LOCAL ROAD

SAFETY PLAN

BOONE COUNTY
KENTUCKY

College of Engineering
Kentucky Transportation Center

TECHNOLOGY TRANSFER PROGRAM

KENTUCKY TRANSPORTATION CABINET

ACKNOWLEDGEMENTS

This original 2021 document was prepared by the Boone County Engineers office in partnership with the Federal Highway Administration, Kentucky Transportation Cabinet (KYTC) Highway Safety Improvement Program (HSIP) Staff and the Kentucky Transportation Center's Technology Transfer Program at the University of Kentucky. Special thanks is given to the following people who were instrumental in the development of this document.

Jerry Roche, *FHWA Resource Center*
Hillary Isebrands, *FHWA Resource Center*
Ryan Tenges, *FHWA Kentucky Division*
Jason Siwula, *Kentucky Transportation Cabinet*
Jarrod Stanley, *Kentucky Transportation Cabinet*
Mike Vaughn, *Kentucky Transportation Cabinet*
Nathan Ridgway, *Kentucky Transportation Cabinet*
Perry Newcom, *Crittenden County Judge/Executive*
Duane Campbell, *Boyle County Engineer*
Robert Franxman, *Boone County Engineer*
Scott Pennington, *Boone County Engineer (ret)*
Martha Horseman, *Kentucky LTAP*
Adam Kirk, *Kentucky LTAP*

The updated document was prepared by the Boone County Engineers office specifically involving the people outlined below.

Robert Franxman, *Boone County Engineer*
Daniel Menetrey, *Boone County Capital Project Manager*
Adam Kirk, *Kentucky LTAP*
Boone County Traffic Safety Committee

TABLE OF CONTENTS

Introduction and Plan Development 4
Plan Development 6
Relationship to Boone County Transportation Programs 6
Road User Considerations 7
Safety Partners 7
Countywide Crash Analysis 9
Priority Locations for Safety Improvements 13
- County Collector Roadways 13
- Equivalent Property Damage Only Crash Analysis 15
- Roadway Hazard Rating 156

Countermeasures 18
- Roadway Signing 19
- Stop Controlled Intersections 23
- GUARDRAIL 25
- Wet Weather Crashes 27
- Complete Streets 28

Conclusions & Recommendations 328
Evaluation & Implementation 32

LIST OF TABLES

Table 1: Boone County EPDO Analysis 15
Table 2: Boone County Hazard Rating Analysis 16
Table 3: Boone County LRSP Final Ranking 17
Table 4: Summary of Recommended Improvements 30-31
Table 5: MUTCD Table 2C-4 Guidelines for Advanced Placement of Warning Signs 20

LIST OF FIGURES

Figure 1: FHWA Local Road Safety Plan Roadmap 4
Figure 2: Boone County Roadways 5
Figure 3: Crash Distribution by Year 9
Figure 4: Boone County Crashes 10
Figure 5: Crash Frequency and Severity 11
Figure 6: Statewide Crash Type Distribution 11
Figure 7: Statewide Contributing Human Factor 12
Figure 8: Boone County Collector Roads 14
Figure 9: Pedestrian Crossing and Speed Limit 19
Figure 10: W1-1a Used as Advanced Warning Sign 19
Figure 11: Horizontal Alignment Signs 20
Figure 12: Horizontal Alignment Signs With Advisory Speeds 20
Figure 13: Large Arrow Board and Chevrons 21
Figure 14: Conceptual Sign Layout 21
Figure 15: MUTCD Object Marker 22
Figure 16: Object Marker Application a) Type 3 and b) Type 2 22
Figure 17: 'T' Intersection Conrad Lane at Limaburg Road 23
Figure 18: Large Arrow Board Placement At T-Intersections 23
Figure 19: Improvement Progression At A 'T' Intersection 24
Figure 20: Existing Guardrail Installations (Hicks Pike and Bullitsville Road) 25
Figure 21: Barrier Consideration for Embankments (AASHTO Roadside Design Guide) 25
Figure 22: Normal Guardrail Installation 26
Figure 23: Preferred Guardrail End Treatments 26
Figure 24: Type 7 End Treatments 26
Figure 25: Crashes by Roadway Condition (Longbranch Road at Fowler Creek Road) 27
Figure 26: Longbranch Road at Fowler Creek Road 27

INTRODUCTION

Boone County is committed to improving transportation safety for all users and has implemented this Boone County Local Road Safety Plan (LRSP) because of that commitment. A LRSP provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads and results in a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on the local road network. LRSP's have proven to effective in reducing fatalities on local roads in states that have implemented them. Boone County's LRSP includes the elements depicted in **Figure 1** identified by the Federal Highway Administration.

In addition, on August 23rd, 2022, by resolution the Boone County Fiscal Court directed the Department of Public Works to collaborate with the Fiscal Court, Kentucky Transportation Cabinet and other relevant departments of State / County / City Government, such as Emergency Services, Public Health and Wellness, Law Enforcement, to include ***Vision Zero*** as a component of the LRSP.

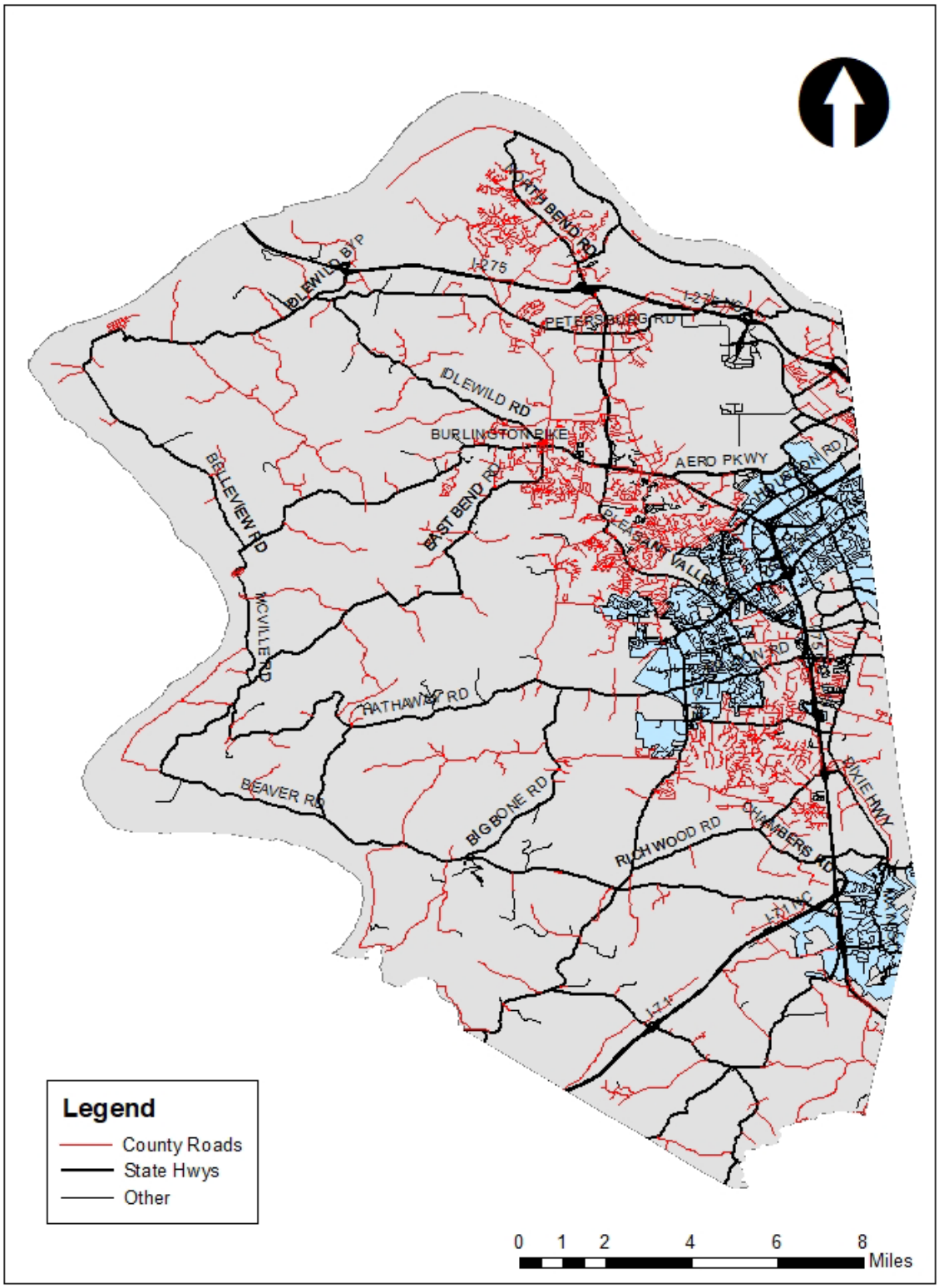
Boone County lies in Northern Kentucky and maintains 430 miles of County owned roadway. **Figure 2** shows the county boundary and highlights the county roadway system. This study evaluated crash data on these roadways from January 1, 2016-December 31, 2020, to determine overrepresented crash types and identify high crash areas on the local roadway network. As part of an ongoing effort to make safety improvements, this LRSP was developed with input from several safety partners. The plan should be viewed as a living document that can be updated to reflect changing local needs and priorities. This plan will also be used by the county to prioritize current road department activities and to pursue additional projects in coordination with KYTC partners.

Figure 1: FHWA Local Road Safety Plan Roadmap

The first section of this report outlines the data sources used within the analysis, county-wide crash analysis and methodologies used in developing a priority ranking for high crash locations. The Appendix provides site specific analysis of the crash patterns and existing conditions at the priority locations, identified as the "County Collector Roadways." Safety countermeasures have been identified for each location, focusing on low-cost improvements that have the potential to mitigate the high crash pattern. The following sections summarize the process used to identify areas that would benefit from the

implementation of these low-cost safety measures as well as an overview and plan for those systematic safety concerns observed across the County.

Figure 2: Boone County Roadways



PLAN DEVELOPMENT

This plan was a collaborative effort with Boone County, the Kentucky LTAP, KYTC, the FHWA and included active participation from the Boone County Traffic Safety Committee. The planning process shared data collection, analysis, and stakeholder engagement.

This plan is based on an integrated performance-based planning approach that provides:

- A data-driven determination of priority safety corridors
- Goals to support a transportation safety culture
- Multidisciplinary safety solutions to reduce fatal and severe-injury crashes

RELATIONSHIP TO BOONE COUNTY TRANSPORTATION PROGRAMS

This LRSP is a non-mandated, standalone document that complements the Boone County Transportation Plan and the general work programs of Boone County Public Works. The Transportation Plan was last updated in 2018 and is available at the following web address https://booneky.oki.org/. The plan establishes transportation policy, needs, funding assumptions, and projects. Key considerations are safety, equity, active transportation, economic development and sustainability. In particular, the Transportation Plan set a goal "to improve safety and security for all travelers in Boone County" and documented crashes over a five-year period from 2012 through 2016. The crash data was reviewed to identify any crash patterns and develop potential countermeasures to reduce the number of crashes within the county. While the Transportation Plan analysis included investigation of crashes on all public roads, it largely identified countermeasures and projects along major corridors and state-controlled highways. During development of the LRSP it was determined that focus had to be applied to the local system controlled by the county. This procedure provides a tool for county work crews to focus efforts in areas with measurable and defined problems. In the absence of specific funding sources for safety improvements, work programs utilizing a general yearly budget can be tailored to perform general maintenance while also addressing identified safety needs. Over several months, Boone County and Kentucky LTAP staff evaluated new countywide crash data across the region focusing specifically on Boone County Public Works system of maintained roads. Review of crash data for the LRSP focused on severity and accounted for the scattered nature of collisions on the county-maintained system.

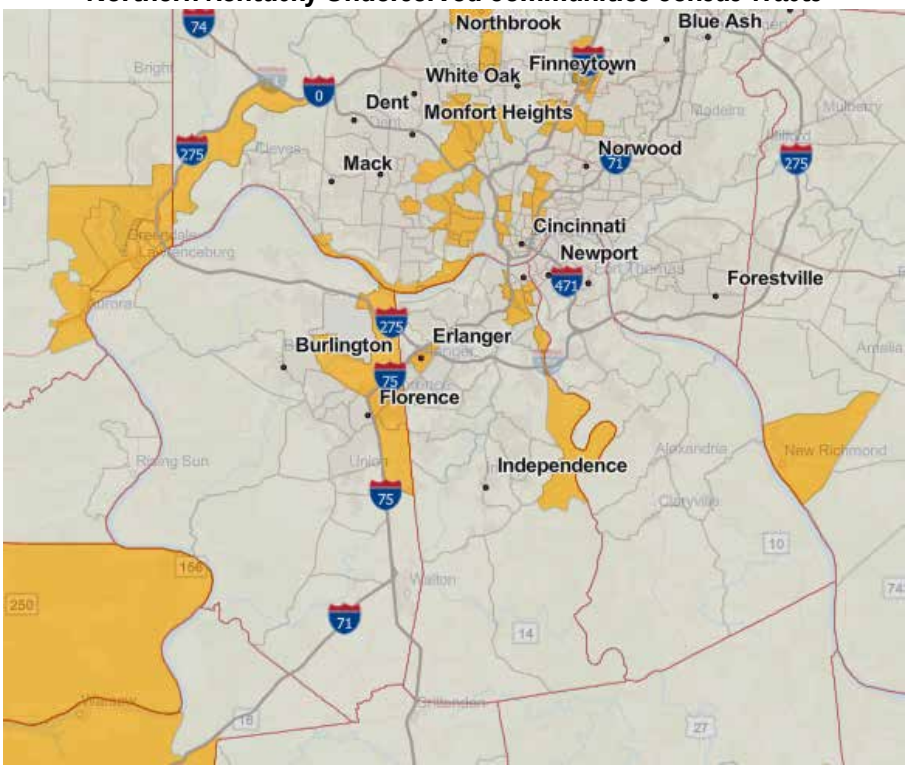
In General, the Boone County Transportation Plan is the policy plan with project lists, whereas the LRSP is the action-oriented plan that recommends systemic engineering solutions that can be applied across the entire County. The safety policies of the Transportation Plan are consistent with and help to further the actions recommended in the LRSP.

In August 2021, the Boone County Fiscal Court elected to establish a recurring allotment of funds for a special program with the specific intent of improving rural mobility and safety by widening roadways with substandard width. Boone County Public Works has convened a project group to prioritize projects for the Fiscal Court. The project group will utilize the LRSP during development of policies and prioritization of projects for the special widening program.

ROAD USER CONSIDERATIONS

The burden of traffic crashes is not distributed evenly across society, creating an equity issue In the transportation system. Most highway fatalities take place on rural roads creating a disproportionate impact to rural areas regarding fatal and severe-injury collisions. In addition, inequities persist along socioeconomic lines and generally even along different types of road users (i.e., pedestrians and bicyclists). This LRSP will consider equity in all project implementation. The establishment of the special program designed to improve rural mobility and safety by widening roadways will create a focus on rural inequities. Socioeconomic inequities will be included in prioritization by using the established Underserved Communities Census Tracts and coordination with the Transit Authority of Northern Kentucky (TANK) and community advocates. Sensitive road user inequities will be addressed by applying techniques identified in Boone County's Americans with Disabilities Act (ADA) Transition Plan and the guidance offered by Public Rights-of-Way Accessibility Guidelines (PROWAG).

Northern Kentucky Underserved Communities Census Tracts



SAFETY PARTNERS

Safety partners are a vital resource for acquiring and analyzing data, selecting emphasis areas, developing safety strategies, and implementing this LRSP. The Boone County Fiscal Court has been instrumental in the prioritization and implementation of the Boone County Local Road Safety Plan.

The planning process relied on input from a diverse group of stakeholders from multiple disciplines including these agencies:

- Boone County Public Works
- Boone County Sheriff
- Boone County Fiscal Court
- Kentucky LTAP
- Kentucky Transportation Cabinet
- Federal Highway Administration
- Boone County Traffic Safety Committee

Further evaluation, planning and updates to the LRSP intends to broaden the scope of agencies and stakeholders to include:

- City of Florence Public Works
- Kentucky Transportation Cabinet – District 6
- Boone County School Districts
- Boone County Fire Departments
- Boone County Public Health
- Transit Authority of Northern Kentucky (TANK)
- Community Advocates

During plan development the Boone County Traffic Safety Committee (TSC) was able to bring significant information and data to the LRSP. The TSC engages the Boone County community and to gather data regarding traffic safety issues. The group consists of engineering, law enforcement, administration, zoning, public service and transportation planning professionals. The group meets on a monthly basis and accepts complaints and/or observations from the community. Complaints are gathered thru e-mail correspondence, social media and the Boone County Sheriff's website:

https://boonecountykysheriff.com/traffic-complaint/

Combined, each group serves as a partnership with one another to consider the situation and determine if changes to a location may be deemed necessary. Each group can recommend changes or changes may be considered after a complaint is made by someone living in the community. Once a complaint is received by the TSC, a structured process is followed to determine if action is warranted.

Boone County Traffic Safety Committee Process

COUNTYWIDE CRASH ANALYSIS

Crash data for the all Boone County roadways was extracted from the Kentucky Crash Database maintained by the Kentucky State Police. Crash data was analyzed for a 5-year period from January 1, 2016 to December 31, 2020. During this 5-year period, 3,019 crashes occurred on the county roadway system resulting in 343 injury crashes and 2 fatal crashes. Figure 2 shows all crashes and severity on the County road system.

The Boone County Engineers office reviewed initial crash and roadway data, background information on potential safety issues and identification of initial emphasis areas for the LRSP. High priority roadways within the county were identified that had 1) documented crash history and 2) identified risk factors that may contribute to increased crash frequency or severity. These risk factors and roadway evaluations were used to prioritize the roadways and identify safety improvements.

Crash patterns in the county saw a decrease from 2017 to 2018, increased in 2019 and decreased again in 2020. This pattern follows other county road systems in Kentucky and statewide trends (**Figure 3**).

Figure 3: Crash Distribution by Year

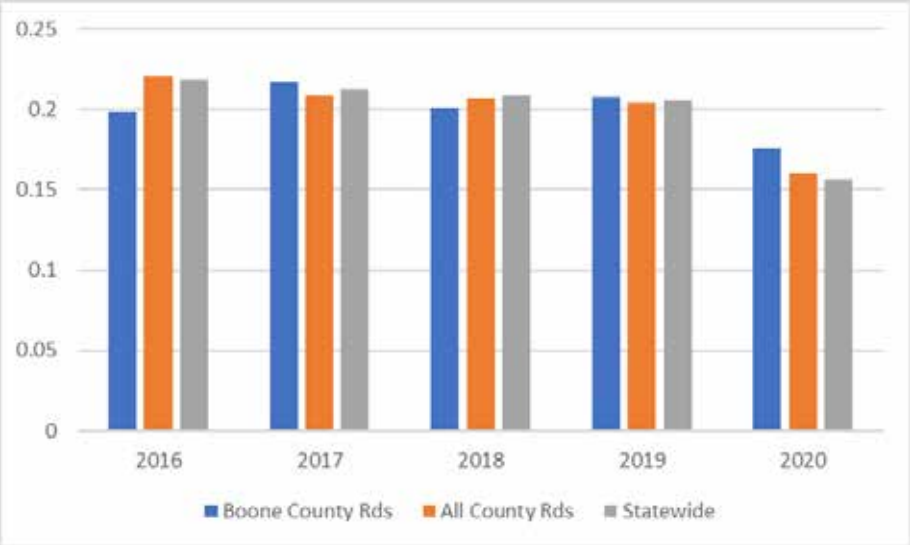
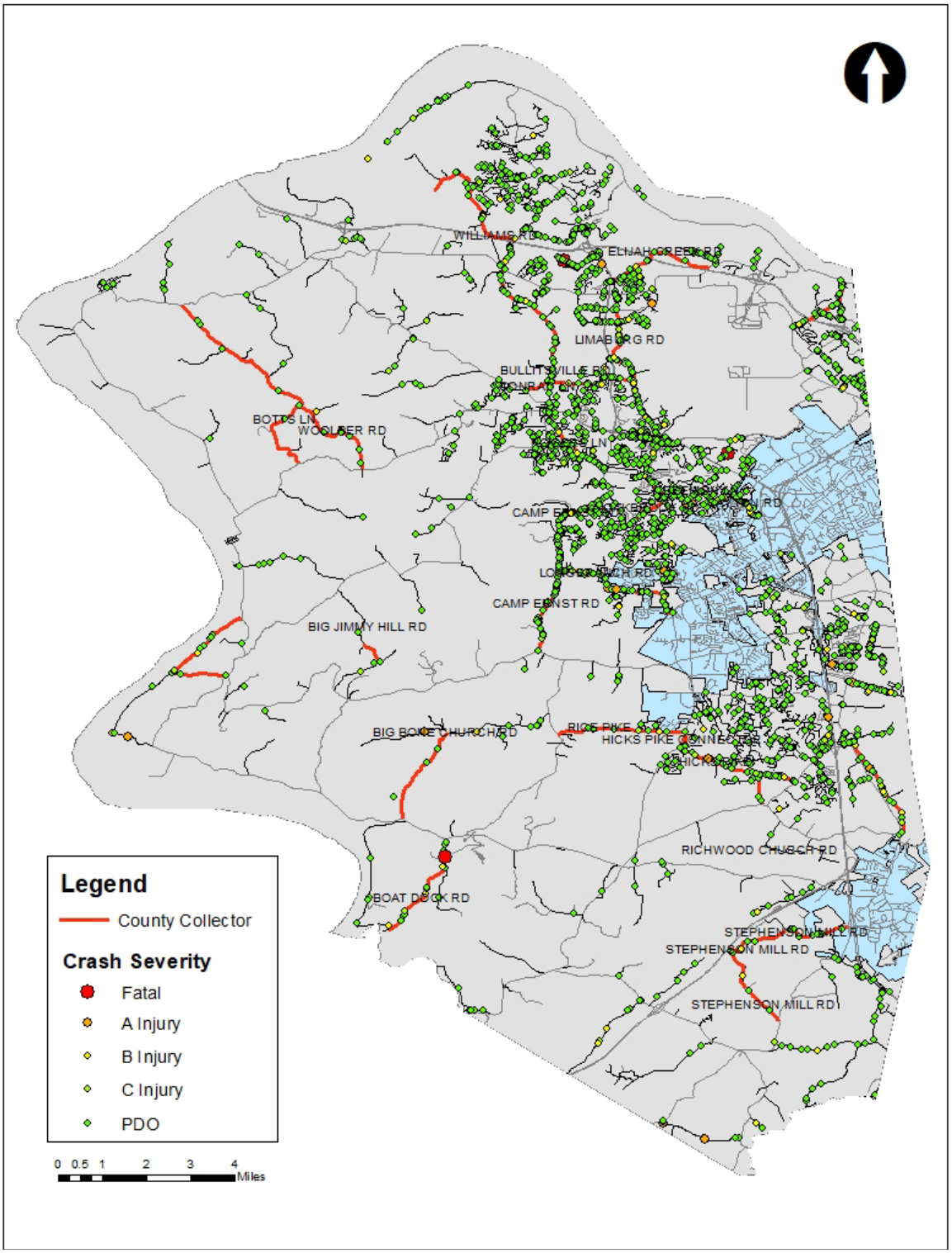


Figure 4 shows the crash distribution throughout the county which demonstrates a concentration of crashes in the north central part of the county, which is the densest population area within the county. Other crash concentrations are noted near in the south near the city of Walton and to the east adjacent to Kenton County in the northern part of county.

Figure 4: Boone County Crashes



The primary crash type within the county was single vehicle crashes representing 35 percent of total crashes and 51 percent of injury crashes (174 injury crashes) and all 3 fatal crashes. Of these crashes, 591 involved collision with a fixed object. Rear end crashes were the second most frequent crash type on the county road system accounting for 492 crashes and 46 injury crashes. Angle crashes represented the second highest injury crash type with 58 in jury crashes out of a 440 total crashes A distribution of crash types in shown in **Figure 5**. Single vehicle crashes are overrepresented compared to state owned roadways, likely due to the lower geometric standards on county roads, combined with the higher volumes experienced in Boone County. It is noted that single vehicle crashes are not overrepresented compared to other counties, due to the relatively larger road widths and clear zones.

Figure 5: Crash Frequency and Severity

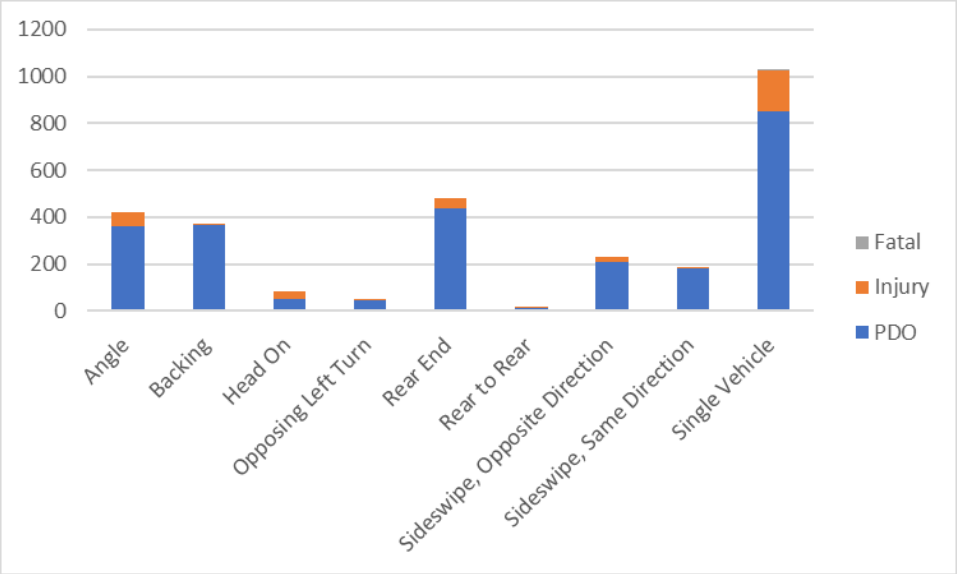
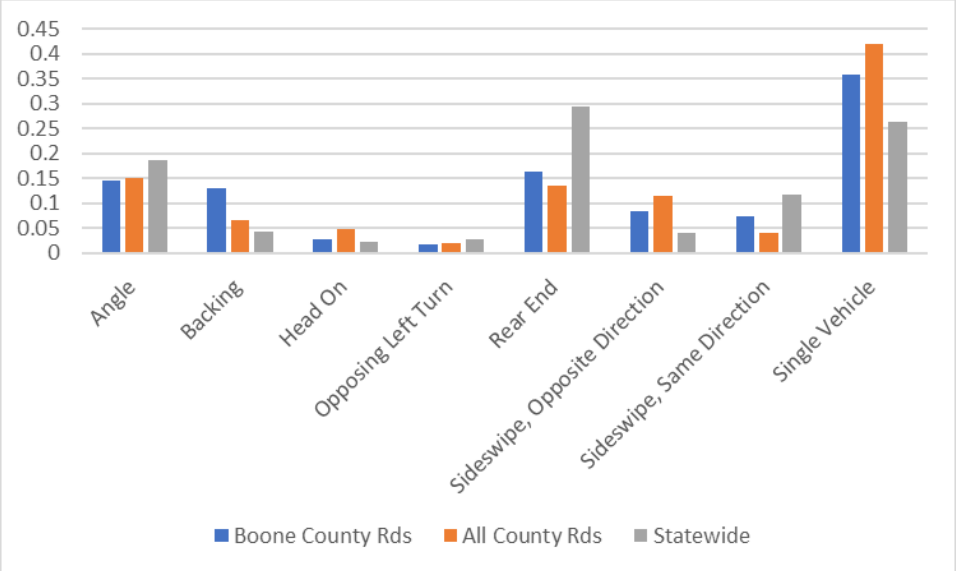
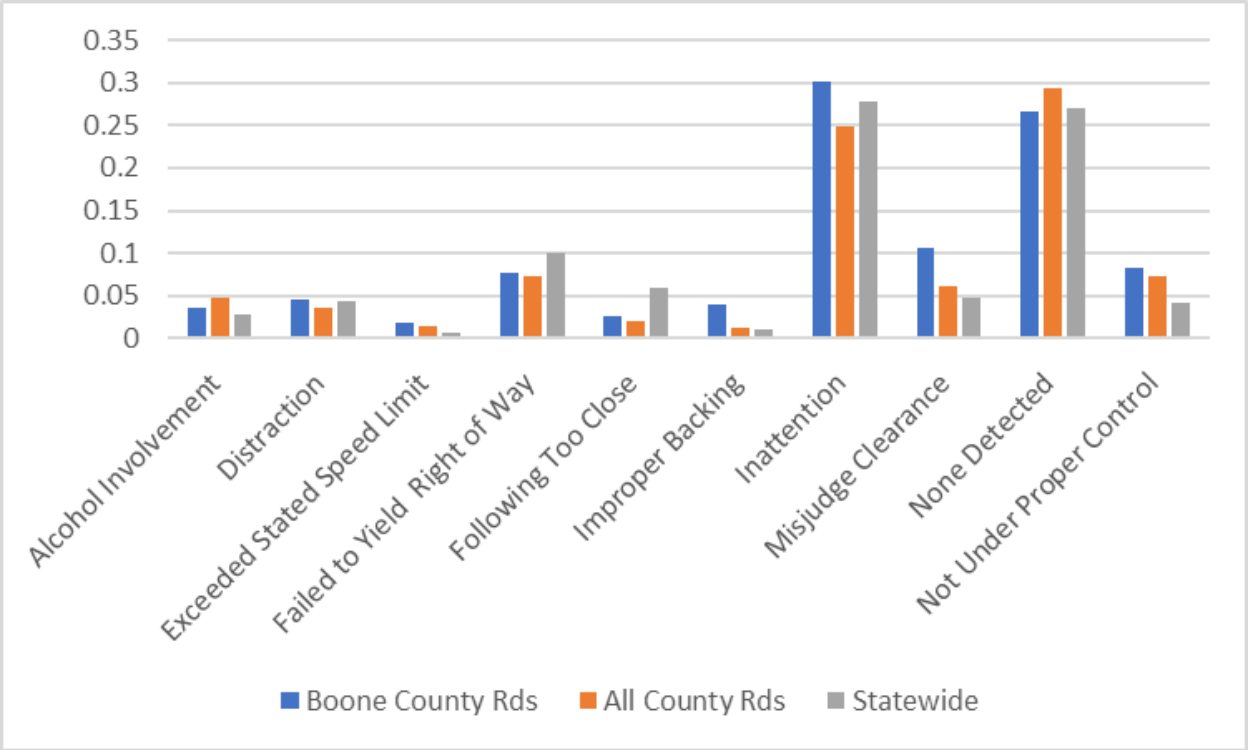


Figure 6: Statewide Crash Type Distribution



When evaluating human factors, "Inattention" was identified as the most frequent cited contributing human factor (30 percent). This is consistent with other county roadways, but far exceeds the statewide trends, in which "misjudge clearance" is the most frequently cited human factor. No contributing human factors were cited in 26 percent of crashes, while :"Misjudge Clearance" was the third most cited human factor (11 percent). Alcohol involvement was cited in less than 4 percent of crashes which is below other county experience, but slightly above the statewide average. (**Figure 7**).

Figure 7: Statewide Contributing Human Factor



The crash analysis presented here can assist in identifying emphasis crash types, and subsequently, potential mitigation measures to implement on the county's roadway system. The high number of single vehicle fixed object crashes identified indicates there is a significant need to keep errant vehicles on the roadway and minimize the crash impact for vehicles that leave the roadway. Specific treatments to address these crash types are presented in subsequent section of the report.

PRIORITY LOCATIONS FOR SAFETY IMPROVEMENTS

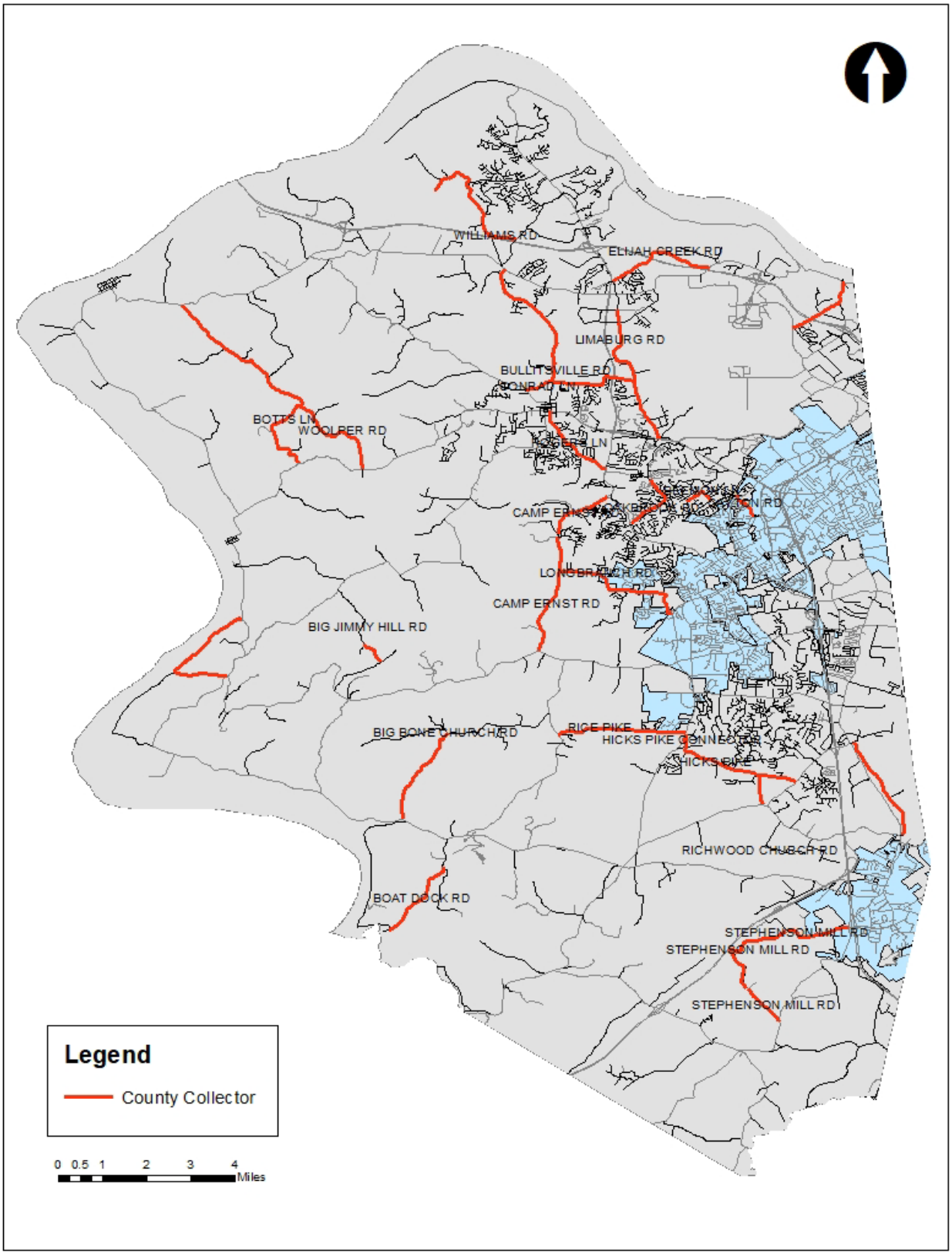
County Collector Roadways

Boone County currently maintains over 430 miles of roadway on the county road system. Camp Ernst Road is the only roadway functionally classified as a collector road and all other county roads are classified as local roads. As this high mileage makes it difficult to implement safety treatments county-wide due to cost constraints, a more focused roadway network was identified. Working with county leadership and KYTC, a "County Collector" system was developed that sought to identify roadways having higher importance to the county and which function more as a traditional collector roadway than local roads. County Collectors were identified as those roads which may connect higher state routes and have higher associated traffic volume or roadways which serve a larger populations or employments centers due to development patterns. Based on these factors, 22 roadways accounting for 35 miles were identified as County Collector roadways. These roads are listed below and shown in **Figure 8**. These roadways account for 872 total crashes and 150 injury and 2 fatal crashes on the county roadway system. These totals represent 29 percent of all crashes, and 43 percent of injury and fatal crashes.

Boone County Collector Roads:

- Big Bone Church Rd
- Boat Dock Rd
- Botts Ln
- Bullitsville Rd
- Camp Ernst Rd
- Cayton Rd
- Conrad Ln
- Eads Road
- Elijah Creek Rd
- Evergreen Rd
- Hanover Blvd
- Hicks Pike
- Limaburg Rd
- Litton Lane
- Longbranch Rd
- Lower River Rd
- Oakbrook Rd
- Old Lexington Pike
- Pebble Creek
- Point Pleasant Rd
- Rabbit Hash Hill Rd
- Rice Pike
- Rogers Ln
- Salem Creek Rd
- Stephenson Mill Rd
- Triple Crown Blvd
- Violet Rd
- Williams Rd
- Woolper Rd

Figure 8: Boone County Collector Roads



Equivalent Property Damage Only Crash Analysis

An Equivalent Property Damage Only (EPDO), which uses a weighted rating technique based on crash severity, was used to targeting areas with frequent severe crashes. The EPDO formula used in this analysis assigned a weight of 10 to crashes resulting in a fatality, 5 for crashes resulting in an injury, and 1 to crashes resulting in property damage only. Spatial analysis was used to match crash data to each segment and each were then ranked based on their EPDO values. **Table 1** lists each of these locations and **Figure 8** shows the location of each of these selected roadways.

Table 1: Boone County EPDO Analysis

Street Name	Total Crashes	Total Injury Crashes	Number Injured	Number Killed	EPDO	EPDO Rank
LITTON	236	17	24	1	313	1
CAMP ERNST	181	32	47	0	309	2
LIMABURG	161	19	26	0	237	3
CAYTON	105	18	25	0	177	4
OAKBROOK	85	14	17	0	141	5
LONGBRANCH	89	10	18	0	129	6
CONRAD	62	14	17	0	118	7
ROGERS	77	9	11	0	113	8
HICKS	46	8	9	0	78	9
BULLITSVILLE	45	4	5	0	61	10
OLD LEXINGTON	25	7	9	0	53	11
POINT PLEASANT	35	3	3	0	47	12
LOWER RIVER	16	7	10	0	44	13
STEPHENSON MILL	21	3	3	0	33	14
WILLIAMS	13	4	4	0	29	15
BOAT DOCK	11	2	2	1	28	16
TRIPLE CROWN	24	1	1	0	28	16
RICE	9	3	4	0	21	18
WOOLPER	13	1	1	0	17	19
HANOVER	8	2	2	0	16	20
ELIJAH CREEK	11	1	2	0	15	21
EVERGREEN	11	1	1	0	15	21
PEBBLE CREEK	7	2	4	0	15	21
EADS	10	1	1	0	14	24
BIG BONE CHURCH	9	1	1	0	13	25
VIOLET	4	0	0	0	4	26
RABBIT HASH HILL	2	0	0	0	2	27
BOTTS	1	0	0	0	1	28
RABBIT HASH	1	0	0	0	1	28

Roadway Hazard Rating

In addition to the crash analysis presented above, roadways were also evaluated based on a qualitative hazard index. The hazard index evaluated each roadway against 6 different risk factors for lane departure crashes relative to other roads in the category. The 6 risk factors are listed below. Risk factors were evaluated based on a consensus of County Officials including the County Judge Executive, County Engineer, County Sheriff, County EMS and School Transportation Supervisor. Risk factors were ranked on a scale of 1 (minimal hazard) to 3 (high hazard). A final "Hazard Rating" was then calculated as the sum of individual assessments for each risk factor. **Table 2** summarizes the results of this analysis.

Boone County Lane Departure Risk Factors

- Horizontal Curves
- Operating Speed
- ADT
- Vertical Curvature
- Clear Zone
- Roadway Width

Table 2: Boone County Hazard Rating Analysis

Road Name	Horizontal Curvature	Speed	ADT	Vertical Curvature	Clear Zone	Road Width	Hazard Score	Hazard Rank
CAMP ERNST	3	3	3	3	3	3	18	1
LIMABURG	3	3	3	3	3	3	18	1
LONGBRANCH	3	3	3	3	3	3	18	1
LITTON	3	3	3	3	3	3	18	1
HICKS	3	3	3	3	2	3	17	5
WILLIAMS	3	3	3	2	3	3	17	5
EADS	3	2	2	3	3	3	16	7
WOOLPER	3	3	2	2	3	3	16	7
POINT PLEASANT	3	2	2	3	3	2	15	9
BOTTS	3	2	1	2	3	3	14	10
BULLITSVILLE	2	2	3	3	2	2	14	10
OAKBROOK	3	2	3	3	2	1	14	10
ROGERS	3	2	3	2	2	2	14	10
BIG BONE CHURCH	2	2	2	2	3	2	13	14
CONRAD	2	3	3	2	2	1	13	14
ELIJAH CREEK	3	2	2	2	2	2	13	14
RICE	2	2	2	2	2	3	13	14
SALEM CREEK	2	2	1	2	3	3	13	14
STEPHENSON MILL	2	2	2	2	2	3	13	14
OLD LEXINGTON	2	2	2	2	2	2	12	20
VIOLET	3	2	1	1	3	2	12	20
CAYTON	2	2	3	2	1	1	11	22
BOAT DOCK	1	1	1	1	3	3	10	23
LOWER RIVER	1	3	3	1	1	1	10	23
PEBBLE CREEK	1	3	2	1	2	1	10	23
TRIPLE CROWN	2	3	2	1	1	1	10	23
EVERGREEN	1	1	1	1	2	2	8	27
HANOVER	1	2	2	1	1	1	8	28
RABBIT HASH HILL	1	1	3	1	1	1	8	29

Based on the EPDO and Hazard Rating analysis roadways a composite ranking was developed. This ranking was based on the relative ranking from both the EPDO and Hazard rating. Table 3 summarizes the roadways in priority based on these assessments. These priority rankings were used to identify roadways for further investigation and investment of safety countermeasures.

Table 3: Boone County LRSP Final Ranking

Street Name	EPDO Rank	Hazard Rank	Final Rating	Final Rank
LITTON	1	1	2	1
CAMP ERNST	2	1	3	2
LIMABURG	3	1	4	3
LONGBRANCH	6	1	7	4
HICKS	9	5	14	5
OAKBROOK	5	10	15	6
ROGERS	8	10	18	7
BULLITSVILLE	10	10	20	8
CONRAD	7	14	21	9
POINT PLEASANT	12	9	21	9
WILLIAMS	16	5	21	9
CAYTON	4	22	26	12
WOOLPER	20	7	27	13
SALEM CREEK	14	14	28	14
STEPHENSON MILL	15	14	29	15
OLD LEXINGTON	11	20	31	16
EADS	25	7	32	17
RICE	19	14	33	18
LOWER RIVER	13	23	36	19
ELIJAH CREEK	22	14	36	19
BOTTS	29	10	39	21
BOAT DOCK	17	23	40	22
TRIPLE CROWN	17	23	40	22
BIG BONE CHURCH	26	14	40	22
PEBBLE CREEK	22	23	45	25
VIOLET	27	20	47	26
HANOVER	21	28	49	27
EVERGREEN	22	27	49	27
RABBIT HASH HILL	28	29	57	29

COUNTERMEASURES

Specific countermeasures have been developed for the County Collector roadways based on crash history, and field reviews. A summary of recommended countermeasures is provided in **Table 4**. Specific countermeasures for each roadway can be found in **Appendix A**. In developing these site-specific countermeasures and conducting field observations, several recurring safety concerns emerged that could be addressed countywide. The following sections highlight these recurring safety concerns and potential countermeasures that can be applied to sites beyond the priority project locations.

Roadway Signing

Roadway signing on Boone County's roadways was observed to be some of the most comprehensive county roadway signing practices in Kentucky. However, due to the miles of roadway and the number of signs, outdated and/or inconsistent practices were observed. These include:

1. Dual mounting of signs on a single post, such as mounting a "No Outlet" Signs on Stop Signs, which can obscure the shape of the stop sign, or dual mounting speed limit signs with other signs as shown in **Figure 9**.
2. Inconsistent use of W1-1a signs for advance warning signs (**Figure 10**) and/or inconsistent sign size and sheeting material.
3. Inconsistent placement of advanced warning signs for horizontal alignment and intersections, which often far exceed minimum MUTCD requirements.

Figure 9: Pedestrian Crossing and Speed Limit

It is recommended that a sign inventory database be developed and maintained for Boone County Roadways to document, the sign type, location, placement and condition on all county roadways. This inventory will allow for improved review of signing layouts, and assist in the prioritization of signing improvements throughout the county. A summary of additional guidance provided by the MUTCD is provided below.

Horizontal Alignment Signing

The MUTCD provides guidance for the use of horizontal alignment warning signs on roadways based on the speed differential between prevailing speed on the roadway and the horizontal curve's advisory speed. These warning signs are required on arterial and collector roadways with more than 1,000 AADT but may be used on other roadways based on engineering judgment. It is recommended that all roadways within the priority locations that have been identified as having crashes associated with curves be evaluated to determine appropriate advisory speeds and signed appropriately.

Figure 10: W1-1a Used as Advanced Warning Sign

The MUTCD provides for three placements of signing to address horizontal alignment issues. These include
1) in advance of the horizontal curve,
2) at the beginning of the horizontal curve and
3) guidance throughout the horizontal curve.

Advanced sign placement includes the Turn, Curve, Reverse Turn, Reverse Curve and Winding Road Signs, shown in **Figure 14** below. Advisory speed plaques are recommended by the MUTCD in conjunction with these signs when the advisory speed is 5 mph or less than the prevailing speed on the roadway.

Figure 11: Horizontal Alignment Signs

The minimum placement distance before a curve for advanced warning signs is based on the advisory speed of the curve and the Posted OR 85th percentile speed of approaching traffic. The MUTCD provides this minimum distance in *Table 2C-4: Guidelines for Advance Placement of Warning Signs*, which is duplicated below in **Table 5**. It is recommended that advanced warning signs not be placed more than 100 feet beyond the minimum distance in the table so that warnings are provided immediately before the hazardous condition. However, when placing signal ahead signs queued traffic should be taken into consideration when determining placement.

Table 5: MUTCD Table 2C-4 Guidelines for Advanced Placement of Warning Signs

Posted or 85th-Percentile Speed	Condition B: Deceleration to the listed advisory speed (mph) for the condition							
	0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	100 ft[6]	N/A[5]	—	—	—	—	—	—
25 mph	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
30 mph	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
35 mph	100 ft[6]	N/A[5]	N/A[5]	N/A[5]	—	—	—	—
40 mph	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—	—
45 mph	175 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—
50 mph	250 ft	200 ft	175 ft	125 ft	100 ft[6]	—	—	—
55 mph	325 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]	—	—
60 mph	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]	—	—
65 mph	475 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft[6]	—
70 mph	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	—
75 mph	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

The MUTCD allows for horizontal alignment signs to be repeated as supplemental signs at beginning of curvature. Additionally, a combination turn or curve sign with advisory speed is also permitted at the beginning of the curve as shown in **Figure 12**. However, the W1-1a and W1-2a signs are not permitted for use as an advanced warning sign.

Figure 12: Horizontal Alignment Signs With Advisory Speeds

Finally, directional guidance signs including the chevron and large arrow board are recommended by the MUTCD to provide additional guidance through the curve (**Figure 13**). The recommended minimum height for chevrons is lower than standard signing, with a minimum height of 4 ft above the edge of the roadway. This lowered height allows chevrons to be within the direct eye line of the driver and vehicle headlights. Reflective post delineators are also permitted to provide guidance through a curve, but are not classified as warning devices.

Figure 13: Large Arrow Board and Chevrons

Figure 14 shows a conceptual sign layout for a series of 'S' curves on the guidance from the MUTCD and the proposed practice resulting from the safety study. All Horizontal Alignment Warning signs should follow guidance for placement, location and spacing as specified in Chapter 2 of the MUTCD.

Figure 14: Conceptual Sign Layout

Object Markers

On roadways such as a County Collector roadway , it may not be cost effective to remove or relocate fixed objects within the clear zone due to their prevalence and the lower speeds associated with the county road system. In those cases object markers are recommended by the MUTCD to demarcate roadside obstacles. The MUTCD provides standards for type 2 and type 3 markers as shown in the Figure 15. It is recommended that Type 3 object markers be used to mark significant obstacles directly adjacent to the roadside, such as culvert headwalls (Figure 16a), while type 2 markers may be used to delineate frequent occurrences such as utility pole locations (Figure 16b).

The recommended minimum height for object markers is lower than standard signing, with a minimum height of 4 ft above the edge of the roadway. This lowered height allows for the object markers to be within the direct eye line of the driver and indicate the obstacle position relative to the vehicle. Additionally, when placing Type 2 and Type 3 object markers the near edge of the object marker should be placed in-line with the near edge of the obstacle to provide further guidance to the driver.

Figure 15: MUTCD Object Marker

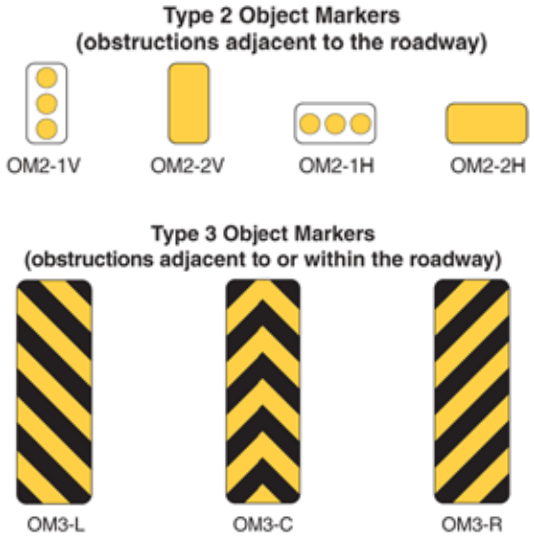


Figure 16: Object Marker Application a) Type 3 and b) Type 2

Stop Controlled Intersections

Some roadways were observed to have minimally placed traffic control at intersections, particularly at 'T' intersections. These intersections typically only had a single stop sign (**Figure 17**).

Figure 17: 'T' Intersection Conrad Lane at Limaburg Road

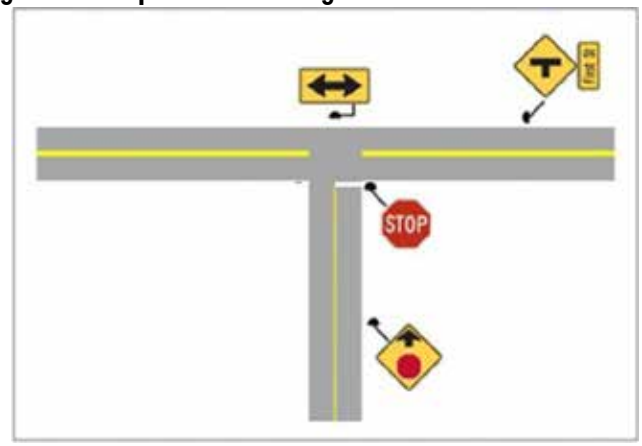
At 'T' intersections, especially in unlit areas, the presence of the intersection may be even more difficult to discern for some drivers. In addition to the risk associated with entering the intersection, fixed object crashes if a driver proceeds through a 'T' intersection are also common. A Two Direction Large Arrow signs (W1-7; see figure) is another low-cost method to reinforce stop control at T- intersections. It is proposed that Boone County adopt the use of the Two Direction Large Arrow (W1-7) sign at all 'T' intersections on rural roads as shown in **Figure 18**.

Figure 18: Large Arrow Board Placement At T-Intersections

In cases where vegetation partially or fully blocks existing signs, vegetation should be trimmed back. In cases where other sight distance limitations exist that block signs from view, such as horizontal or vertical curves, advance traffic control signs should be utilized, such as stop ahead signing (W3-1) (**Figure 19**).

For intersections with persistent crash history or demonstrated high frequency and high severity of crashes, dual mounted signing may be used.

Figure 19: Improvement Progression At A 'T' Intersection



In addition to signing, pavement markings, specifically painted stop bars, can be effective in delineating the intended stopping point of vehicles at intersections and indicating the presence of the intersection. While pavement markings can present additional maintenance requirements, they are recommended for installation at:

1. Wide or skewed access points and intersections within curves (See Figure 10) which increase driver uncertainty as to the intended stop location,
2. At intersections or on corridors with a documented intersection crash history or
3. At intersections with high exposure for severe crashes, such as high volume / high speed uncontrolled cross streets, e.g., state highways or high volume county roadways.

GUARDRAIL

On several roadways within the county, the need for guardrail to protect against critical slopes and/or fixed objects was observed. In some cases guardrail was present, but required adjustment or replacement to meet current standards (**Figure 20**); while in other areas guardrail was absent or required extension of the length of need to adequately protect errant vehicles. In most cases, guardrail end treatments were noted to not meet current design and crashworthy standards. Select guidance based on KYTC standards for guardrail installation is provided below. Additional guidance can be found in KYTC Standard Roadway Drawings and the AASHTO Roadside Design Guide.

Figure 20: Existing Guardrail Installations (Hicks Pike and Bullitsville Road)

Based on AASHTO guidance from the Roadside Design Guide, guardrail should be considered on critical slopes steeper than 3:1 with a fill height over 10 feet (**Figure 21**). To give vehicles sufficient opportunity to recover without impacting an obstacle, guardrail should be placed as far away from the traveled way as practical.

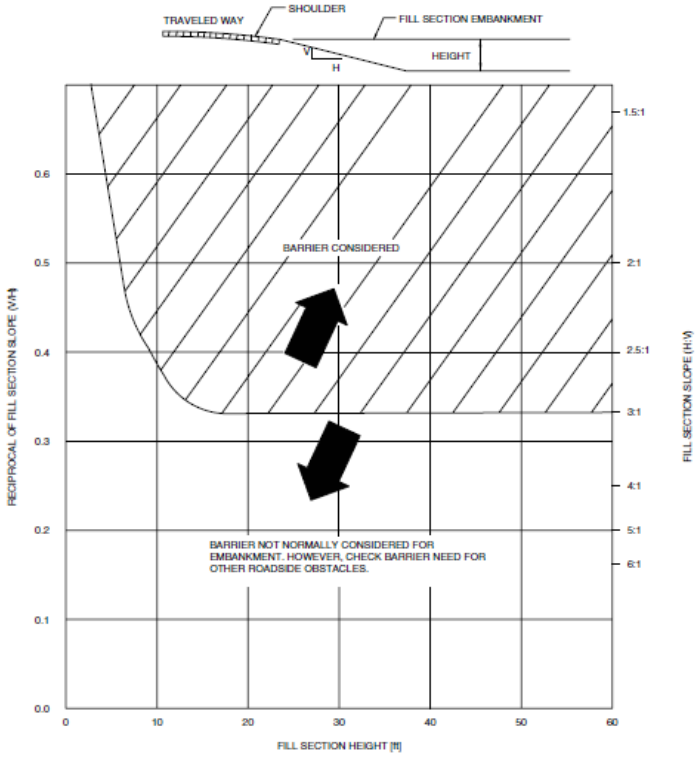


Figure 21: Barrier Consideration for Embankments (AASHTO Roadside Design Guide)

Barrier Installation

To protect against rollover crashes guardrail should be 31" (+/- 1") above the road surface and should have a minimum of 2 foot of soil backing at a slope of 10:1 or flatter (**Figure 22**). If placing 2 feet of fill material behind the barrier is not practical, longer post lengths (e.g., 7-foot) may be used.

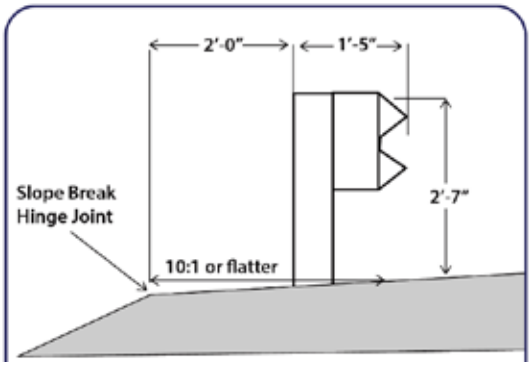


Figure 22: Normal Guardrail Installation

Barrier End Treatments

If the end of barrier systems (e.g., guardrail) are located within the clear zone, they must be anchored and shielded with end treatments. Guardrail end treatments are frequently used to minimize the severity of impacts with fixed objects by gradually decelerating an impacting vehicle to a stop or redirecting it around the object of concern. Barrier end treatments should comply with MASH guidelines.

Figure 23: Preferred Guardrail End Treatments

The preferred end treatment for guardrail sections is to anchor the guardrail in a backslope terminal, known as a Type 3 end treatment at appropriate height (**Figure 23**). If the guardrail can be anchored out of the clear zone an anchored end treatment Type 2A may be used which installs a terminal Section No. 1. When these types of end treatments are not feasible, a Type 1 (Energy Absorbing Straight-Line Terminal) is preferred.

A Type 7, commonly known as a turn down end treatment (**Figure 24**) do not meet MASH crash guidelines and are only permitted on low speed / low volume roadways. These should be used only when adequate recovery zones are unavailable for other preferred end treatment types.

Figure 24: Type 7 End Treatments

Wet Weather Crashes

A review of road conditions for all crashes was conducted for each roadway to determine if wet conditions contributed to crashes along the corridor or in specific areas. Of the 10 roadways reviewed, 7 were identified as having at least one section of the roadway having a high incidence of wet weather crashes (wet pavement in over 70 percent of crashes). **Figure 25** shows one of these locations on Longbranch Road near the intersection with Fowler Creek Road where 9 of the 11 crashes involved wet pavement conditions. Several similar locations have been previously identified and mitigate by the Boone County Road Department through the installation of High Friction Surface Treatment (HFST) which increases surface friction during wet weather events. HFST has been installed on Camp Ernst Road, Cayton Road, Conrad Lane and Beemon Lane. However, other locations under review indicate that drainage issues may be present either from clogged or absent drainage culverts at access drives, and/or vegetation growth which may prevent water from reaching the ditch. **Figure 26** shows Longbranch Road at Fowler Creek Road, where the superelevation of the roadway, combined with rutting on the shoulder may contribute to ponding water on the inside of the curve.

Figure 25: Crashes by Roadway Condition (Longbranch Road at Fowler Creek Road)

Figure 26: Longbranch Road at Fowler Creek Road

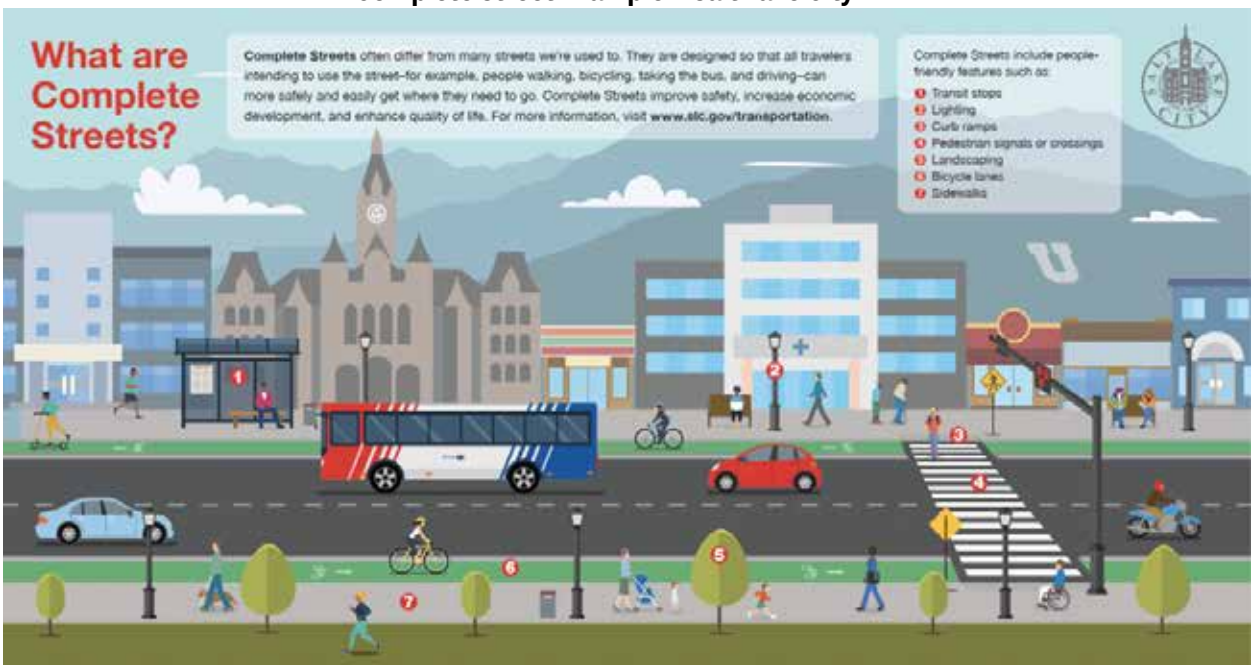
It is recommended that areas identified as having a higher concentration of wet weather crashes be observed during significant rain events to identify areas of ponding and/or excessive sheet flow. If no drainage issues are identified, friction testing is recommended to determine if HFST would be a suitable mitigation measure.

COMPLETE STREETS

As part of Boone County's efforts to improve the quality of life for residents, visitors and businesses, the County has established an ongoing effort to provide dedicated bicycle and pedestrian facilities throughout the County. The Boone County Transportation Plan continues a Boone County policy to consider bicycle and pedestrian facilities in all transportation improvement projects. In consideration of this policy, the Boone County LRSP intends to further this effort by employing a Complete Streets Policy as a counter measure. When driven by data LRSP will intend to retrofit existing roadways with new multi-use paths and sidewalks to further Boone County's strong emphasis on promoting safety, healthy lifestyles and multi-modal travel options.

The Complete Streets approach intends for roadways to be planned, designed, maintained, and operated to accommodates all road users and those who use the surrounding community. Complete Streets may look different in rural communities than they do in more urban counterparts.

Complete Street Example – Salt Lake City



The Complete Streets Policy for Boone County is to utilize existing guidance and standards, set forth by organizations and manuals such as the Federal Highway Administration (FHWA), the American Association of State Highway Transportation Officials (AASHTO), the National Association of City Transportation Officials (NACTO), and the *Manual on Uniform Traffic Control Devices* (MUTCD). In addition, the Boone County Complete Streets Policy will utilize the existing ADA transition plan. The guidance from these resources will be applied in each phase of the project, planning, design, environmental and construction.

Table 4: Summary of Recommended Improvements (1 of 2)

LRS_ID	Road Name	Surface Type	Width	Length	Improvements		
					Striping	Signing	Other
008 CR-1001	CAMP ERNST RD	Asphalt		4.07	EL and CL present	Upgrade signing on Corridor	Replace Guardrail north of Longbranch Road Ditching and Shouldering south of Klotz Lane; Consider relocating crossdrains from driveway back away from road edge. Address shouldering and dropoffs throughout entire corridor. Evaluate additional fill and guardrail at proposed subdivision near Hathaway Road. Evaluate sight distances and increased / flashing warning signage at Longbranch, Gordon and Camp Ernst Lane. Northern portion of Camp Ernst planned for paving
008 CR-1002	LONGBRANCH RD	Asphalt		2.67	EL and CL Present	Upgrade signing on Corridor	Install Curve signing at intersection with Orleans Blvd to avoid visual trap Replace guardrail west of Lingbranch Creek
008 CR-1151	HICKS PIKE	Asphalt		2.51		Upgrade signing on Corridor	Replace Guardrail sections between Huey Place and Harrison Way Replace Gardrail at intersection of Richwood Church Road; Consider sight distance restriction correct from building Evaluate Utility Pole location east of Richwood Church Road on outside of curve northside of road Repair roadway surface west of Richwood Road Consider Utility Pole Relocation on inside corner of curve at Huey Place; May consider curve widening Improve T intersection signing at Harmony Hill Drive and Stallion Way. Address shouldering and dropoffs throughout entire corridor.
008 CR-1040	ELIJAH CREEK RD	Asphalt		2.09		Upgrade signing on Corridor	Replace guardrail (or remove) on length of roadway Improved signing to demarcate fixed objects Remove Concrete blocks (fixed object) near Elijah Creek crossing
008 CR-1042A	LIMABURG RD	Asphalt		3.22		Upgrade signing on Corridor	Consider ditching / shouldering to correct edge drop off; ditches near road edge. Improve signing / striping at Youell Road and Conrad intersections
008 CR-1052	BULLITSVILLE RD	Asphalt		2.99		Upgrade signing on Corridor	Replace Guardrail between Conrad Lane and Petersburg Road Upgrade signing and sign material along roadway Consider shoulder widneing on BS approach to Brents Way Remove Fixed Objects between Federalist Trail and Conrad Lane Check Speed Limit Consistency between Conrad Lan and Temperate Street Improve signing / striping at intersection of Bullitsville Road and Temperate Street
008 CR-1056	CONRAD LN	Asphalt		2.11		Upgrade signing on Corridor	Evaluate need for guardrail 1000 ft east of Bullitsville Road to Regal Ridge Drive Remove fixed object at National Guard Recruiting Office / Consider ned for cross drainage at driveway Replace guardrail east of Carryback Drive Consider Ditching / shouldering near Limaburg road approach

Table 4: Summary of Recommended Improvements (2 of 2)

LRS_ID	Road Name	Surface Type	Width	Length	Improvements		
					Striping	Signing	Other
008 CR-1058	ROGERS LN	Asphalt		1.75		Upgrade signing on Corridor	Signing on Rogers appears inconsistent in sizing and sheeting; evaluate/upgrade signing Check sign layout for pedestrian crossings on corridor
008 CR-1016J	CAYTON RD	Asphalt		0.58		Upgrade signing on Corridor	Improve T intersection signing along Cayton Road Add Chevrons on Curve along approach to Hopeful Church Road
008 CR-1144	STEPHENSON MILL RD	Asphalt		4.37		Upgrade signing on Corridor	
008 CR-1328	WOOLPER RD	Asphalt		5.51		Upgrade signing on Corridor	Several Ongoing Slide Projects. Likely upcoming Water and Sewer Projects.
008 CR-1333	BOTTS LN	Asphalt		1.87		Upgrade signing on Corridor	
008 CR-1032	POINT PLEASANT RD	Asphalt		1.54		Upgrade signing on Corridor	
008 CR-1153	RICE PIKE	Asphalt		2.32		Upgrade signing on Corridor	
008 CR-1221	RABBIT HASH HILL RD	Asphalt		0.93		Upgrade signing on Corridor	Currently working with historic district for improved signage and markings in historic area.
008 CR-1222	LOWER RIVER RD	Asphalt		1.78		Upgrade signing on Corridor	Currently working with historic district for improved signage and markings in historic area.
008 CR-1121	OLD LEXINGTON PIKE	Asphalt		2.36		Upgrade signing on Corridor	Recent Contract for widening and shouldering. Still open to support KYTC interchange project. Additional widening expected from development on each end. KYTC currently "operating" signal and rail crossing at Chambers.
008 CR-1201	BIG BONE CHURCH RD	Asphalt		2.22		Upgrade signing on Corridor	
008 CR-1312	WILLIAMS RD	Asphalt		2.76		Upgrade signing on Corridor	
008 CR-1296	BOAT DOCK RD	Asphalt		1.81		Upgrade signing on Corridor	
008 CR-1011	OAKBROOK RD	Asphalt		1.33		Upgrade signing on Corridor	
	EADS RD	Asphalt				Upgrade signing on Corridor	Evaluate Widening and shouldering. Increased development in area and becoming a bypass for 71/75 issues.
	PEBBLE CREEK	Asphalt				Upgrade signing and striping on Corridor	Urban road with Rural section. Has history of departures. Evaluate striping signing and potential speed limit modification.
	SALEM CREEK	Asphalt				Upgrade signing on Corridor	Evaluate Widening and shouldering. Increased development in area and becoming a bypass for 71/75 issues.
	VIOLET ROAD	Asphalt				Upgrade signing on Corridor	
	HANOVER BLVD	Asphalt				Upgrade signing on Corridor	
	LITTON LANE	Asphalt				Upgrade signing on Corridor Seek Complete Street	Urban road with Rural section. Has history of departures. Short term- Evaluate striping signing and potential speed limit modification. Long Term - Seek and obtain funding for street widening and application of sidewalks and multi-use path for alternate modes to accommodate transit users.
	EVERGREEN	Asphalt				Upgrade signing on Corridor	
	TRIPLE CROWN BLVD	Asphalt				Upgrade signing on Corridor	

CONCLUSIONS & RECOMMENDATIONS

This Local Road Safety Plan identifies implementable countermeasures at a specific, project-based level and at the county- wide level. County Collector roadways should be prioritized for countermeasure implementation, as they represent over 30 percent of the crashes that occurred on county roadways during the study period. At the county-wide level, it is recommended that locations with hazards identified above be considered for correction as resources allow. Due to the proven cost effectiveness of signing applications against single vehicle crashes, improved signing including horizontal alignment signs and object markers are recommended for system wide implementation.

This safety study should be shared with local agencies to communicate safety concerns and potential improvements for locally owned and maintained roadways. Distracted driving, impaired driving, and speeding are elements that may be addressed by coordinating with local law enforcement agencies. Developing law enforcement and education strategies, such as speed feedback signs and awareness programs, may help address these types of crashes, which are scattered throughout Boone County but more concentrated in areas with roadway safety concerns.

EVALUATION & IMPLEMENTATION

This LRSP is a living document that is recommended to be updated every three years in order to utilize the latest data and detect trends. Crash data can be used to evaluate the success of the plan. The Boone County Engineers Office will be the primary department responsible for updating this LRSP and may host an annual stakeholder meeting to discuss implementation of the plan and strategies for each emphasis area.

APPENDIX A
IDENTIFIED ROADWAY IMPROVEMENTS

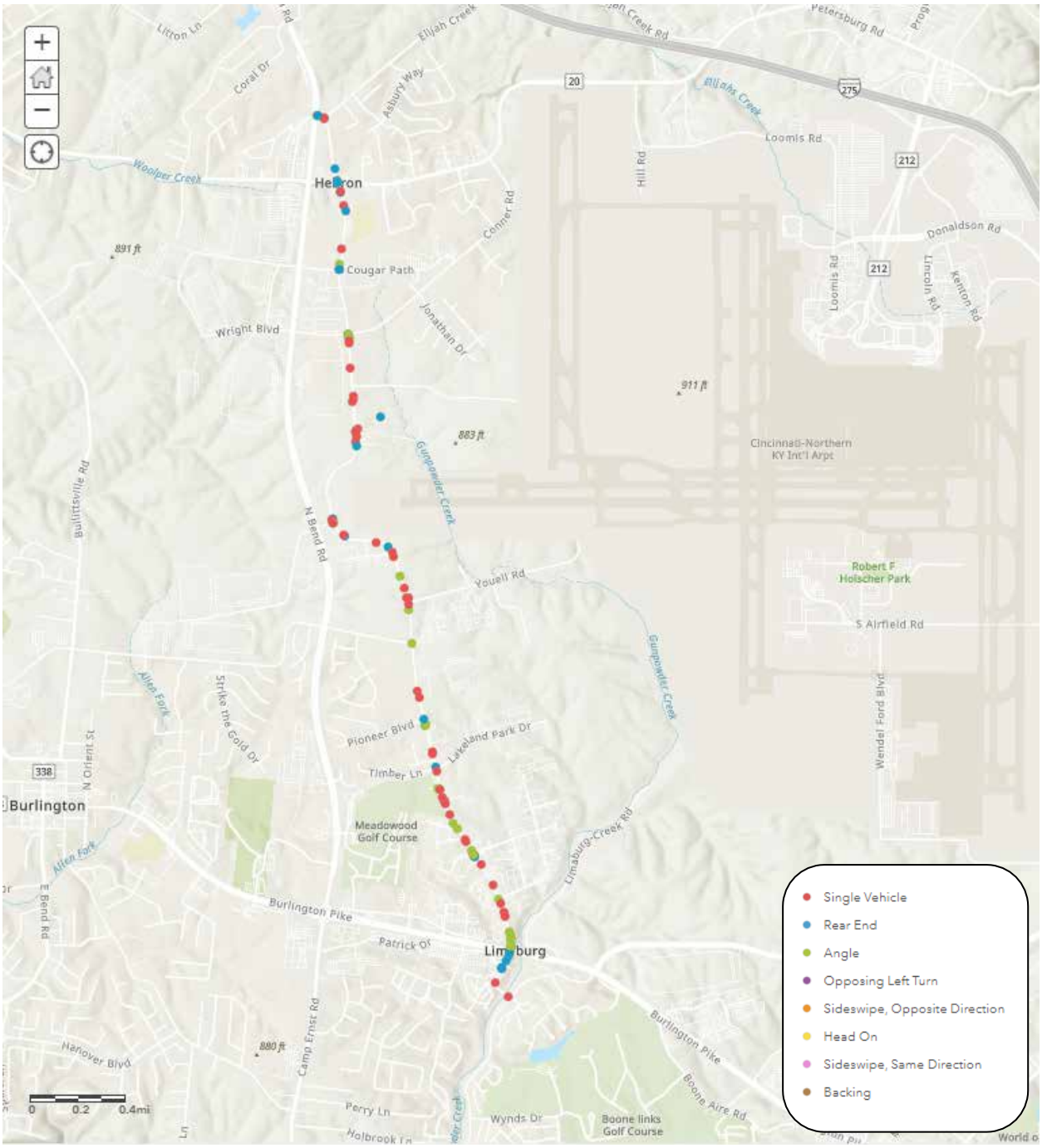
LIMABURG ROAD

Existing Conditions

Limaburg Road (CR 1042A) is a county roadway which runs north-south parallel to KY 237 along the western edge of the Cincinnati/Northern Kentucky International Airport. Limaburg Road provides connectivity for residential and commercial areas to the south, as well as Conner High School, and Residential areas to the north. This connectivity makes Limaburg Road a critical north-south route connecting Boone County. The Roadway is approximately 3.9 miles long with a width of 20 feet. A traffic count station north of Conrad Road recorded an ADT of 4,635 in 2018. Centerline and edgeline striping is present with intermittent passing zones along the corridor. Signalized intersections are present at Production Lane and Petersburg Road in addition to the signalized intersection at the north and south terminus of the road at KY 237 and KY 18, respectively. Two all-way stop intersections are present near Conner High School at Conner Road and Cougar Path. The speed limit is 25 mph north of Petersburg Road, 35 mph south of Petersburg Road to Conner Road and 45 mph South of Conner Road. Land use along the roadway is primarily residential with direct access driveways as well as commercial and industrial use concentrations throughout.

During the 5-year study period, 136 crashes were recorded on Limaburg Road including 19 injury crashes, 1 of which had a severity rating of 'A.' Forty-Nine (49) of the crashes were single vehicle crashes, 18 of which were fixed object crashes. The next highest crash types were angle and rear end crashes, accounting for 31 crashes each. These crashes are shown in Figure A1-1. Single Vehicle Crashes are scattered throughout the entire corridor, while rear end crashes are concentrated south of Timber Lane. Angle crashes are present at most major intersections, with a concentration of 5 at the signalized intersection with Petersburg Road.

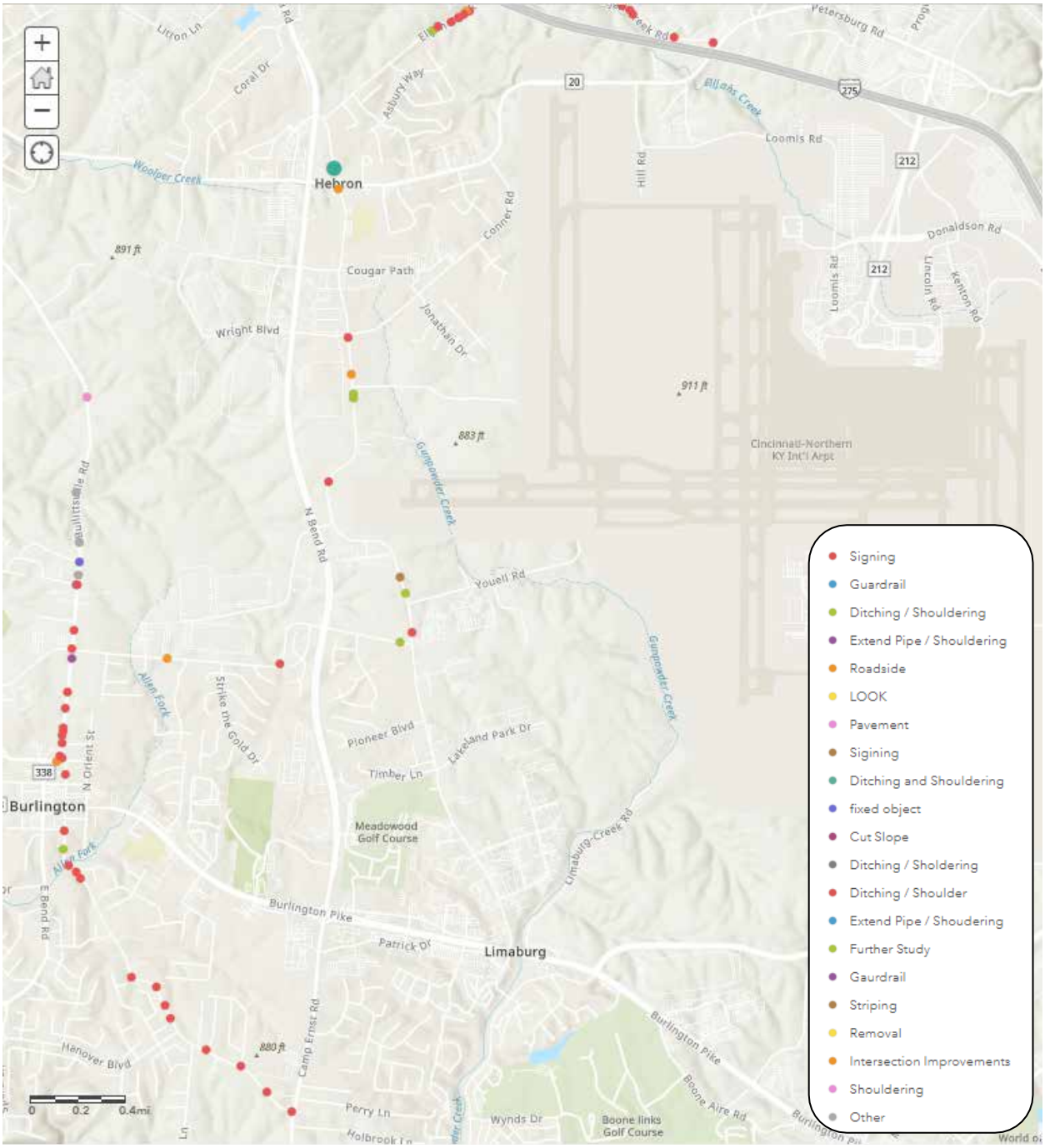
Figure A1-1: Limaburg Road Crash Data (2016-2020)



Contributing Factors

A field review of Limaburg Road identified several issues along the roadway which are located in Figure A1-2. Each of these issues is discussed below.

Figure A1-2: Identified Roadway Hazards



Fixed Objects

The northern half of the corridor has a high frequency of fixed objects, as shown in Figure A1-3 and A1-4. Utility poles are located close to the road edge presenting a hazard as well as other fixed objects and debris, such as the logs shown in Figure A1-3. The proximity of these obstacles to the roadway increase the likelihood of crashes as is evidenced by the crash analysis above and shown in Figure A1-1. It is recommended that utility poles close to the roadway be demarcated with Type 2 object markers. Debris and vegetation within the right-of-way that can be removed should be removed.

Figure A1-3: Fixed Objects (Limaburg Road)

Edge Drop Offs

Roadway edge drop offs are also prevalent along the corridor primarily due to roadside drainage ditches and narrow right of way. Steep fill slopes also present a hazard where no shoulder as present. In these instances a vehicle that may depart the roadway slightly can either overcorrect to get back onto the roadway heading into oncoming traffic or fully depart the roadway and crash into a fixed object or

embankment. Driver inattention was cited in 31 crashes and overcorrecting/oversteering was cited in 3 crashes on the corridor. Figure A1-4 shows some examples of these edge drop offs.

Figure A1-4: Edge Drop Off (Limaburg Road)

Signing

Signing is extensive on the corridor for both horizontal alignment and advanced traffic control, especially along the realigned section of Limaburg Road on the western edge of CVG airport (**Figure A1-5**). However, some inconsistencies exist, and older signing is present on the corridor. Several of these instances are contrary to guidance provided in the MUTCD and may send mixed or unclear messages to drivers. **Figures A1-6** through **A1-8** show examples of some of these sign installations.

Figure A1-5: Horizontal Alignment Signing (Limaburg Road)

Figure A1-6: No Outlet Sign

The no outlet sign shown in **Figure A1-6** obscures the shape of the stop sign from the opposite approach. In doing so, the stop sign may not be as readily recognizable in low visibility conditions or if retroreflectivity of the stop sign is compromised.

Figure A1-7: Pedestrian Crossing and Speed Limit

The pedestrian crossing sign mounted on the same post as the 25 mph speed limit sign shown in **Figure A1-7** can cause confusion as to whether the 25 mph speed is the regulatory speed limit or an advisory speed associated with the pedestrian crossing.

Figure A1-8: Horizontal Alignment Chevron

The Chevron sign shown in Figure A1-8 is placed high above the roadside, estimated at approximately 7 feet. While this placement meets MUTCD guidance; chevrons are permitted to be placed lower than other signs with a minimum height of 4 feet. This lower height places the sign more in line with the drivers line of sight and the vehicles headlights and can provide additional guidance through curves.

Access Management

As indicated above the majority of rear end crashes on the corridor are located on the southern end of Limaburg Road south of Lakeland Park Drive. This area has the highest concentration of commercial uses on the corridor and a high density of higher volume driveways, as shown in **Figure A1-9**. In addition, several driveways and intersections are poorly defined as highlighted in Figure A1-9 and shown in Figure **A1-10**. The high concentration of driveway and unclear entry / exit points can cause confusion as to the intended path of turning drivers and increase the potential for rear end and angle crashes.

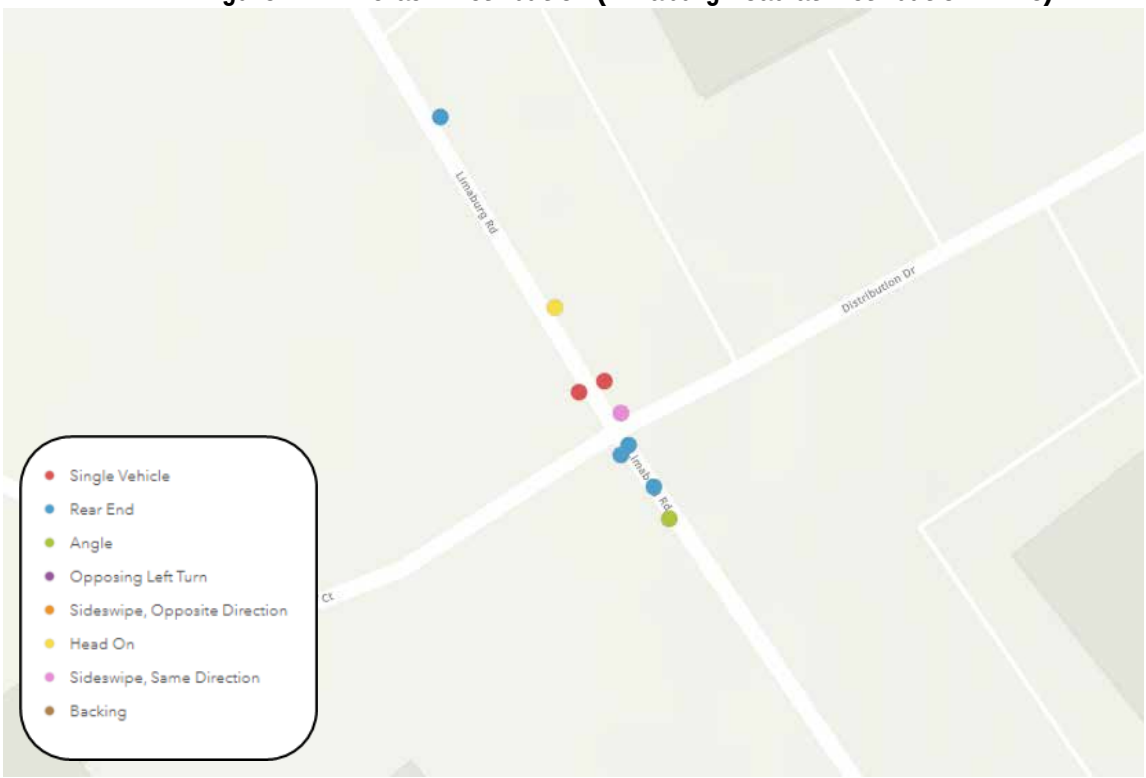
Figure A1-9: Limaburg Road North Bend Road to Distribution Drive

Figure A1-10: Undefined Access Location (Limaburg Road)

A concentration of single-vehicle, rear end and angle crashes are present at Distribution Drive, as well as a smaller concentration at Production Drive, 1000 feet to the south. It is recommended that these intersections be evaluated for the need for left and/or right turn lanes due to the large amount of industrial development that is served by these two intersections shown in the **Figure A1-11**. **Figure A1-12** shows the 5-year crash history at Limaburg Road and Distribution Drive.

Figure A1-11: Horizontal Alignment Chevron

Figure A1-12: Crash Distribution (Limaburg Road at Distribution Drive)

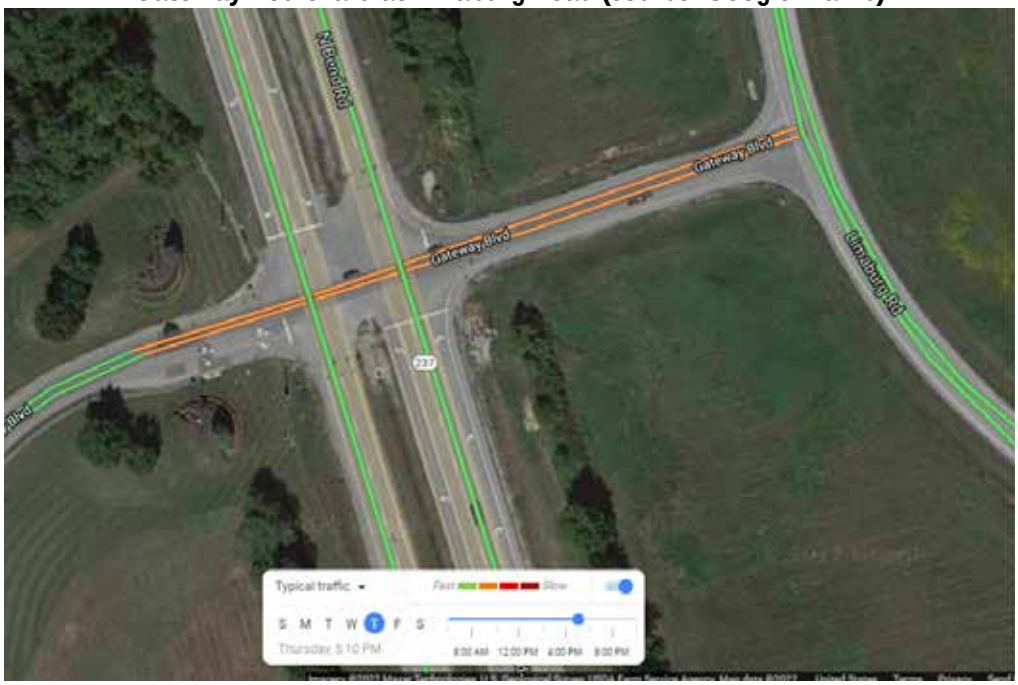


Gateway Boulevard at Limaburg Road

Several crashes, including 3 single vehicle crashes, a rear end and an angle crash have occurred at the intersection of Gateway Boulevard and Limaburg Road. This intersection is a standard 'T' intersection with stop control on Gateway Boulevard. Gateway Boulevard approaches CVG Runway 9 which is relatively featureless and may not clearly communicate that the roadway is ending, especially in low-light or low visibility conditions (See **Figure A1-13**). Additionally, a review of typical traffic conditions from the Google Traffic API indicate slow moving traffic along this link during the PM peak hours when all of the identified crashes have occurred (**Figure A1-14**) .

Figure A1-13: Eastbound Approach of Gateway Boulevard at Limaburg Road

Figure A1-14: Typical PM Peak Traffic Conditions
Gateway Boulevard at Limaburg Road (source: Google Traffic)



Cougar Path at Limaburg Road

The intersection of Cougar Path at Limaburg Road is a 4-way stop controlled intersection. In addition, an uncontrolled entrance to a parking lot is also within the physical intersection area (**Figure A1-15**). Stop signs are present on all approaches; "All Way" supplemental plaques are present on the NB and EB approaches, and "4-way" supplemental plaques are present on the WB and SB approaches. Pavement markings are used to delineate a pedestrian crosswalk and the intended entrance. Stop Ahead and Intersection Ahead warning signs are installed on Limaburg road and a Stop Ahead sign is present on the eastbound approach of Cougar Path. The Stop Ahead sign is approximately 650 feet prior to the intersection and the intersection Warning sign is approximately 4450 feet prior to the intersection. The Stop Ahead sign also appears to potentially be partially blocked by vegetation (**Figure A1-16**). The MUTCD recommends a minimum placement of 100 feet prior to the intersection for an approach spee6 of 35 mph. Four angle crashes occurred at the intersection, which may be attributable to either a vehicle disregarding the stop sign or associated with entering the parking area at the intersection. Significant congestion also appears to be present at the intersection during the AM peak period (**Figure A1-17**).

Figure A1-15: Cougar Path at Limaburg Road

Figure A1-16: Southbound Approach to Cougar Path (Stop Ahead Sign Partially blocked by Vegetation)

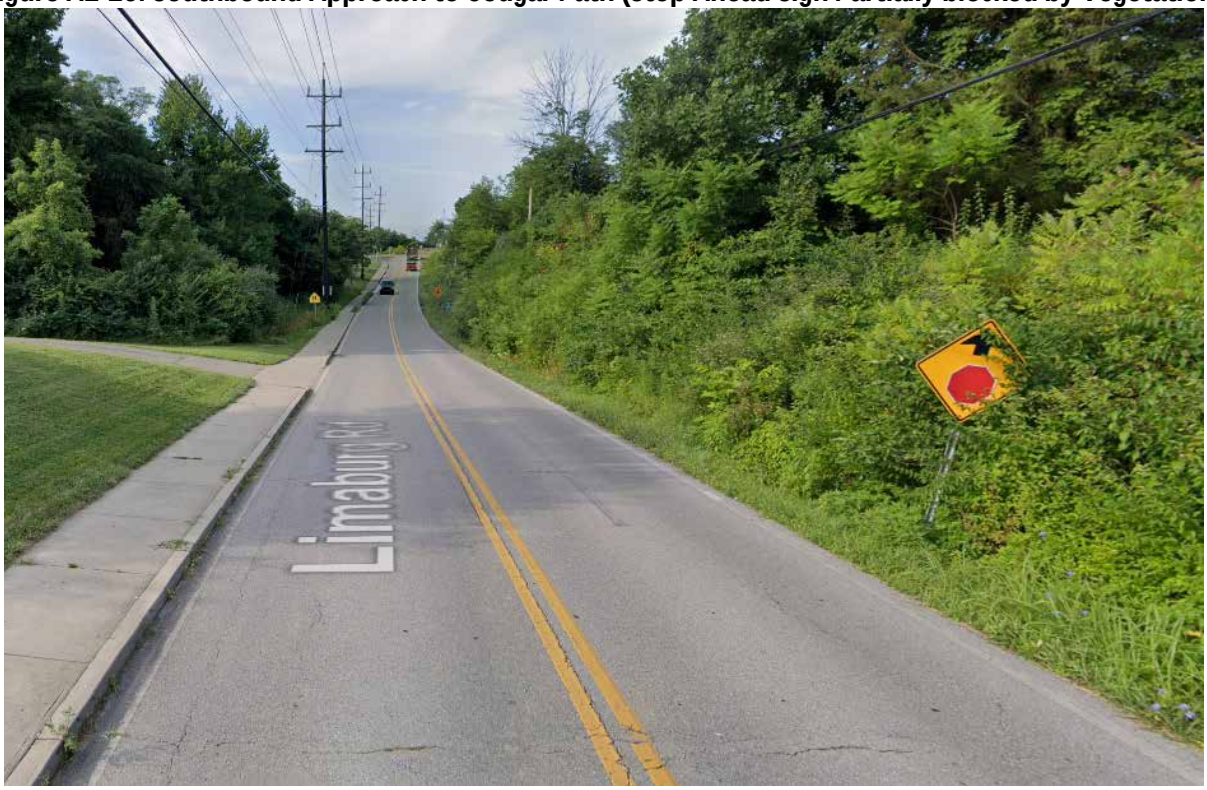


Figure A1-17: Typical AM Weekday Traffic Conditions

Conner Road at Limaburg Road

The intersection of Conner Road at Limaburg Road is a 4-way stop controlled intersection. There is a single approach lane in each direction, with auxiliary left turn lanes on Conner Road (**Figure A1-18**). Stop signs are present on all approaches; an "All Way" supplemental plaque is present on the southbound approach and a "4-way" supplemental plaque is present on the northbound approach. No supplemental plaques are present on the eastbound and westbound approaches of Conner Road. Stop Ahead and Intersection warning signs are installed on Limaburg road. The Stop Ahead signs are approximately 350 feet prior to the intersection and the Intersection warning sign is approximately 250 feet prior to the intersection. The MUTCD recommends a minimum placement of 100 feet prior to the intersection for an approach speed of 35 mph and 175 feet for an approach speed of 45 mph. Four rear-end crashes and 1 angle occurred at the intersection, primarily on the northbound approach.

Figure A1-18: Cougar Path at Limaburg Road

Limaburg Road at North Bend Road

The intersection of Limaburg Road with North Bend Road is the northern terminus of Limaburg Road and is controlled by a traffic signal installation. The intersection is directly after a sharp curve of approximately a 150 foot radius. A Signal Ahead warning sign is present, approximately 330 feet prior to the intersection. A driveway located at the apex of the curve, as well as the vegetation and embankment on the west side of the roadway presents a visual trap, making it difficult to identify the curvature of the

roadway. The roadway also maintains a wide shoulder resulting from the previous alignment of Limaburg Road that may appear to be a right turn lane to approaching drivers. Two single vehicle crashes have occurred near the intersection of Elijah Creek Road, directly south of North Bend Road and two same direction sideswipe crashes have occurred at the intersection in addition to a rear end, angle and backing crash.

Figure A1-19: Limaburg Road at North Bend Road

Recommended Improvements

Recommended Improvements for Alum Springs Cross Pike include the following:

1. Remove Fixed objects within 5 feet of the roadside where feasible. If removal is infeasible, the use of Type 2 or Type 3 Object Markers is recommended.
2. Provide ditching and shouldering where feasible to relocate drainage ditches away from roadway to increase recovery area for vehicles.
3. Consider the adoption of county ordinance for new driveway permits to require driveway crossdrains 8-10 feet back from edge of pavement to increase available room for ditches and allow the provision of an adequate ditch slope.
4. Review all signing on corridor and document sign type, location and condition within a sign management database. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted.
5. Repaint edgeline and Centerline Striping along the entire roadway. Consideration should be given to thermoplastic striping to increase the longevity and reduce maintenance costs associated with the striping as the county does not currently stripe roadways. Additionally, pavement conditions should be evaluated to determine if the pavement condition will affect edgeline and centerline viability and longevity.
6. Consider Access Management alternatives along the corridor including consolidation, delineation or restriction of access points and the evaluation of auxiliary turn lane warrants for high volume intersections, specifically on the south end of corridor.
7. Install a double arrow (W7-1) at the ‘T’ intersection of Gateway Boulevard and Limaburg Road.

8. At the intersections of Cougar Path/Limaburg Road and Conner Road/Limaburg Road, eliminary the use of the Intersection Warning signs and relocate Stop Ahead signs to within the MUTCD minimum spacing standards consistent with approach speeds. Provide "All Way" plaques for all approaches at both intersections.
9. Consider relocation of the parking lot entrance in the NE quadrant of the intersection of Cougar Path and Limaburg, 50 feet north on Limaburg Road to remove it from the primary intersection. This would require reversing the circulation pattern within the parking lot.

10. Improve the Limaburg approach to North Bend Road to eliminate the visual trap and increase visibility of the roadway curvature.
    a. Install chevrons along the curve
    b. Remove additional pavement leading to driveway location within the curve
    c. Relocate the Signal Ahead sign closer to the intersection, approximately 250 feet prior to the intersection (near side of Elijah Creek Road)

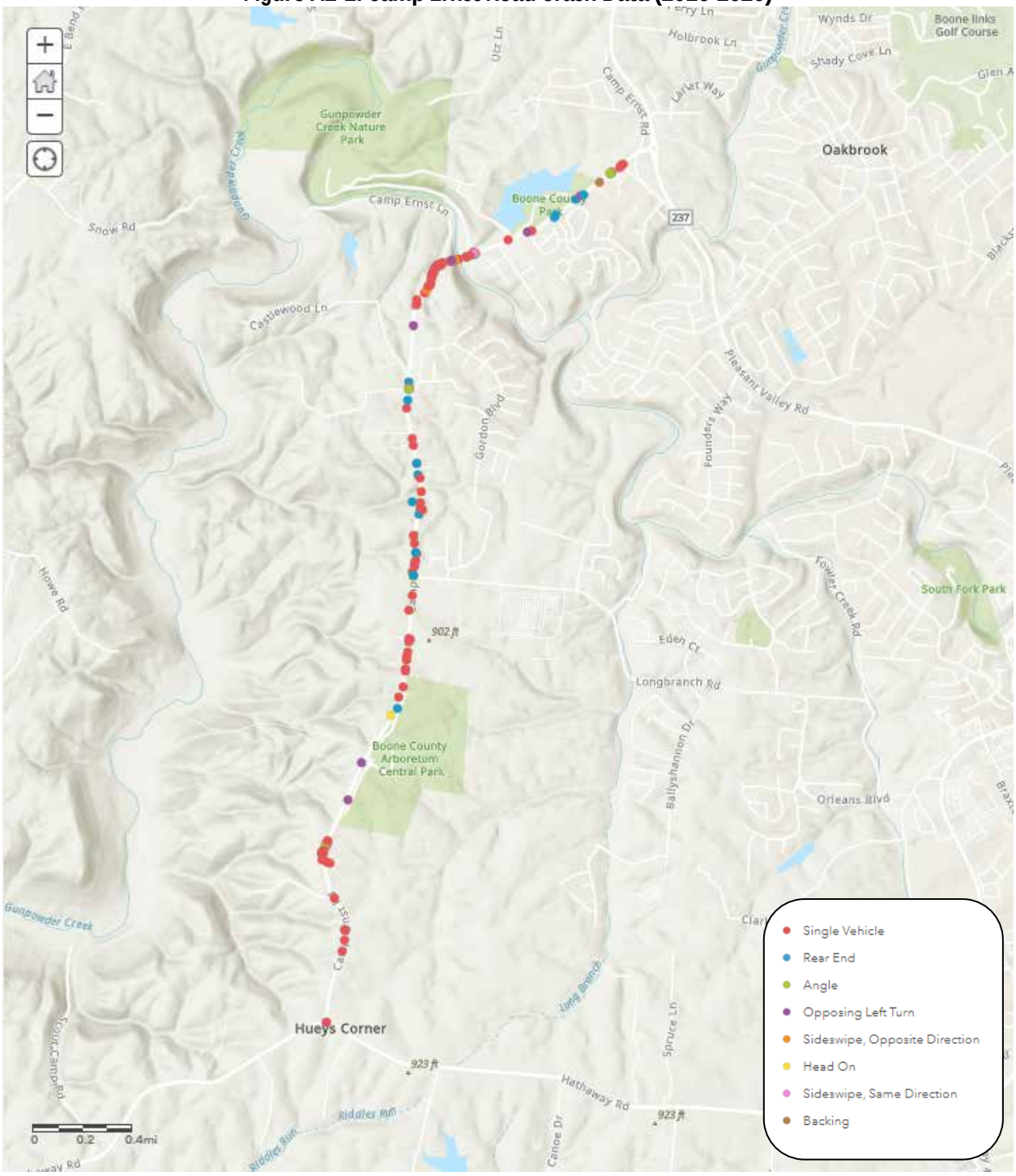
CAMP ERNST ROAD

Existing Conditions

Camp Ernst Road (CR 1001) provides a north-south connection, parallel to KY 237 connecting KY 18 and KY 536. This route provides a more direct connection from the southwestern part of the county to commercial centers in Burlington and Florence. The Roadway is approximately 4.2 miles long with a width varying from 21 feet to 24 feet near Camp Ernst Lane. A KYTC traffic count station north of Longbranch Road recorded an ADT of 7,093 in 2019. Edgeline and Centerline markings are present along the entire length of the roadway. Land use along the roadway is primarily agricultural / Rural with residential properties having direct access on the south end of the corridor and residential subdivision access to the north.

During the 5-year study period, 144 crashes were recorded on Camp Ernst Road including 25 injury crashes, 1 of which had a severity rating of 'A.' Eighty-Nine (89) of the crashes were single vehicle crashes, 46 of which were fixed object crashes. The next highest crash type was rear end crashes, accounting for 19 crashes, followed by opposite direction sideswipe accounting for 16 crashes. These crashes are shown in Figure A1-1. As can be seen, a high concentration of crashes is contained at the horizontal curve near Camp Ernst Lane; this area has been the subject of a project by the Boone County Road Department in recent years and is discussed below.

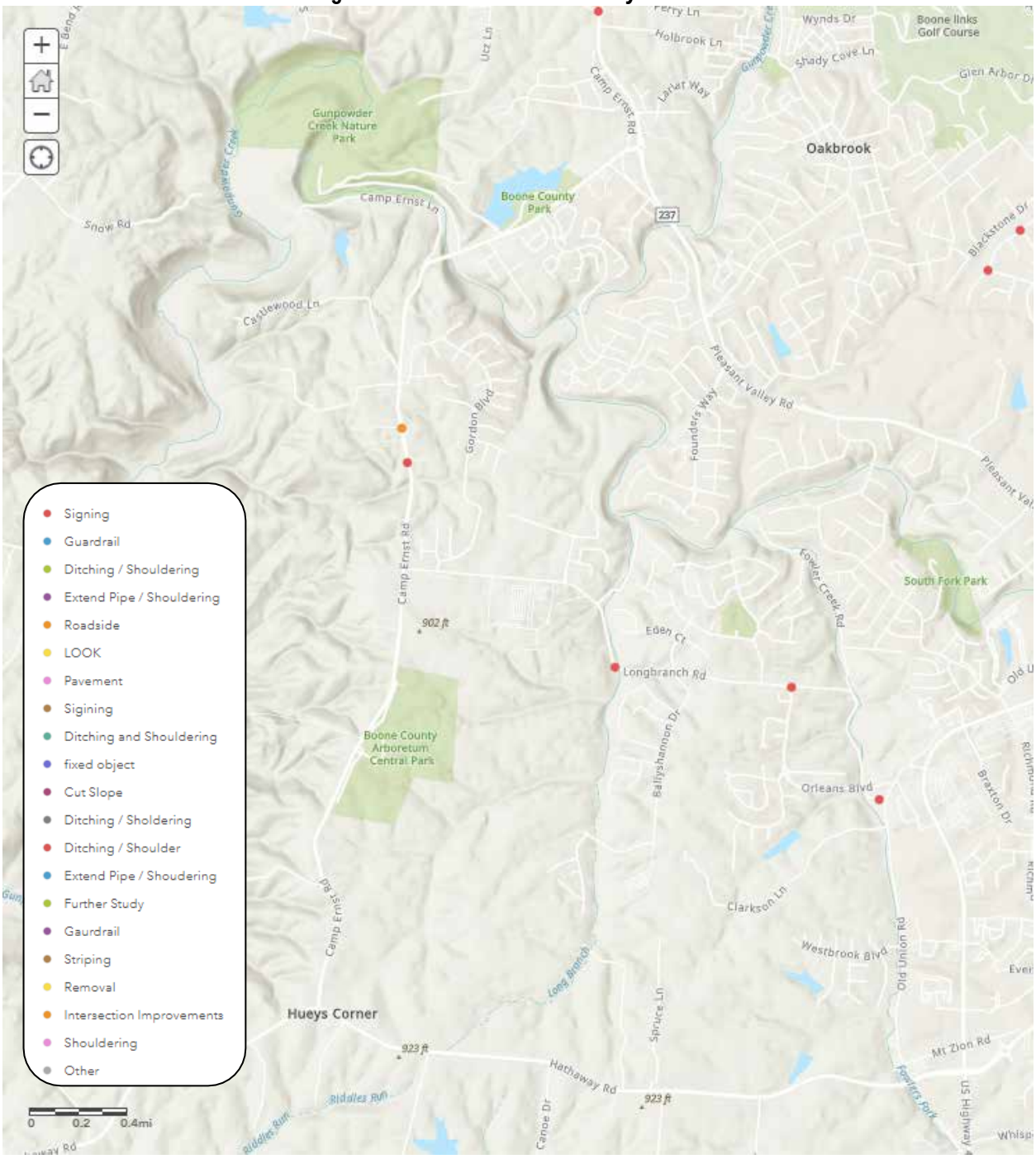
Figure A2-1: Camp Ernst Road Crash Data (2016-2020)



Contributing Factors

A field review of Camp Ernst Road was conducted and identified several issues along the roadway which are located in **Figure A2-2**. Each of these issues is discussed below.

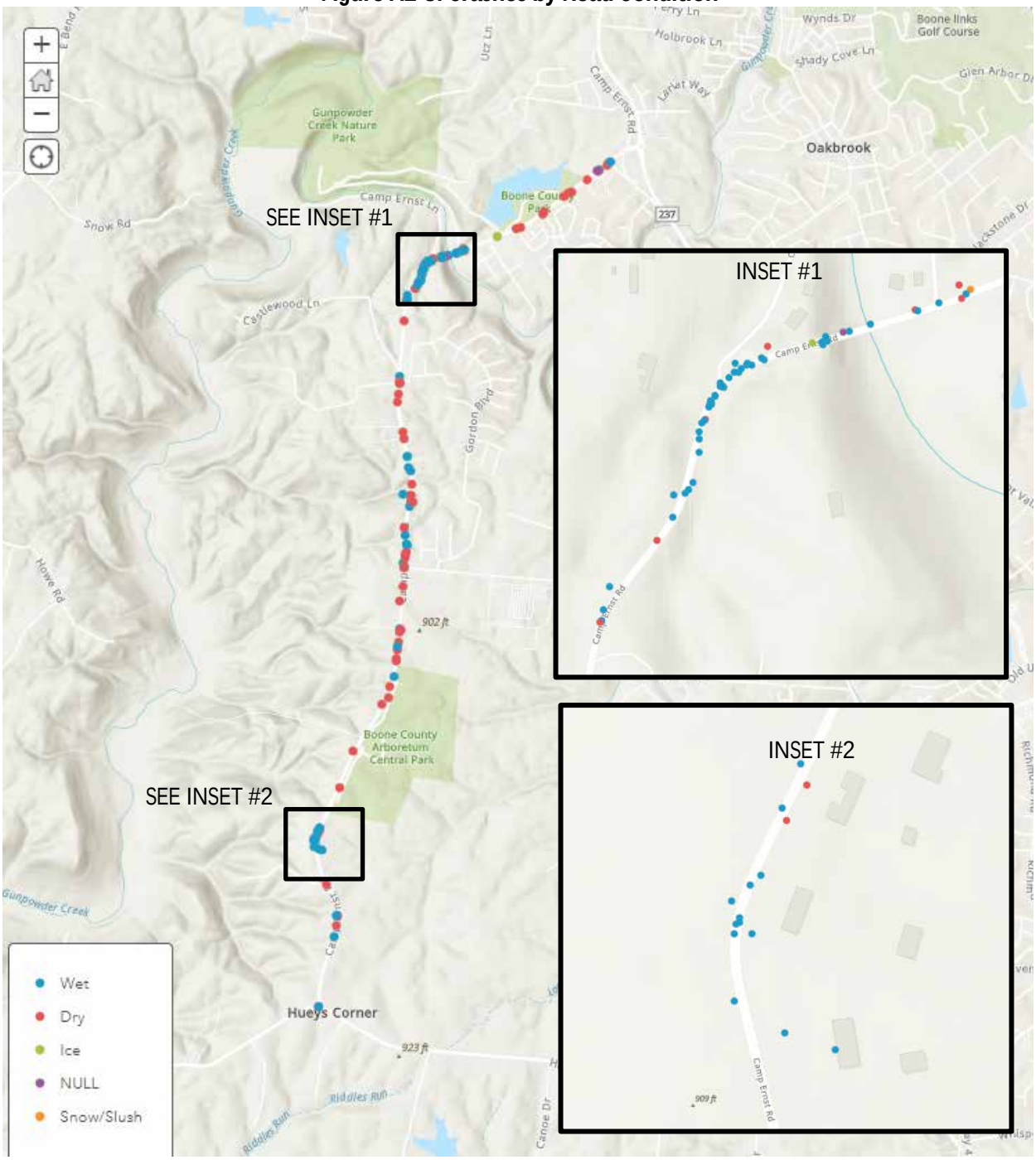
Figure A2-2: Identified Roadway Hazards



Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A2-3**. As is evident from the figure 2 areas have a high concentration of wet road crashes, indicated in blue in the figure. These are near Camp Ernst Lane and the curve directly south of the Boone County Arboretum Central Park.

Figure A2-3: Crashes by Road Condition



Wet Crash Location No. 1. The northern location near the intersection of Camp Ernst Lane experience 56 crashes within the 5-year study period, 41 of which involved a wet pavement condition. The curve has a radius of approximately 400 feet and proper superelevation, though it is located on a downward grade from the south as it approaches Gunpowder Creek. The intersection of Camp Ernst Lane near the apex of the curve, further complicates the negotiation of the curve as it can cause a visual trap as to the intended path of the curve.

This location was the site of a previous project by the county to install High Friction Surface Treatment (HFST) in 2020, which is anticipated to have addressed the crash issues in this area. The location, and the recently completed HFST is shown in **Figure A2-4**.

Figure A2-4: Northern High Crash Location

Wet Crash Location No. 2. The southern location, shown in Inset No. 2 experienced 15 crashes over the 5-year study period with 13 involving wet pavement conditions. The curve has a radius of approximately 400 feet with proper superelevation. Curve warning signs are present from the south, as the cruve develops after a vertical crest. Advanced curve signs are not present from the north (**Figure A2-5a**). Chevrons are located throughout the curve. A secondary entrance to the Boone County Knothole Baseball complex is located at the north PC of the curve (**Figure A2-5b**). The road appears to be have good drainage ditches on both sides with the water flowing off the roadway (**Figure A2-6**). Approximately 400 feet to the north, ditches are not as prominent as through the curve, but any flow from this area is not anticipated to impact the operations of the curve itself where crashes are occurring. If drainage is not an issue as it appears, a lack of pavement friction may be contributing to the high number of wet weather crashes.

Figure A2-5: Northbound and Southbound Approaches to High Wet Crash Curve No.2

Figure A2-6: High Wet Crash Curve No. 2 (South of Boone County Knothole Baseball Complex)

Edge Drop Off

Roadway edge drop offs are prevalent along the corridor primarily due to roadside drainage ditches and narrow right of way. Steep fill slopes also present a hazard where no shoulder as present. In these instances a vehicle that may depart the roadway slightly can either overcorrect to get back onto the roadway heading into oncoming traffic or fully depart the roadway and crash into a fixed object or embankment. Driver inattention was cited in 20 crashes and overcorrecting/oversteering was cited in 10 crashes on the corridor. **Figure A2-7** shows some examples of these edge drop offs.

Figure A2-7: Edge Drop Offs on Camp Ernst Rd

Guardrail

Minimal guardrail exists along Camp Ernst Road, compared to other roads in the areas, however, all installations that are present appear to not meet minimum guardrail height requirements, or provide crash worthy end treatments. In addition, guardrail installation near the Boone County Park and Camp Ernst Lake appear to be unwarranted and not protecting against fixed objects and/or critical slopes. Unnecessary guardrail installation, are in fact fixed objects directly adjacent to the roadway. **Figure A2-8** shows the guardrail installations along the corridor, and **Figure A2-9** shows typical guardrail installations and end treatments.

Figure A2-8: Guardrail Installations Camp Ernst Road

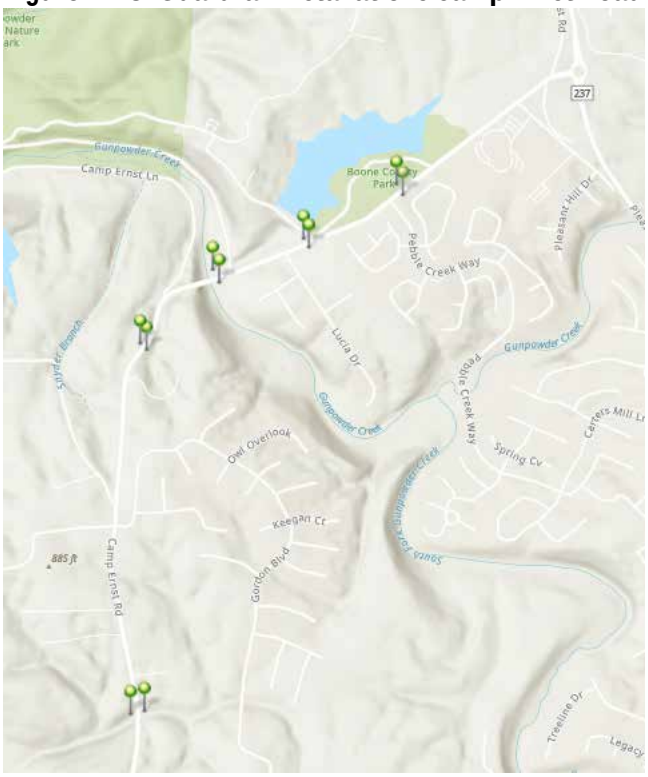


Figure A2-9: Typical Guardrail Installations Camp Ernst Road

Signing

Signing is extensive on the corridor for both horizontal alignment and advanced traffic control, especially along the northern high crash location (Figure A1-5). However, some inconsistencies exist, and older signing is present on the corridor. Several of these instances are contrary to guidance provided in the MUTCD and may send mixed or unclear messages to drivers. Figures A2-10 through A1-8 show examples of some of these sign installations.

Figure A2-10: Ballpark Entrance and Speed Limit

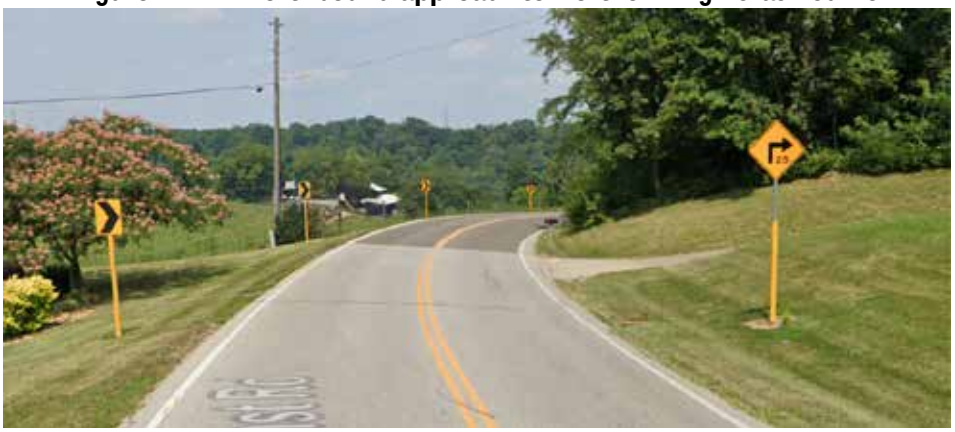
A Ballpark Entrance sign mounted on the same post as the 35 mph speed limit sign shown in **Figure A2-10** can cause confusion as to whether the 35 mph speed is the regulatory speed limit or an advisory speed associated with the entrance.

Speed Limit signs mounted on the left side of the road (**Figure A2-11**) as opposed to the right side of the road may not meet driver expectations and cause drivers to be unaware or confused by the sign due to its location.

Figure A2-11: Left Side Mounted Speed Limit Sign

The Curve warning signs on the northern high crash curve (**Figure A2-12**), does not have an advance curve warning with advisory speed plaque to provide drivers adequate distance to slow down prior to entering the curve.

Figure A2-12: Northbound approach to Northern High Crash Curve



Recommended Improvements

Recommended Improvements for Camp Ernst Road include the following:

1. Continue to monitor crash history at the northern high crash curve, recently improved with the HFST to ensure that crashes have been sufficiently addressed by the improvement.
2. Evaluate drainage at the southern high crash curve location near the Boone County Knothole Baseball Complex to ensure that standing or sheeting water on the roadway is not the primary cause of the high wet pavement crash frequency. If drainage is deemed sufficient, consider a similar HFST application as was installed for the northern curve.
3. Provide improved ditching and shouldering throughout the corridor to relocate drainage ditches away from roadway to increase recovery area for vehicles. This may require relocation of driveway crossdrains to provide adequate slope within the ditch. A similar project was recently completed by a home owner along Camp Ernst Road as shown below.

Additionally, roadside ditches which present edge drop off hazards, may require the installation of drainage structures and inlet boxes to eliminate the need for ditches. A similar treatment appears to have been implemented on Limaburg Road north of Petersburg Road as shown below.

4. Consider the adoption of county ordinance for new driveway permits to require driveway crossdrains 8-10 feet back from edge of pavement to increase available room for ditches and allow the provision of an adequate ditch slope.
5. Review all signing on corridor and document sign type, location, post type and condition within a sign management database. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted.
6. Install Edgeline Striping along the entire roadway. Consideration should be given to thermoplastic striping to increase the longevity and reduce maintenance costs associated with the striping as the county does not currently stripe roadways. Additionally, pavement conditions should be evaluated to determine if the pavement condition will affect edgeline and centerline viability and longevity.
7. Evaluate existing guardrail locations along the corridor to determine the ultimate need for the guardrail installation, and to ensure necessary installations are properly maintained, at the appropriate height and provide a crash-worthy end treatment.
8. Evaluate available sight distance and traffic control measures at intersections with increased crash history including the intersections of Longbranch Road, Klotz Ln/Gordon Ln and Camp Ernst Lane.

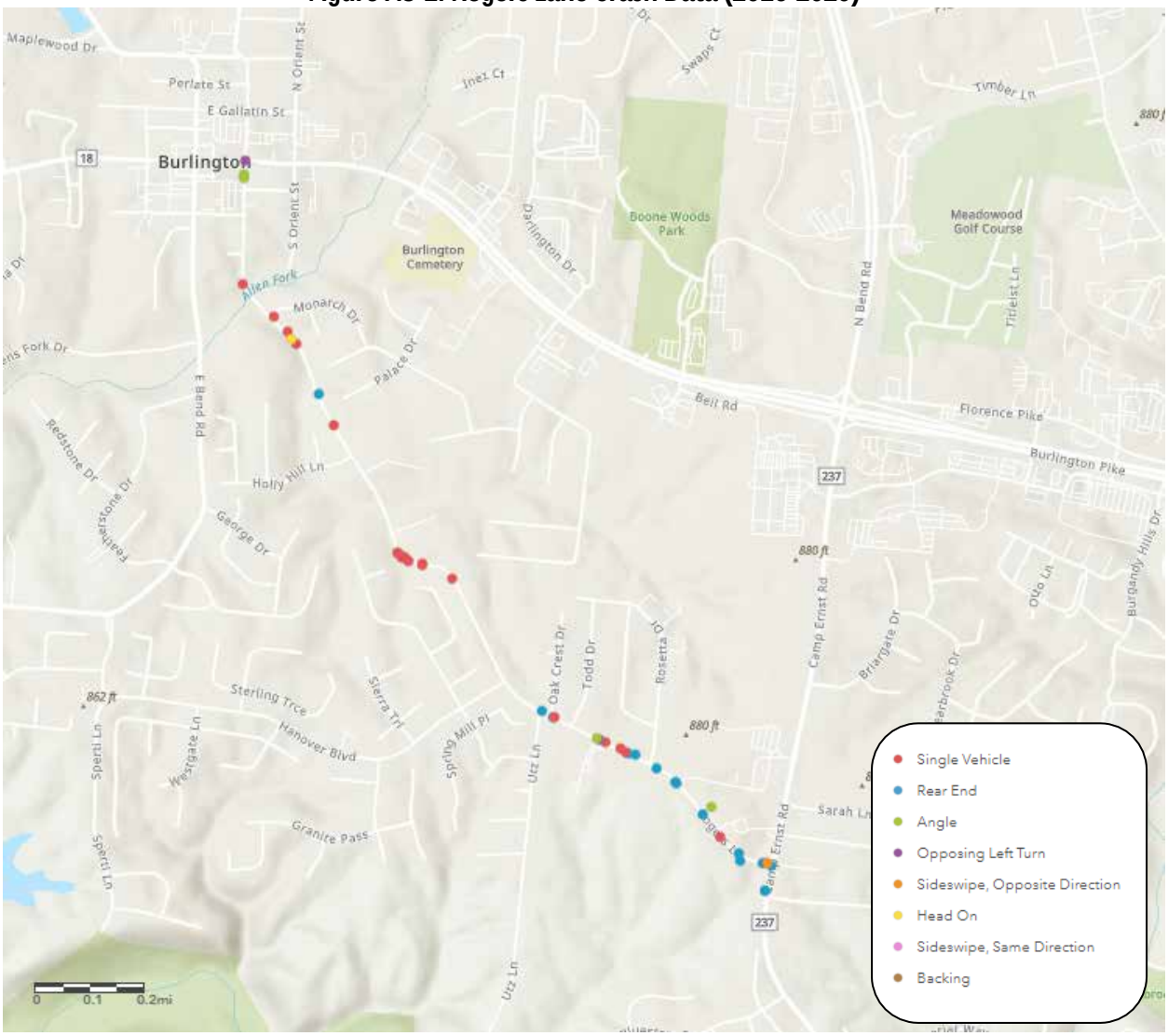
ROGERS LANE

Existing Conditions

Rogers Lane (CR 1058) connects downtown Burlington (KY 18) and KY 237. The Roadway is approximately 1.7 miles long and 21 feet wide. The roadway widens near the southern terminus with an improved intersection with KY 237 near the Camp Ernst Middle School. A KYTC traffic count station on Rogers Lane recorded an ADT of 1821 in 2020. Edgeline and Centerline markings are present along the entire length of the roadway. Land use along the roadway is primarily residential with properties having direct access to Rogers Lane.

During the 5-year study period, 46 crashes were recorded on Rogers Lane including 5 injury crashes. Twenty-two (22) of the crashes were single vehicle crashes , 10 of which were fixed object crashes. The next highest crash type was rear end crashes, accounting for 15 crashes. These crashes are shown in **Figure A3-1**. As can be see from the figure, single vehicle crashes are primarily concentrated in the north end of the corridor, and rear end crashes are more frequent on the south end of the corridor, where a higher density of access points is present.

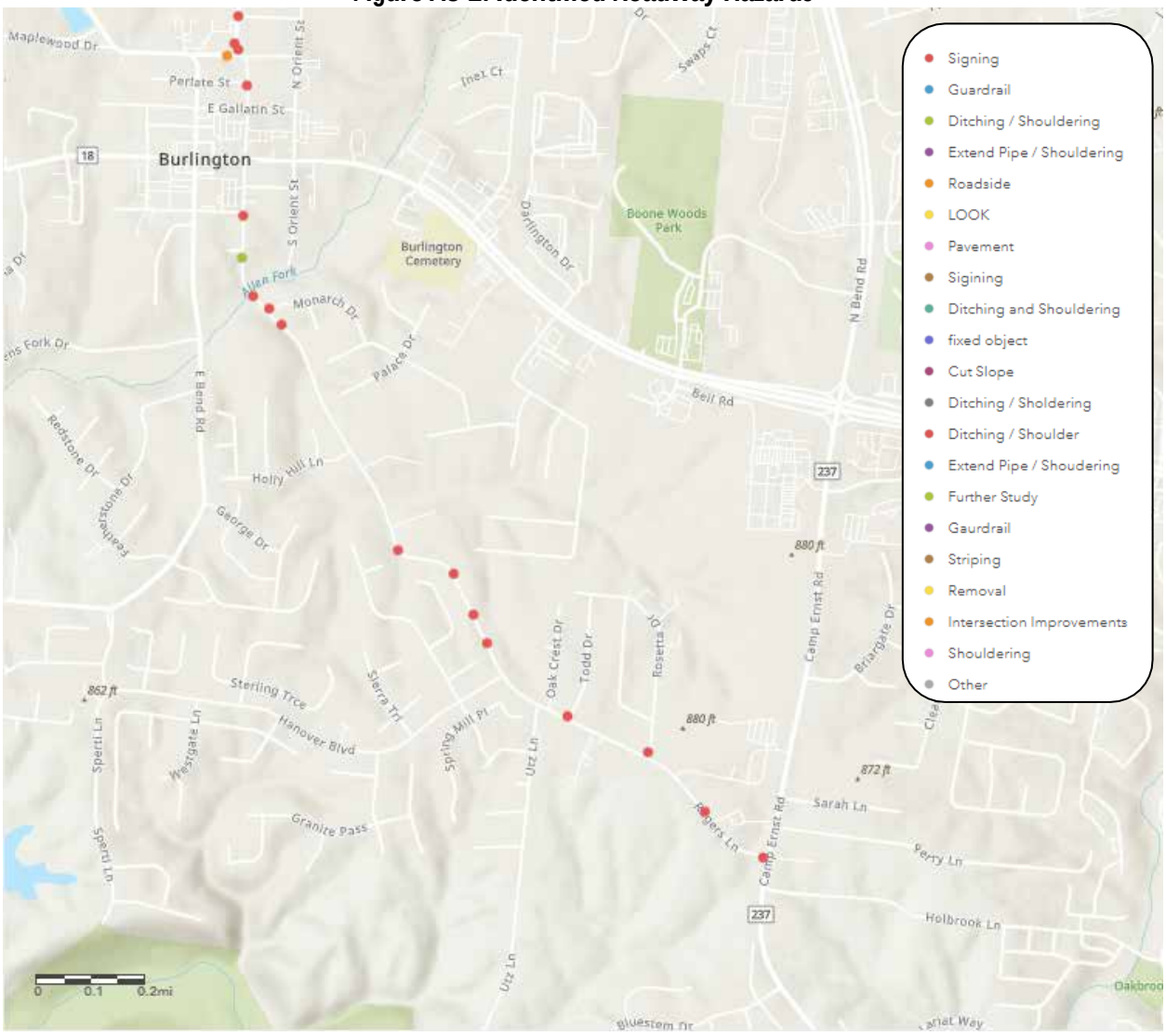
Figure A3-1: Rogers Lane Crash Data (2016-2020)



Contributing Factors

A field review of Rogers Lane was conducted and identified several issues along the roadway which are located in Figure A3-2. Each of these issues is discussed below.

Figure A3-2: Identified Roadway Hazards



Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A3-3**. As is evident from the figure, 2 areas have a small concentration of wet road crashes, indicated in blue in the figure. These are between Allen Creek Crossing and Monarch Drive (5 of 8 crashes) and near the reverse curve between Holly Hill Lane and Hanover Boulevard (11 of 15 crashes).

The concentrations of wet weather crashes may be the result of blocked drainage ditches or may result from sheet flow over the roadways as both roadways are superelevated and on grade with a high resulting relative gradient. (See **Figure A3-4**) Observation of these areas during rain events are necessary to detect any drainage or wet weather related issues.

Figure A3-3: Identified Roadway Hazards

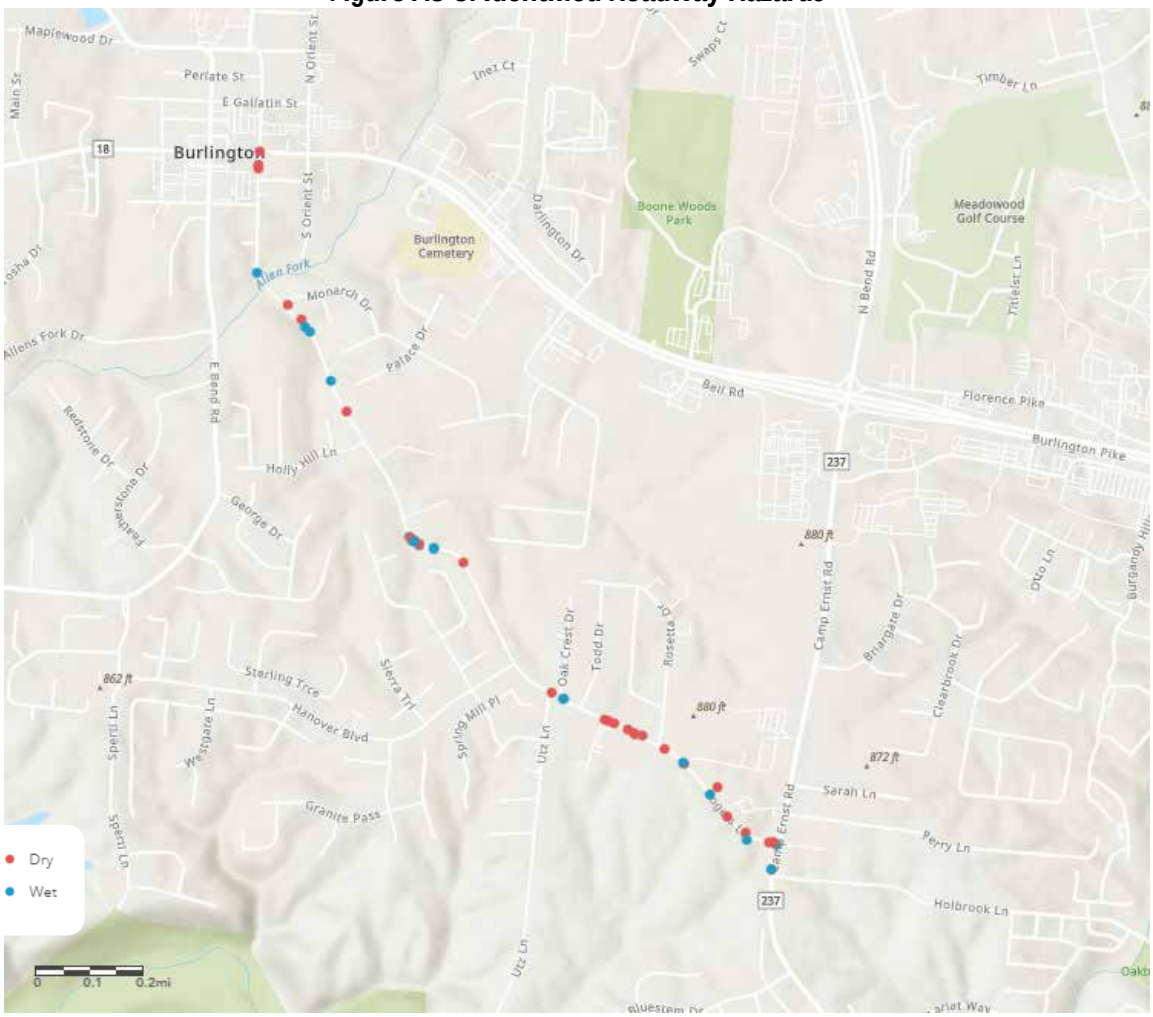


Figure A3-4: Rogers Lane (South of Monarch Drive and Reverse Curve)

Land Use Changes

As indicated above, the south end of the Rogers Lane Corridor has a high concentration of rear end and angle crashes as shown in Figure A3-1. In this area, residential properties have direct driveway access increasing access density, and several pedestrian crossings connecting sidewalks along Rogers Lane and

adjacent residential neighborhood streets are present (**Figure A3-5**). The speed limit on Rogers Lane is 35 mph through the entire corridor, even with the significant land use change south of Utz Lane.

Figure A3-5: Rogers Lane (High Access Density and Pedestrian Crossings South of Utz Lane)

Signing

Good signing exists on the corridor as shown in **Figure A3-6**. However, inconsistencies in signing applications are present with signing practices inconsistent with MUTCD guidance, reduced sign reflectivity and mixed installation materials including non-crashworthy installations, as well as varied sign heights as shown in **Figure A3-7**.

Figure A3-6: Rogers Lane Signing Example

Figure A3-7: Roger Lane Signing Examples

Shoulder Edge Drop Off

On the northern section of the corridor, driveway culverts are placed relatively close to the road edge, which minimizes available space for the roadside ditch. As the ditch erodes this creates edge drop offs which can lead to overcorrection for errant drivers and contribute to single vehicle, head-on or sideswipe crashes. (Figure A3-8)

Figure A3-8: Roger Near Allen Fork Crossing

Recommended Improvements

Recommended Improvements for Godbey Lane include the following:

1. The areas identified as having higher frequency wet-weather crashes should be observed during rain events to determine if drainage in the area and/or sheet flow presents an increased hazard for crashes. If drainage is determined to be sufficient, friction tests should be conducted to determine if additional treatments such as HFST would be warranted.
2. Consideration should be given to lowering the speed limit on the southern section of Rogers Lane south of Utz Lane. The lower speed limit may be warranted due to the increased number of access points, residential driveways and the presence of Camp Ernst Middle School.
3. Provide improved ditching and shouldering where feasible to relocate drainage ditches away from roadway to increase recovery area for vehicles. This may require relocation of driveway crossdrains to provide adequate slope within the ditch. A similar project was recently completed by a home owner along Camp Ernst Road as shown below.

Additionally, roadside ditches which present edge drop off hazards, may require the installation of drainage structures and yard boxes to eliminate the need for ditches. A similar treatment appears to have been implemented on Limaburg Road north of Petersburg Road as shown below.

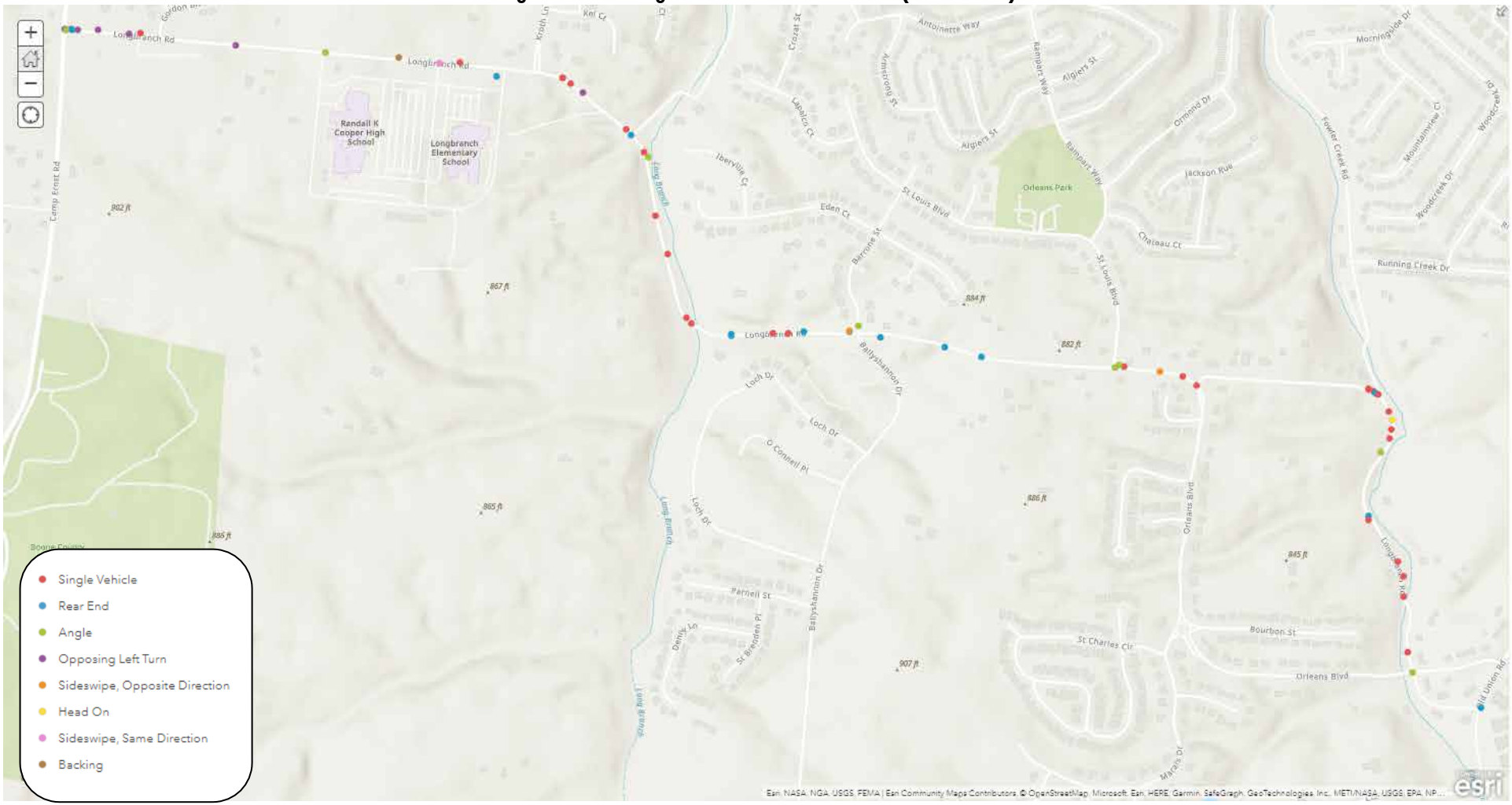
LONGBRANCH ROAD

Existing Conditions

Longbranch Road (CR 1002) connects Camp Ernst Road and Randall K. Cooper High School with Old Union Road and ultimately US 42 to the east. The Roadway is approximately 2.7 miles long and typically 20 feet wide, except for the section from Camp Ernst Road to Kroth Lane in front of the Cooper High School which maintains a 3-lane, 36 foot wide cross-section. A KYTC traffic count station on east of Kroth Lane recorded an ADT of 3,176 in 2020. Edgeline and Centerline markings are present along the entire length of the roadway. Land use changes from institutional in front of the school, to rural then to residential. Longbranch road redirects at its intersection with Orleans Blvd with Orleans Blvd serving as the through street.

During the 5-year study period, 62 crashes were recorded on Rogers Lane including 9 injury crashes. Twenty-nine (29) of the crashes were single vehicle crashes , 14 of which were fixed object crashes. The next highest crash type was opposite direction sideswipe crashes, accounting for 13 crashes. These crashes are shown in **Figure A4-1**. As can be seen from the figure, single vehicle crashes are primarily concentrated between Kroth Lane and the Longbranch Creek Crossing, near the redirected intersection with Orleans Blvd and along Fowler Creek.

Figure A4-1: Longbranch Road Crash Data (2016-2020)



Contributing Factors

A field review of Longbranch Road was conducted and identified several issues along the roadway which are located in Figure A3-2. Each of these issues is discussed below.

Figure A4-2: Identified Roadway Hazards

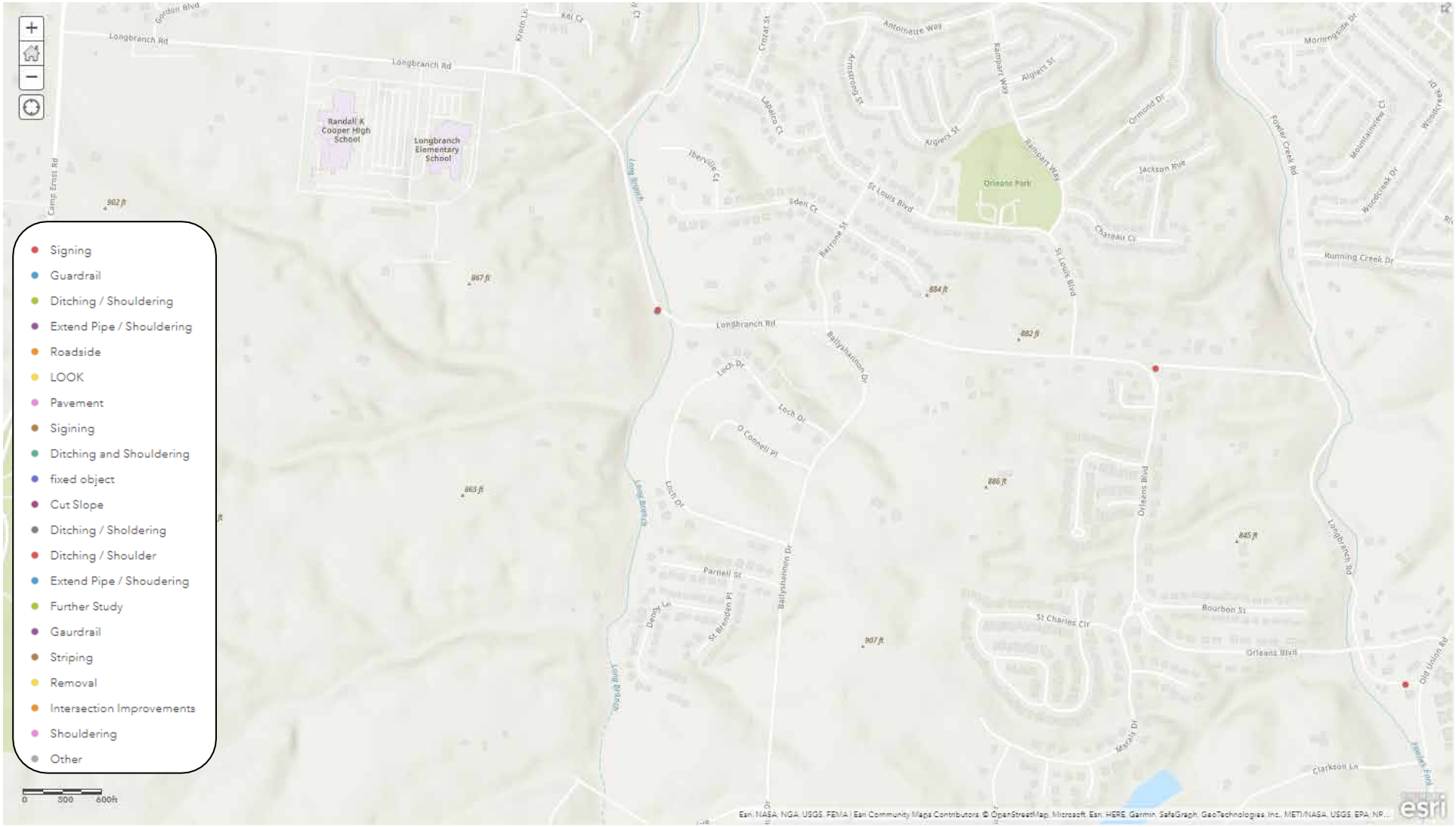
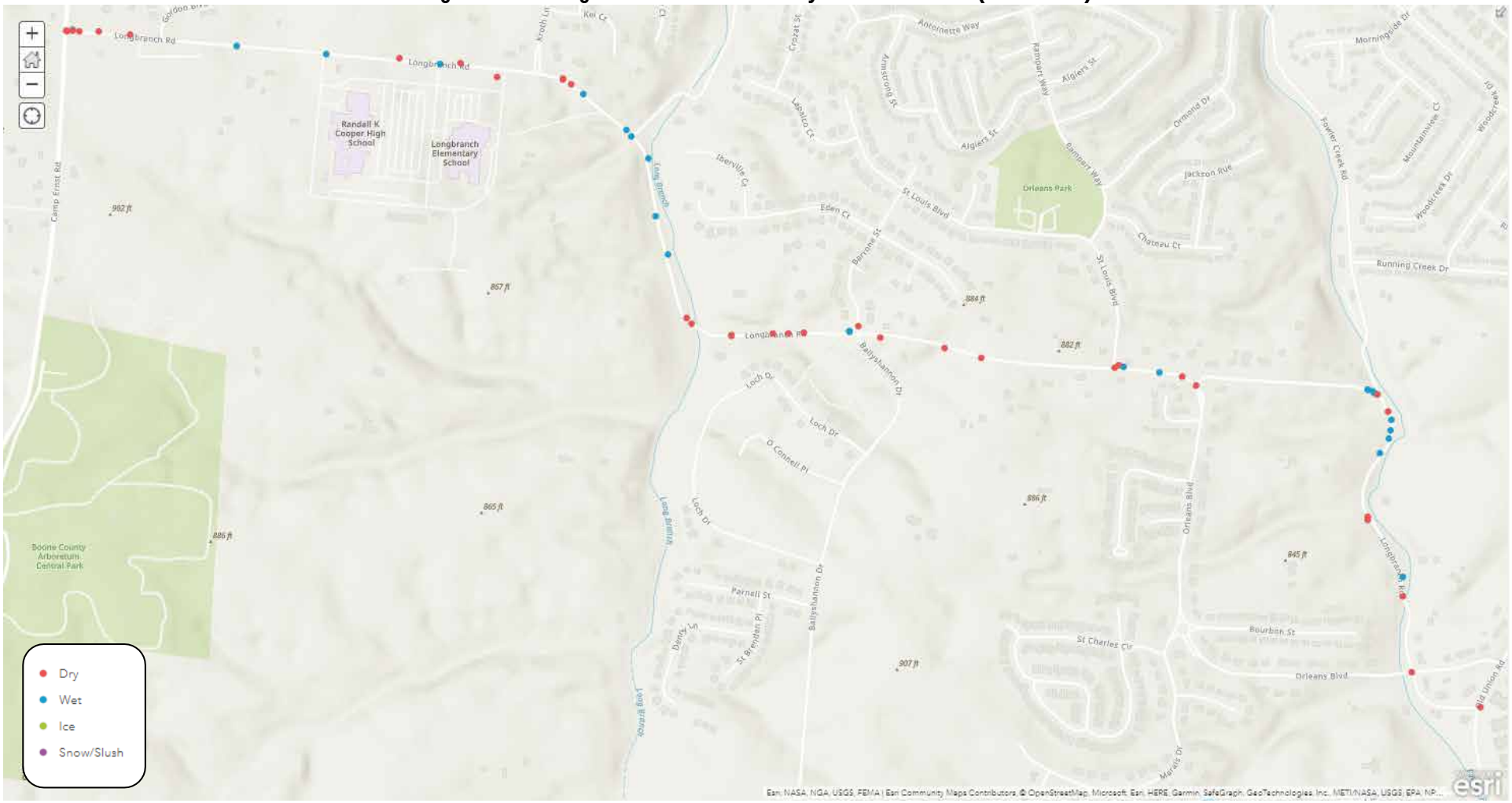


Figure A4-3: Longbranch Road Crashes by Road Condition (2016-2020)



Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A4-3**. As is evident from the figure, 2 areas have a small concentration of wet road crashes, indicated in blue in the figure. These are between Hidden Creek Drive to the Longbranch Creek crossing (6 of 8 crashes) and near Fowler Creek Road (9 of 11).

The concentrations of wet weather crashes near Hidden Creek Drive may be the result of poor drainage, especially on the cut side along slopes, where space for proper roadway ditches is not available (**Figure A4-4**).

Figure A4-4: Longbranch Road near Hidden Creek Drive

Similar issues may also exist near Fowler Creek Road, where ditches along the inside of the curve are minimal. Vegetation growth is this area may also prevent water from draining to the cross-drain and hold water on the roadway (**Figure A4-5**).

Observation of these areas during rain events are necessary to detect any drainage or wet weather related issues.

Figure A4-5: Longbranch Road at Fowler Creek Road

Intersection with Camp Ernst Road

As is evident from the crash diagram in Figure A4-1, a higher concentration of crashes is present on the approach to Camp Ernst Road. It is noted that Longbranch Road approach to Camp Ernst Road was widened in early 2021. **Figure A4-3a and A4-3b** show the before and after improvements at the intersection. Since the completion of the development, no crashes have been documented along Longbranch Road.

Figures 4-3a and A4-3b: Longbranch Road Improvements

Guardrail

Several instances of guardrail are present on Longbranch Road as shown in **Figure A4-4**, and appear to not meet minimum guardrail height requirements, or provide crash worthy end treatments. **Figure A4-5** shows typical guardrail installations along the corridor

Figure A4-4: Guardrail Locations

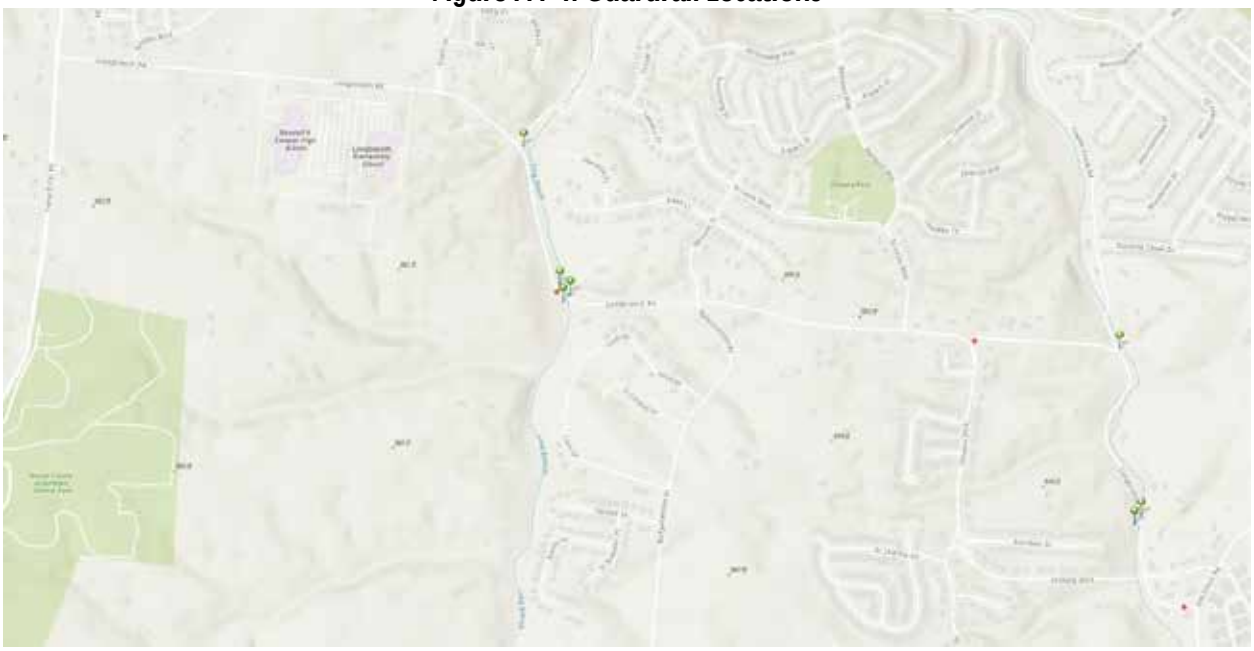


Figure A4-5: Typical Guardrail Installations (Longbranch Road)

Intersection with Orlleans Drive

Longbranch Road was realigned in the early 2000's to continue straight to Orlleans Boulevard. The realignment of the roadway within a long tangent section, introduced a short curve (radius approximately 250 feet) to each approach of Longbranch Road (**Figure A4-6**). The continuation of Longbranch is still visible and creates a visual trap for approaching drivers (**Figure A4-7**). The landscaped berm on the southside of the roadway restricts visibility of the continuation of Orlleans Boulevard which further contributes to the visual trap. Several single vehicle and rear end crashes have occurred at this location.

Figure A4-6: Longbranch Road at Orleans Boulevard

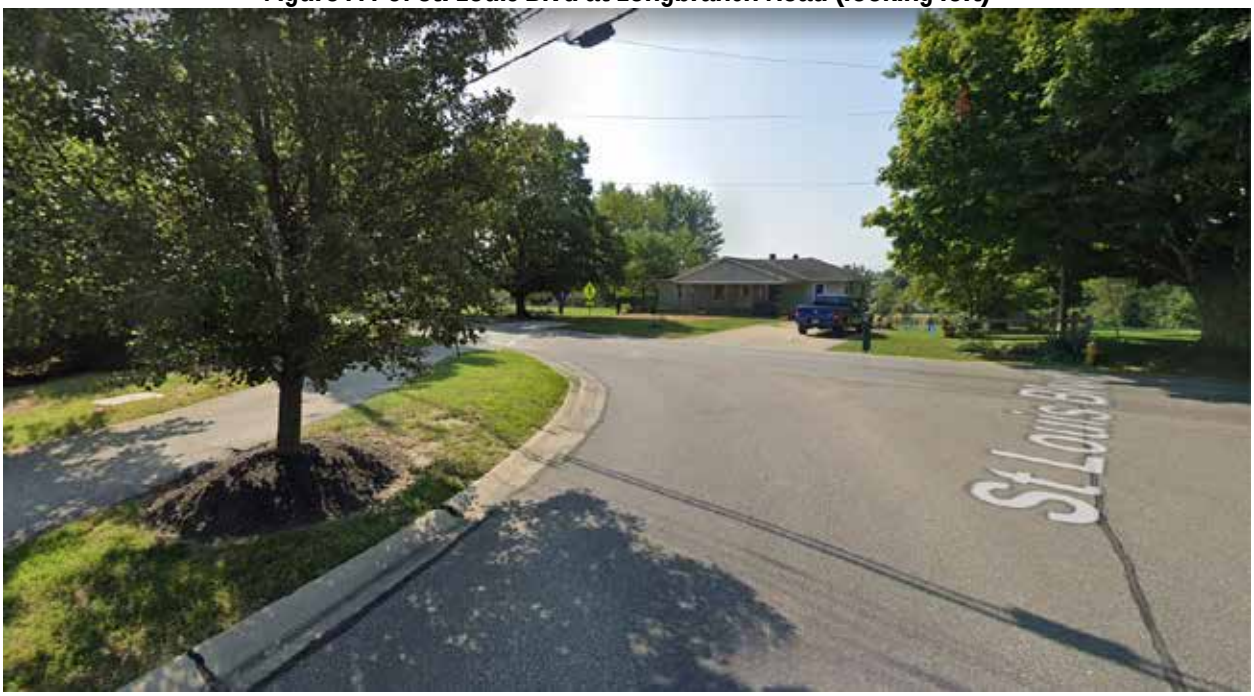
Figure A4-7: Longbranch Road at Orleans Boulevard

Stop Controlled Intersections

Several Crashes were noted at the intersection of St. Louis Boulevard and Longbranch Road including 3 angle crashes and 3 single vehicles crashes. During field review it was noted that the stop sign for the intersection is set approximately 35 feet back from the intersection due to the large curb return radius and the landscaped entrance (**Figure A4-8**) . From this location sight distance is severely restricted as shown in **Figure A4-9**.

Figure A4-8: St. Louis Blvd at Longbranch Road

Figure A4-9: St. Louis Blvd at Longbranch Road (looking left)



The intersection of Fowler Creek Road which is located in a curve (**Figure A4-10**), can also present issues as to the appropriate stop location, as well as cause issues for drivers on Longbranch road, understanding the intended vehicle path.

Figure A4-10: Fowler Creek Road at Longbranch Road (looking left)

Horizontal Alignment Signing

Several horizontal curves along the corridor also exist (Figure A1-3). While some signing is present minimum advanced warning signs and chevrons are present. The disparity in sign placement and curvature may be due to the posted speed limit of 35 mph which is exceeded by the majority of traffic.

Recommended Improvements

Recommended Improvements for Longbranch Road include the following:

1. The areas identified as having higher frequency wet-weather crashes should be observed during rain events to determine if drainage in the area and/or sheet flow presents an increased hazard for crashes. If drainage is determined to be sufficient, friction tests should be conducted to determine if additional treatments such as HFST would be warranted.
2. Evaluate existing guardrail locations along the corridor to determine the ultimate need for the guardrail installation, and to ensure necessary installations are properly maintained, at the appropriate height and provide a crash-worthy end treatment.
3. Provide Chevrons on the Longbranch Road approaches to Orlleans Boulevard to clearly indicate the presence of roadway curvature and the intersection. Consider the use of a “Stop Ahead” Sign for the westbound approach of Longbranch Road.
4. Consider the installation of stop bars for intersections with restricted sight distance, and/or having a placement at curves to properly indicate the intended stopping location. ‘T’ type intersections may benefit from the installation of a two-direction large arrow sign (W1-7) to further emphasize the end of the roadway and presence of the intersection.
5. Review all signing on corridor and document sign type, location, post type and condition within a sign management database. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted. Advanced warning signs should be checked for placement to ensure that warning signs are not placed too far in advance of hazardous conditions (Recommended no greater than 100 feet greater than MUTCD minimum distance).

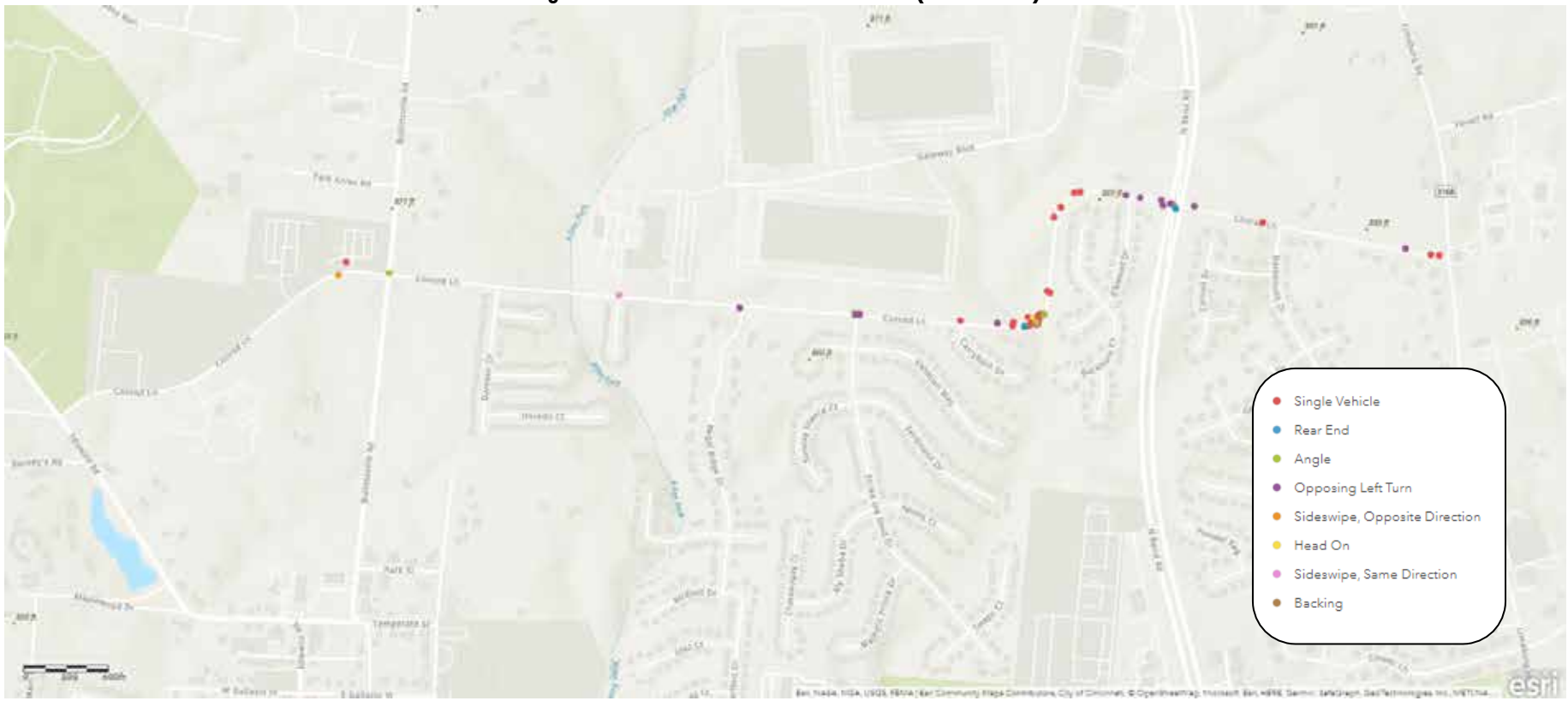
CONRAD LANE

Existing Conditions

Conrad Lane (CR 1056) connects runs east-west, north of downtown Burlington connecting KY 338 and Bullitsville Road with KY 237 (North Bend Road,) and Limaburg Road to the east. This east-west connection serves several county facilities on the west side, including the Boone County Fairgrounds, Road Department, Boone County Sheriff's Office and Idlewild Park. The Roadway is approximately 2.1 miles long and typically 20 feet wide. A KYTC traffic count station recorded an ADT of 4,435 in 2018. Edgeline and Centerline markings are present along the entire length of the roadway. Land use changes from institutional in front of the school, to rural then to residential.

During the 5-year study period, 55 crashes were recorded on Conrad Lane including 14 injury crashes. Twenty-eight (28) of the crashes were single vehicle crashes , 17 of which were fixed object crashes. The next highest crash type was rear end crashes, accounting for 13 crashes. The highest number of injury crashes were angle crashes, with 5 injury crashes out of 8 total crashes. These crashes are shown in **Figure A5-1.** As can be seen from the figure, crashes are concentrated along the 'S' Curve approaching KY 237, and as shown in Figure A5-2, a majority of these crashes are related to wet pavement conditions. It is also noted that it appears that this location also recently implemented a high-Friction Surface Treatment (HFST).

Figure A5-1: Conrad Lane Crash Data (2015-2019)



It appears high friction surface treatment has been placed at this location.

Contributing Factors

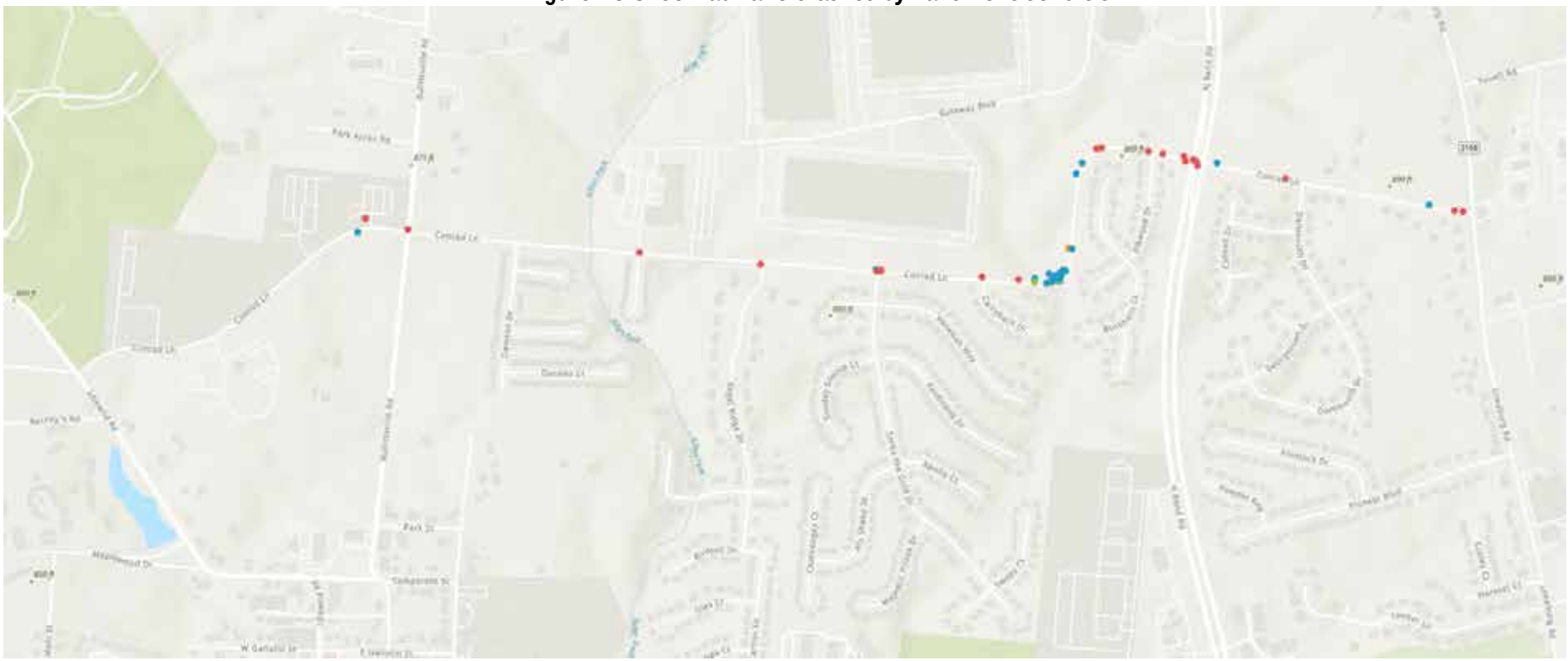
A field review of Conrad Lane was conducted and identified several issues along the roadway which are located in Figure A5-2. Each of these issues is discussed below.

Figure A5-2: Identified Roadway Hazards

Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A5-3**.

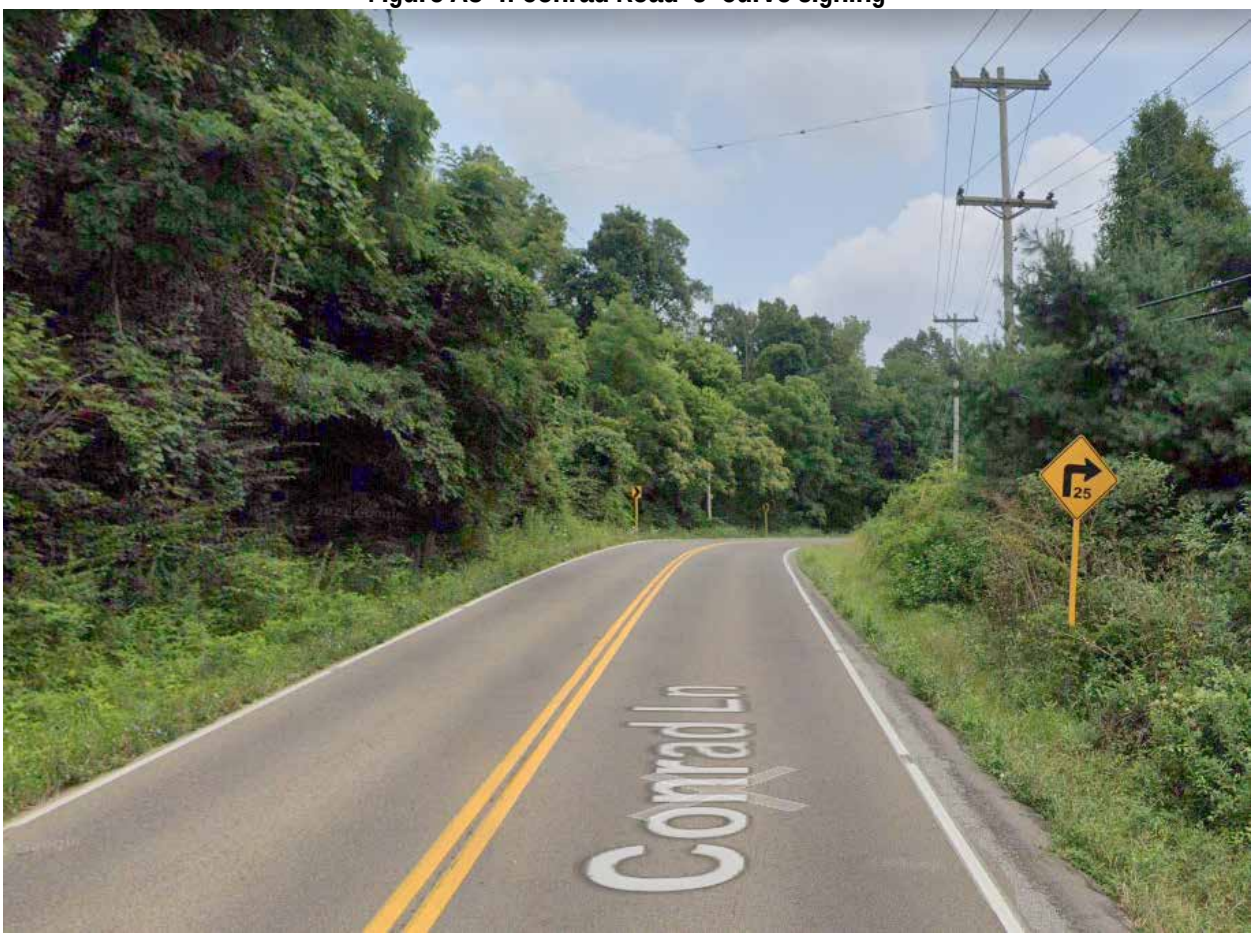
Figure A5-3: Conrad Lane Crashes by Pavement Condition



'S' Curve

As is evident from Figure A5-3, there is high concentration of crashes near the 'S' curve, primarily dominated by wet pavement conditions. It is noted that this section of roadway was treated with a high friction surface treatment in 2020. Additionally, enhanced horizontal alignment signing is present at this location (**Figure A5-4**). In the curve nearest to Northbend Road, a W1-1a sign is used as an advanced curve warning sign, though the MUTCD identifies the W1-1a for supplemental signing only at the PC of the curve. Additionally, dense vegetation on the outside of the curve has the potential to restrict visibility of the chevron signs.

Figure A5-4: Conrad Road 'S' Curve Signing



Intersection at Northbend Road

Several crashes are also noted on the approach to and at the intersection of Conrad Lane and Northbend Road. It is noted that traffic signal head enhancements included retroreflective backplates have been installed at this location (**Figure A5-5**).

Figure A5-5: Conrad Lane at Northbend Road Intersection

The signal ahead sign on the eastbound approach to Northbend Road is located over 400 feet from the intersection and appears to be placed below the 5 foot minimum height recommended by the MUTCD (Figure A5-6). Minimum distance for advance warning signs for traffic signal control is 100 feet, though the presence of stopped queues may require additional distance.

Figure A5-6: Conrad Lane at Northbend Road Intersection

Fixed Objects

Clear zone through Conrad lane is generally good with minimum encroachment on ROW from vegetation and other hazards. However, several fixed objects have been noted as shown in **Figure A5-7** near the Boone County Readiness Center. It is also noted that a drainage tile does not appear to exist under the driveway which may lead to water running over the roadway.

Figure A5-7: Conrad Lane Fixed Object

Strike the Gold Drive

Five crashes are recorded at hat the intersection of Strike the Gold Drive, including 3 rear end crashes and 2 angle crashes. It is noted that vegetation and trees east of the intersection may restrict sight distance of approaching traffic, especially for traffic stopped at the stop sign location (**Figure A5-8**).

Figure A5-8: Strike the Gold Drive at Conrad Lane

SIGNING

Several instances of signing were identified that are inconsistent with MUTCD requirements and recommendations, such as the W1-1a sign shown in Figure A5-4. Additionally, “No Outlet” signs are present mounted to the back of stop signs, which can obscure the shape of the stop sign at these locations (**Figure A5-9**).

Figure A5-9: Dual Mounted No Outlet Sign

Recommended Improvements

Recommended Improvements for Conrad Lane include the following:

1. Review signing on 'S' curve to ensure compliance with MUTCD and that vegetation does not obscure visibility of Chevrons.
2. Consider relocation of Signal Ahead sign on Eastbound approach to Northbend Road to move the sign closer to the intersection, as well as increase distance from the 'S' curve to the advanced warning sign to decrease driver load. Standing queues at the intersection should be evaluated prior to relocation of the sign.
3. Remove Fixed objects within 5 feet of the roadside where feasible. If removal is infeasible, the use of Type 2 or Type 3 Object Markers is recommended.
4. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted. When determining horizontal alignment signing needs it is recommended that the prevailing speed of the roadway be considered in addition to the posted speed limit.
5. Review sight distance at Strike the Gold Drive and remove/trim vegetation as necessary.
6. Install a Two-Direction Large Arrow sign (W1-7) at the intersection of Limaburg Road. Consideration should be given to the use of a stop bar at this location due to the high volume and high speed of the intersecting roadway.

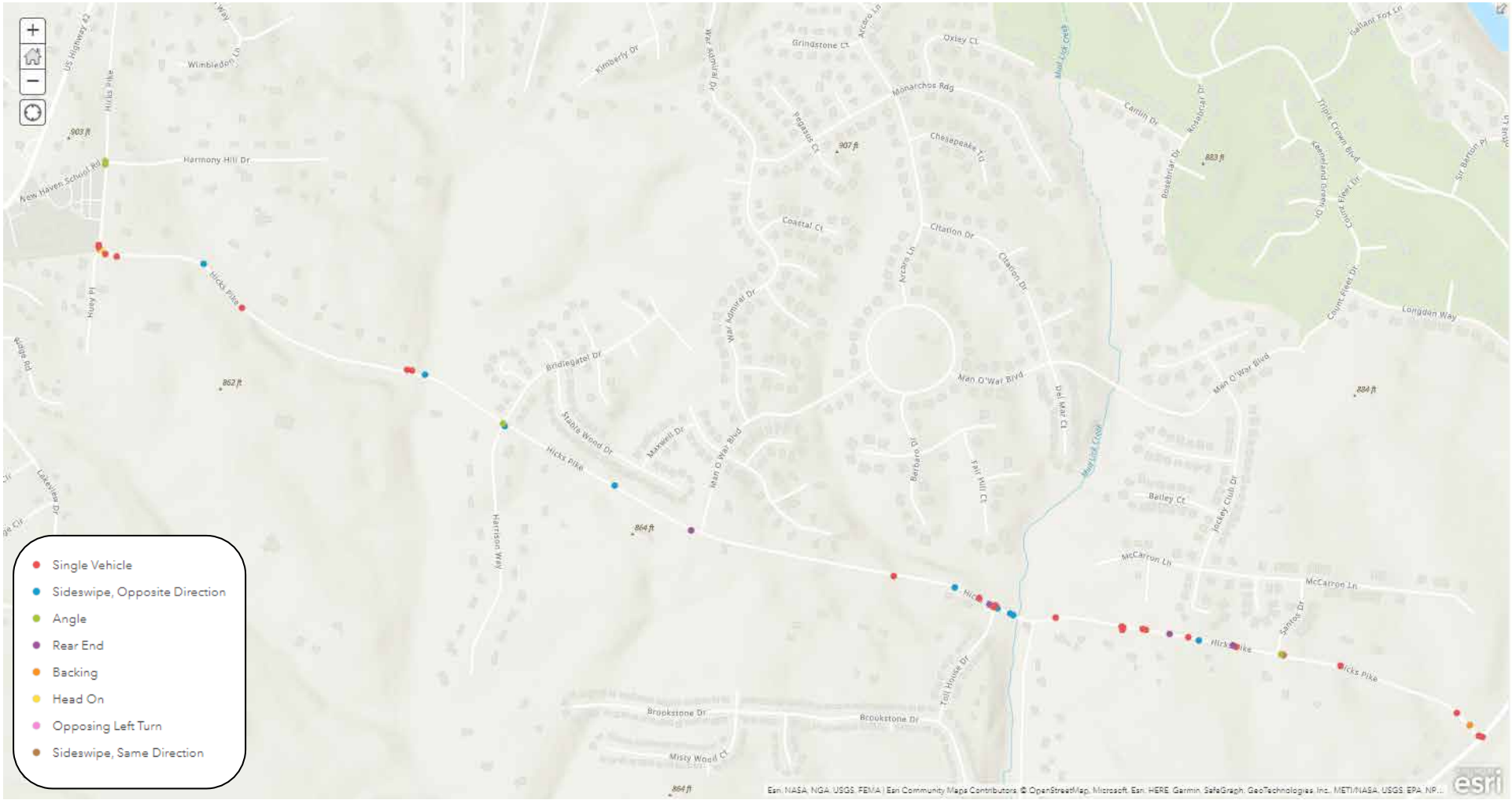
HICKS PIKE

Existing Conditions

Hicks Pike (CR 1151) is a county roadway which provides connects KY 338 to US 42. It provides alternative access to the Triple Crown subdivision and also provides access to New Haven Elementary School The roadway is approximately 2.4 miles long and typically 19-20 feet wide. An ADT is not available for Hicks Pike. Edgeline and Centerline markings are present along the entire length of the roadway. Land use varies from rural to residential.

During the 5-year study period, 46 crashes were recorded on Hicks Pike including 8 injury crashes. Twenty-five (25) of the crashes were single vehicle crashes , 12 of which were fixed object crashes. The next highest crash type was opposite direction sideswipe, accounting for 9 crashes. These crashes are shown in **Figure A6-1**. As can be seen from the figure, the majority of crashes are concentrated on the eastern portion of the corridor east of Man O' War Blvd, though a small concentration of crashes is also seen at the 90 degree turn near New Haven School.

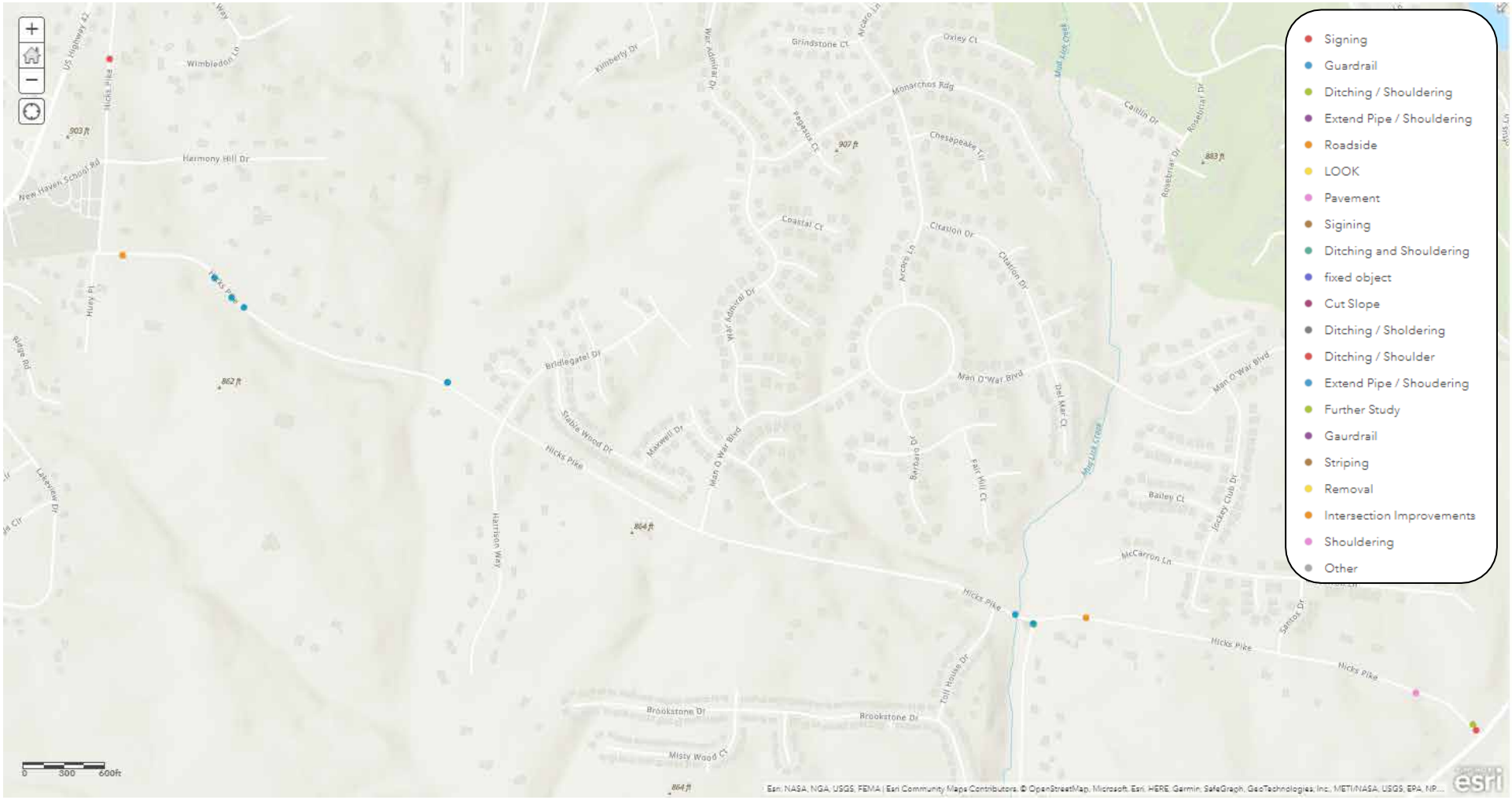
Figure A6-1: Hicks Pike Crash Data (2016-2020)



Contributing Factors

A field review of Hicks Pike was conducted and identified several issues along the roadway which are located in Figure A6-2. Each of these issues is discussed below.

Figure A6-2: Identified Roadway Hazards



90 Degree Turn Near New Haven Elementary

Six crashes have occurred at the 90 degree turn near New Haven Elementary. Five of the six crashes were single vehicle crashes and 1 was a head on crash. Horizontal alignment signing with reflective post strips is present at the intersection as shown in **Figure A6-3**.

Figure A6-3: 90 Degree Turn Near New Haven Elementary

A pedestrian crossing sign is also present at the apex of the curve adjacent to a utility pole (**Figure A6-4**). Several signs, including the Large Arrow Sign at the turn also appear to be undersized (Figure A6-4). Additionally, The intersection of Huey Place and a residential driveway at this location further complicate the signing and geometrics of the curve. From the north only two chevrons are present at the turn, primarily oriented towards the tangent of the roadway. It is also noted that gravel from one of the driveways is present on the roadway which could contribute to loss of control crashes (**Figure A6-5**).

Figure A6-4: 90 Degree Turn Near New Haven Elementary

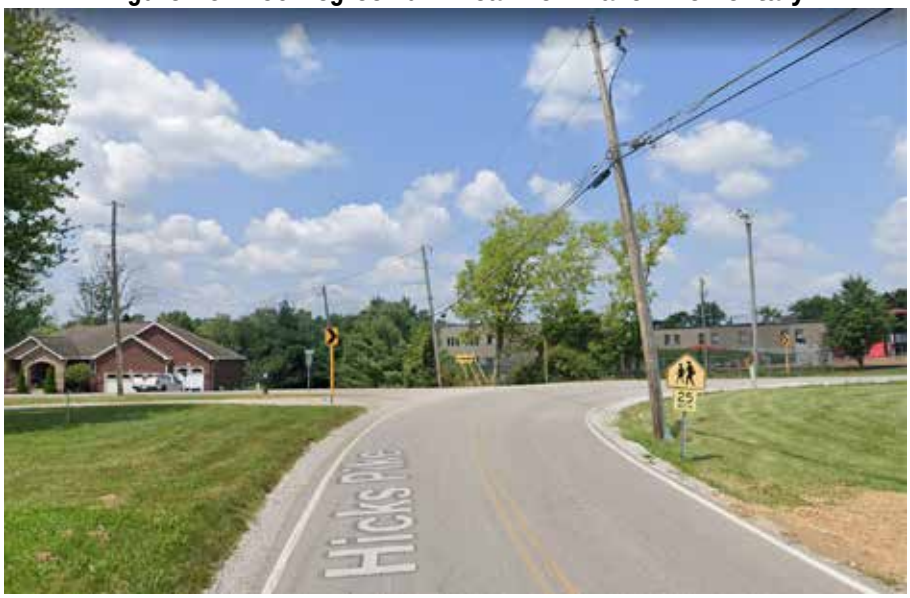


Figure A6-5: Hicks Pike 90 Degree Turn Southbound Approach.

New Haven School Road

Two angle crashes are present on New Haven School Road, opposite Harmony Hill Road. The wide entrance to New Haven School Road is necessary due to the grade of the approach and turning bus traffic, but also complicates the geometry of the intersection. Further New Haven School Road is relatively narrow (18 feet) and the significant widening at the intersection, may make the intended vehicle path difficult to discern (Figure A6-6).

Figure A6-6: Hicks Pike at New Haven School Road

Culvert West of Harrison Road.

A culvert over an unnamed creek west of Harrison Road presents a significant drop off on both sides of the roadway (Figure A6-7). Three crashes are present at this location, including 2 single vehicle crashes and 1 sideswipe opposite direction crash. Guardrail is present, but does not appear to be at proper height or provide crashworthy end treatments and provide minimal offset from the traveled way.

Figure A6-7: Culvert on Hicks Pike west of Harrison Road.

Tollhouse Road at Hicks Pike

Sight distance is restricted to the west on Hicks Pike due to the presence of a slight horizontal curve and vegetation (**Figure A6-8**).This location is the site of 9 crashes including sideswipe, rear end and single vehicle crashes. The eastbound approach is downgrade and prevailing speeds along the roadway were observed to exceed the posted speed limit, which may lengthen stopping sight and intersection sight distance requirements at this location. Vegetation can also limit the visibility of the intersection when approaching from the west (**Figure A6-9**).

Figure A6-8: Sight Distance to the west from Tollhouse Road

Figure A6-9: Sight Distance approaching Tollhouse Road

Richwood Church Road

A building located in the northwest quadrant of the intersection of Hicks Pike and Richwood Church Road provides minimal setback and separation from both roadways. The building also presents a sight distance restriction for vehicle turning from Richwood Church Road. Guardrail has been installed and on the opposite side of the roadway which presents a narrowing of the roadway. Centerline markings appear worn at this location, likely due to vehicles shying away from the guardrail and encroaching on the centerline. Two sideswipe opposite direction crashes are present at near location. Guardrail on the

north side of the road also does not provide a crashworthy end treatment.

Figure A6-9: Narrowed Roadway near Richwood Church Road

Richwood Church Road to Richwood Road.

Edge drop offs were identified along Hicks Pike, but appear to have been repaired with DGA shouldering and partial width pavement repairs (**Figure A6-10**).

Figure A6-10: Before/After of Edge Drop off and Pothole Repairs along Hicks Pike .

Hicks Pike at Richwood Road

The intersection of Hicks Pike at Richwood Road is a stop controlled 'T' intersection with stop control on Hicks Pike. Two single vehicle crashes are present at the intersection. A Stop ahead sign is present 320 feet away from the intersection within the limits of a horizontal curve (**Figure A6-11**). The stop ahead sign appears below the minimum 5-foot sign height recommended by the MUTCD.

Figure A6-11: Hicks Pike Approach to Richwood Road

Fixed Objects

The primary fixed objects on the corridor are utility poles, located a minimum distance from the roadway as shown in **Figure A6-12**. Fixed objects, especially those on the outside of horizontal curves have the potential to increase the frequency and severity of crashes for vehicles departing the roadway.

Figure A6-12: Utility Pole Locations on Hicks Pike

Vegetation

Vegetation along the roadway can become overgrown and present a visual narrowing of the roadway (**Figure A6-13**). This may also restrict sight distance around curves, at intersections and obscure singing

Figure A6-13: Vegetation along Hicks Pike

Guardrail

Several instances of guardrail are present on Hicks Pike as shown in **Figure A6-14**, and appear to not meet minimum guardrail height requirements, or provide crash worthy end treatments. **Figure A6-15** shows typical guardrail installations along the corridor.

Figure A6-14: Guardrail Locations along Hicks Pike

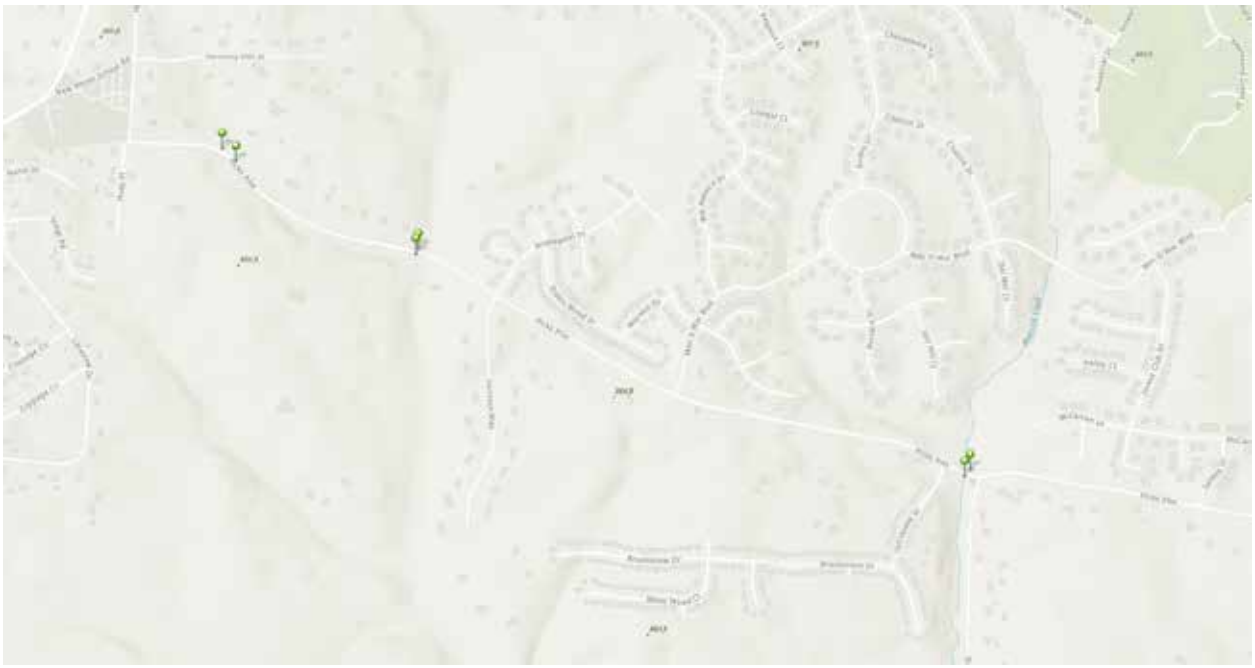


Figure A6-15: Hicks Pike Typical Guardrail Installations

Recommended Improvements

Recommended Improvements for Hicks Pike include the following:

1. 90 Degree Turn near New Haven Elementary School
    a. Relocate Utility Pole and provide curve widening to mitigate head-on and single vehicle crashes.
    b. Improve signing to provide additional chevrons and/or large arrow signs
    c. Consider paving the gravel driveway within right-of-way near the turn to limit gravel on roadway.
2. Consider providing centerline markings and a stop bar along New Haven School Road to delineate the intended vehicle path entering and exiting the intersection as shown in Figure A6-16, below.

Figure A6-16: Conceptual Pavement Marking Improvement at New Haven Road

3. Extend or replace culvert west of Harrison Road to provide improved shy distance from traveled way to guardrail face. Upgrade guardrail height/end treatment to meet minimum crashworthy standards.
4. Richwood Church Road Intersection
    a. Reconfigure guardrail on southside of roadway near building to increase setback from roadway. Current placement is 10 feet from the building, this may be decreased to 5 feet maintain clear zone for guardrail deflection while minimizing roadside obstructions.
    b. Remove guardrail on north side of roadway as it does not appear to meet barrier considerations from the AASHTO Roadside Design Guide.
    c. Consider long term plan to remove building from corner of Richwood Church Road
5. Clear Roadside vegetation on the eastbound approach to Tollhouse Road to provide adequate intersection sight distance. It is recommended that intersection sight distance be established based on the 85th percentile speed on the roadway and not the posted speed limit.
6. Relocate Stop Ahead Sign at Richwood Road approach to remove from the horizontal curve on the approach. Install a two-direction large arrow (W1-7) opposite Richwood Road at the 'T' intersection.
7. Remove fixed objects including utility poles within 5 feet of the roadside especially on the outside of the curves if feasible. If it is infeasible to remove or relocate fixed objects, they should be delineated with type 2 or type 3 object markers.
8. Clear Roadside vegetation along entire roadway to increase sight distance and perceived clear zone.
9. Improve shouldering and edge-drop offs throughout the corridor in addition to those previously addressed.
10. Evaluate existing guardrail locations along the corridor to determine the ultimate need for the guardrail installation, and to ensure necessary installations are properly maintained, at the appropriate height and provide a crash-worthy end treatment.
11. Remove Fixed objects where feasible. If removal is infeasible, the use of Type 2 or Type 3 Object Markers is recommended.

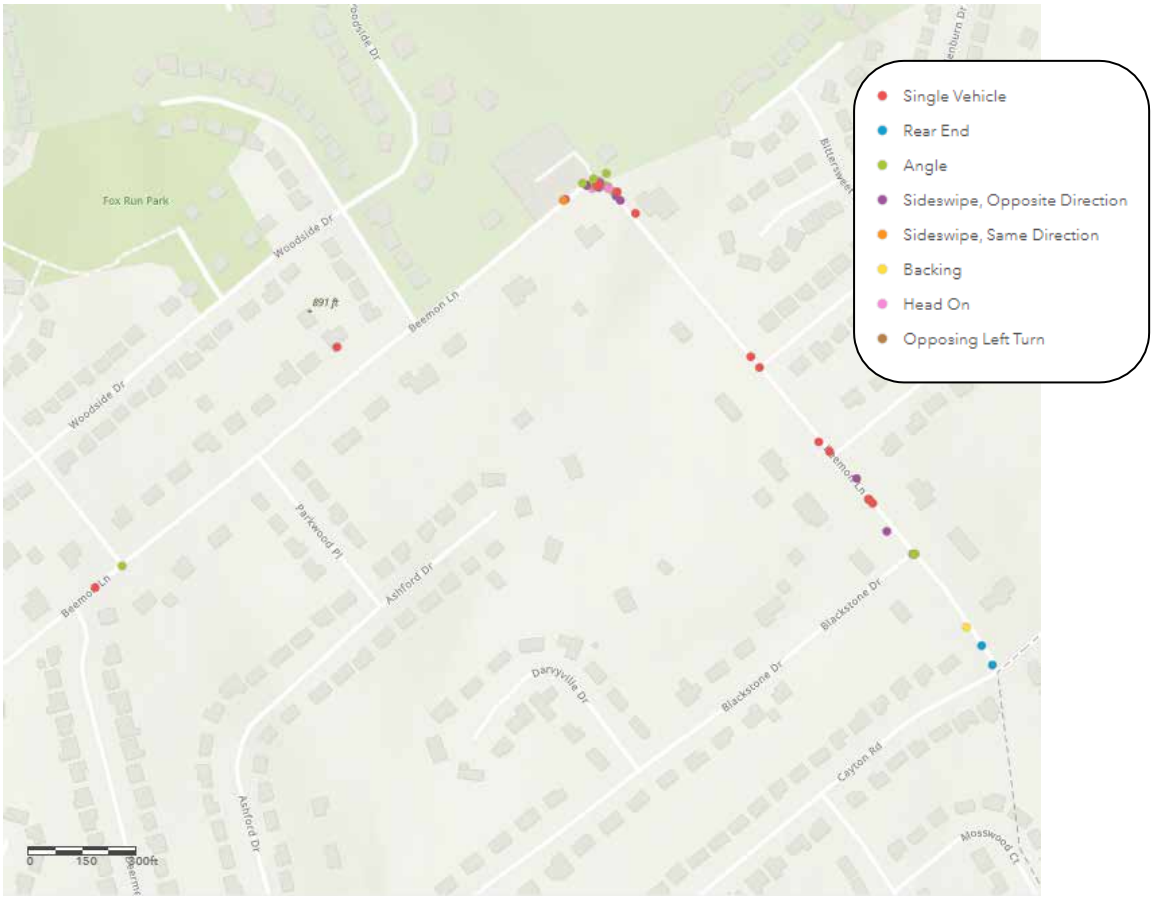
BEEMON LANE

Existing Conditions

Beemon Lane (CR 1016K) is a county roadway which provides serves as a primary collector roadway within the Oakbrook residential development, providing connection to Cayton Road and ultimately Hopeful Church Road (KY 842). The roadway is approximately 0.7 miles long and approximately 20 feet wide. An ADT is not available for Beemon Lane. Edgeline and Centerline markings are present along the entire length of the roadway. Land use is residential with direct access from abutting properties. The speed limit on Beemon Lane is 35 mph.

During the 5-year study period, 50 crashes were recorded on Beemon Lane including 7 injury crashes. Single vehicle crashes were the highest crash type, with 16 crashes. Thirteen (13) of the crashes were angle crashes , followed by sideswipe opposite direction crashes (11 crashes). Head-on crashes represented the highest frequency of injury crashes with 3. These crashes are shown in **Figure A7-1**. As can be seen from the figure, the majority of crashes are concentrated at the 90 degree turn in the middle of the roadway.

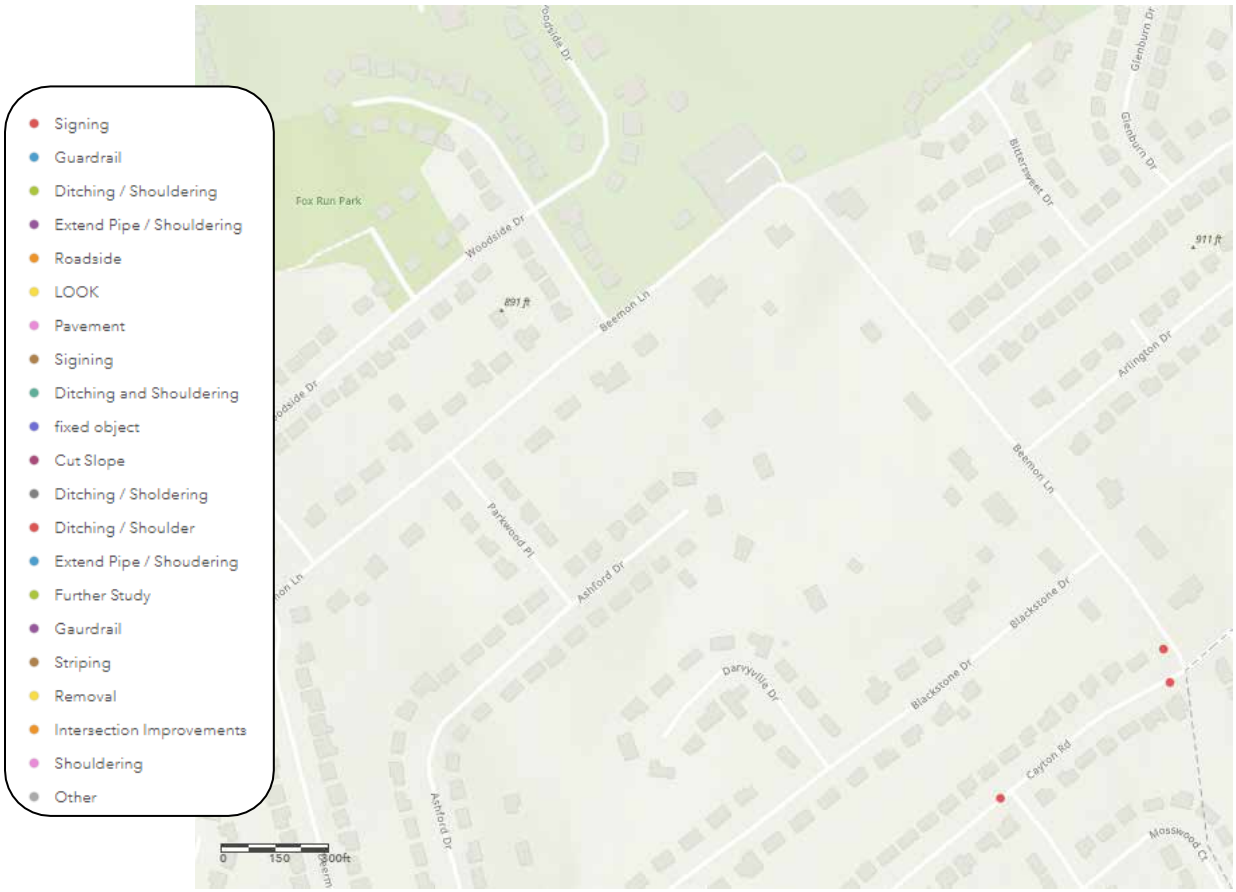
Figure A7-1: Beemon Lane Crash Data (2016-2020)



Contributing Factors

A field review of Beemon Lane was conducted and identified several issues along the roadway which are located in **Figure A7-2**. Each of these issues is discussed below.

Figure A7-2: Identified Roadway Hazards



Horizontal Curve

As identified above the majority of crashes occurred at the 90 degree horizontal curve on Beemon Lane. **Figure A7-3** shows a close up snapshot of crash patterns at this location. While single vehicle crashes are present as would be expected, they are not the predominate crash type at the location, with angle, head-on and sideswipe opposite direction crashes have a higher frequency. All crashes at this location occurred under wet pavement conditions.

A high friction surface treatment was applied in 2020. During 2021, not crashes were recorded at this location. The high friction surface treatment and eastbound approach to the curve is shown in **Figure A7-4.**

Figure A7-3: Beemon Lane Horizontal Curve Crashes

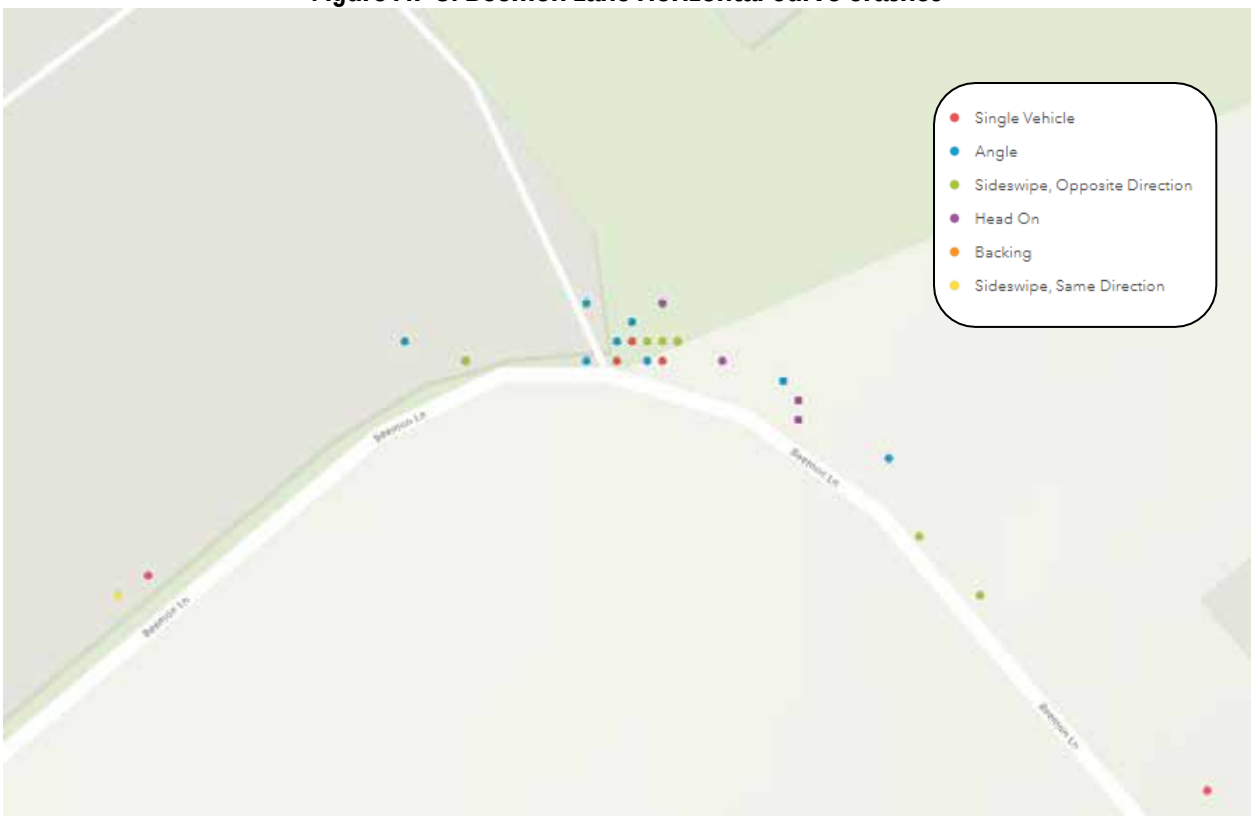


Figure A7-4: Beemon Lane Horizontal Curve Eastbound Approach

Speed

Several crashes also occurred between the horizontal curve and the intersection with Cayton Road. This section of roadway is residential in nature with direct access driveways and intersections with adjacent streets. The speed limit is 35 mph which may not be reflective of the surrounding context and direct driveway access.

Cayton Road Intersection

Signing at the intersection with Cayton Road has been vandalized and/or compromised through impacts (**Figure A7-5**). Three crashes have occurred near the intersection including 2 rear end crashes 1 resulting from a vehicle backing out of a driveway.

Figure A7-5: Intersection Signing (Beemon Lane at Cayton Road)

Recommended Improvements

Recommended Improvements for Beemon Lane include the following:

1. Continue to monitor crash experience at Horizontal Curve after installation of the High Friction Surface Treatment. If crashes are shown to increase, consider curve widening within the available pavement section to address head-on, angle and sideswipe crashes as shown in **Figure A7-6**.

Figure A7-6: Conceptual Curve Widening on Beemon Lane

12. Conduct a speed study using the methodology in the FHWA USLIMITS program to evaluate the appropriateness of the 35 mph speed limit on Beemon Lane in light of the crash history and adjacent land use and access density.
13. Replace signing at the intersection of Beemon Lane and Cayton Road to replace damaged signs.

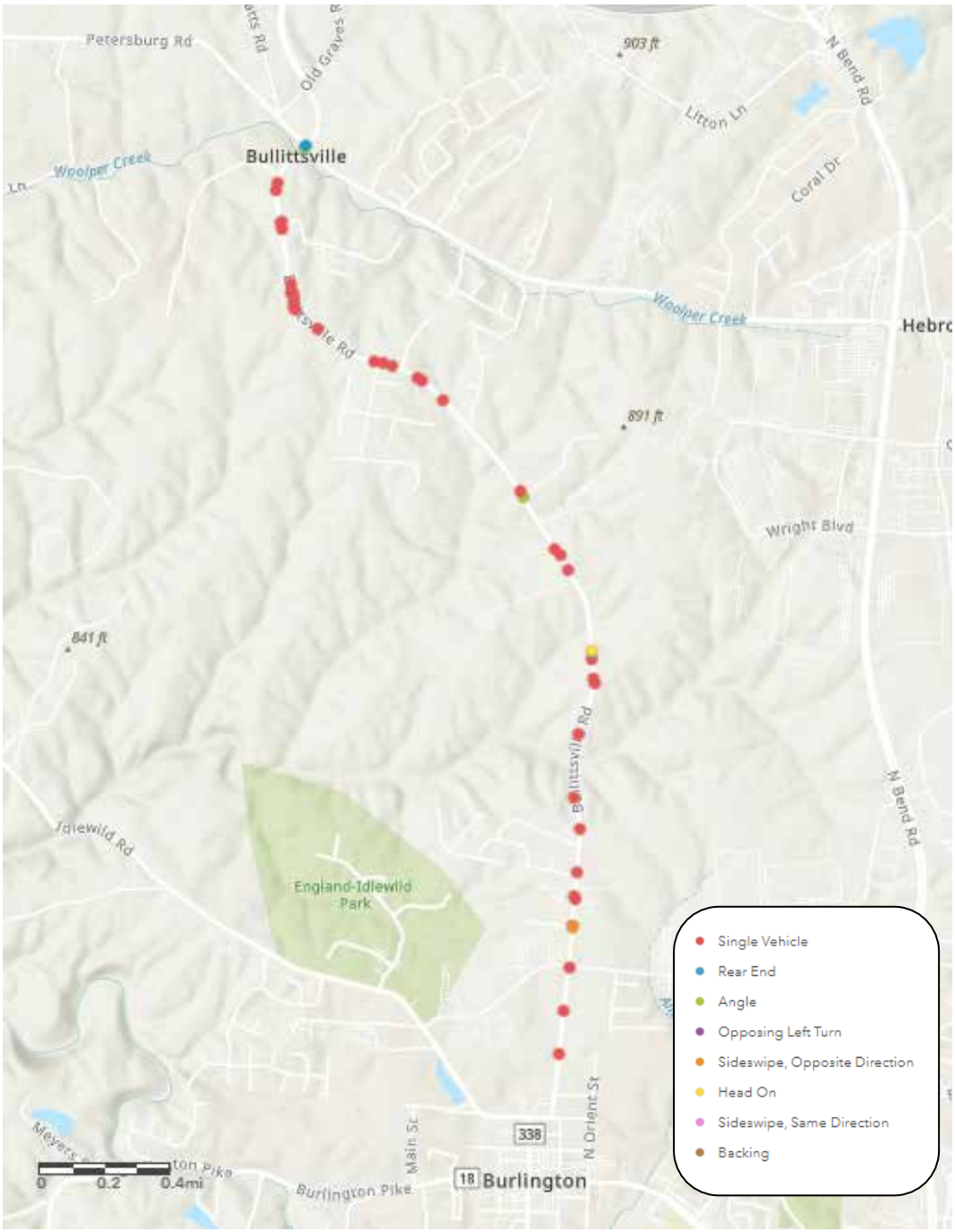
BULLITSVILLE ROAD

Existing Conditions

Bullitsville Road (CR 1052) is a county roadway which runs north out of Burlington to connect with Petersburg Road, and ultimately Hebron and I-275. The roadway is approximately 3.5 miles long and approximately 20 feet wide. An ADT of 2,197 was recorded by a KYTC count station south of Conrad Lane. Edgeline and Centerline markings are present along the entire length of the roadway. Land use is residential with direct access from abutting properties. The speed limit on Bullitsville Road varies from 25 near Burlington, to 35 mph and ultimately 45 mph north of Conrad Lane.

During the 5-year study period, 43 crashes were recorded on Bullitsville Road including 4 injury crashes. Single vehicle crashes were the highest crash type, with 37 crashes, 13 of which involved collision with a fixed object. 10 crashes were collisions with animals. These crashes are shown in **Figure A8-1**.

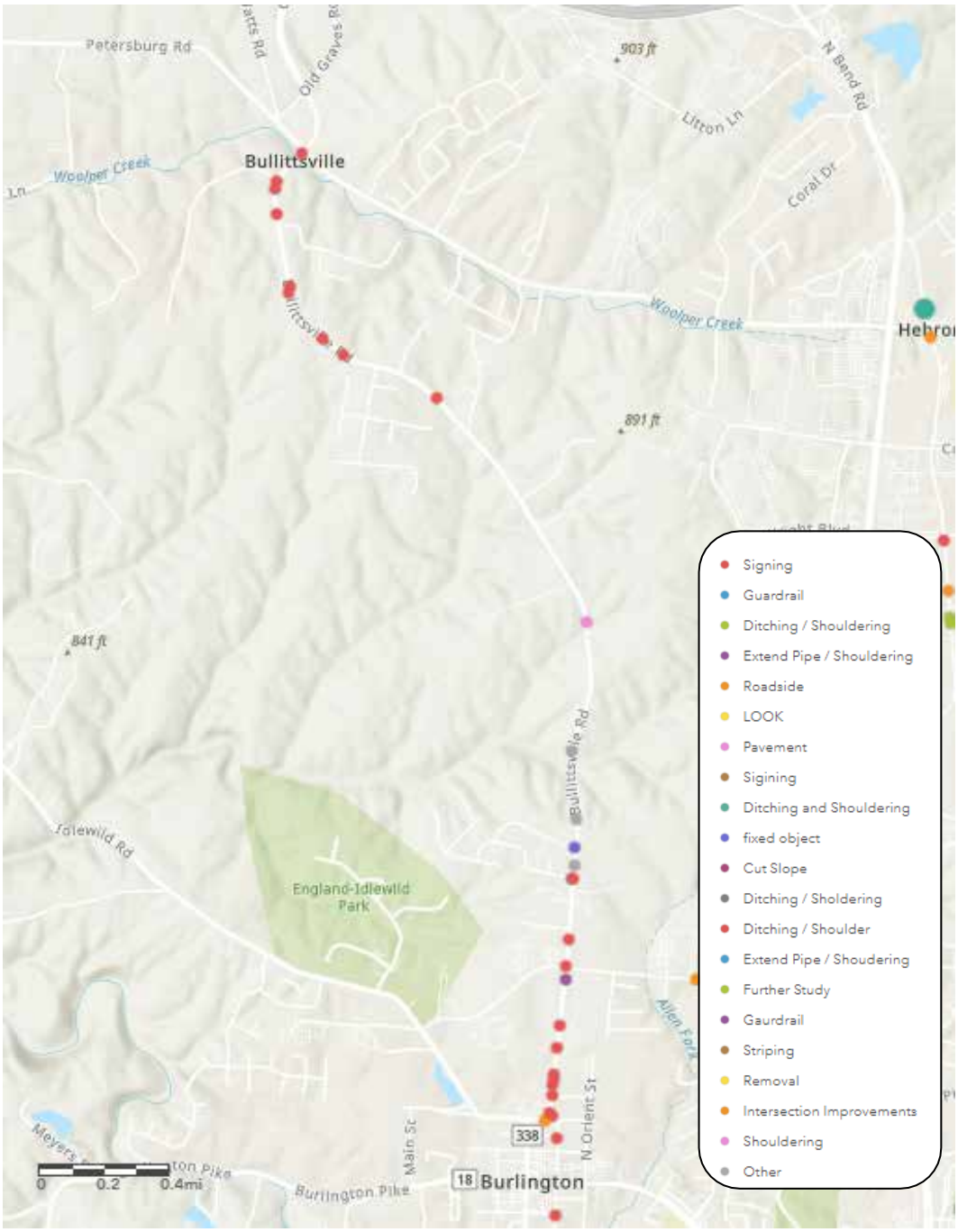
Figure A8-1: Bullitsville Road Crashes (2016-2020)



Contributing Factors

A field review of Bullitsville Road was conducted and identified several issues along the roadway which are located in **Figure A8-2**. Each of these issues is discussed below.

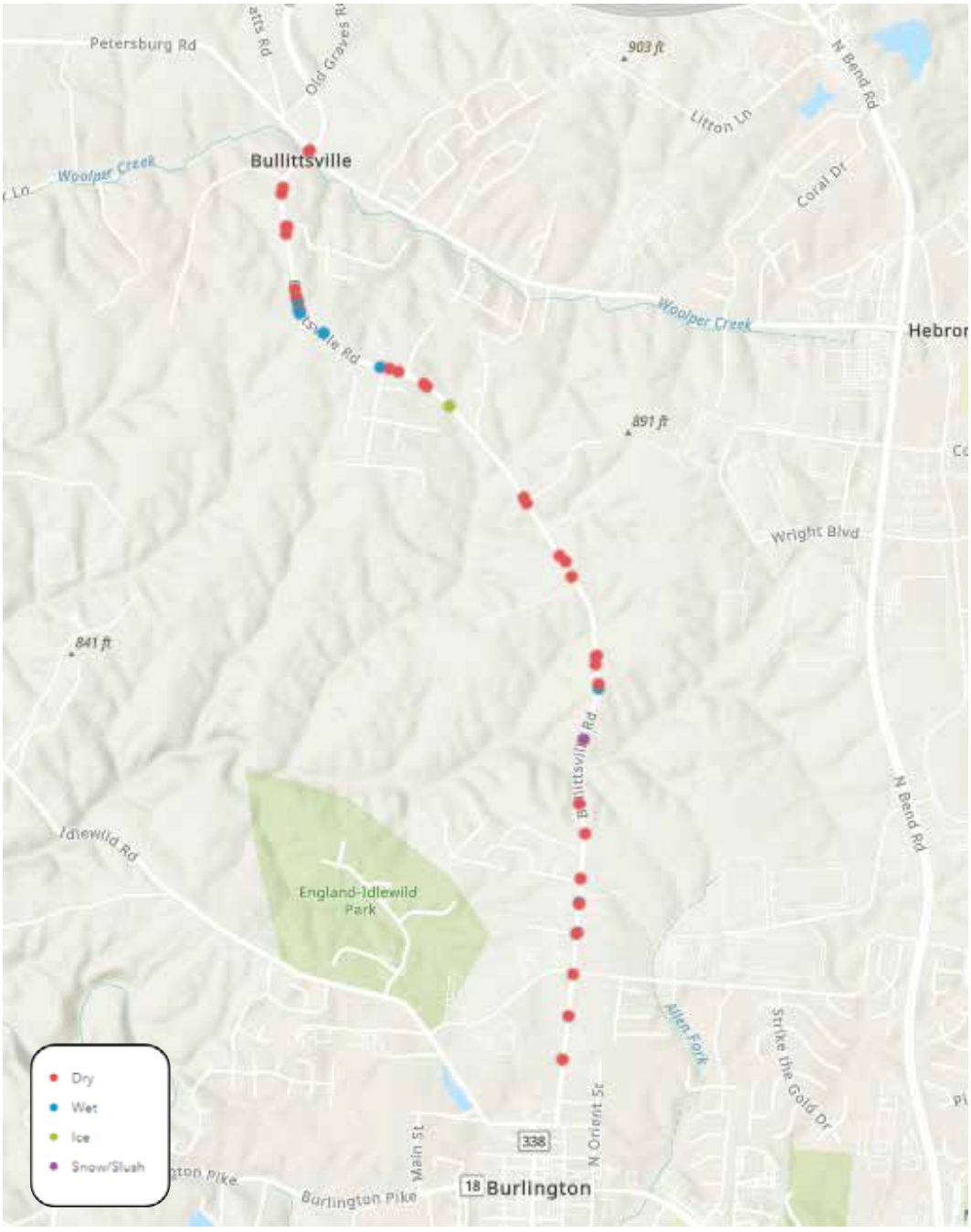
Figure A8-2: Identified Roadway Hazards



Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A8-3**. Only one area is shown to have a small concentration of wet road crashes, indicated in blue in the figure. These are between Cornerstone Drive and Brents Way where 7 out 10 crashes involved wet pavement.

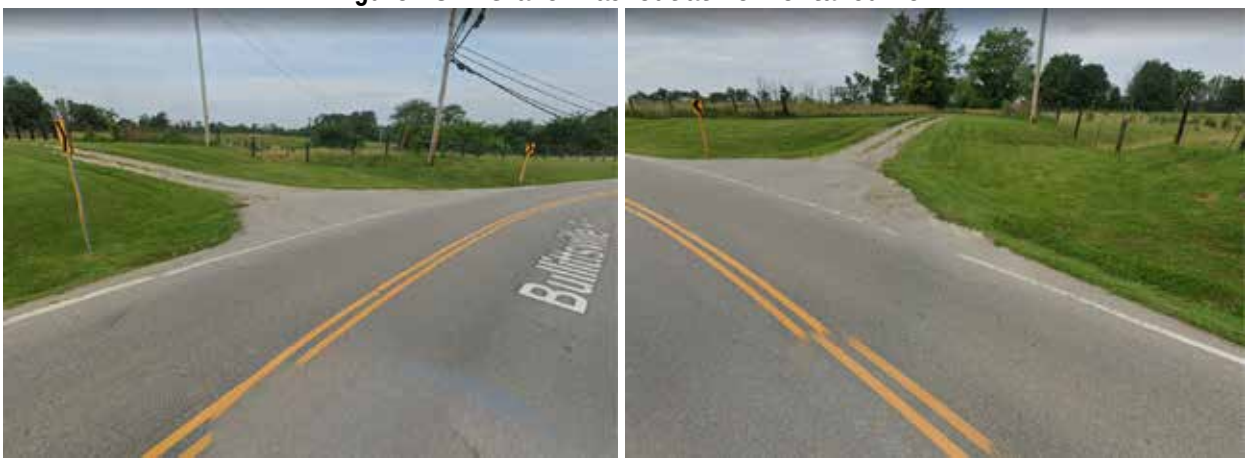
Figure A8-3: Crashes by Roadway Condition



Potential drainage issues were identified in the field review at this location resulting from a farm entrance that appears to have blocked drainage culvert. Washed out gravel from the drive was present,

which may be indicative of water running over the driveway (Figure A8-4).

Figure A8-4: Gravel washout at Horizontal Curve



Horizontal Curve Near Brents Way

The horizontal curve west of Brent's way provides a sharp drop off due to the superelevation of the curve. Advanced curve signing is present, but chevrons are not (**Figure A8-5**).

Figure A8-5: Horizontal Curve near Brent's Way

Bullitsville Road at Temperate Street

The intersection of Bullitsville Road is a skewed/offset intersection that presents challenges to drivers when negotiating. Temperate Street intersection Bullitsville Road at stop controlled approaches in the middle of an 'S' Curve. No control is present on Bullitsville Road (**Figure A8-6**). Three crashes were recorded at the intersection during the study period (**Figure A8-7)**. It is noted that no horizontal alignment signing is present through the 'S' Curve. A horizontal alignment sign (**Figure A8-8**) is present 275 to 325 feet in advance of the curve on Bullitsville Road. **Figure A8-9** shows the approaches to the intersection from the North, West, East and South.

Figure A8-6: Crashes at Bullittsville Road/Temperate Street

Figure A8-7: Crashes at Bullittsville Road/Temperate Street

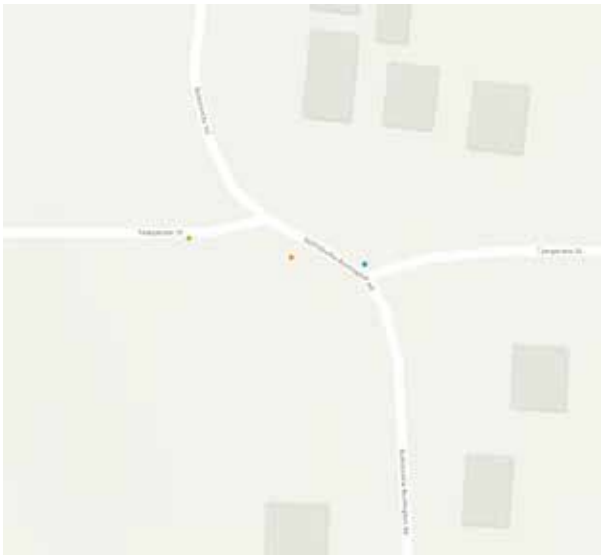


Figure A8-8: Horizontal Alignment Signing Approaching 'S' Curve

Figure A8-9: N, E, S, W approaches to Bullitsville Rd/Temperate Street

Sign Consistency

Signing along the corridor is well placed and provides sufficient information, however, inconsistencies in placement, installation and maintenance are present. **Figure A8-10** shows the following issues:

1. "Stop Ahead Sign" appears below 5 ft minimum height near Millakin Place (symbol faded)
2. "No Outlet" sign mounted to back of Stop Sign obscuring sign shape.
3. "Stop Sign" sheeting faded and vandalized at Petersburg Road
4. "Speed Limit Sign" mounted on left side of road south of Cornerstone Drive
5. Curve Sign too Small (3514 Bullitsville Road)

Figure A8-10: Sign Installations on Bullitsville Road

Speed Limit Consistency

In addition to the sign installation consistency, speed limit signs on the southern end of the corridor near the Temperate/Garrard Street intersection are inconsistent with a 25 mph speed limit northbound and a 20 mph speed limit with a 15 mph advisory speed southbound. **Figure A8-11** shows the speed limit signs in this area.

Figure 8-11: Speed Limit Signing on Bullittsville Rd between Conrad Ln and Temperate St.

Guardrail

Several instances of guardrail are present on Bullitsville Road as shown in **Figure A8-12**, and appear to not meet minimum guardrail height requirements, or provide crash worthy end treatments. **Figure A8-13** shows typical guardrail installations along the corridor.

Figure A8-12: Guardrail Locations on Bullitsville Road

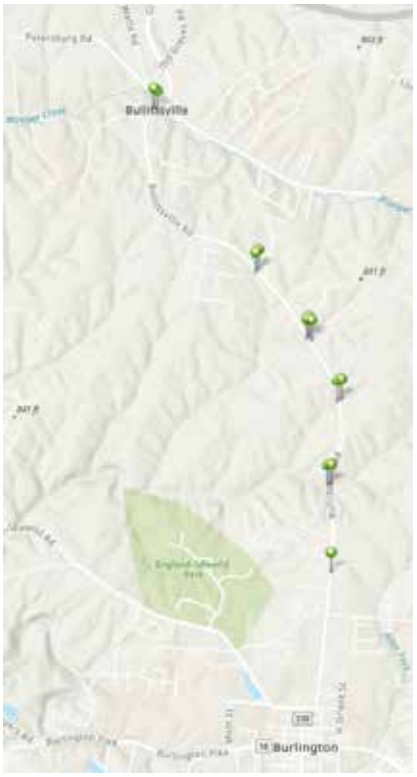


Figure A8-13: Typical Guardrail Installations on Bullitsville Road

Fixed Objects

Fixed objects within the right of way of Bullitsville Road are also present throughout the corridor. Several of these, including in the vicinity of Federalist Trail appear to be easily removed (**Figure A8-14**). Fixed objects, especially those on the outside of horizontal curves have the potential to increase the frequency and severity of crashes for vehicles departing the roadway.

Figure A8-14: Fixed Objects near Federalist Trail

Recommended Improvements

Recommended Improvements for Waterworks Road include the following:

1. The areas identified as having higher frequency wet-weather crashes should be observed during rain events to determine if drainage in the area and/or sheet flow presents an increased hazard for crashes. If drainage is determined to be sufficient, friction tests should be conducted to determine if additional treatments such as HFST would be warranted.
2. Consider the installation of chevrons or post delineators to delineate the horizontal alignment of the curve near Brent's Way.
3. Temperate/Garrard Street Intersection
    a. Install Stop Bars on Temperate Street Approaches.
    b. Consider the installation of Horizontal Alignment signing, such as a Large One-Direction Arrow on the
    c. Horizontal Advanced Warning Signs should be relocated closer to the 'S' Curve, near the location of the existing speed limit signs. Minimum MUTCD sign placement is 100 feet.
4. Review all signing on corridor and document sign type, location, post type and condition within a sign management database. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted. Advanced warning signs should be checked for placement to ensure that warning signs are not placed too far in advance of hazardous conditions (Recommended no greater than 100 feet greater than MUTCD minimum distance).
5. Review speed limits on the corridor to provide consistent speed and messaging along the roadway.
6. Evaluate existing guardrail locations along the corridor to determine the ultimate need for the guardrail installation, and to ensure necessary installations are properly maintained, at the appropriate height and provide a crash-worthy end treatment.
7. Remove Fixed objects within 5 feet of the roadside where feasible. If removal is infeasible, the use of Type 2 or Type 3 Object Markers is recommended.

CAYTON ROAD

Existing Conditions

Cayton Road Lane (CR 1016J) is a county roadway which serves as a primary collector roadway within the Oakbrook residential development and connects to Hopeful Church Road (KY 842) and retail areas along Mall Road and Florence Square. The roadway is approximately 1.8 miles long and approximately 24 feet wide west of Hopeful Church Road and 28 feet wide east of Hopeful Church Road. An ADTof 7,309 was recorded by a KYTC count station east of Hopeful Church Road. Edgeline and Centerline markings are present along the entire length of the roadway. Land use is primarily residential with direct access from abutting properties, but transitions to commercial on the east end of the roadway. The speed limit on Cayton Road is 35 mph.

During the 5-year study period, 106 crashes were recorded on Cayton Road including 18 injury crashes. Angle crashes were the highest crash type, with 35 crashes, followed by rear end crashes with 34. These crashes are shown in **Figure A9-1**. As can be seen from the figure, the majority of crashes are concentrated at Hopeful Church Road and at the approaches and intersections to retail areas at Florence Square and Mall Road.

Figure A9-1: Cayton Road Crash Data (2016-2020)

Contributing Factors

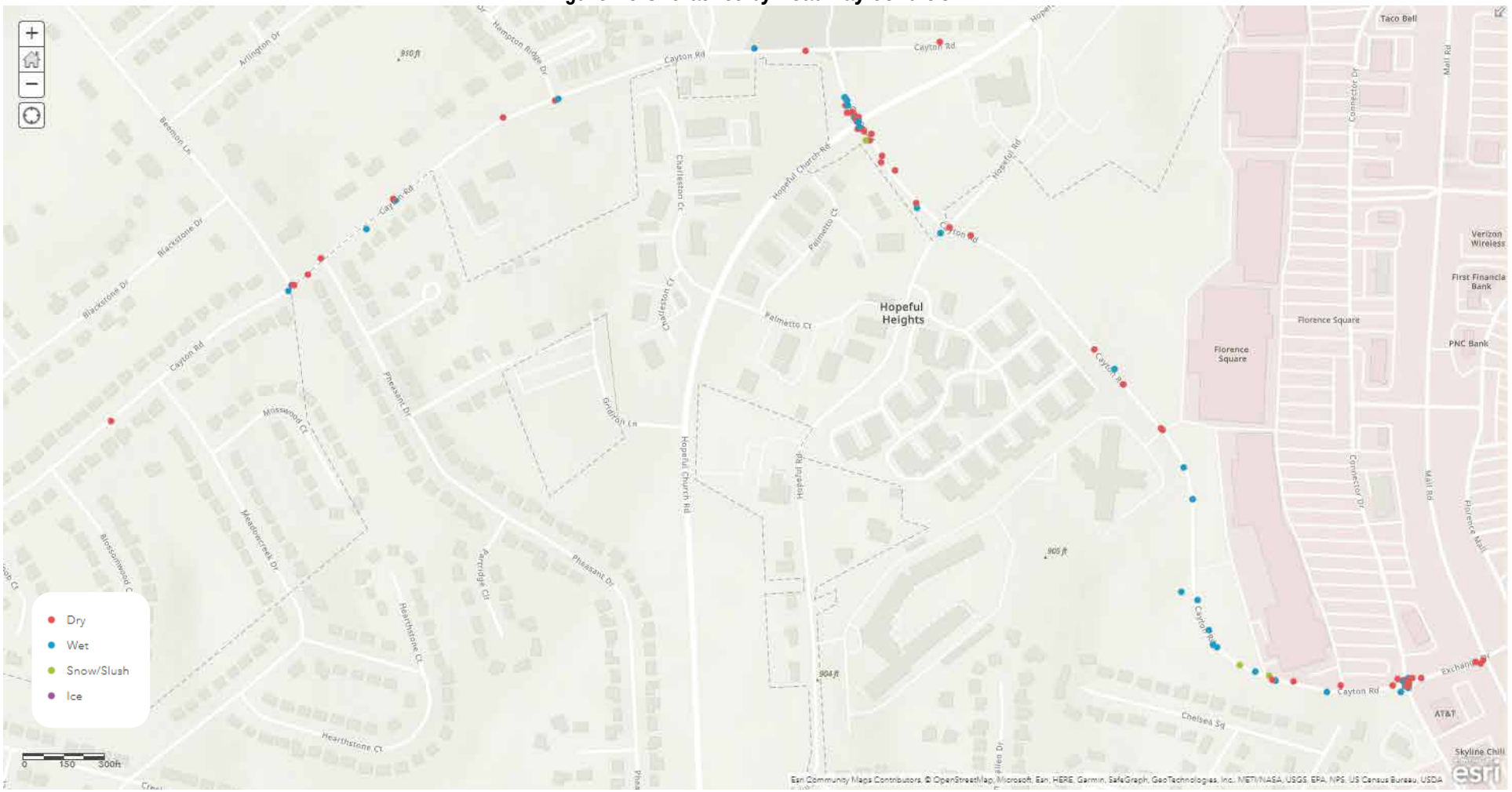
A field review of Cayton Road was conducted and identified several issues along the roadway which are located in Figure A3-2. Each of these issues is discussed below.

Figure A5-2: Identified Roadway Hazards

Wet Weather Crashes

A review of road conditions for all crashes was conducted to determine if wet conditions contributed to crashes in the area. This review is shown in **Figure A9-3**. Only one area, directly behind Florence Square, is shown to have a small concentration of wet road crashes, indicated in blue in the figure. In this area 14 out of 16 crashes involved wet pavement or snow/slush covered roadways.

Figure A9-3: Crashes by Roadway Condition



Potential drainage issues were identified in the field review at this location resulting from sheet flow from the rear parking area of the retail buildings flowing onto Cayton Road at the driveway access shown in Figure **A9-4**. A drainage ditch is present along this parking area, but vegetation appears that it may prevent drainage to the ditch instead following the flow of the pavement (**Figure A9-5**).

Figure A9-4: Rear Entrance to Florence Square

Figure A9-5: Drainage Ditch between Florence Square and Retail Acess

Catyon Road at Hopeful Church Road

Several crashes are present at the intersection of Cayton Road and Hopeful Church Road, which is a signal controlled intersection. The north leg of Cayton Road approaches through a sharp curve to the resulting from realignment of Cayton Road, due to the reconstruction of Hopeful Church Road **(Figure A9-6)**. Signal head visibility is limited approaching the intersection the north due to the roadway curvature (**Figure A9-7**). It is also noted that the signal ahead warning sign is oriented perpendicular to the roadway in the approach curve, and not oriented toward approaching traffic.

Figure A9-6: Cayton Road at Hopeful Church Road

Figure A9-7: Cayton Road Approaching Hopeful Church Road from the North

Cayton Road at Connector Road

Several Crashes have also occurred at the intersection of Cayton Road and Connector Road, the majority of which are angle crashes (**Figure A9-8**). The intersection is stop controlled, with control on three approaches, but traffic entering from the east from Mall Road does not stop in order to prevent queuing back to the primary intersection. Entering traffic has 2-through lanes which also accommodate right and left turning traffic. This configuration creates an offset of left turning traffic on Cayton Road as shown in **Figure A9-9**.

Figure A9-8: Cayton Road at Connector Road Crashes

Figure A9-9 Cayton Road at Connector Road Intersection Configuration

Supplemental plaques are present on the stop-controlled approaches indicating that incoming traffic does not stop (**Figure A9-10**).

Figure A9-10: Stop Control on Cayton Road and Connector Road

Recommended Improvements

Recommended Improvements for Waterworks Road include the following:

1. Cayton Road at Hopeful Church Road
    a. Consider near side signal head and side mounted lane use sign to provide direction to vehicles as sight distance to signal is restricted on southbound approach of Cayton Road.
    b. Relocate and/or reorient signal ahead sign so that it is visible prior to location.
    c. Install back plates to increase conspicuity of signal heads.
2. Cayton Road at Connector Road
    a. Reconfigure westbound Cayton Road to a through-right lane and an exclusive left turn lane to avoid confusion intended traffic destination and align left turns on Cayton Road as shown in **Figure A9-11**. Provide left turn lane pavement markings for northbound Connector Road.

Figure A9-11: Proposed Reconfiguration of Cayton Road and Connector Road

    b. Long term solutions for the intersection may include reconfiguration of the intersection to reduce size and clarify intended vehicle paths. Alternative intersection designs such as a modern roundabout or turn restrictions may also be considered, though any alternatives should consider interactions with adjacent intersections, traffic signals and business access.
    c. Modify supplemental plaques on Cayton Road and Connector Road to current MUTCD standard signs (W4-4bP and W4-4aP) (**Figure A9-12**)

Figure A9-12: Stop Sign Supplemental Plaques W4-4bP and W4-4aP

ELIJAH CREEK ROAD

Existing Conditions

Elijah Creek Road (CR 1052) is a county roadway which runs east-west on the northside of the Cincinnati Northern Kentucky International Airport. The roadway runs parallel to and connects with Petersburg Road in the east and connects with Limaburg Road and North Bend Road to the west. Elijah Creek also provides an crossing point under I-275. The roadway is approximately 2.1 miles long and approximately 20 feet wide. An ADT is not available for Elijah Creek Road. Edgeline and Centerline markings are present along the entire length of the roadway. Land use is primarily residential and rural west of the I-275 underpass and industrial to the east. The speed limit is 35 mph.

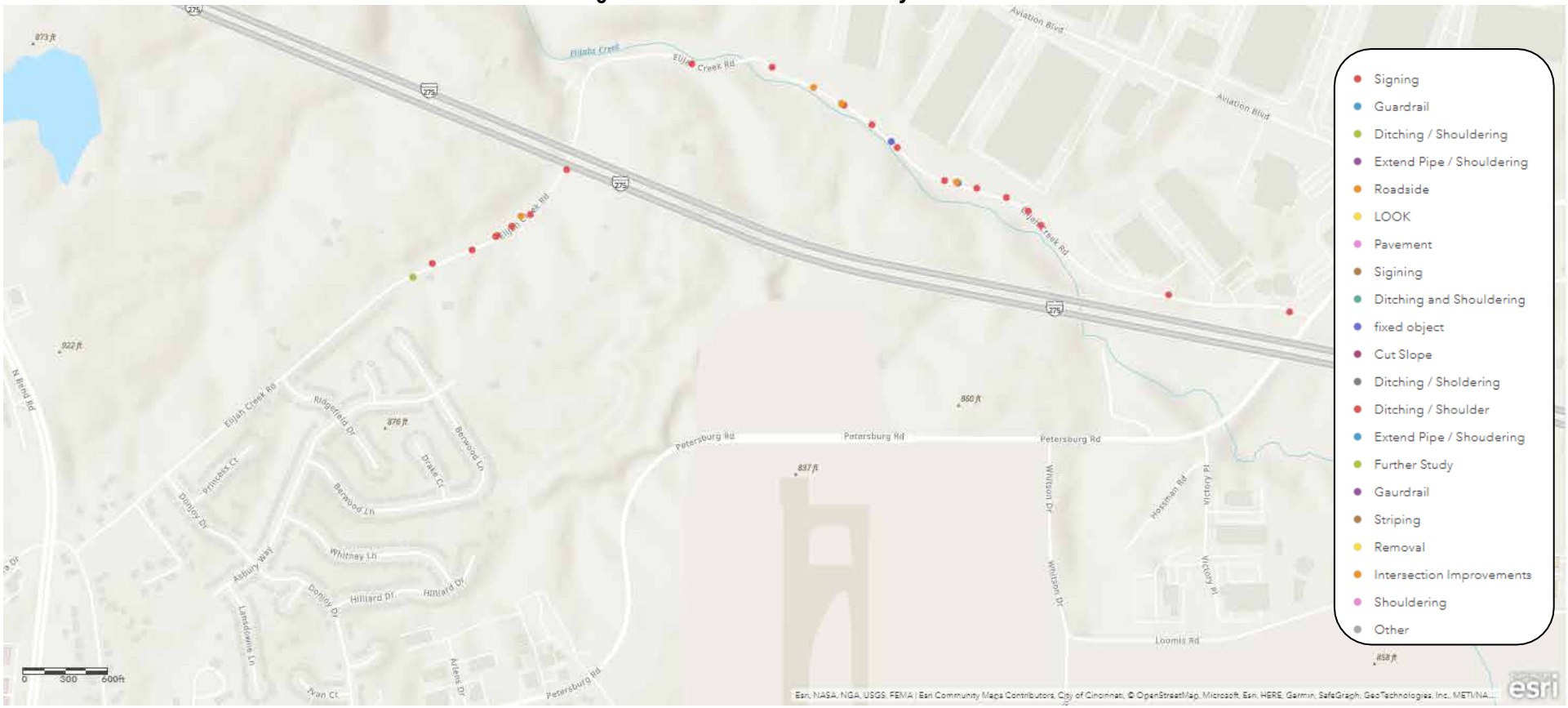
During the 5-year study period, 8 crashes were recorded on Elijah Creek Road including 1 injury crash. Single vehicle crashes were the highest crash type, with 6 crashes, 13 of which involved collision with a fixed object. These crashes are shown in **Figure A10-1**. As can be seen from the figure crashes are scattered throughout the corridor.

Figure A10-1: Elijah Creek Road Crash Data (2016-2020)

Contributing Factors

A field review of Elijah Creek Road was conducted and identified several issues along the roadway which are located in Figure A10-2. Each of these issues is discussed below.

Figure A10-2: Identified Roadway Hazards



Guardrail

Twelve guardrail installations primarily on the eastern portion of Elijah Creek Road north of I-275 as shown in **Figure A10-3.** Most installations do not appear to meet minimum guardrail height requirements, or provide crash worthy end treatments. **Figure A10-4** shows typical guardrail installations along the corridor.

Figure A10-3: Guardrail Locations on Elijah Creek Road

Figure A10-4: Typical Guardrail Installations on Elijah Creek Road

In addition to guardrail installations that should be upgraded and/or removed some potential guardrail applications were found along Elijah Creek due to critical drop off heights and the presence of water which can increase the severity of crashes. Figure A10-5 shows a potential area near 1459 Elijah Creek Road.

Figure A10-5: Potential Guardrail Installation at 1459 Elijah Creek Road

Roadside Hazards

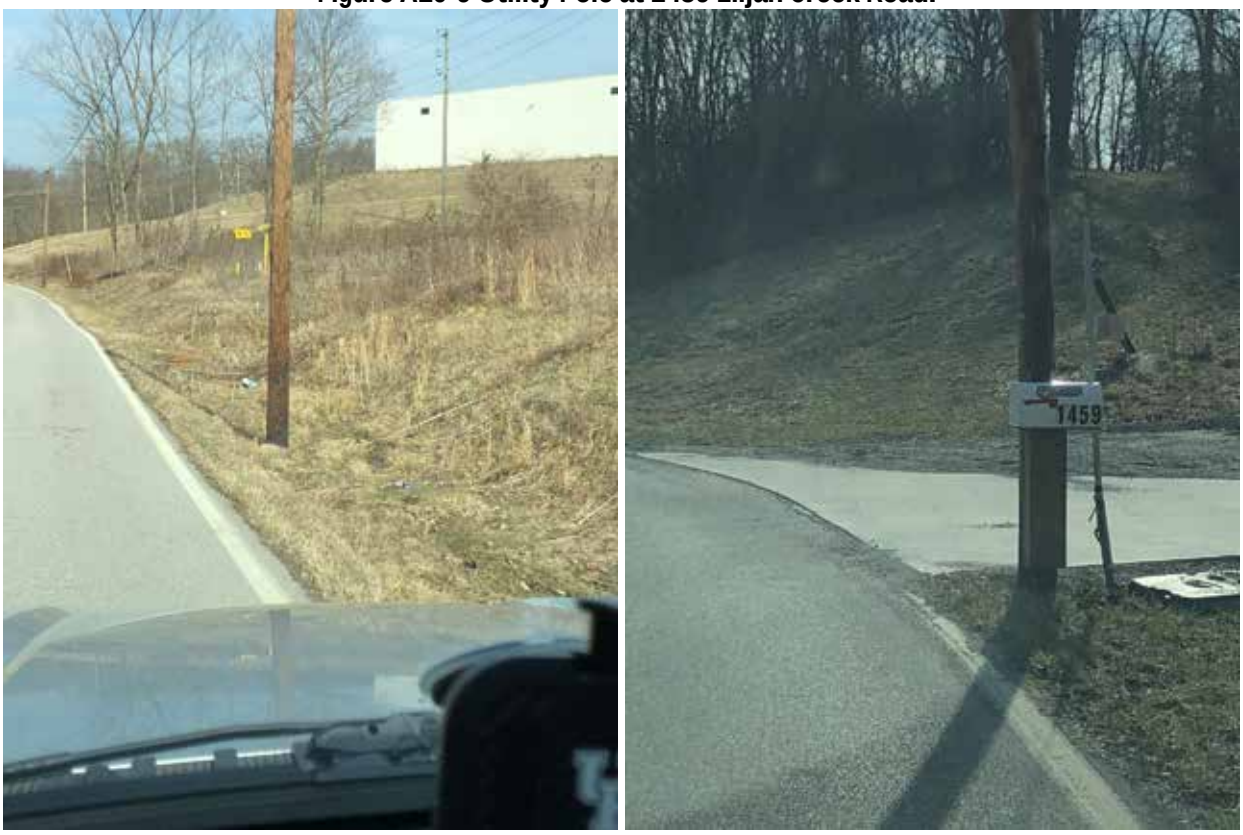
Several roadside hazards were also identified with a concentration just west of I-275, and between I-275 and the road terminus at Petersburg Road. These include edge drop offs, steep ditches, headwalls and fixed objects along the roadway. These are shown in **Figures A10-7 and A10-8**.

Figure A10-7: Typical Roadway Hazards; Elijah Creek Road

Figure A10-8: Fixed Objects east of Elijah Creek Crossing

Utility poles are also present within close proximity to the travel way east of I-275. Several are also located on the outside of horizontal curves as shown in **Figure A10-9**.

Figure A10-9 Utility Pole at 1459 Elijah Creek Road.



Recommended Improvements

Recommended Improvements for Elijah Creek Road include the following:

1. Evaluate existing guardrail locations along the corridor to determine the ultimate need for the guardrail installation, and to ensure necessary installations are properly maintained, at the appropriate height and provide a crash-worthy end treatment.
2. Remove fixed objects including utility poles within 5 feet of the roadside especially on the outside of the curves if feasible. If it is infeasible to remove or relocate fixed objects, they should be delineated with type 2 or type 3 object markers.
3. Review all signing on corridor and document sign type, location, post type and condition within a sign management database. Install signing consistent with MUTCD recommendations. Specifically horizontal alignment signing and object markers should be installed where warranted. Advanced warning signs should be checked for placement to ensure that warning signs are not placed too far in advance of hazardous conditions (Recommended no greater than 100 feet greater than MUTCD minimum distance).

LITTON LANE

Existing Conditions

Litton Lane is a narrow two-lane road with 11-foot lanes and a sidewalk on one side along the length of the road. The sidewalk was completed in 2020 in response to a large number of people walking along the side of the road to get to work. A pedestrian was killed in 2017 crossing Litton Lane leaving work. The narrow conditions and lack of turnaround at the terminus prevent the possibility of transit traffic along the route. Being a large economic hub, a significant portion of employees report to work from nearby underserved communities and arrive by transit. Those employees are then tasked to walk along Litton Lane. While a sidewalk does exist, the narrow roadway widths and lack of shoulder make the proximity of the sidewalk less than ideal.

During the 5-year study period, 236 crashes including 24 injuries and 1 fatality. During calendar year 2021, an additional 72 crashes occurred on Litton Lane including another 5 injuries. The crashes recorded in during the 5-year study period are shown in **Figure A11-1**.

Figure A11-1: Litton Lane Crashes

Contributing Factors

A field review of Litton Lane was conducted and identified several issues along the roadway.

Pedestrian Traffic and Truck Proximity

A field review indicates pedestrian paths extremely close to the truck traveled lane. Truck rutting is clearly evidenced immediately adjacent to the sidewalk and possibly on the sidewalk.

Truck tracking out of their lane is evident and cause for concern.

Horizontal Curvature

Litton Lane is comprised of a near 90 degree curve near the midpoint of the 1 mile dead-end road. Increased speed results in a significant amount of crashes on the outside of the curve.

Truck Traffic and ADT

Litton Lane services eight large warehouses, two medical offices, three restaurants and one gas station. As a result, the Average Daily Traffic (ADT) is quite high and the percentage of truck traffic is excessive.

Recommended Improvements

Recommended Improvements for Litton Lane include the following:

1. Evaluate existing striping and signage for repair, replacement or addition within normal work programs.
2. Pursue funding for a capital program improvement. Poor access and congestion issues contribute to increased crash activity. Addition of a center turn lane for access and separation of pedestrians with new sidewalk and MUP. Barriers may be required where positive space separation cannot be obtained for pedestrians. Seek completion of the capital improvement through use of the Complete Street countermeasure.