29/35 WB to SB. For the purpose of this analysis, crashes on the ramps which resulted in property damage where excluded and only crashes which resulted in injury or fatality were considered.

The frequency of crashes by type and severity for the all on/off ramps are shown in Table 10. It was found that the most common crash types were rear-end and run off the road crashes. In addition, the pedestrian/bike crashes represented 50% of the serious injury crashes. As shown in Figure 26 pedestrian/bike crashes were located near the I-29/35 on/off ramps. After further analysis, it was found that the bike crash was located near the SB I-29/35 off-ramp and the cyclist was headed west Armour Road; this crash resulted in a disabling injury. The pedestrian crash was located near the NB I-29/35 off-ramp and resulted in a minor injury.

Table 14: Type and Number Crashes by Severity on all I-29/35 On/Off Ramps (2012-2020)

	SB I-29/35 Off-Ramp, WB to I-29/35 SB On-Ramp, NB I-29/35 Off-Ramp, and EB to I-29/35 NB On-Ramp			
	Minor Injury	Serious Injury	Total	Percentage
Rear-end	8	0	8	42%
Run off the Road	8	1	9	47%
Pedestrian/Bike Collison	1	1	2	10%
Total	17	2	19	100%



Figure 26: General Location of I-29/35 Ramp Crashes by Crash Class (2015-2020)

The frequency of crashes on the on/off-ramps sorted by severity and year are displayed in Table 15 and

Table 16. Out of the 19 total injury crashes, it was found that 17 (89%) resulted in a minor injury and the remaining (11%) resulted in a serious/disabling injury. The serious/disabling injury crashes were located at the WB to NB I-29/35 on-ramp and the SB I-29/35 off-ramp to WB Armour Road. In addition, these crash types were a run off

the road and a collision with a bike, respectively. The general location of these crashes sorted by severity are displayed in Figure 27.

Table 15: Number of Crashes by Year, Location and Severity - I-29/35 Off-Ramps

	NB I-29/35 WB to Armour Rd NB Off-Ramp			SB to I-29/35 EB to Armour Off-Ramp			SB to I-29/35 WB to Armour Off-Ramp		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	0	0	0	0	0	0	0	1	1
2013	0	0	0	2	0	2	0	0	0
2014	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0
2016	2	0	2	0	0	0	1	0	0
2017	0	0	0	1	0	1	0	0	0
2018	0	0	0	0	0	0	0	0	0
2019	1	0	1	0	0	0	2	0	2
2020	3	0	3	0	0	0	0	0	0
Total	6	0	6	3	0	3	3	1	3

Table 16: Number of Crashes by Year, Location and Severity- I-29/35 On-Ramps

	WB Armour Rd I-29/35 NB On-Ramp			Armour Rd WB to I-29/35 SB On-Ramp		
	Minor Injury	Serious Injury	Total	Minor Injury	Serious Injury	Total
2012	1	0	1	1	0	1
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2015	1	1	2	0	0	0
2016	1	0	1	0	0	0
2017	1	0	1	1	0	1
2018	0	0	0	0	0	0
2019	0	0	0	1	0	1
2020	0	0	0	1	0	1
Total	4	1	5	4	0	4



Figure 27: General Location of I-29/35 Ramp Crashes by Crash Severity (2015-2020)

Traffic Analysis

Many of the concepts considered with this study may impact motor vehicle traffic through the interchange. To assess the impacts of changing the roadway configuration on vehicle travel time and delay, traffic modeling was performed. The existing conditions were evaluated, and the two proposed options were evaluated. These options included repurposing some motor vehicle drive lanes for bicycle and pedestrian facilities.

Proposed Options

The public desires better bicycle and pedestrian facilities to cross the I-35 interchange on Armour Road. However, the space available for expanded bicycle and pedestrian facilities is very limited under the bridge. Because of this, changes to the vehicle driving lanes were explored to see what the impact would be of repurposing motor vehicle driving lanes for sidewalks and trails. Two options were considered:

- Option 1 repurposes the eastbound on-ramp from Armour Road to northbound I-35. This space between the bridge columns and retaining wall would be utilized for bicycle and pedestrian facilities. The traffic turning on to the northbound I-35 On-ramp would utilize the existing outside through lane and then make a right-turn at the eastern ramp traffic signal. This is shown in Figure 28.
- Option 2 repurposes the outside eastbound lane on Armour Road for bicycle and pedestrian facilities. The on-ramp configuration would remain as it is today. This is shown in Figure 29.

Other changes proposed geometric, lighting, and other changes in the area which will not have significant impact on traffic operations. These options were not analyzed with the traffic modeling.

Figure 28: Proposed Option 1 Lane Configuration

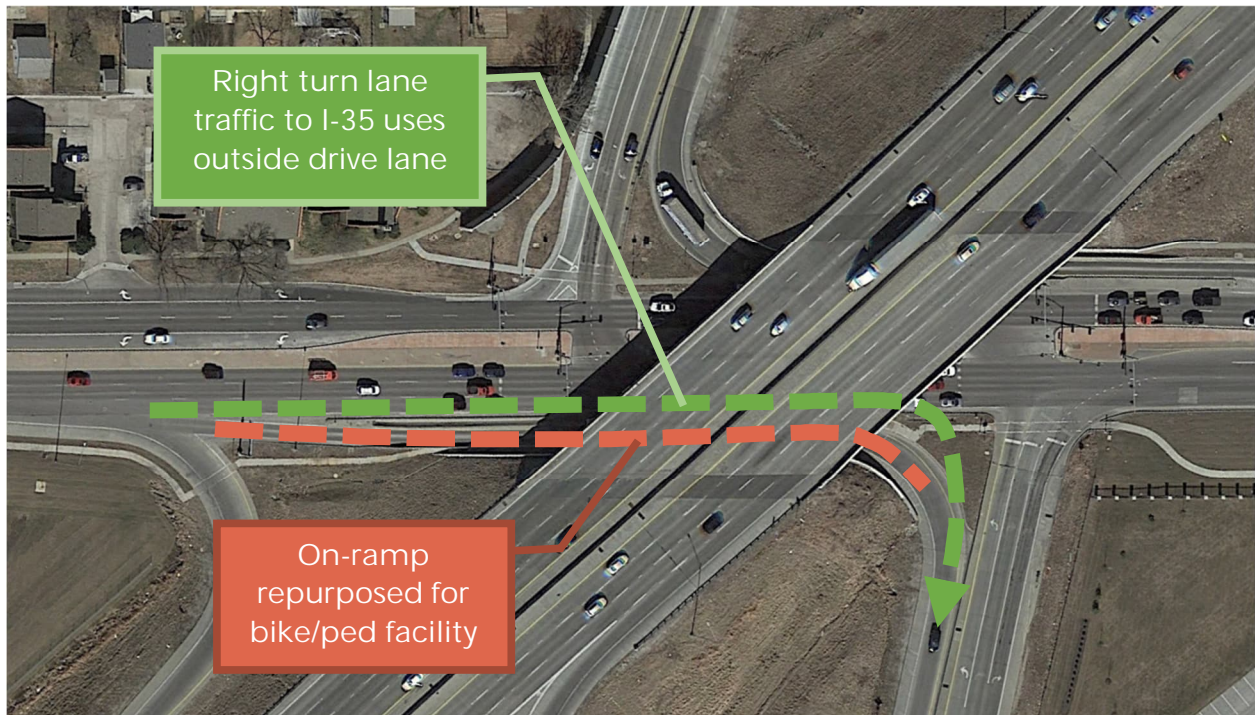
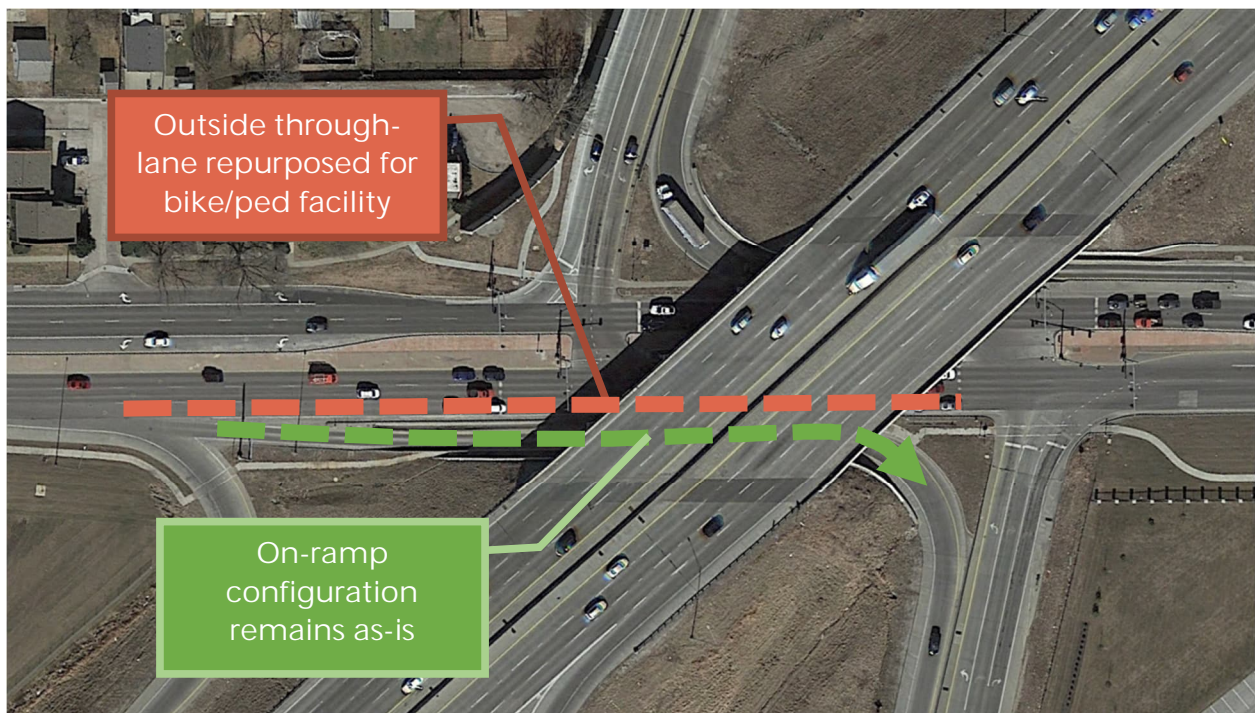


Figure 29: Proposed Option 2 Lane Configuration



Traffic Operations Summary

The proposed options have nearly identical operational characteristics to the existing conditions. They do not significantly change delay, levels of service, travel time, or overall network performance. Table 17 and Table 18 summarize the operational characteristics of the existing conditions and proposed options.

Table 17: Overall Network Performance & Travel Time Comparison

Simulation Scenario	Average Delay All Vehicles	Average Stops (All Vehicles)	Average Speed (All Vehicles)	Eastbound Armour Travel Time	Westbound Armour Travel Time
Existing Conditions	55.3 sec	2.0 stops	19.7 mph	1 min 40 sec	1 min 49 sec
Proposed Option 1	54.4 seconds	2.0 stops	19.8 mph	1 min 40 sec	1 min 48 sec
Proposed Option 2	54.9 sec	1.9 stops	19.7 mph	1 min 45 sec	1 min 50 sec

Table 18: Intersection Levels of Service (LOS) Comparison

Simulation Scenario	Armour & Ozark LOS	Armour & I-35 SB Off-Ramp LOS	Armour & I-35 NB Off-Ramp LOS	Armour & Taney LOS
Existing Conditions	C	B	B	B
Proposed Option 1	C	B	B	B
Proposed Option 2	C	B	B	B

Traffic Operations Modeling

Armour Road has approximately 28,000 vehicles traversing the interchange every day. Approximately 17,000 vehicles enter I-35 from Armour Road and 19,000 vehicles exit I-35 on to Armour Road every day. Existing traffic volumes were provided by Operation Green Light in the form of a Synchro traffic modeling software file that was created in conjunction with the planning of the QuikTrip development at Armour Road and Ozark Street and the corresponding changes to the Armour Road and I-35 interchange.

It was not practical to collect turning movement traffic counts with this study because of the nature of the traffic impacts of the COVID-19 pandemic. Traffic patterns were substantially disrupted by the pandemic and not necessarily representative of what typical traffic would be post-pandemic. Because of this, the previously collected traffic counts from 2016 were used. Using traffic volumes from five years in the past meant that the traffic in the model may not be representative of typical traffic. Because of this,

an analysis on traffic growth was conducted using newer AADT traffic counts from MoDOT along the various corridors.

It was found that between 2016 and 2019 (pre-pandemic) traffic volumes declined in the area with the exception of the westbound Armour Road movements turning onto I-35. All traffic volumes dropped in 2020 as well as a result of the pandemic. The percent change in the volumes at various locations in the study area are shown in Figure 30. The traffic volumes from westbound Armour Road to I-35 increased by approximately 30% from the base year. It is not known why this increase occurred but could have been a result of construction activities at MO-210 and I-435 west of the study area. Regardless of the cause, to account for this, the turning movement traffic volumes from westbound Armour Road to I-35 were increased by 30% from the base year volumes provided in the model. Traffic volumes for QuikTrip were estimated as part of the traffic study conducted with the development. With this in consideration, the traffic volumes in the model are likely higher than traffic volumes will be after the effects of the COVID-19 pandemic diminish.

For the purposes of this study, only the PM peak hour period (afternoon rush hour) was analyzed. The PM peak hour in the study area has more traffic for nearly all movements than the AM or mid-day peak hours and can be considered the most conservative timeframe. Because of the use of the conservative pre-pandemic traffic volumes and the use of the PM peak hour period the traffic modeling can be considered the “worst case scenario” model.

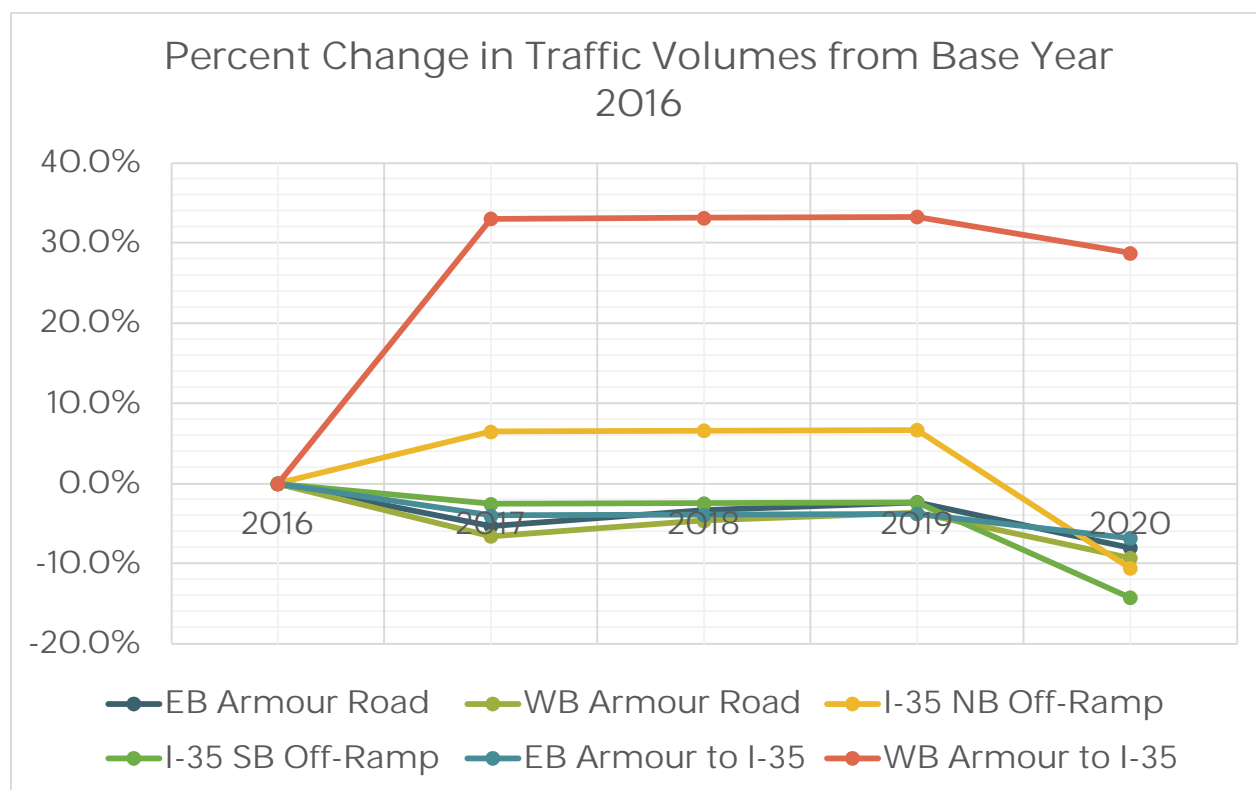


Figure 30: Percent Change in Traffic Volumes in Study Area from Base Year 2016

A microsimulation model of the study area was provided by MoDOT that had been previously created and calibrated to local driving conditions. Only minor modifications to this calibrated model were made to focus on the particular aspects of this study. This microsimulation model was utilized to extract traffic characteristics in the study area. The simulation model was run five times each for a one hour PM peak hour (afternoon rush hour) period and results averaged. Three primary characteristics were extracted:

- Overall network performance and delay
- Travel time on Armour Road from west of Ozark to east of Taney
- Intersection Levels of Service (LOS) and delay

LOS is a tool from the Highway Capacity Manual used to describe the conditions of the roadway from a driver's viewpoint using a rating scale of A through F. LOS A represents little to no delay to drivers and LOS F represents long delays which can result in a breakdown of the facility's functionality. The LOS is based solely on the amount of delay experienced by drivers traveling through an intersection. The criteria for the LOS of signalized and unsignalized intersections are shown in

Table 19: Signalized Intersection Level of Service Criteria

Level of Service	Description	Average Control Delay per Vehicle (seconds/vehicle)
A	Little to no delay. Progression is either exceptionally favorable or the cycle length is very short.	≤ 10.0
B	Volume-to-capacity ratio is low and either progression is highly favorable or the cycle length is short.	> 10.0 and ≤ 20.0
C	Progression is favorable or the cycle length is moderate. Individual cycle failures may begin to appear at this level	> 20.0 and ≤ 35.0
D	Volume-to-capacity ratio is high, progression is unfavorable, and the cycle length is long. Individual cycle failures are noticeable.	> 35.0 and ≤ 55.0
E	Volume -to- capacity ratio is very high, progression is unfavorable and the cycle length is long. Individual cycle failures are frequent.	> 55.0 and ≤ 80.0
F	Volume-to-capacity ratio is very high, progression is very poor, and the cycle length is long. Most cycles fail to clear the queue.	> 80.0

Existing Traffic Operations

Table 20 and Table 21 show the operational characteristics of the study area existing conditions based on the pre-pandemic traffic volumes. Charts showing full operational details are included in the appendix of this report. In general traffic flows well through this corridor. All intersections have an LOS of B or C. There is minimal delay for the majority of the movements. In general, Armour Road has lower delay than the minor street approaches, which is typical for a corridor like this.

One exception to the low congestion is westbound Armour Road (MO-210 Hwy) approaching Taney from the east. This section of Armour Road historically has had very high traffic volumes and experienced long delays and long queue lengths. This congestion is typically experienced most acutely at Walker Road and Vernon Street (MO-1 Hwy). Analysis of Walker Road and Vernon Street was out of the scope of this study. Because of this, the delay and queuing at Taney Street was only measured to where the Vernon Street intersection would be located, and any additional queuing and delay was assumed to be assigned to Vernon Street or Walker Road in actuality.

Another movement that is near capacity is the Southbound I-35 On-Ramp from westbound Armour Road. This on-ramp has approximately 1,300 vehicles entering the Interstate highway from westbound Armour Road in the PM peak hour. Based on this high volume, it would likely not be practical to change the configuration of this on-Proposed ramp.

Table 20: Overall Network Performance & Travel Time Existing Conditions

Simulation Scenario	Average Delay All Vehicles	Average Stops (All Vehicles)	Average Speed (All Vehicles)	Eastbound Armour Travel Time	Westbound Armour Travel Time
Existing Conditions	55.3 sec	2.0 stops	19.7 mph	1 min 40 sec	1 min 49 sec

Table 21: Intersection Levels of Service Existing Conditions

Intersection	Intersection LOS	Eastbound LOS	Westbound LOS	Northbound LOS	Southbound LOS
Armour & Ozark	C	C	C	D	C
Armour & I-35 SB Off-Ramp	B	B	A	N/A	C
Armour & I-35 NB Off-Ramp	B	A	A	C	N/A
Armour & Taney	B	A	C	D	D

Proposed Options Traffic Operations

Table 22 and

Table 23 show the operational characteristics of Option 1.

Table 24 and

Table 25 show the operational characteristics of Option 2. The changes proposed in Option 1 and Option 2 have virtually no impact on traffic operations at the interchange.

The only potential issue with the reconfiguration is with Option 2. With Option 2 one of the outer through lanes is repurposed for bicycle and pedestrian facilities. Because

only two lanes exist instead of three in this area, there is less queue storage space. The eastbound queue at the eastern ramp signal tends to extend back through the western ramp signal. This could pose minor operational issues, but does not significantly increase delay or travel time on the corridor. Option 1 does not pose any additional operational issues not present in the existing conditions model.

Table 22: Overall Network Performance & Travel Time Proposed Option 1

Simulation Scenario	Average Delay All Vehicles	Average Stops (All Vehicles)	Average Speed (All Vehicles)	Eastbound Armour Travel Time	Westbound Armour Travel Time
Proposed Option 1	54.4 seconds	2.0 stops	19.8 mph	1 min 40 sec	1 min 48 sec

Table 23: Intersection Levels of Service Proposed Option 1

Intersection	Intersection LOS	Eastbound LOS	Westbound LOS	Northbound LOS	Southbound LOS
Armour & Ozark	C	C	C	D	C
Armour & I-35 SB Off-Ramp	B	B	A	N/A	C
Armour & I-35 NB Off-Ramp	B	A	A	C	N/A
Armour & Taney	B	A	C	D	D

Table 24: Overall Network Performance & Travel Time Proposed Option 2

Simulation Scenario	Average Delay All Vehicles	Average Stops (All Vehicles)	Average Speed (All Vehicles)	Eastbound Armour Travel Time	Westbound Armour Travel Time
Proposed Option 2	54.9 sec	1.9 stops	19.7 mph	1 min 45 sec	1 min 50 sec

Table 25: Intersection Levels of Service Proposed Option 2

Intersection	Intersection LOS	Eastbound LOS	Westbound LOS	Northbound LOS	Southbound LOS
Armour & Ozark	C	C	C	D	D
Armour & I-35 SB Off-Ramp	B	B	A	N/A	C

Armour & I-35 NB Off-Ramp	B	A	B	C	N/A
Armour & Taney	B	A	C	D	D

MoDOT Coordination

Almost the entire plan area for this project resides within the MoDOT right of way. Because of this, any proposed options will need to comply with MoDOT design standards. This section provides an overview of the controlling design standards for this project that are considered in the design options.

Coordination Meetings

MoDOT was engaged throughout this project process. Three meetings were held throughout the process. A highlight of these meetings are included below.

Coordination Meeting #1

An initial coordination meeting was held with MoDOT Kansas City District staff members Joshua Scott and Ryan Hale on June 25, 2021. This meeting was used to introduce MoDOT staff to the project and identify opportunities and challenges on the project. MoDOT's primary concern in the area was noted as the bicycle pedestrian crossings with the free flow right turn lanes onto the I-35 on-ramps. MoDOT has a desire to minimize conflicts between cars and cyclists/pedestrians and make sure all users can see each other at the conflict areas. A secondary concern was noted with the northbound I-35 on-ramp from westbound Armour Road. This on-ramp is located directly behind the traffic signal at Taney Street, making it difficult to see the overhead signs and requiring drivers to make last-moment lane changes if they do not choose the proper lane before traversing the traffic signal. MoDOT also noted that one relatively straightforward improvement to the area could be lighting under the bridge.

Coordination Meeting #2

A second round of coordination was held with MoDOT Kansas City District staff members Joshua Scott and Ryan Hale in January 2022. This round of coordination focused on evaluating the presented options pending comment resolution. MoDOT's primary concern in the area was noted as the specific alignment issues present with the concepts being explored. A primary concern was noted about shared-use-path crossings of ramps immediately downstream of bridge column sight obstructions if using the space on the south side of the bridge columns for the shared use path space. After further review, sufficient sight distance did not exist for this cross-walk crossing, and so this option was removed from consideration. Another issue with this concept related to signing of the movement from eastbound Armour Road to northbound I-35. This would require signing on or under the bridge, or well before the bridge, all of which could make this a confusing movement for drivers. MoDOT also wished to see the VISSIM modeling files, which were provided to them upon request. A list of specific comments from MoDOT are included below with action steps taken as a result. All of these items were taken into consideration with the refinement of the preferred concept.

MoDOT Comments:

1. Option 1: There is concern about shared-use-path crossings of ramps immediately downstream of bridge column sight obstructions. Will the crossing resemble the existing condition?
 - a. Action step: sight distance was analyzed and this option was deemed to be infeasible as a result/
2. Option 1: With a diverge so soon after the bridge, will signing the "EB MO-210 to NB I-35" movement be feasible? Will drivers be confused by this layout; could this have safety implications?
 - a. Action step: this was no longer a consideration once this option was deemed infeasible.
3. Figure 28 shows different alignment for (a) "EB MO-210 to SB I-35" and (b) "WB MO-210 to NB I-35". Are the shown radii feasible with WB-67? (I'm a bit concerned the crossings may not be able to get much shorter due to large vehicle design)
 - a. Action step: WB-67 truck turning movements were conducted with final design and it was shown that accommodating these vehicles appears to be possible.
4. Figure 28 shows different alignment for "WB MO-210 to NB I-35". Is there a way to build this with the diverge to SB I-35 so close downstream? As the report mentions, the "WB MO-210 to SB I-35" volume is quite high so I assume changing WB lane use isn't desirable?
 - a. Action step: this improvement was determined to be outside the scope of this plan, so no additional steps were taken on this comment.
5. Figure 29 shows (on the south side of MO-210) wider non-motorized facilities west of Taney and east of Vernon. Is it feasible to provide facilities there to avoid a "gap"?
 - a. Action step: this area was outside the scope of this plan so no additional action was taken
6. Vissim: Please provide results files.
 - a. Action step: Vissim files were provided
7. Vissim: Since some volumes are higher in AM, please complete analysis of this time period too.
 - a. Action step: the traffic study conducted in this plan was limited in scope, so this additional modeling was not performed, but noted as something that would need to be performed if this project moved forward into preliminary design.
8. Vissim: Some PM volumes in the delivery were noticeably smaller than the QT "existing+development" scenario. For instance, the SB off-ramp went from 891 to 637. The NB (diamond) on-ramp went from 697 to 520. EB MO-210 (at SB ramp signal) went from 1332 to 1081). Would the proposed options still operate well under these volumes?

- a. Action step: the traffic study conducted in this plan was limited in scope, so this additional modeling was not performed, but noted as something that would need to be performed if this project moved forward into preliminary design. It is recommended that new traffic counts be obtained prior to additional traffic modeling.
- 9. Vissim: Interchange modifications like this will involve FHWA and a future year traffic analysis. The report discusses growth rates over a very short history (2016-2020); what would operations look like after 20 years of modest growth?
 - a. Action step: the traffic study conducted in this plan was limited in scope, so this additional modeling was not performed, but noted as something that would need to be performed if this project moved forward into preliminary design.
- 10. Vissim: it was noted that Option 2 may have a difficult time avoiding EB queues when SBL volumes are high (with only 2 lanes to turn into versus 3). The short distance between ramp terminals may make signal timing difficult.
 - a. Action step: this comment was acknowledged and is recommended for further study if this project moved forward into preliminary design.

Coordination Meeting #3

A third round of coordination was held with MoDOT Kansas City District staff members Joshua Scott and Ryan Hale in July 2022. This round of coordination focused on specific issues related to the finalized preferred concept. Several issues were raised including mitigation of any potential confusion for RRFB “parallel” to uncontrolled lanes. MoDOT also requested a westward shift for the on-ramp due to the short distance between Taney and the NB (diamond) on-ramp; this was agreed upon and was taken into consideration for the future. Final refinement issues, regarding things such as landscaping were also discussed. A list of specific comments from MoDOT are included below. All of these items should be taken into consideration with the refinement of the final design moving forward.

MoDOT Comments:

- 1. I know nothing about MoDOT’s rules on trees, but assume attributes like size, location, sight lines, proximity to signs, proximity to lights, etc. may differ from stakeholder preference. I just want to mention early in case there are strong opinions. Some trees look like they could obscure sightlines, particularly for pedestrians.
 - a. Action step: this comment was acknowledged and is recommended for further study if this project moved forward into preliminary design.
- 2. How should we mitigate potential confusion for RRFB “parallel” to uncontrolled lanes (i.e. where peds cross “EB↔NB” in SW quad and “WB↔SB” in NE quad)? Will drivers think all lanes need to stop; how do we convey the

- other lanes are not to stop at flashers? I assume we'll want to consider potential for rear-end crashes.
- a. Action step: this comment was acknowledged and is recommended for further study if this project moved forward into preliminary design.
3. The WB-67 making the NBL turn seems to be doing so from a NBR turn lane. Is this an intentional change of lane-use, or just a typo?
 - a. Action step: the truck turning exhibit was updated to show proper lane usage.
 4. Due to the short distance between Taney and the NB (diamond) on-ramp, will MoDOT request the on-ramp to shift west (as was drawn in the Dec '21 report [PDF 55/57])? This would hopefully add clarity/safety to both intersections for cars and non-motorized traffic.
 - a. Action step: this improvement was determined to be outside the scope of this plan, so no additional steps were taken on this comment.
 5. (maybe too "in the weeds") The pedestrian crossing of the SB off-ramp seems to be a little more skewed and close to the intersection than at the NB off-ramp. I assume MoDOT would want NB off-ramp crossing as close to intersection as possible, are there other considerations here?
 - a. Action step: this comment was acknowledged and is recommended for further study if this project moved forward into preliminary design.
 6. Is it important enough to reconstruct the curb return in this area to force a yield and open a lane on the right? Could this could help lower turning vehicle speeds, making conditions more comfortable for non-motorized users?
 - a. Action step: this comment was acknowledged and is recommended for further study if this project moved forward into preliminary design.

Design Criteria Review

Table 26 highlights many of the design standards and the following sections provide additional detail.

Table 26: Functional Classification and Design Criteria of MoDOT Routes in Study Area

DESIGN CRITERIA	210 Highway	Highway 1/ Antioch	I-29/35 Ramps
Functional Classification	Expressway	Minor Arterial/Major Collector	Interstate
Design Speed (mph)	45	35	55 at nose/35 at intersection
Clear Zone	20'	14'	30'/14'
Typical Section	90' R/W	60'	Varied
Lane Width (Min)	12'	12'	18' - 12' min Off Ramp - 24' at the signalized intersection
Curb & Gutter	MoDOT C&G Std Plan 609.00	MoDOT C&G	MoDOT C&G
Sidewalk	5' with 3' from curb/ 6' on back of curb. Thickness: 4" Concrete Std Plan 608.10	5' with 3' from curb/ 6' on back of curb. Thickness: 4" Concrete	
Grassy Sidewalk Buffer (Min)	3' (unless on back of curb)		
Shoulder	3' C&G (6" curb)	3' C&G (6" Curb)	Next to Barrier: 4' outside/ 2' Inside No Barrier: 4' inside/ 6' outside
Pavement	Asphalt	Asphalt	Concrete with asphalt Overlay
Horizontal Curve Radius (min.)	N/A	N/A	N/A
SSD	360'	250'	495'/250'
Profile	Match Existing	Match Existing	Match Existing
K-Value (min) Sag Vertical Curve	N/A	N/A	N/A
Drainage			
Design Storm	25-50 year pipes 50 -100 year culverts	10 year	10 year

Engineering Policy Guide Design Information

The following are excerpts from MoDOT's Engineering Policy Guide (EPG) and other resources that may apply to the proposed improvements.

[EPG 642.8 Sidewalk Design Criteria](#)

Barrier curb. Refer to [Standard Plan 609.00](#). When sidewalks are constructed, a barrier curb is sufficient to separate pedestrians from vehicular traffic on low-speed roadways (posted speed of 45 mph or less). At higher speeds, a vehicle can mount a barrier curb at a relatively flat impact angle. In the event a sidewalk located adjacent to a high-speed roadway is necessary, another type of physical separation between the vehicle and the pedestrian will be considered. Guardrail and concrete traffic barriers are two of the options that may be considered.

The cross slope on all accessible routes must be 1.0% minimum to 2.0% maximum

The running slope should be as flat as possible, up to a maximum of 5%. However, sidewalks may follow the slope of the adjacent roadway if less than 5% is technically infeasible.

[EPG 642.11 Pedestrian Grade Separation](#)

It is not practical to develop warrants governing the construction of pedestrian grade separation facilities. Each situation must be considered on its own merits. Such facilities are generally warranted only at locations where exceedingly heavy volumes of pedestrian traffic must cross a heavy vehicular flow. When the construction of a pedestrian grade separation is considered, an investigation should be made including studies of pedestrian crossing volumes, type of highway to be crossed, location of adjacent crossing facilities, the predominant type and age of persons who will use the facility and the cost of constructing the pedestrian grade separation. A pedestrian grade separation should only be constructed when the need for the safe movement of pedestrians cannot be provided in a more efficient manner. Additional guidance concerning pedestrian grade separations can be found in an AASHTO publication *Guide Specifications for Design of Pedestrian Bridges*.

[EPG 902.7 Pedestrian Hybrid Beacons \(MUTCD Chapter 4F\)](#)

Support. A pedestrian hybrid beacon is a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.

Option. A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see [EPG 902.3 Traffic Control Signal Needs Studies](#)), or at a location that meets traffic signal warrants under [EPG 902.3.6](#) and/or [EPG 902.3.7](#) but a decision is made to not install a traffic control signal.

Additional Engineering Guidance

[FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations](#)

Table 1 provides initial countermeasure options for various roadway conditions. Each matrix cell indicates possibilities that may be appropriate for designated pedestrian crossings. Not all of the countermeasures listed in the matrix cell should necessarily be installed at a crossing.

For multi-lane roadway crossings with vehicle AADTs exceeding 10,000, a marked crosswalk alone is typically insufficient (Zegeer, 2005). Under such conditions, more substantial crossing improvements (such as the refuge island, PHB, and RRFB) are also needed to prevent an increase in pedestrian crash potential.

Table 1. Application of pedestrian crash countermeasures by roadway feature.

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	① 2 4 5 6	① 5 6 7 9	① 5 6 7 9	① 4 5 6 7 9	① 5 6 7 9	① 5 6 7 9	① 4 5 6 7 9	① 5 6 7 9	① 5 6 7 9
3 lanes with raised median (1 lane in each direction)	① 2 3 4 5	① ③ 5	① ③ 5	① 3 4 5	① ③ 5	① ③ 5	① ③ 4 5	① ③ 5	① ③ 5
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	① 2 3 4 5 6	① ③ 5 6	① ③ 5 6	① 3 4 5 6	① ③ 5 6	① ③ 5 6	① ③ 4 5 6	① ③ 5 6	① ③ 5 6
4+ lanes with raised median (2 or more lanes in each direction)	① ③ 5	① ③ 5	① ③ 5	① ③ 5	① ③ 5	① ③ 5	① ③ 5	① ③ 5	① ③ 5
4+ lanes w/o raised median (2 or more lanes in each direction)	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6	① ③ 5 6

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

- 1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
- 2 Raised crosswalk
- 3 Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
- 4 In-Street Pedestrian Crossing sign
- 5 Curb extension
- 6 Pedestrian refuge island
- 7 Rectangular Rapid-Flashing Beacon (RRFB)**
- 8 Road Diet
- 9 Pedestrian Hybrid Beacon (PHB)**

Figure 31: Application of pedestrian crash countermeasures by roadway feature (Source: FHWA)

AASHTO Roadway Lighting Design Guide

Underpasses should be illuminated at the same level of illumination as the outside roadway. Supplemental lighting may be needed when the pole mounted luminaires do not sufficiently penetrate the underpass. Daytime and nighttime lighting may be needed when pedestrian safety is involved. Consideration should be given to glare issues entering or exiting an underpass and how that affects the vehicle's ability to see an obstacle/pedestrian in the roadway. This can be compounded due to the orientation of the underpass and time of day.

4.2.2 Warrants for Nighttime Underpass Lighting

Meeting minimum lighting levels through underpasses is warranted (1) in areas that have frequent nighttime pedestrian traffic or (2) where unusually or critical roadway geometry occurs adjacent to or in the underpass area.

Continuous lighting on the associated freeway lanes also warrants the continuation of minimum lighting levels through the underpass.

Minimum lighting levels may be met by using supplemental. Underpass lighting or with luminaires positioned adjacent to the underpass to provide adequate lighting.

[Supplemental Information from Colorado DOT Lighting Guidelines:](#)

When to Light

- Underpasses do not require nighttime lighting if the adjacent roadway is not lighted.
- Underpasses on lighted roadways should be lighted to the same luminance as the roadway.
- Underpasses less than 80 feet in length, do not require supplemental lighting for daytime adaptation.
- Underpasses between 80 feet and 410 feet in length, may require supplemental lighting for daytime adaptation. Refer to Section 2.2.5 for more information.

Lighting Criteria

- Lighting levels will be considered as meeting the criteria if the calculated values are within ten percent (10%) of the criteria or do not exceed the criteria by more than two times (2x).

Best Practices

- Luminaire optics or shielding should be carefully considered to avoid glare for motorists.
- Whenever possible the lights should be located above the shoulder on the outside edge of the roadway to minimize traffic impacts, due to lane closure, when the luminaire is maintained.
- Controls should be installed such that all underpass lights turn on and off at the same time.

Special Considerations

- Most underpasses do not require lighting if the roadway light standards are adequately spaced and light the pavement beneath the underpass.
- For shorter underpasses, it may be possible to locate the roadway luminaires such that sufficient light shines into the underpass without the bridge shadowing the roadway.
- For longer underpasses, it will be necessary to install wall or ceiling mounted luminaires.
- Use lighting calculation software to confirm whether adjacent streetlights sufficiently illuminate the underpass or if additional underpass lights are needed.
- When the length to height ratio of an underpass exceeds approximately 6:1, it should be evaluated for the need for additional daylight illumination

When to Light

- Mid-block crossings shall always be lighted. Denoted crosswalks should be lighted whenever possible. Denoted crosswalks include those identified by the use of: signage, flashing beacons, etc. Crosswalks located at roundabouts, near schools, near bus stops, or adjacent to city centers, restaurants, shopping centers, or other areas with anticipated pedestrian use should be lighted. An appropriate lighting design will allow motorists to see pedestrians within the crosswalk.

Concept Layouts

Several improvement concepts were investigated with this plan. These include geometric, operational, and maintenance recommendations. These recommendations have been subdivided based on geometric changes to the roadway and infrastructure, and non-geometric changes. Each of these options were developed through engagement with the Focus Group and tested with the public in the online survey. The top options identified through the public engagement efforts are included here as recommended improvements. These top options can be seen in the chart below how the improvement options were scored by the public. The top options include:

- Improve Crosswalks
- Improve Lighting
- Widen Sidewalks/Trails
- Improve Maintenance
- Construct Levee Trail

Each of these was pursued except the levee trail. The levee trail was deemed to be a potentially positive improvement for the community, but was outside the scope of this project. The following sections detail these concept recommendations and options.

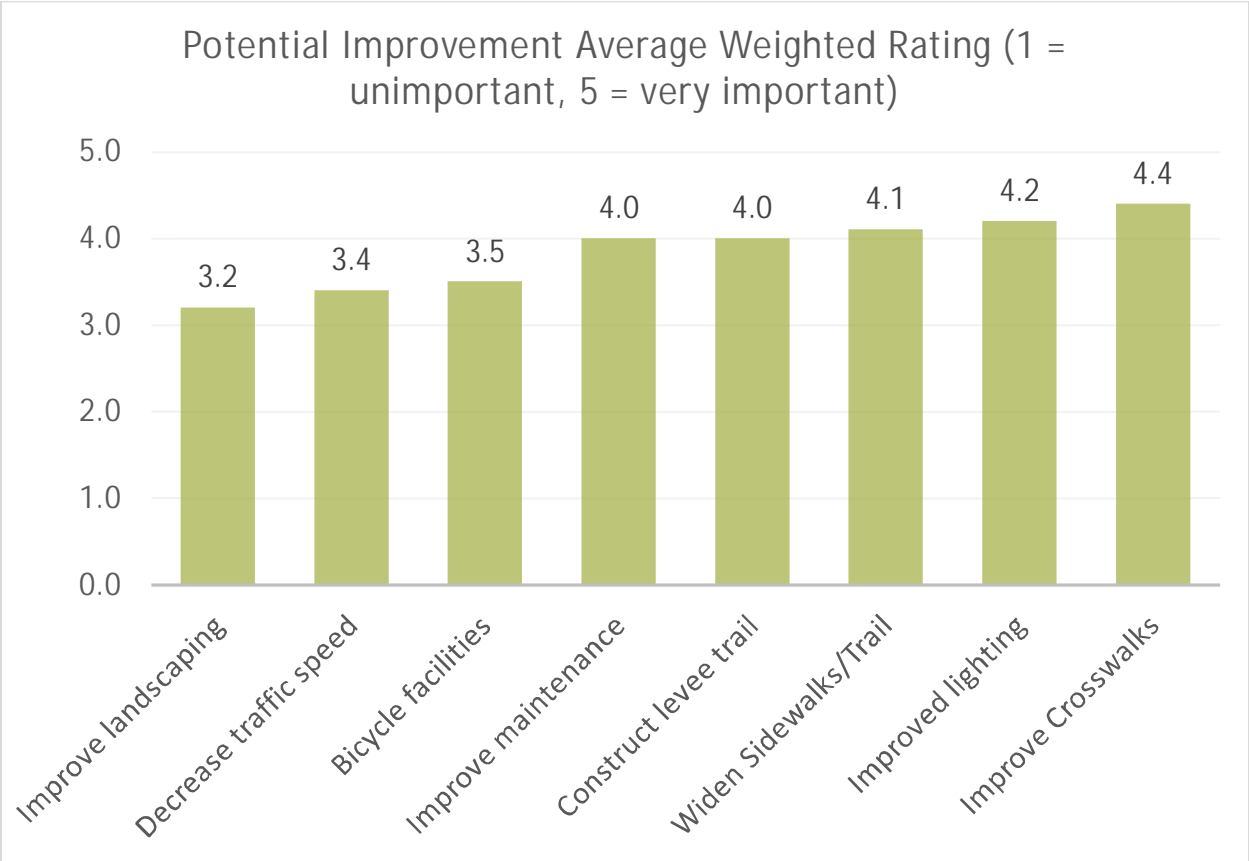


Figure 32: Voting on Improvement Options

Non-Geometric Recommendations

These recommendations do not necessitate reconfiguration of the roadway layout and can be implemented independent of each other or of roadway construction/reconfiguration.

Crosswalk Improvements

Crosswalk improvements were the single most important issue as identified by the public and is a clear area of concern. Especially in having to cross high speed right-turn on-ramps to I-29/I-35. Public comments also showed strong support for Improving crosswalks with flashing warning lights for drivers, pavement marking, and signs. Therefore, it is recommended that rectangular rapid flashing beacons (RRFB's) be installed on either side of the ramp lane with pedestrian warning signs and "down" arrow plaques below which would be offset from the through lanes. RRFBs are pedestrian-actuated conspicuity enhancements used in combination with a crossing warning sign to improve safety at uncontrolled, marked crosswalk such as the one shown in the figure below.



Figure 33; Rendering showing crosswalk of ramp from eastbound Armour to southbound I-35 with high visibility pavement marking, signs, and rapid rectangular flashing beacons

Lighting Under Bridge

The current lack of lighting under the bridge was a concern that was brought up repeatedly as an issue that makes all public users feel unsafe, including drivers, cyclists, and pedestrians. Upon examination the underpass was of a sufficient enough length that AASHTO tunnel lighting standards were warranted. Providing good visual

conditions for drivers approaching the underpass entrance is an easy and effective way to address real public concerns while increasing the relative safety of users. Providing good visual conditions for drivers approaching the entrance and exiting into bright sunlight is a crucial factor in the increasing safety for the users. Better lighting levels for pedestrians and cyclists will also improve the access and safety for these users under the bridge. It is recommended that the underpass is luminated to current standards. A model rendering for the proposed lighting is seen below.



Figure 34: Rendering of how bridge appears in daytime with current lighting levels and tunnel standard lighting levels

Maintenance and Cleaning of Sidewalks

Currently the existing sidewalks have litter and debris on them from pedestrians and passing cars. There is also a lack of maintenance due to a lack of trash cans as well as conflicts in terms of where cleaning responsibilities lie. There were consistent comments and concerns over the trash on the sidewalks, which is exacerbated due to conflicting concerns on responsibility for maintenance. It is recommended that to best address public comments and concerns that there should be consistent trash cleaning, and the installation of trash cans and that the City should take the lead, although consistent communication with MoDOT should be used in order to address any internal concerns of jurisdiction.

Landscaping & Trees

Public outreach also identified that landscape improvements including trees were among desired enhancements but much lower priority. However, this improvement could easily be incorporated with the geometric recommendations, so it is included in the recommendations. While safety concerns were prioritized more, aesthetic and environmental improvements would bring wanted benefits to the community. The improved foliage and landscaping would allow for greater comfort for pedestrians with increased shade and overall improved beauty. A model of which is seen below.



Figure 35: Rendering showing new trees planted along a future shared use path.

Geometric Recommendations

The following recommendations include structural changes to the road. This include changes to how lanes are aligned, number of lanes, and the way turning movements are accomplished. Three primary recommendations exist:

- Construct a Shared Use Path under I-35
- Construct Shared Use Path Near Levee
- Fill in Sidewalk Gaps in Area
- Re-align High Speed Right-Turn Lanes onto I-35 Ramps

The following sections detail these options.

Construct Shared Use Path Under I-35

16' Wide Barrier Protected Shared Use Path on South Side of Armour

Originally among the most popular considerations was the construction of 16' barrier protected shared use path following the route shown in Figure 36. The public was adamant over the construction of a shared use path rather than separated facilities for bicyclists and pedestrians. Most focus group attendees also felt that safety was the top priority, both traffic safety and personal safety. Traffic safety concerns were primarily related to having to cross the right-turn lanes for the on-ramps and the high speed of traffic through the area. The focus group preferred 16' shared use path behind columns where right-turn lane exists today because it was seen as very protected from traffic and had a wide open space. However, a fatal flaw was identified with this option with the pedestrian crossing of the right turn lane from Armour Road onto I-35 northbound. At this location, pedestrian sight distance for cars in the right turn lane created significant safety concerns sufficient to find this alternative infeasible to build.

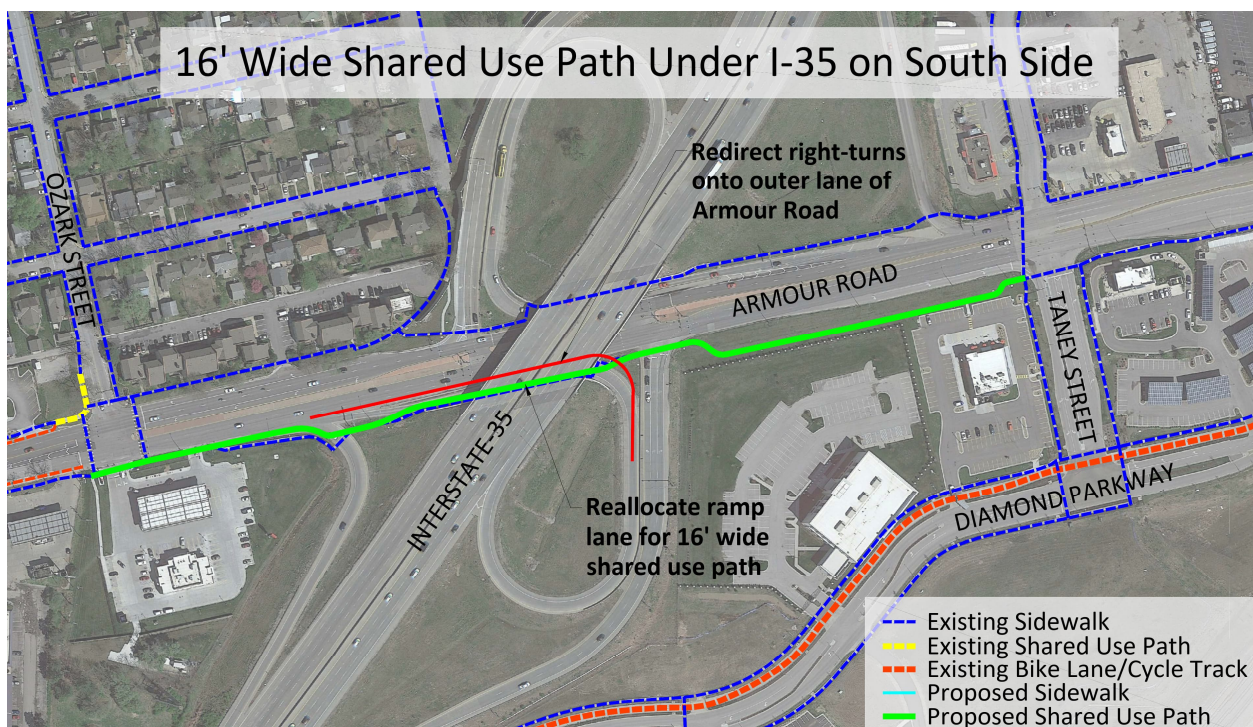


Figure 36: Geometric Recommendation - 16' Wide Barrier Protected Shared Use Path on South Side of Armour

10' Wide Shared Use Path on South Side of Armour

Another explored alternative was the construction of a 10' wide shared use path along the southern portion of Armour Road. This alternative was not barrier protected and had only a curb and gutter for user protection. This alternative did not have the same sightline issue as the previous alternative as it instead reallocated the outside driving lane. However, when presented to the public, concerns were raised about the lack of a barrier, with the public being adamant about barrier protection. This alternative, while too exposed, was used as a starting basis for the recommended concept, as it met most considerations of the public, with only the lack of protection being of concern.

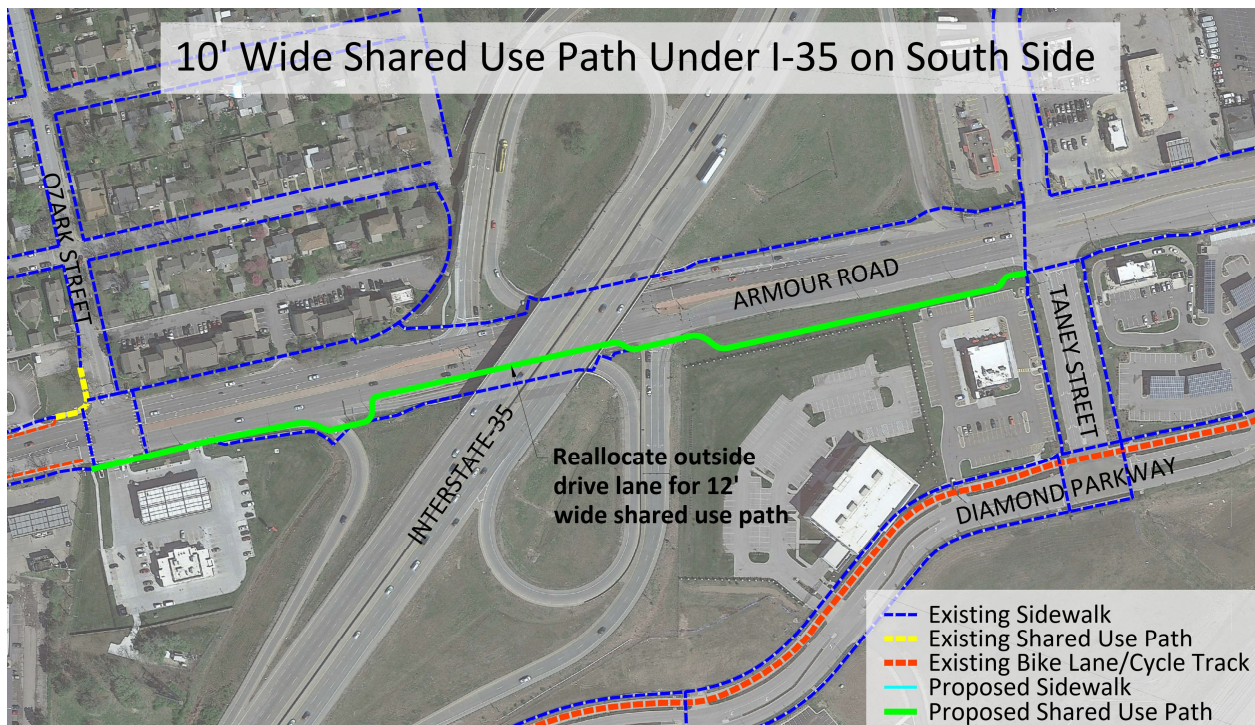


Figure 37: Geometric Recommendation - 10' Wide Shared Use Path on South Side of Armour

10' Shared Use Path on North Side of Armour

Similarly, to the southern route a 10' shared use path alternative protected only by a curb and gutter on the north side was explored. Once again, while not having the sightline issues seen before, the lack of barrier protection made this solution unpopular with the public as they felt too exposed to traffic. Beyond protection there was solid support for this plan in terms of the connectivity offered, specifically being on the northern side of Armour Road and therefore next to the neighborhood streets. If protection issues could be addressed, the public and city council would be much more amenable.

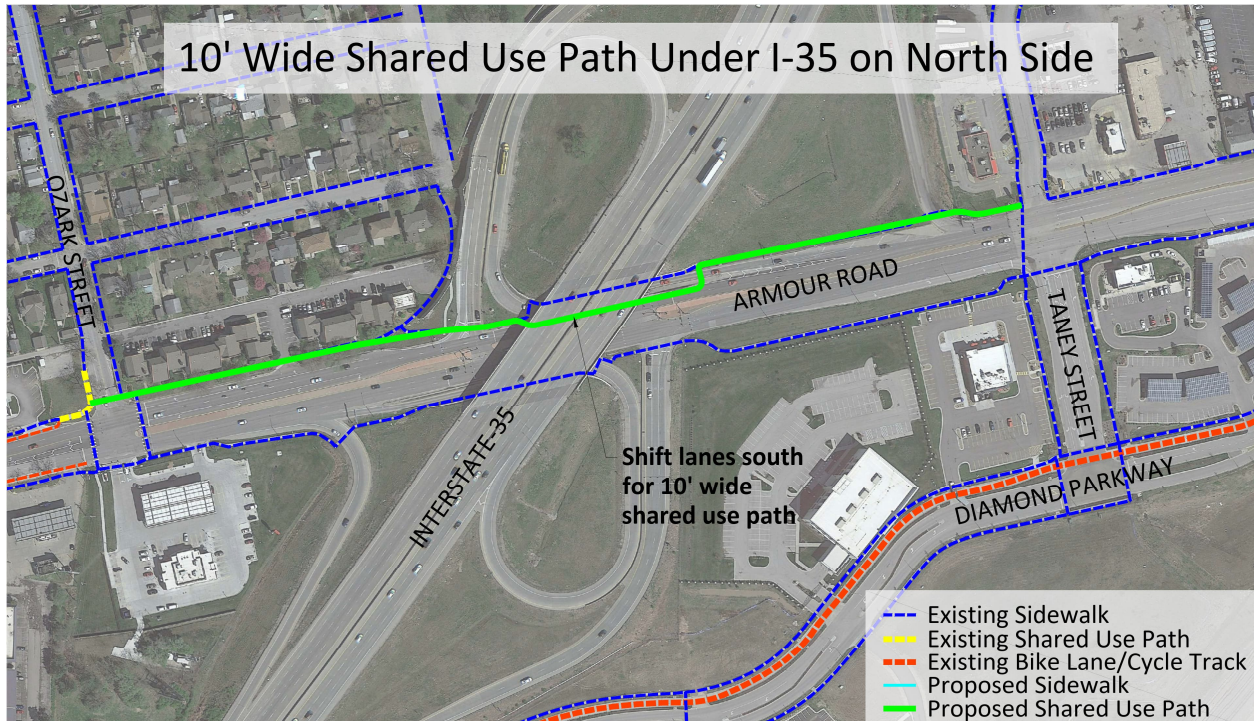


Figure 38: Geometric Recommendation - 10' Shared Use Path on North Side of Armour

Construct Shared Use Path Near Levee

In addition to the shared use path along Armour Road, a shared use path running along the southern bank of the levee was suggested. While this route would allow for paths for the northern end of the neighborhood connecting to the shops on the other side of the interstate in what would be a public greenspace; this is currently outside the scope of the plan, and it is recommended for further study.

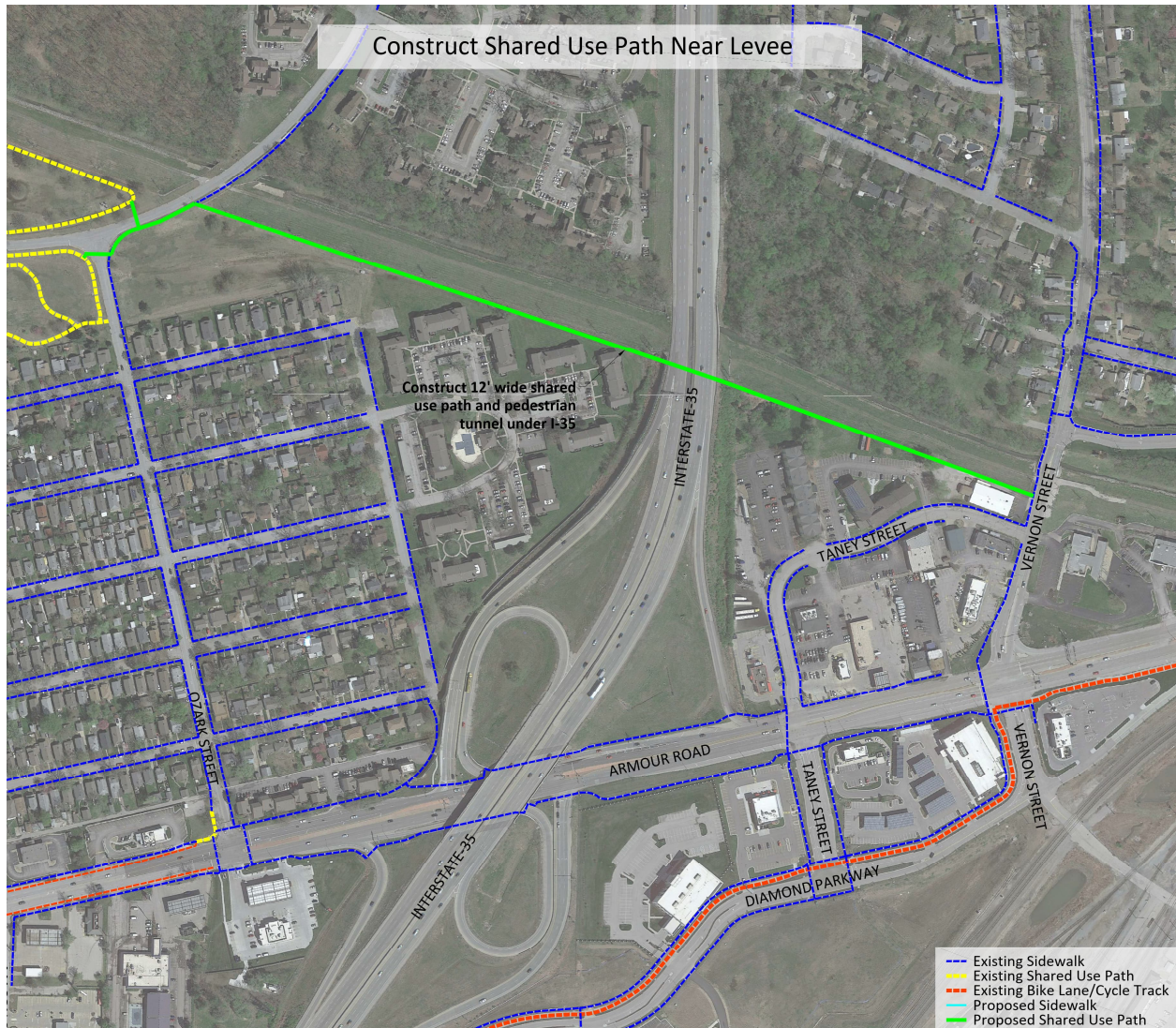


Figure 39: Geometric Recommendation - Construct Shared Use Path Near Levee

Fill in Sidewalk Gaps in Area

The focus group also identified the need to infill several existing gaps in the sidewalk network to enhance the ease of pedestrian and cyclist mobility in the study area. While this is a clear need, it too falls outside the scope of this plan. Further study is recommended.

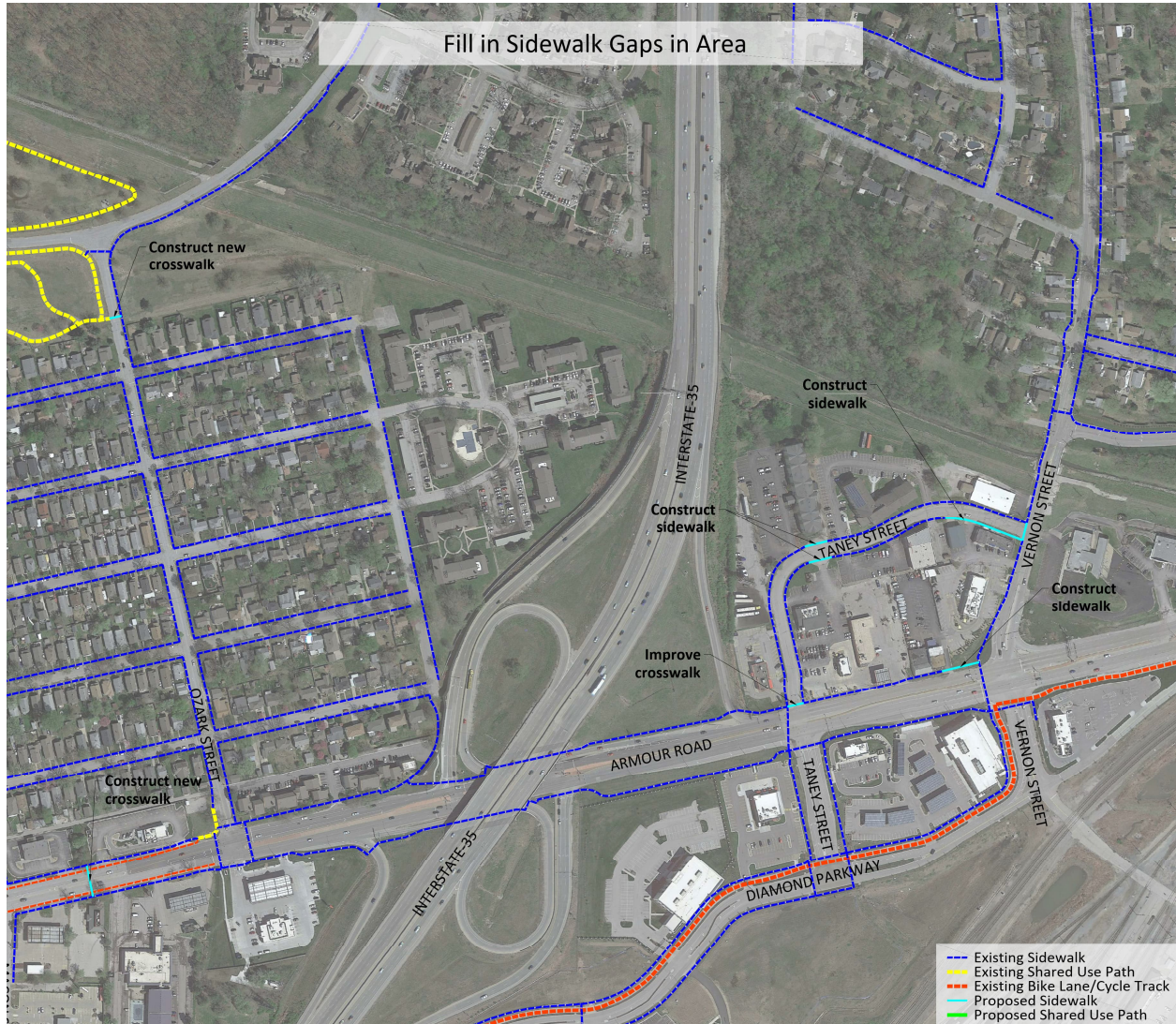


Figure 40: Geometric Recommendation - Fill in Sidewalk Gaps in Area

Re-align High Speed Right-Turn Lanes onto I-35 Ramps

The Missouri Department of Transportation also suggested the re-alignment of the right turn lanes connecting Armour Road and Interstate 35. The current alignments are very close to existing intersections, specifically Taney Street and Armour Road, which creates lane disruptions and confusion for drivers. By realigning the high speed right turn lanes, the aim would be to increase safety creating less conflicts for drivers. However, this recommendation is outside the scope of this plan, but it is suggested to be further explored.



Figure 41: Geometric Recommendation - Re-align High Speed Right Turn Lanes

Recommended Concept

The concept recommended for the location was one in which combined the best attributes of the above proposals. While the configuration of the 10' paths was highly agreeable to the public, they were adamant in pointing out the lack of barrier, exposing them to traffic. The main concerns regarding the existing site according to the public

- Narrow sidewalks
- Having to cross high speed right-turn on-ramps to I-35
- Lack of lighting, dark under bridge and difficult to see when entering or emerging into sunlight

A new concept was drawn up based on the 10' shared use path alongside Armour Rd that would have the same configuration but instead be a 12' barrier protected path on both sides of the street. This has many benefits, specifically this would allow construction phasing to construct one side at a time, making the project usable by the public before it is fully completed. This would also allow traffic to continue to operation through the interchange with minimal disruption as the construction is completed. The increased bike and pedestrian traffic in addition to the additional lighting is expected to contribute to the cleanliness of the area as illegal dumping would be mitigated by the increased traffic and eyes in the area. Fencing alongside the barrier to prevent littering dumping from vehicles will also be considered as an area for refinement in the recommended concept, to address the trash concerns some members of the city council brought up. A concept design is shown below along with a number of rendering images showing various parts of the area.



Figure 42: Overview rendering of recommended concept



Figure 43: Rendering view of improved pedestrian crossing of ramp from eastbound Armour Road to southbound I-35 (looking east)



Figure 44: Rendering view of new pedestrian crossing across ramp from eastbound Armour to northbound I-35 (looking east)



Figure 45: Rendering view of shared use path under the I-35 bridge on the south side of Armour Road (looking west)



Figure 46: Rendering view of improved crosswalk across northbound I-35 off-ramp (looking east)



Figure 47: Rendering view of shared use path on south side of Armour Road east of I-35 northbound off-ramp (looking west)



Figure 48: Rendering view of improved pedestrian crossing of ramp from westbound Armour Road to northbound I-35 (looking west)



Figure 49: Rendering view of new pedestrian crossing across ramp from westbound Armour Road to southbound I-35 (looking west)

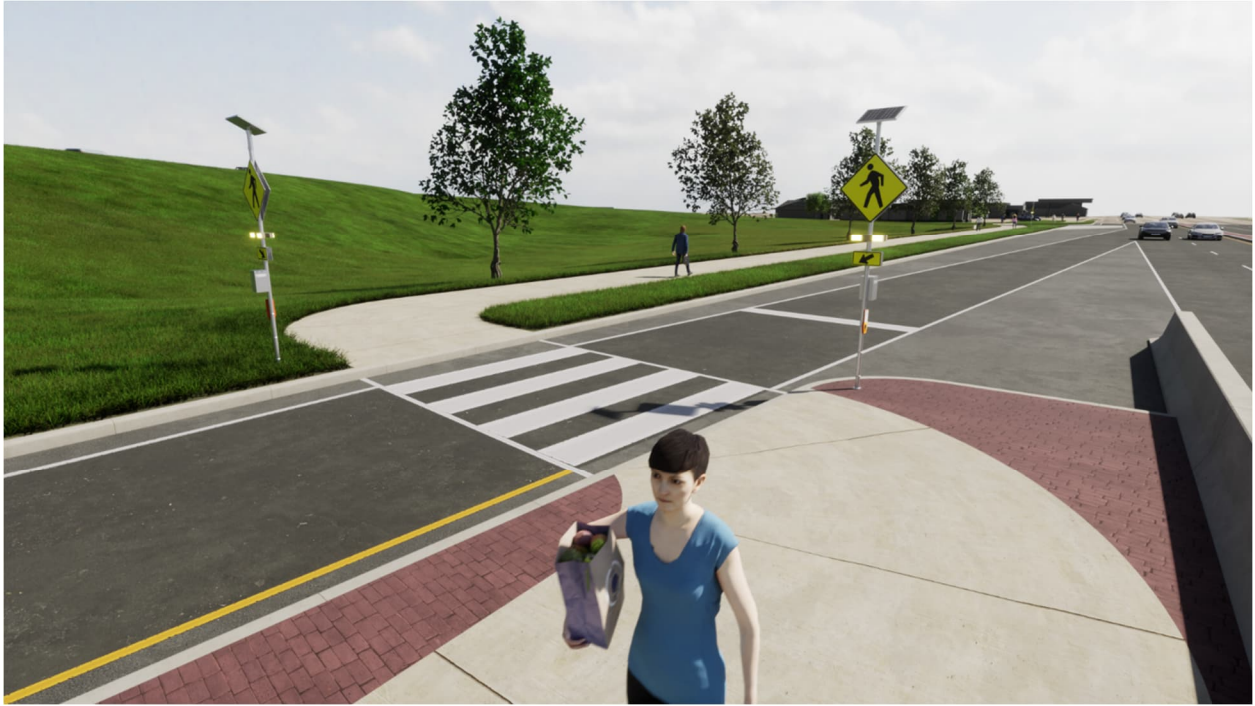


Figure 50: Figure 51: Rendering view of new pedestrian crossing across ramp from westbound Armour Road to southbound I-35 (looking east)



Figure 52: Rendering view of shared use path under the I-35 bridge on the north side of Armour Road (looking west)



Figure 53: Rendering view of shared use path on north side of Armour Road just west of the southbound I-35 off-ramps (looking northwest)



Figure 54: Rendering view of shared use path on north side of Armour Road east of Ozark Street (looking east)

When this concept was brought before the City Council, comments were generally positive with some concerns regarding the ease of access for trucks, being of particular note. Luckily, this was considered in some detail and taken into account in the design of the barrier protected pathway. There was enough room to create 2' barrier without restricting the movements of trucks. This concept would also allow the current barriers behind the bridge columns to be removed, currently they are in a state of disrepair allowing for easier turning for trucks. A model of the truck movements can be seen below. It should be noted that trucks turning off of the highway ramps will need to cross over adjacent lanes to complete this maneuver. This is the current circumstances today (trucks cannot maintain their position in a single lane and make the turn today) and would remain the circumstance with this improvement.

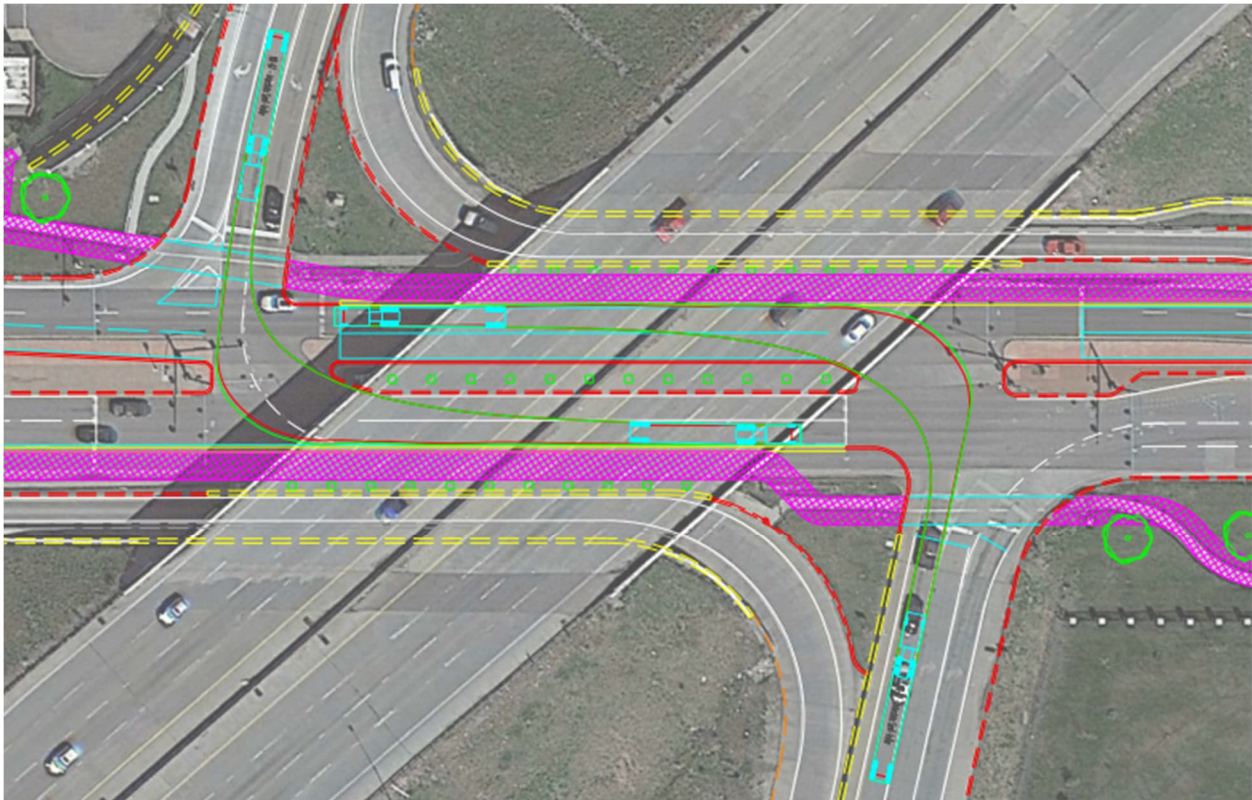


Figure 55: Truck turning movements for full sized semi-trucks (WB-67) turning off the highway ramps

Overall, this 12' barrier protected concept alongside Armour Road provides the needed improvements desired by the public, as noted by the focus groups. These being:

- Improving crosswalks including moving the crossing of the ramps to highly visible and safe locations
- Widening sidewalks for bicycle and pedestrian access
- Creating a comfortable, safe, clean, and well-lit environment for bicyclists and pedestrians in the area

It is recommended this concept move forward into the final steps of coordination with MoDOT to develop final designs and begin construction. The expected cost for this project is \$2.5 million, a breakdown of which can be seen below. It should be noted that this cost estimate includes shared use paths on both sides of Armour Road. This project could be phased with the shared use path constructed on the north or south side initially.

Table 27: Estimated Project Costs

Estimated Cost Item	Estimated Cost
Barrier Protected 12' Wide Shared Use Path (North and South sides, incl. landscaping)	\$1,870,000
Improve lighting under bridge	\$330,000
Professional Services for Shared Use Path and Lighting	\$320,000
Estimated Total Cost	\$2,520,000

Conclusion

In conclusion, a 12' barrier protected shared used path alongside both sides of Armour Road provide the best overall value for safety, connections, and ease of access. The public was very positive towards the recommendation since it addressed most of the concerns that were voiced throughout the process including:

- Narrow sidewalks
- High speed crossings
- Lack of lighting
- Lack of maintenance, trash clearing

The proposed concept achieves all of this through the use of shared use path, RRFB's, tunnel lighting stands, increased travel demand. This is a step forward in increasing the safety for pedestrians and cyclists. This recommendation will also serve to connect the neighborhoods and local shops while improving the current bicycle and pedestrian facilities. Therefore, it is recommended that this moves forward into final design and construction.