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Transportation Safety Center 2020 – Levy County

Final Report

Prepared by:
University of Florida

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CHAPTER 1: Introduction

1.1 University of Florida Transportation Institute

The University of Florida Transportation Institute (UFTI) leads the nation in several transportation programs that include traffic operations and transportation safety. The goal at UFTI is to provide advanced, innovative, and real-time solutions to transportation challenges through research and technical assistance and through education of transportation professionals. The Institute is an umbrella organization housing several other transportation-related centers within the University of Florida. It houses McTrans, the largest transportation software dissemination center in the world, and the UFTI Technology Transfer (UFTI-T2) Center, which provides training and technical assistance to professionals around the country and internationally. Additionally, the UFTI is home to the Southeastern Transportation Research, Innovation, Development and Education (STRIDE) Center, one of ten Regional University Transportation Centers (UTCs) funded by the U.S. Department of Transportation (USDOT).

1.2 Transportation Safety Center

The Transportation Safety Center (TSC) is housed at the University of Florida Transportation Institute's (UFTI) Technology Transfer (T2) Center in Gainesville, Florida. UFTI-T2's team of transportation professionals gather, manage, and analyze qualitative and quantitative data to improve safety along locally owned and maintained roadways. Through past projects, TSC developed a process and template for conducting safety studies (spot analysis) and implemented the analysis through providing technical assistance in Columbia county, Gadsden county, Hendry county, Jackson county, and Union county.

The first objective of the TSC is to assist counties in prioritizing roadway improvements by identifying safety improvements and implementation through a systematic analysis based on the FHWA methodologies, customized for Florida in a previous project. This covers the first two steps of the Highway Safety Manual's Six-Step Roadway Safety Management Process. This process identifies high-risk intersections, tangents, and curves based on roadway and site characteristics. The reports herein have been written with consultation from FDOT, the District, and the local agency of Levy County.

The second objective of the project is the development of a local road safety plan. The local road safety plan is a living document identifying the focus crash types overrepresented in the county as well as identifying focus facility types that are experiencing a disproportionate number of crashes. Network screening and input from stakeholders allow UFTI-T2 to produce a comprehensive local road safety plan which identifies projects at high-risk crash locations. This second objective accomplishes steps 3 and 4 of the Highway Safety Manual six-step process.

Through the processes, the county and the UFTI-T2 team have collaborated with various stakeholders to validate data, identified high priority areas of concern with near misses, and created an engineering report which isolates roadways and improvements to focus on reducing fatalities and serious injury crashes.

1.3 County Prioritization Background

The focus of TSC is to provide technical assistance to small (population less than 50,000) rural counties. In 2018, Dr. Agarwal and Dr. Goodknight met with District Safety Engineer and State Safety Engineer at the FDOT Midway Office in Gadsden County to select and prioritize candidate counties in FDOT Districts 2 and 3 for safety studies for subsequent TSC cycle. During that meeting, state and district safety engineers considered each county's crash history, experience and interest in developing safety projects, recent and upcoming roadway safety improvement projects, and the capabilities of each county's staff (Table 1). Based on these discussions, Levy County was selected as the first county for TSC to work with. FDOT District 2 representatives advised that the Levy County Board of County Commission has been active in seeking solutions to highway safety issues, and subsequent discussions between TSC and County staff confirmed that the County would likely welcome support from the TSC for conducting a highway safety study. Dr. Agarwal and Dr. Goodknight met with Levy County Coordinator and staff from the Levy County Road Department. The County expressed a strong desire to work with TSC. The County identified several locations where they were aware of safety issues. The Levy County Board of County Commissioners met on August 7, 2018. TSC attended the meeting to discuss the proposed study with the commission and to answer questions. The Levy County Commission provided a formal commitment to participate with TSC on August 10, 2018.

Table 1. Florida small counties priority matrix

Counties	District	Fatal (K) Crash Data 2012-2017				Incap Injury (A) Crash Data 2012-2017								Program Eligibility			In-house Professional Engineer
		Total	per 1000 pop	per mile	per 10,000 Daily VMT	Total Incap Injury	per 1000 pop	per mile	per 10,000 Daily VMT	Total K+A	K+A per 1000 pop	K+A per mile	K+A per 10,000 Daily VMT	SCRAP	SCOP	REDI	
Levy	2	43	1.048	0.050	1.342	184	4.486	0.212	5.742	227.0	5.5	0.26	7.08	x	x		
Hendry	1	40	1.024	0.103	1.673	155	3.969	0.399	6.481	195.0	5.0	0.50	8.15	x	x		x
Suwannee	2	35	0.783	0.031	0.443	308	6.892	0.276	3.899	343.0	7.7	0.31	4.34	x			
Jackson	3	34	0.674	0.027	0.387	225	4.463	0.179	2.562	259.0	5.1	0.21	2.95	x	x		x
Gadsden	3	34	0.704	0.050	0.675	145	3.004	0.212	2.878	179.0	3.7	0.26	3.55	x	x		
Taylor	2	24	1.076	0.037	0.505	145	6.504	0.222	3.050	169.0	7.6	0.26	3.55	x			x
Baker	2	18	0.662	0.021	0.331	120	4.413	0.143	2.206	138.0	5.1	0.16	2.54	x	x	x	
DeSoto	1	16	0.449	0.047	0.625	276	7.748	0.813	10.780	292.0	8.2	0.86	11.41	x	x	x	x
Holmes	3	15	0.742	0.022	0.323	111	5.492	0.164	2.391	126.0	6.2	0.19	2.71	x	x		
Dixie	2	15	0.897	0.037	0.572	87	5.201	0.217	3.320	102.0	6.1	0.25	3.89	x	x		
Hardee	1	14	0.510	0.037	0.506	249	9.079	0.654	8.996	263.0	9.6	0.69	9.50	x	x		x
Washington	3	12	0.480	0.012	0.172	78	3.122	0.076	1.116	90.0	3.6	0.09	1.29	x		x	
Wakulla	3	11	0.345	0.012	0.194	50	1.567	0.057	0.880	61.0	1.9	0.07	1.07	x		x	
Hamilton	2	11	0.750	0.027	0.365	73	4.979	0.177	2.424	84.0	5.7	0.20	2.79	x	x	x	
Okeechobee	1	11	0.267	0.033	0.436	37	0.899	0.112	1.466	48.0	1.2	0.15	1.90	x	x	x	
Madison	2	10	0.516	0.017	0.254	86	4.438	0.149	2.181	96.0	5.0	0.17	2.43	x	x		
Bradford	2	8	0.289	0.029	0.387	52	1.881	0.190	2.513	60.0	2.2	0.22	2.90	x	x		
Glades	1	8	0.611	0.036	0.666	26	1.987	0.118	2.163	34.0	2.6	0.15	2.83	x	x		
Gilchrist	2	8	0.464	0.020	0.289	47	2.729	0.116	1.696	55.0	3.2	0.14	1.98	x	x		
Calhoun	3	7	0.467	0.016	0.237	53	3.533	0.123	1.793	60.0	4.0	0.14	2.03	x	x	x	
Jefferson	3	6	0.411	0.012	0.182	46	3.148	0.095	1.395	52.0	3.6	0.11	1.58	x	x		
Union	2	5	0.314	0.027	0.368	24	1.505	0.128	1.766	29.0	1.8	0.15	2.13	x			
Gulf	3	5	0.307	0.017	0.244	49	3.007	0.163	2.390	54.0	3.3	0.18	2.63	x	x		
Liberty	3	4	0.459	0.006	0.125	33	3.785	0.050	1.030	37.0	4.2	0.06	1.15	x	x		
Franklin	3	4	0.329	0.014	0.219	12	0.987	0.043	0.658	16.0	1.3	0.06	0.88		x	x	
Lafayette	2	4	0.472	0.013	0.186	28	3.302	0.089	1.302	32.0	3.8	0.10	1.49	x	x		

1.4 Levy County General Overview

Levy County is situated in the Big Bend region along north central Florida's west coast; it is part of the Florida Department of Transportation's District 2. Levy County serves more than 40,000 residents. Levy County has 616,220 miles of paved county roadways and more than half as many of unpaved county roadways, 390,650 miles, for a total of just over one million miles of roadway. Additional city roadways are located in Bronson, Cedar Key, Chiefland, Fanning Springs, Inglis, Otter Creek, Williston, and Yankeetown, totaling 146,060 miles of city roadway miles. Only three paved roads lead to the 40-mile stretch of rural coastline. The county's road department coordinates utility placement and relocation and maintains county roads dedicated to the public by grading, paving, re-surfacing, signing, mowing, and tree maintenance within the county right-of-way. The Levy County safety study assesses corridors and intersections through spot analysis and the Highway Capacity Manual Roadway Safety Management procedure. In the next chapters of this report, a network analysis of Levy County local roadways is presented along with crash data, stakeholders, selected sites, curve improvement program, and intersection improvement program.

1.5 Study Approach

The integrated hotspot analysis, systemic analysis, and systematic analysis has been documented in detail in the previous TSC reports for Jackson and Columbia counties[1]. Figure 1 summarizes the overall process that the TSC adopts with each county. The four main steps include: network screening, data analysis, countermeasure selection, and benefit-cost analysis. Each of these steps has a number of subtasks which requires local, state, or national resources and tools to accomplish the task as detailed in Figure 1. The outcome of these efforts is a list of project recommendations for the county and the districts to consider for programming in Highway Safety Improvement Program (HSIP).

[1] TSC reports available at: https://techtransfer.ce.ufl.edu/2020/08/19/tsc-completed-research-and-reports/

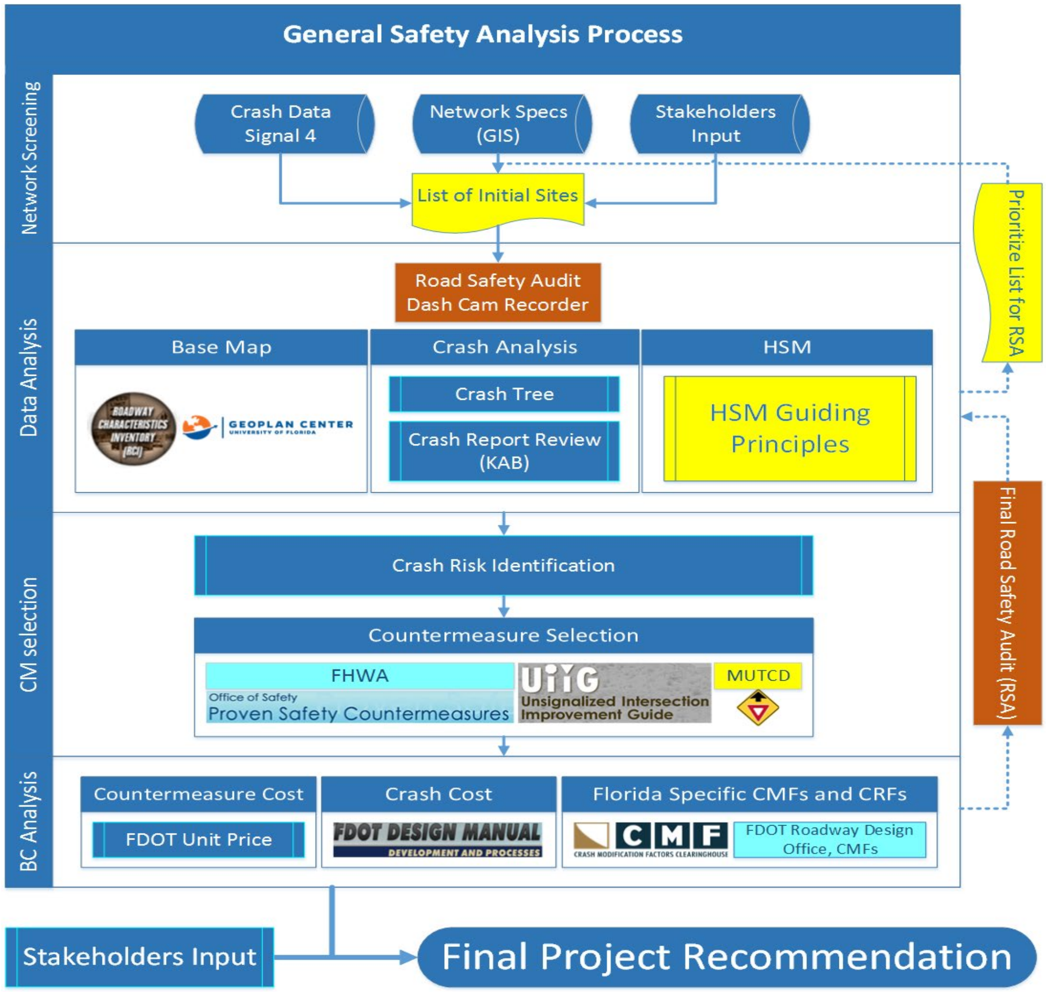


Figure 1. Overall safety analysis process adopted by TSC

CHAPTER 2: Data Gathering

This chapter provides an overview of the data gathered for Levy County in order to perform the safety analysis. The following data were compiled for this study effort:

- Network
- Crash data
- County priorities
- FHWA Bridge

2.1 Network data

The TSC focuses its efforts only on local roadways, and as such, data related to local and county roads were retrieved. These data were compiled from several sources, including a GIS database for Florida roadway, curves, and intersections maintained by the UF GeoPlan Center. These roadways do not contain subdivision or private roadways. GIS shape files were retrieved for the Levy County jurisdiction. Table 2 and Table 3 below list the curve and intersection parameters and attributes that were available in the database. The section following the table documents the data assembly efforts for Levy County. For the detailed procedures to collect intersection and curve characteristics, please refer to the TSC's 2019 systemic analysis report[2] for Jackson and Columbia counties.

[2] TSC Reports available at: https://techtransfer.ce.ufl.edu/2020/08/19/tsc-completed-research-and-reports/

Table 2. Data guide: Curve parameters and definitions

Curves Data	
Parameter	Definition
CURVE_ID_1	A unique ID for each curve
COUNTY	the county where the curve locates
CURVE_TYPE_1	Curve type from MIRE including simple, compound, reverse
CURVE_LENGTH	Curve length
SIMPLE_RADIUS	Radius of curve (in meters, only for simple curves)
SIMPLE_CENTRAL_ANGLE	Central angle of curve (in degrees, only for simple curves)
NUM_HORIZONTALANGLEPOINT	Number of horizontal angle point components (only for compound and reverse curves)
NUM_SIMPLE	Number of curved segment components (only for compound and reverse curves)
MAX_DEFLECTION_ANGLE	Maximum deflection angle of horizontal angle point components (in degrees, only for compound and reverse curves)
MIN_DEFLECTION_ANGLE	Minimum deflection angle of horizontal angle point components (in degrees, only for compound and reverse curves)
MAX_RADIUS	Maximum radius of curved segment components (in meters, only for compound and reverse curves)
MIN_RADIUS	Minimum radius of curved segment components (in meters, only for compound and reverse curves)
MAX_CENTRAL_ANGLE	Maximum central angle of curved segment components (in degrees, only for compound and reverse curves)
MIN_CENTRAL_ANGLE	Minimum central angle of curved segment components (in degrees, only for compound and reverse curves)
SPIRAL	Whether the curve has a spiral transition (Y / N, only for compound curves)
DIST_INT	Minimum distance from the curve to the next intersection
NUM_INT	Number of intersections on the curve
MAX_AADT_2015RCI	Maximum AADT on the curve (data from 2015 RCI)
MIN_AADT_2015RCI	Minimum AADT on the curve (data from 2015 RCI)
MAX_AADT_Estimated	Maximum AADT on the curve (data from FDOT estimation)
MIN_AADT_Estimated	Minimum AADT on the curve (data from FDOT estimation)
MAX_FUNCLASS	Maximum functional classification on the curve (data from HERE)
MIN_FUNCLASS	Minimum functional classification on the curve (data from HERE)
MAX_SPEEDCAT	Maximum speed category on the curve (data from HERE)
MIN_SPEEDCAT	Minimum speed category on the curve (data from HERE)
MAX_LANECAT	Maximum lane category on the curve (data from HERE)
MIN_LANECAT	Minimum lane category on the curve (data from HERE)
FUNCLASS	Functional classification on the majority of the curve (data from HERE)
SPEEDCAT	Speed category on the majority of the curve (data from HERE)
LANECAT	Lane category on the majority of the curve (data from HERE)
AADT_Estimated	AADT on the majority of the curve (data from FDOT estimation)
Intersect_OnSysRd	Whether the curve is intersected with the on-system roads
CRASH_SE	Number of fatal and injury crashes on the curve
CRASH_SE_LANE_DEPART	Number of lane departure fatal and injury crashes on the curve
INTERSECTION_ID	Intersection ID if the curve has one intersection on it
INTERSECTION_GEO	Intersection geographic type including point, polyline, polygon intersection
RELATION_TO_CURVE	Spatial relation between the intersection with the curve
DIST_TO_CURVE	Distance from the intersection to its nearest curve
DIST_TO_INT	Minimum distance from the intersection to its next intersection among all approaches
INTERSECTION_TYPE	Intersection geometry type
INTERSECTION_SHAPE	Intersection shape based on type and leg
INTERSECTION_LEG	Number of intersection approaches
INTERSECTION_ANGLE	Skew angle between intersection approaches
MAX_AADT_2015RCI	Maximum AADT among the intersection all approaches (data from 2015 RCI)
MIN_AADT_2015RCI	Minimum AADT among the intersection all approaches (data from 2015 RCI)
MAX_AADT_Estimated	Maximum AADT among the intersection all approaches (data from FDOT estimation)
MIN_AADT_Estimated	Minimum AADT among the intersection all approaches (data from FDOT estimation)
MAX_FUNCLASS	Maximum functional classification among the intersection all approaches (data from HERE)
MIN_FUNCLASS	Minimum functional classification among the intersection all approaches (data from HERE)
MAX_SPEEDCAT	Maximum speed category among the intersection all approaches (data from HERE)
MIN_SPEEDCAT	Minimum speed category among the intersection all approaches (data from HERE)
MAX_LANECAT	Maximum lane category among the intersection all approaches (data from HERE)
MIN_LANECAT	Minimum lane category among the intersection all approaches (data from HERE)
Intersect_OnSysRd	Whether the intersection is intersected with the on-system roads
CurveInInt_Tab	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful
IntInInt_Tab	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful
Shape_Length	Curve length

Table 3. Data guide: Intersection parameters and definitions

Intersections data	
Parameter	Definition
INTERSECTION_ID	A unique ID for each intersection
COUNTY	the county where the intersection locates
INTERSECTION_GEO	Intersection geographic type including point, polyline, polygon intersection
RELATION_TO_CURVE	Spatial relation between the intersection with the curve including on curve, have a distance to a curve, no relation to a curve
DIST_TO_CURVE	Distance from the intersection to its nearest curve
DIST_TO_INT	Minimum distance from the intersection to its next intersection among all approaches
INTERSECTION_TYPE	Intersection geometry type
INTERSECTION_SHAPE	Intersection shape based on type and leg
INTERSECTION_LEG	Number of intersection approaches
INTERSECTION_ANGLE	Skew angle between intersection approaches
MAX_AADT_ESTIMATED	Maximum AADT among the intersection all approaches (data from FDOT estimation)
MIN_AADT_ESTIMATED	Minimum AADT among the intersection all approaches (data from FDOT estimation)
MAX_FUNCLASS	Maximum functional classification among the intersection all approaches (data from HERE)
MIN_FUNCLASS	Minimum functional classification among the intersection all approaches (data from HERE)
MAX_SPEEDCAT	Maximum speed category among the intersection all approaches (data from HERE)
MIN_SPEEDCAT	Minimum speed category among the intersection all approaches (data from HERE)
MAX_LANECAT	Maximum lane category among the intersection all approaches (data from HERE)
MIN_LANECAT	Minimum lane category among the intersection all approaches (data from HERE)
IF_INTERSECT_ONSYSRD	Whether the intersection is intersected with the on-system roads
Num_Close_Int	Number of intersections inside the 250 feet around the intersection
CRASH_KAB	Number of fatal and injury crashes within the 250 feet of the intersection
CRASH_ANGLE	Number of angle fatal and injury crashes within the 250 feet of the intersection
CURVE_ID	Curve ID if the intersection is on a curve or have a distance to a curve
COUNTY_1	the county where the curve locates
CURVE_TYPE	Curve type from MIRE including simple, compound, reverse
CURVE_LENGTH	Curve length
SIMPLE_RADIUS	Radius of curve (in meters, only for simple curves)
SIMPLE_CENTRAL_ANGLE	Central angle of curve (in degrees, only for simple curves)
NUM_HORIZONTALANGLEPOINT	Number of horizontal angle point components (only for compound and reverse curves)
NUM_SIMPLE	Number of curved segment components (only for compound and reverse curves)
MAX_DEFLECTION_ANGLE	Maximum deflection angle of horizontal angle point components (in degrees, only for compound and reverse curves)
MIN_DEFLECTION_ANGLE	Minimum deflection angle of horizontal angle point components (in degrees, only for compound and reverse curves)
MAX_RADIUS	Maximum radius of curved segment components (in meters, only for compound and reverse curves)
MIN_RADIUS	Minimum radius of curved segment components (in meters, only for compound and reverse curves)
MAX_CENTRAL_ANGLE	Maximum central angle of curved segment components (in degrees, only for compound and reverse curves)
MIN_CENTRAL_ANGLE	Minimum central angle of curved segment components (in degrees, only for compound and reverse curves)
NUM_INT	Number of intersections on the curve
FUNCLASS	Functional classification on the majority of the curve (data from HERE)
SPEEDCAT	Speed category on the majority of the curve (data from HERE)
LANECAT	Lane category on the majority of the curve (data from HERE)
AADT_Estimated	AADT on the majority of the curve (data from FDOT estimation)
Fixed	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful
Fixed2	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful
IntInCurve_Tab	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful
CurveInCurve_Tab	This is an intermediate column for checking the spatial relation between intersection and curve, not meaningful

2.2 Crash Data

The TSC has access to UF's Signal4Analytics as well as FDOT's CRASH database. Since Signal4Analytics provides the latest crash data information, Signal4Analytics data were used for the analysis. These data were later verified with an available FDOT database. The following queries were used to retrieve crash data and develop the database for Levy County:

- Analysis period: 1/1/2014–12/31/2018
- Buffer distance: Crashes located within a 100-foot buffer of the county roads
- Severity: Possible injury, non-incapacitating injury, incapacitating injury or fatality (within 30 days).

Based on this, there were 1,333 crashes in the dataset. These crashes were compared to FDOT crash data to improve the location accuracy. The following section explains the process to concatenate crashes to the intersections and curves.

2.2.1 Intersection Crashes

The crashes in the crash dataset were assigned to the intersections for KABC and angle crashes.

- KABC crashes:
  - The first harmful event is at intersection or intersection related
  - The crash is within 250 feet of the corresponding intersection.
- Angle crashes:
  - The first harmful event is at intersection or intersection related
  - The crash is within 250 feet of the corresponding intersection
  - Crash type is angle.

2.2.2 Curve Crashes

The crashes were assigned to the curves for KABC and lane departure crashes.

- KABC crashes:
  - Research was performed to determine the distance for curve-related crash identification. The result shows that crashes which are within the 100-foot buffer of a curve or 700-foot distance to the ends of a curve should be identified as curve related.
- Lane departure crashes:
  - It is based on two conditions: (1) identified as curve-related KABC crashes; (2) crash type falls within run-off road, rollover, head-on, or sideswipe.

2.2.3 Descriptive Analysis for Intersections

Table 4 shows the descriptive statistics of five continuous variables of the intersections: the distance to the nearest curve and intersection, intersection angle, and maximum and minimum AADT.

Table 4. Descriptive statistics for continuous explanatory variables (distance in meters)

	N	Mean	Median	Std. Dev	Min	Max	Percentiles	
							10	90
DIST_TO_INTERSECTION	505	294.71	192.96	305.55	7.77	2,123.51	50.67	802.77
INTERSECTION_ANGLE	505	80.62	90.00	15.23	10.20	92.50	59.92	90.00
MAX_AADT_ESTIMATED	505	2,231.77	1,800.00	1,286.41	513.00	11,300.00	800.00	3,400.00
MIN_AADT_ESTIMATED	505	304.58	114.00	522.35	14.00	3,650.00	25.00	869.00

2.2.4 Descriptive Analysis for Curves

Table 5 shows the descriptive statistics of 13 continuous variables, which are curve length (all curves), simple curve radius (simple curves), central angle (simple curves), maximum and minimum deflection angles (compound and reverse curves), maximum and minimum radius (compound and reverse curves), maximum and minimum central angle (compound and reverse curves), number of horizontal angle points (compound and reverse curves), number of simple curves (compound and reverse curves), the distance to the nearest intersection (curves without intersections) and AADT (all curves).

Table 5 Descriptive statistics for continuous explanatory variables

	N	Mean	Median	Std. Dev	Min	Max	Percentiles	
							10	90
CURVE_LENGTH	108	1,188.24	858.49	1,007.15	44.75	4,670.46	220.35	2,662.81
SIMPLE_RADIUS	78	1,491.07	1,048.31	1,352.69	66.49	7,411.89	370.41	3,353.26
MAX_DEFLECTION_ANGLE	30	30.34	19.63	23.69	6.76	89.65	8.29	67.62
MIN_DEFLECTION_ANGLE	30	5.93	1.28	14.85	0.74	80.50	0.81	15.20
MAX_RADIUS	30	796.15	652.42	747.20	0.00	3,023.42	2.79	1,918.91
MIN_RADIUS	30	230.16	221.44	158.85	0.00	610.89	2.79	452.83
MAX_CENTRAL_ANGLE	30	28.78	18.74	25.08	0.00	89.65	0.62	67.62
MIN_CENTRAL_ANGLE	30	17.77	3.98	25.46	0.00	85.33	0.21	67.49
NUM_HORIZONTALANGLEPOINT	30	14.47	13.00	12.18	0.00	37.00	1.10	31.90
NUM_SIMPLE	30	3.40	2.00	2.87	0.00	9.00	0.10	9.00
AADT_Estimated	108	1,419.41	1,350.00	1,022.14	127.00	3,300.00	200.00	3,300.00

2.2.5 Curve Radius Distribution

One of the FDOT Strategic Highway Safety Plan’s emphasis areas is lane departure crashes, and change in alignment or horizontal curves are high risk locations on roadways for travelers for these crashes. Figure 2 shows the distribution of curves by radius. For this study, any curve with less than a 1,000-foot radius is considered as “severe” and is recommended for systematic countermeasure intervention.

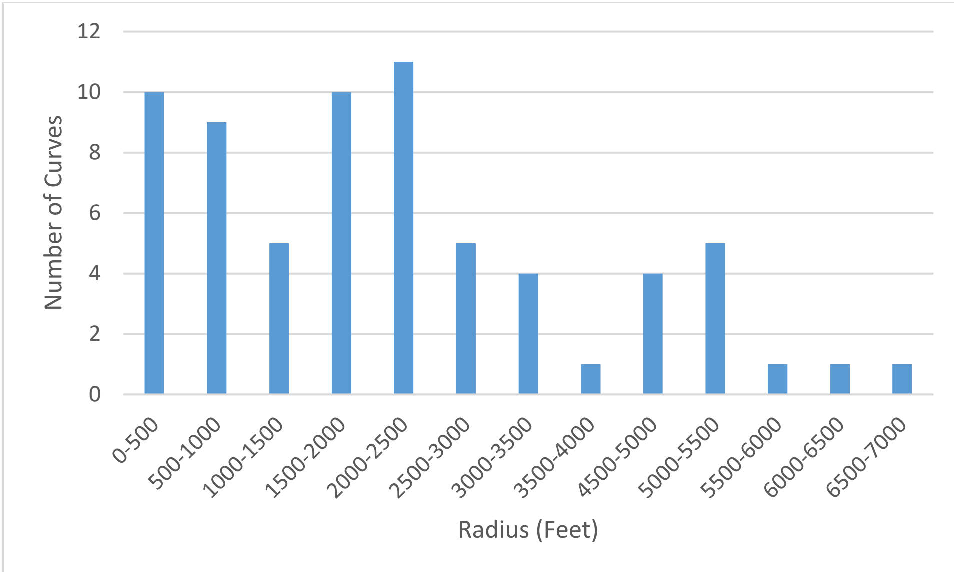


Figure 2. Levy County local road curves and their radii

Note that the curve data are estimates developed using the digitized maps and may not always correspond exactly to the actual conditions in the field.

2.3 FDOT Five-Year Work Program: Levy County 2021–2025

The following information related to ongoing programmed projects was retrieved from the FDOT website[3] for Levy County. Based on this information, four projects are programmed off the State Highway System. The programmed projects include two bridge replacement projects, one resurfacing project, and one project to widen and resurface an existing lane.

[3] https://fdotewp1.dot.state.fl.us/fmsupportapps/workprogram/WorkProgram.aspx, accessed September 2020

Table 6. FDOT 5-year program projects for Levy County

FLORIDA DEPARTMENT OF TRANSPORTATION
5 - YEAR TRANSPORTATION PLAN ($ IN THOUSANDS)
TENTATIVE FY 2021 - 2025 (10/28/2019 17.28.28)

LEVY COUNTY

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025

Highways: State Highways

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025
4135251	D2-LEVY COUNTY TRAFFIC SIGNAL MAINTENANCE AGREEMENT	TRAFFIC CONTROL DEVICES/SYSTEM	.000	58 OPS	60 OPS	62 OPS		
4434871	SR24 FROM NE 92ND PLACE TO NE 99TH PLACE.	ADD LEFT TURN LANE(S)	1.139	50 ROW	233 ROW	146 ROW		
							1,274 CST	
4373321	SR345 FROM: US19/US98 TO: W OF CEMETERY	SIDEWALK	.417	55 PE				
						306 CST		
4410601	SR500(US27A) FROM CR124 TO SR24	RESURFACING	7.629	9,154 CST				
4393451	SR500(US27A) N YOUNG BLVD FROM: NE 8TH ST TO: CR124	RESURFACING	5.666	26 CST				
4436291	SR55(US19) FROM: GILCHRIST CL TO: NE 8TH STREET	RESURFACING	9.013	184 PE				
						15,682 CST		
4455691	US19 @ NW 140 ST/US41 @ SE 30TH ST/US41 @ SE 32ND ST/	SAFETY PROJECT	.660	112 PE				
						650 CST		

Highways: Local Roads

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025
2117281	CR339 WACCASASSA RIVER BRIDGE NO340050	BRIDGE REPLACEMENT	.216	21 CST				
4411531	CR40 FROM: MASTADON COURT TO: 63RD STREET	BIKE LANE/SIDEWALK	4.588		552 CST			

Highways: Off State Hwy Sys/Off Fed Sys

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025
4458211	CR 341 FROM: SR 345 TO: US 19	RESURFACING	2.106	1,719 CST				
4434071	CR345(NW 30TH AVE) FROM SR500 TO US129	WIDEN/RESURFACE EXIST LANES	2.466		1,500 CST			

Maintenance: State Highways

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025
2146361	LEVY COUNTY ROUTINE MAINTENANCE	ROUTINE MAINTENANCE	.000	2,500 MNT	2,500 MNT	2,500 MNT		
4144111	LIGHTING AGREEMENTS LEVY COUNTY	LIGHTING	.000	97 MNT	100 MNT	103 MNT		

Freight, Logistic And Passenger Operation: Aviation

Item No	Project Description	Work Description	Length	2021	2022	2023	2024	2025
4440761	GEORGE T LEWIS AIRPORT - UPDATE AIRPORT MASTER PLAN	AVIATION CAPACITY PROJECT	.000	55 CAP				
4444101	GEORGE T LEWIS APT DESIGN & CONSTRUCT NEW RESTROOM/KIOSK	AVIATION REVENUE/OPERATIONAL	.000				500 CAP	
4461301	GEORGE T LEWIS APT DESIGN & CONSTRUCT SHORELINE RESTORATION	AVIATION ENVIRONMENTAL PROJECT	.000					180 CAP
4367631	GEORGE T LEWIS APT DGN & REHAB R/W 5-23 PHASE 2 PFL0010653	AVIATION PRESERVATION PROJECT	.000	500 CAP				
4461361	GEORGE T LEWIS PURCHASE & INSTALL GENERATOR FOR VAULT	AVIATION SAFETY PROJECT	.000					120 CAP
4461671	WILLISTON APT DESIGN & CONSTRUCT TWF FOR GRASS STRIP	AVIATION PRESERVATION PROJECT	.000					50 CAP
4367281	WILLISTON APT DESIGN & CONSTRUCTION T/W "F" PFL0010645	AVIATION CAPACITY PROJECT	.000	90 CAP	60 CAP			
4367271	WILLISTON APT DGN & CONST HANGAR ACCESS RD & DRAINAGE PFL0010561	AVIATION REVENUE/OPERATIONAL	.000			250 CAP	500 CAP	
4425051	WILLISTON MUNCIPAL AIRPORT DESIGN & CONSTRUCT TERMINAL BLDG PFL0011871	AVIATION REVENUE/OPERATIONAL	.000		82 CAP	2,168 CAP		
4417501	WILLISTON MUNICIPAL APK PURCHASE NEW MAINTENANCE EQUIPMENT PFL11841	AVIATION REVENUE/OPERATIONAL	.000	160 CAP				
4444731	WILLISTON MUNICIPAL APT DESIGN & CONSTRUCT NEW T-HANGARS	AVIATION REVENUE/OPERATIONAL	.000			100 CAP	1,500 CAP	
4312581	WILLISTON MUNICIPAL APT REHAB GA APRON PFL0003496	AVIATION REVENUE/OPERATIONAL	.000	150 CAP				

2.4 County Concerns

TSC met with Levy County and FDOT District 2 staff. The following locations were provided by the county staff to the TSC to review:

1. NW 50th Ave Corridor in Chiefland
2. CR-326 / SR-121 Intersection
3. US-129 / CR-346a / CR-346 Corridor
4. SR-121 / CR-335 Intersection
5. US-129 / CR-321 (NW 50th Ave) Intersection
6. US-41 / CR-323 Intersection
7. US-41 / CR-326 Intersection
8. SR-121 / US-41 South / CR-316 Intersection
9. US-19 / CR-346 Intersection
10. US-19 / NW 60th Ave Intersection

2.5 FHWA Bridge Inspection Reports

Data for 2018 from the FHWA National Bridge Inspection (NBI) database[4] were retrieved and filtered for Levy County. Locations in proximity to the selected projects were reviewed for deficient bridge approaches.

[4] Available at https://www.fhwa.dot.gov/bridge/inspection/

CHAPTER 3: Network Analysis

A list of high crash locations was compiled by the study team based on the network analysis using historical crash data and also in consultation with counties. A list of potential sites was identified for field study, and relevant information (maps, tabulation of crashes, and crash report graphics) were assembled for preliminary field review, completed in September.

3.1 Crash Data

Levy County fatal and incapacitating injury crashes on local roads that occurred during the five-year period between January 1, 2013, and December 31, 2017, were reviewed. There were 132 fatal and incapacitating injury crashes during the five-year period.

Figure 3 shows the aggregated distribution of crashes in the network. Most of these crashes occurred on arterials around the cities of Chiefland, Williston, and Inglis.

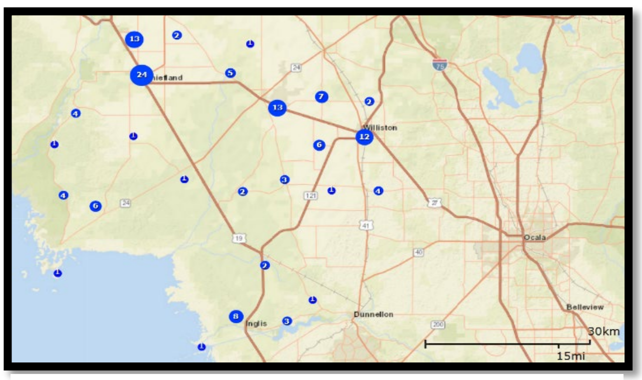


Figure 3. Levy County fatal and incapacitating injury crashes 2013–2017, aggregated

Figure 4 shows the location of fatal and incapacitating injury crashes in Levy County. Among the 132 mentioned crashes, 38 were fatal crashes.

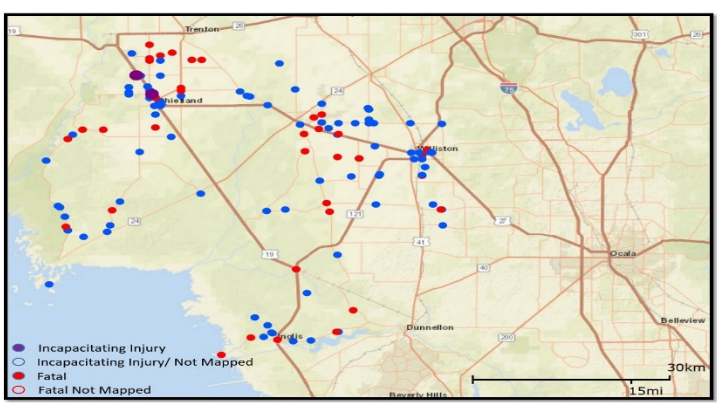


Figure 4. Levy County fatal and incapacitating injury crashes, 2013–2017

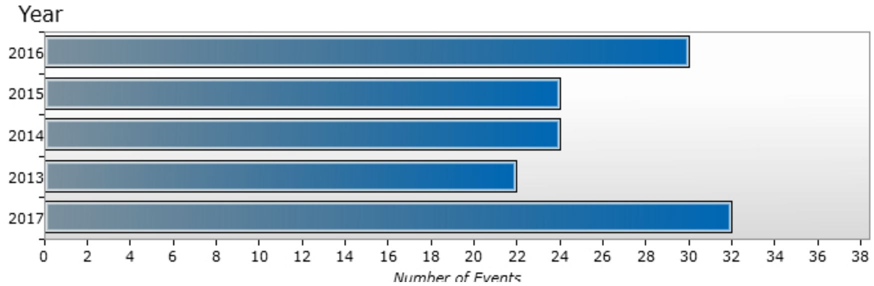


Figure 5. Yearly distribution of fatal and incapacitating injury crashes in Levy County, 2013–2017

The yearly distribution of fatal and incapacitating injury crashes between these years is shown in Figure 5. The number of the severe crashes in 2017 was 13.25 % more than the number in 2013. The increasing trend of the three-year average severe crashes also is shown in Figure 6.

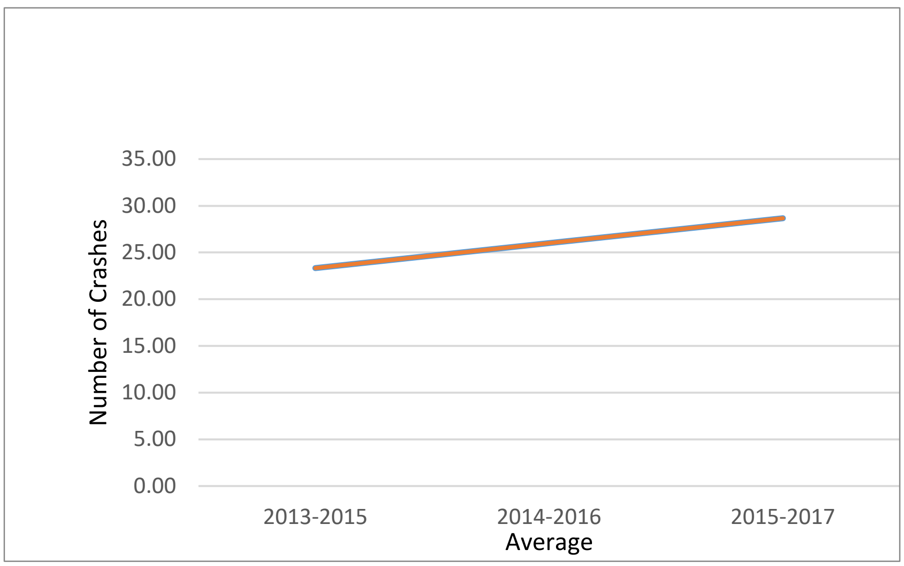


Figure 6. Three-year-average of fatal and incapacitating injury crashes

Figure 7 shows the crash type distribution versus the severity of crashes. As shown, the top three fatal and incapacitating injury crash types were off-road (27+11=38), rollover (35), and angle (19).

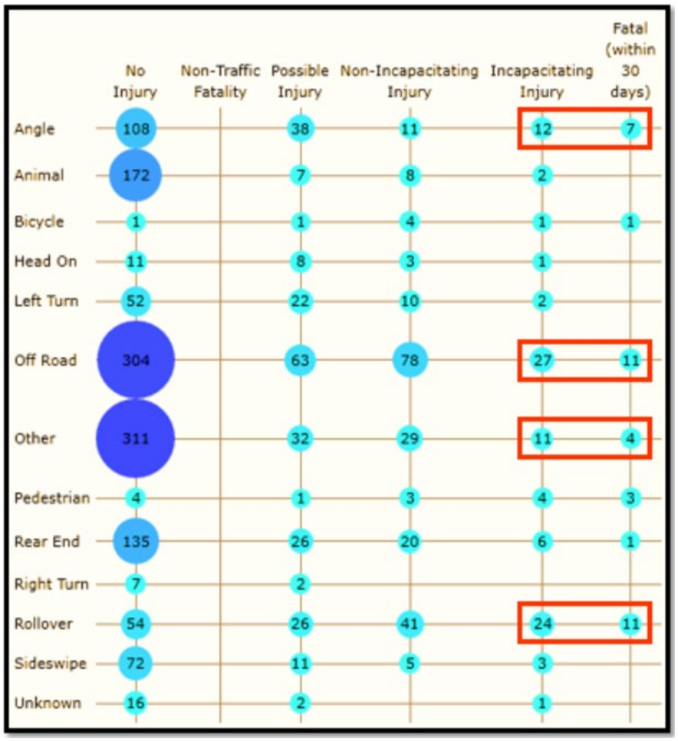


Figure 7. Levy County crash severity versus crash type on local road, 2013–2017

Figure 8 shows the Levy County crash tree for local and county roads between 2013 and 2017. Among the 1,587 crashes, 44% were lane departure, 24% were intersection and driveway related crashes, 1% pedestrian and bike crashes, with remaining 31% other crash type. Among the 26 small rural counties within Florida, Levy ranks sixth highest in terms of fatal and serious injury crashes.

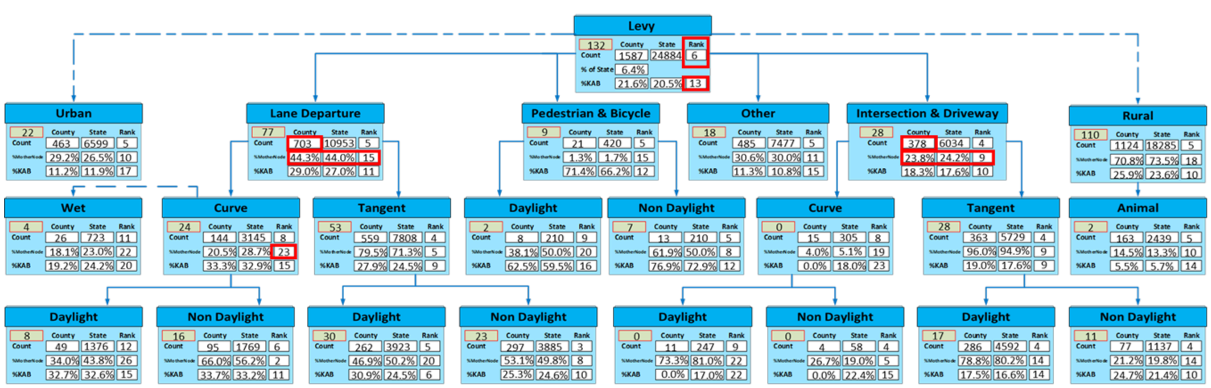


Figure 4. Crash tree for Levy County

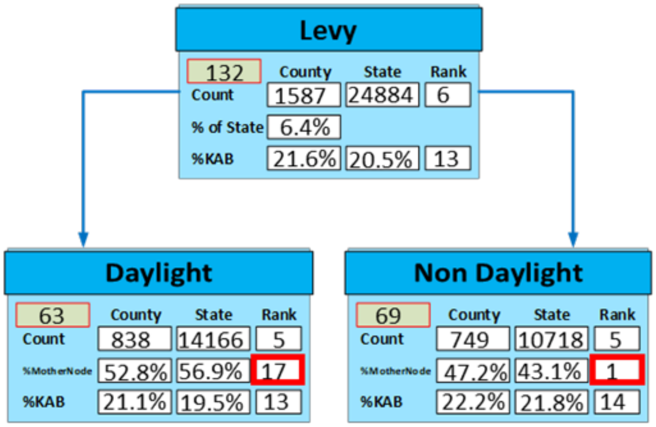


Figure 5. Crash tree showing the disproportionately high non-daylight crash

3.1.1 All Crashes

Figure 10 shows that the crashes distributed in Levy County jurisdiction. Crashes are sporadically distributed with certain concentrations along the city of Chiefland and Williston.

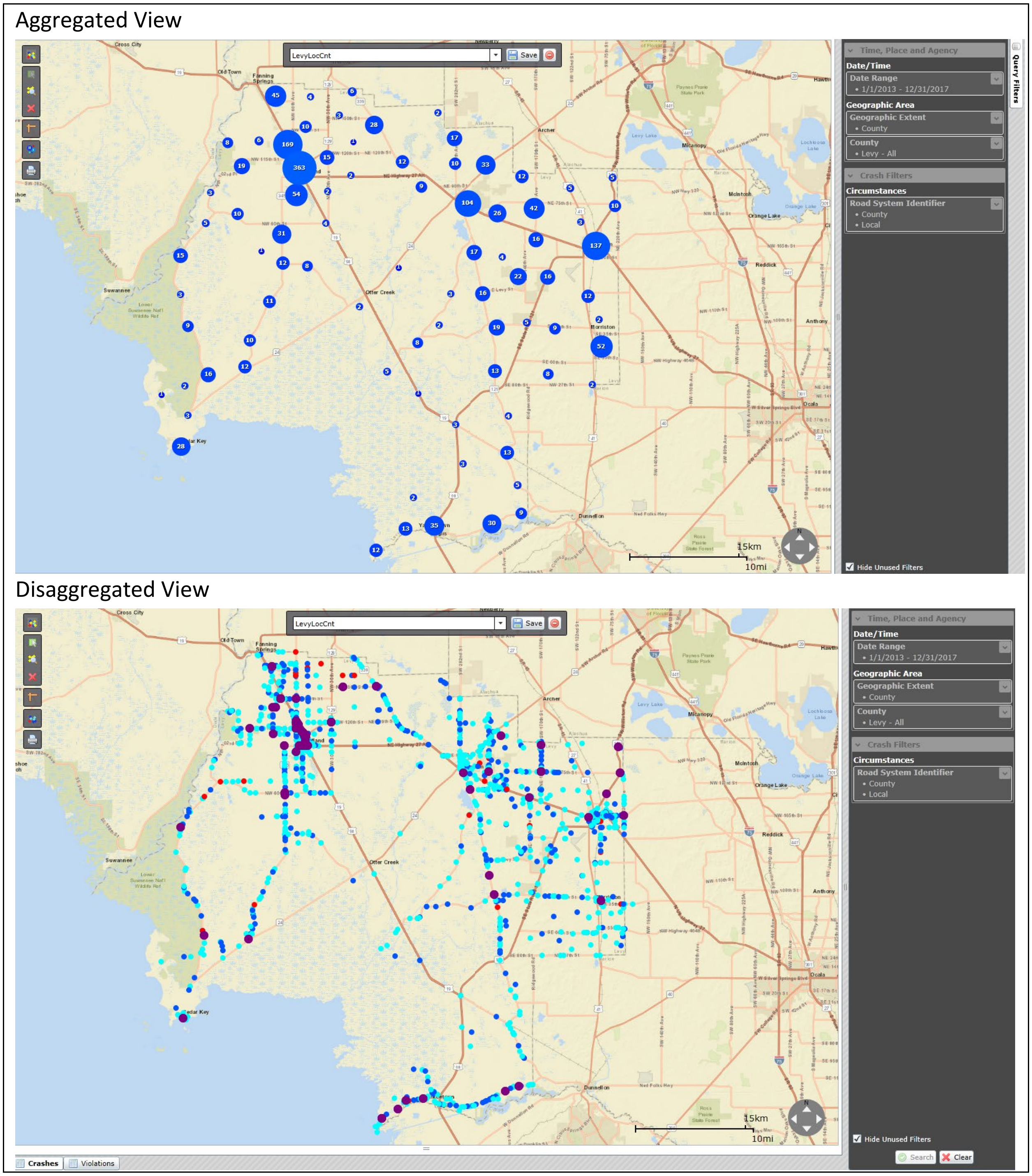
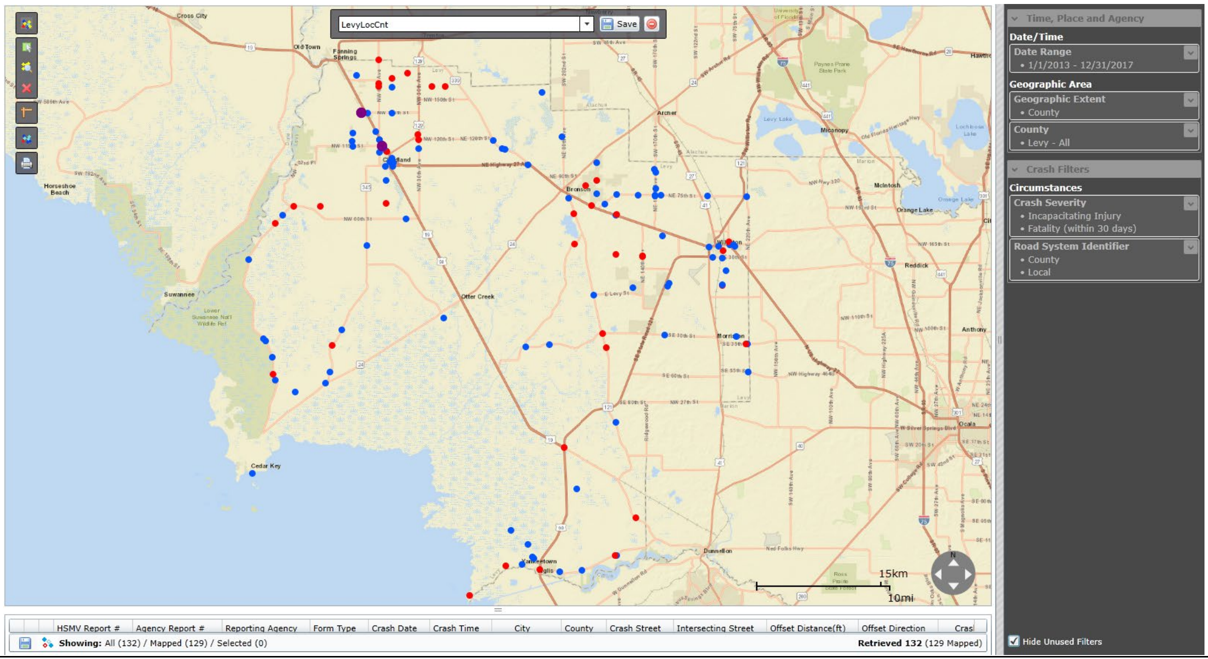


Figure 6. Levy County crashes on local and county roads

3.1.2 KA crashes

Figure 11 shows all 132 KA crashes on local and county roads.

All



3.1.3 Non-daylight

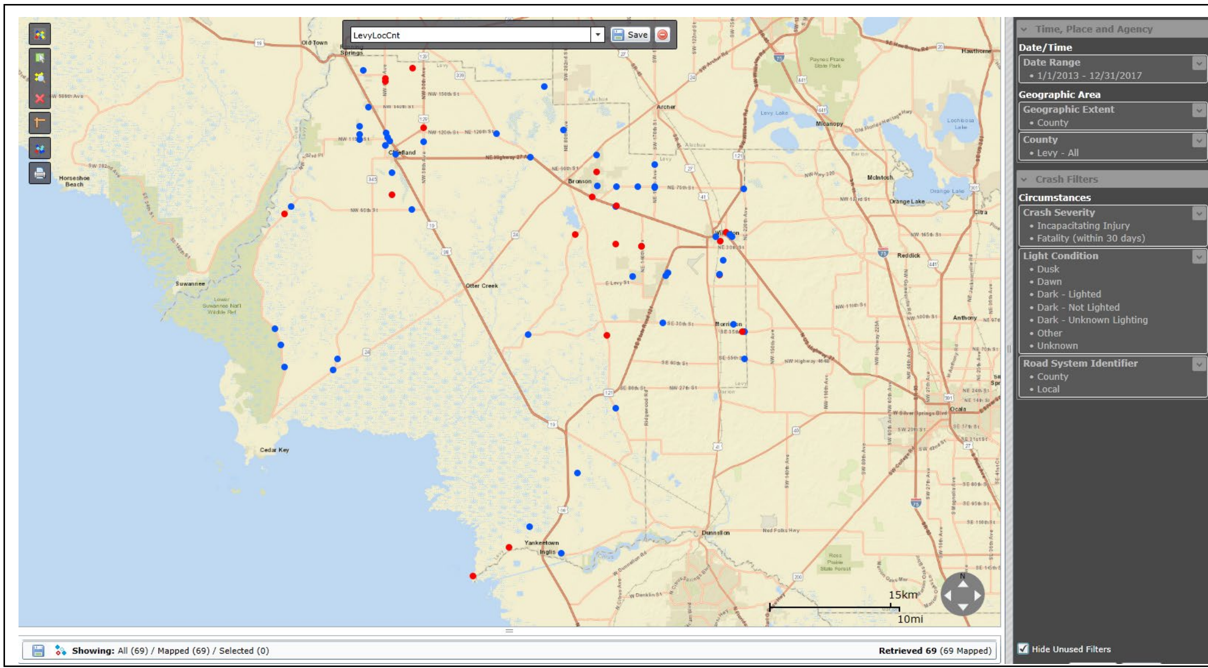
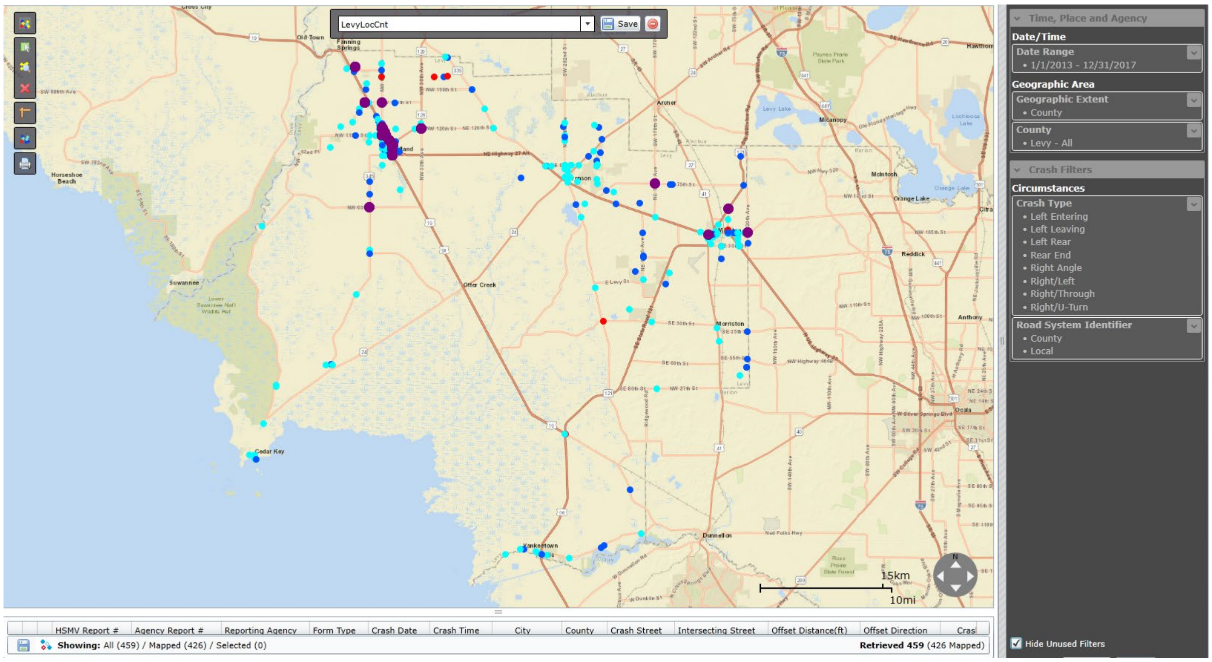


Figure 7. Levy County KA crashes on local and county roads

3.1.4 Intersection and Driveway-Related Crashes

Figure 12 shows the intersection and driveway-related crashes. Most of these crashes occurred in the cities of Chiefland, Williston, and Branson.

All Severities



KA

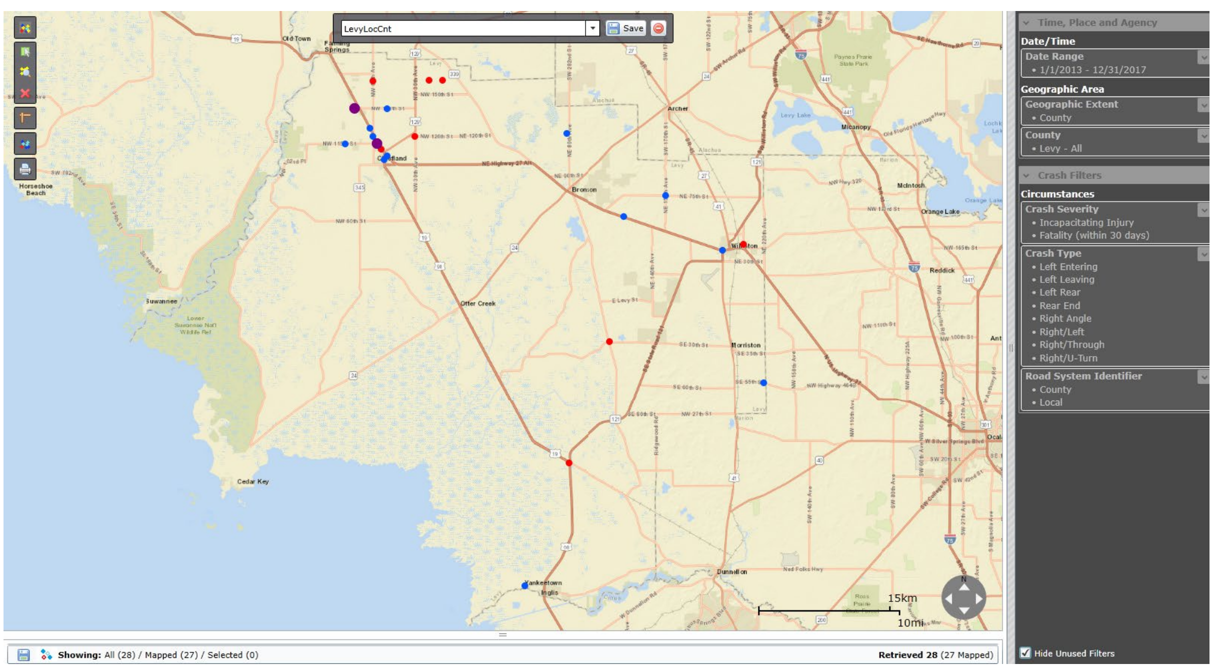
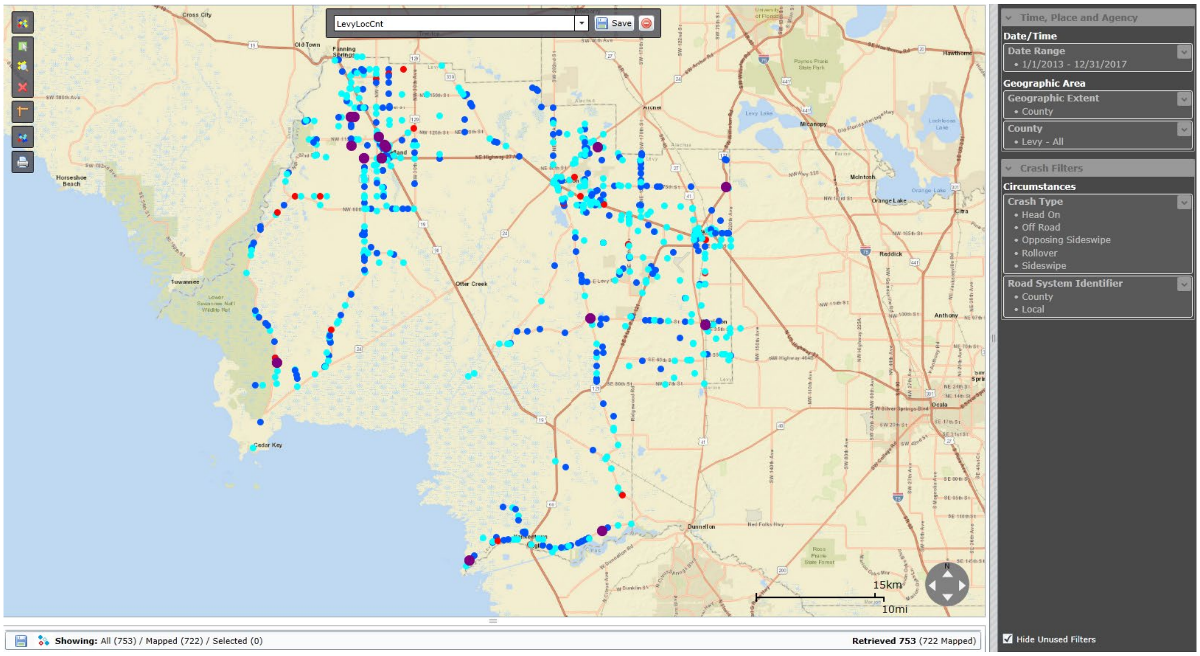


Figure 8. Levy County intersection and driveway-related crashes on local and county roads

3.1.5 Lane departure crashes

Figure 13 shows the lane departure crashes which are scattered all over the network.

All Severities



KA

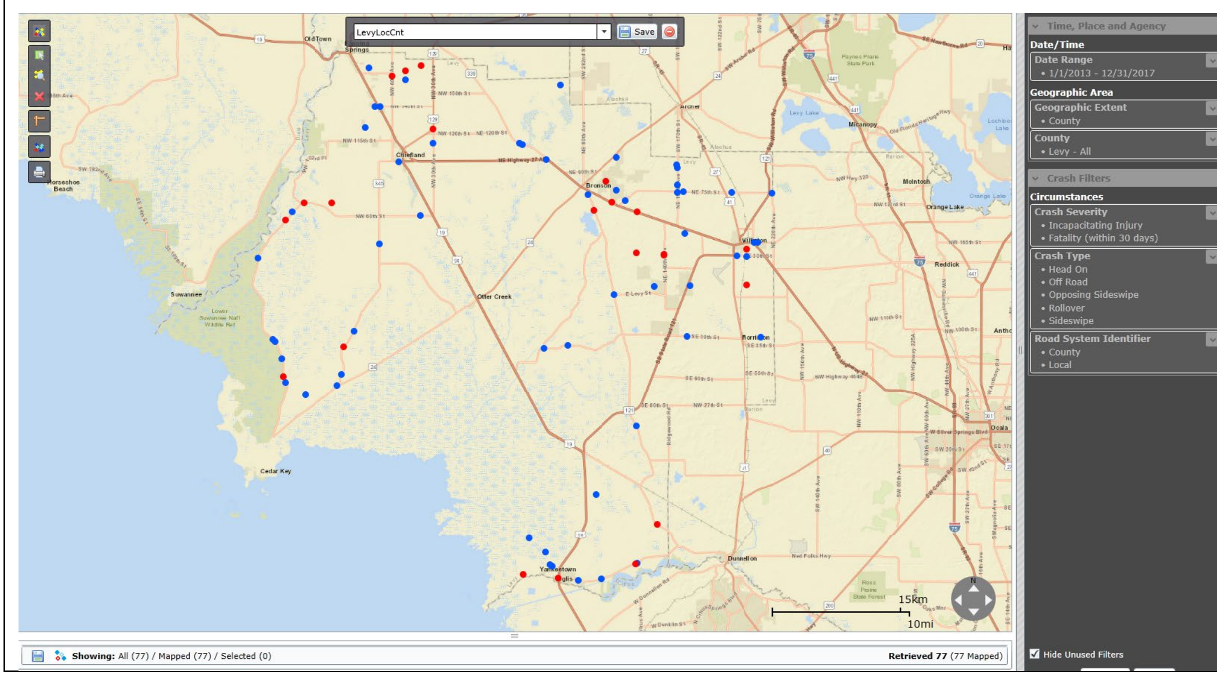


Figure 9. Levy County lane departure crashes on local and county roads

CHAPTER 4: SAFETY STUDY

Field visits to potential study sites were made by TSC staff. Field reviews were planned based on a preliminary review of crash data, sites identified by systemic approach, and other sites of concern identified by the County. Safety studies were conducted for the selected sites following the procedure and templates developed by the TSC. This chapter summarizes the safety analysis and the projects identified as a result of field observations and recommendations. First, a brief response to the locations identified by the county is listed then a list of general countermeasures for curves, intersections, and tangents is detailed. The next chapter details the individual sites that were studied.

4.1 Locations from County

The Levy County staff identified 10 locations for TSC program consideration. Below is the list of locations and the general feedback from the TSC team:

1. NW 50th Ave Corridor in Chiefland:
    - TSC recommends upgrade of intersections in this corridor based on the general countermeasures outlined in the next section.
2. CR-326 / SR-121 Intersection
    - Speed study is being conducted by others.
3. US-129 / CR-346a / CR-346 Corridor
    - Improvements have been made at US-129/CR-346a.
    - TSC recommends similar improvements at other similar intersections in the area.
4. SR-121 / CR-335 Intersection
    - TSC recommends adding flashing beacon on CR-335 approaches.
5. US-129 / CR-321 (NW 50th Ave) Intersection
    - FDOT has made recent changes.

<u>The following intersections are on state highway and managed by FDOT staff:</u>

6. US-41 / CR-323 Intersection
7. US-41 / CR-326 Intersection
8. SR-121 / US-41 South / CR-316 Intersection
9. US-19 / CR-346 Intersection
10. US-19 / NW 60th Ave Intersection

4.2 General Countermeasures

This section provides an overview and recommendation of general countermeasures for countywide implementation. Most of the road sections reviewed during the field visits were two lanes with no curb and gutter.

These recommendations focus primarily on lane departure crashes in the rural areas and on intersection crashes in some areas of the county with stop-controlled approaches. The following description of the recommended countermeasures applies to the countermeasures identified for each site.

For the curve countermeasures, curves with a radius of less than 1,000 feet and curves with special circumstances such as a visual trap are considered “critical curves” for which upgrades in signs and markings are recommended. The recommended upgrades are consistent with MUTCD’s guidance for enhanced conspicuity.

Countermeasure: **Upgrade signs for “critical curves”**

This treatment should generally follow the MUTCD guidance for curve signage and enhanced conspicuity (see Figure 14).

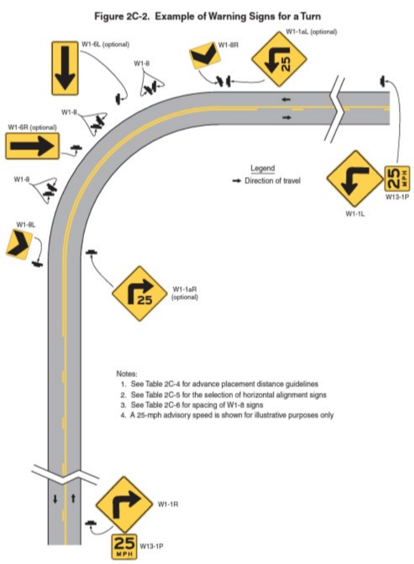


Figure 10. MUTCD guidance for warning signs at curves

In addition, include retroreflective strips (“bright sticks”) on all sign mounting posts.

Reduced advisory speeds may be required for some locations where warranted by a separate study.

Some of the curves identified in this study are signed with reduced advisory speeds, but this study did not address the need to adjust advisory speeds.

The MUTCD chevron spacing suggestions are based on advisory speed and curve radius. For calculating the cost, the chevron spacing based on the radius was used.

Countermeasure: **Upgrade pavement markings for "critical curves"**

This treatment includes audible, vibratory markings for both centerline and edge line.

This may include either profiled thermoplastic or ground-in rumble strip with separate thermoplastic marking. For benefit-cost calculations, the ground-in rumble costs were used.

Special attention should be given to areas where nearby residences or other developments may be adversely affected by noise from the audible markings. In these areas, it may be necessary to omit the audible feature.

This treatment also includes RPMs along both centerline and edge line.

Based on MUTCD, the RPMs need to be placed at a distance equivalent to 5 seconds of travel time before and after a curve. The network database includes the Navteq speed limit classification with the categories of 3, 4, and 5 (3: 55–64 mph, 4: 41–54 mph, and 5: 31–40 mph). The pavement markings are assumed to be placed 500 ft in approach to curves.

Countermeasure: **Upgrade pavement markings for straight segments**

This treatment will apply to segments of a corridor, except the portions identified as "critical curves." Curves with radii greater than 1,000 feet will be included.

Centerline markings (thermoplastic) with RPMs.

Audible, vibratory edge line markings.

Special attention should be given to areas where nearby residences or other developments may be adversely affected by noise from the audible markings. In these areas, it may be necessary to omit the audible feature.

Countermeasure: **Upgrade guardrail**

Upgrade and replace guardrails that do not meet current standards. This will include: reset or replace guardrail, add appropriate end sections. Preliminary estimates are provided where applicable. Final design will require a detailed review of each site.

The FDOT and FHWA bridge inspection reports identify deficient approaches to bridges that require upgrade. As a general guide, most guardrails that do not have collapsible end treatments should be identified for upgrade.

Countermeasure: **Pave shoulder**

This countermeasure includes sufficient pavement widening to provide a minimum lane width of at least 11 feet and paved shoulder of at least 3 feet.

Shoulder paving should include the safety edge.

Evaluate remaining life of existing pavement. If the road is expected to be resurfaced in the near future, shoulder paving should be coordinated with resurfacing or reconstruction.

Countermeasure: **Upgrade signing and marking at intersections**

This countermeasure applies to intersections with stop controls on one or more approaches:

Stop approach:

- Two large stop signs (one on each side of road)
- 1,000-ft pavement marking on centerline and edge line
- 1,000-ft centerline and edge line RPMs
- One “stop ahead” sign
- Transverse rumble strip marking on through and stop approach
- Thermoplastic stop bar
- Bright stick on all signs
- End-of-road signage, including three OM1-1 and one two-way arrow (for 3-leg intersections)

Through approach:

- “Intersection ahead” sign on each approach
- Bright sticks on all signs

4.2.1 Benefit-Cost Analysis

The CMF published by the FDOT Roadway Design Office (on all crash types) for chevron, RPM, sign and pavement marking, rumble strips and add paved shoulders are 0.70, 0.90, 0.89, 0.78, and 0.95 respectively. In order to be conservative, four different levels of measures were addressed for curves.

Curves:

- Level 1 – Includes high priority improvement that includes upgraded signs (curve warning sign, chevron, bright sticks) on selected curves, including flashing beacons in some locations using a CMF of 0.7.
- Level 2 – Includes improvement to pavement: pavement marking, rumble strips on select curves using a CMF of 0.437 (chevron, RPM, sign and pavement marking, rumble strips)
- Level 3 – Includes both sign and pavement upgrades on the entire corridor using a CMF of 0.437 (chevron, RPM, sign and pavement marking, rumble strips)
- Level 4 – Includes paving shoulders and upgraded guardrail on selected locations using a CMF of 0.415 (chevron, RPM, sign and pavement marking, rumble strips and add paved shoulders).

The CMFs published by the FDOT Roadway Design Office (on all crash types) for sign and pavement marking and advanced warning signs are 0.89 and 0.4, respectively. In order to be conservative, two different levels of countermeasures were addressed for intersections.

- Level 1 –Upgraded signs on selected intersections, including flashing beacons in some locations using CMF of 0.89
- Level 2 – Upgrade signs and markings intersections, including flashing beacons and transversal rumble strips in some locations using a CMF 0.356.

The mentioned CMFs are supposed to be applied on all crash types.

The county roads are mostly two-lane undivided roads located in rural areas. FDOT Roadway Design Office suggests $506,164 for the crash cost on these facility types and $246,741 for intersections and segments in suburban two-lane roads. These are the maximum crash cost in the published report. The conservative calculations in the different levels overcome the occasional diversion from the cost assumption.

The FDOT item number for cost calculations is shown in Table 7. The flat cost for all intersections was calculated as $12,344.68. There is no CMF to match exactly to these combined countermeasures. The study team used 0.8 for the benefit calculations.

Table 7. FDOT item number for cost calculations

	Countermeasure	Item #	Unit	Cost (dollars)
Curve	Chevron	0700 1 11	Each	345.52
	Curve warning sign	0700 1 11	Each	345.52
	RPM	0706 3	Each	2.93
	Edge line pavement marking (white)	0711 11141	Mile	722.18
	Centerline pavement marking (yellow)	0711 11241	Mile	2,093.14
	Bright sticks	0700 13 15	Each	95.35
	Rumble strips	0546 71	Assembly	577.30
Intersection	Stop sign and large stop sign	0700 1 11	Each	345.52
	Edge line pavement marking (white)	0711 11141	Mile	722.18
	Centerline pavement marking (yellow)	0711 11241	Mile	2,093.14
	Object marker OM-1-1	0705 10 1	Each	155.79
	Intersection-ahead sign	0700 1 11	Each	345.52
	Transverse rumble strip (minor approach)	---	Intersection	3,000.00
	Thermoplastic stop bar	0711 11125	Feet	3.66
	Bright sticks	0700 13 15	Each	95.35
	Flashing beacon	0700 12 31	Assembly	5,077.13

CHAPTER 5: Site-Specific Suggestions

Table 8 provides a summary of all sections that were selected for detailed review, along with estimated costs, benefit-cost ratio, and net present value to implement different levels of countermeasures. Based on the funding available, the county, district, and the state DOT can decide which level to consider for implementation. The study recommends improvements based on priority; low-cost countermeasures are given preference.

Curves:

- Level 1 – Includes high priority improvement that includes upgraded signs (curve warning sign, chevron, bright sticks) on selected curves including flashing beacons in some locations
- Level 2 – Includes improvement to pavement: pavement marking, rumble strips on select curves
- Level 3 – Includes both sign and pavement upgrades on the entire corridor and upgraded guardrail on selected locations
- Level 4 – Includes paving shoulders and upgraded guardrail on selected locations

Intersections:

- Level 1 – Upgraded signs on selected intersections
- Level 2 – Upgrade signs and markings intersections, including flashing beacons and transverse rumble strips in some locations

Curves suggested for upgrade were based on a review of crash data and limited field observations (due to COVID travel restrictions). A detailed project-level analysis of individual sites is needed to further adjust the cost estimates to implement the recommended improvements accounting for specific site conditions. The primary purpose of this analysis is to provide benefit-cost analysis and guidance for developing detailed implementation plans.

Table 8. Selected Levy County projects with benefit-cost analysis

Site	Section	Level 1			Level 2 - Cumulative (includes Level 1 improvements)			Level 3- Cumulative (includes Level 2 improvements)			Level 4- Cumulative (includes Level 3 improvements)		
		Estimated Cost	**B-C Ratio**	**NPV**	**Estimated Cost**	**B-C Ratio**	**NPV**	**Estimated Cost**	**B-C Ratio**	**NPV**	**Estimated Cost**	**B-C Ratio**	**NPV**
CR-347	SR-24 to CR-330	$139,668	30.78	$3,510,763	$179,051	45.03	$6,667,380	$393,301	92.41	$11,017,417	$16,212,570	2.57	$25,385,479
CR-345	SR-24 to CR-332	$128,029	41.04	$4,333,609	$166,623	59.14	$8,201,237	$290,797	9.37	$22,530,640	$10,397,306	6.22	$54,310,770
CR-343 & CR-326	US-19 to CR-337	$235,689	24.99	$4,766,753	$303,594	36.39	$9,078,552	$509,020	36.55	$1,551,878			
CR-336	between US-98 & county line)	$94,017	33.89	$2,204,402	$123,530	48.27	$4,187,186	$567,631	68.88	$8,589,106			
CR-335	US-27 to CR-318	$24,738	148.32	$3,204,696	$34,690	205.60	$6,022,157	$274,718	68.88	$8,589,106			
NW 102 Place	2 Curves	$29,097	26.65	$511,707	$37,684	38.59	$976,602						
CR-326	SE 200th Ave	$1,370	270.10	$312,786	$8,065	268.55	$1,831,175						
Various Intersections	CR-341 to CR-339	$10,910	59.99	$544,904	$19,715	194.36	$3,234,325						
Other selected curves	Various	$86,054	12.95	$860,354									

5.1 Section 1: CR-347 from SR-24 to CR-30

This section of CR-347 between SR-24 and CR-30 is a two-lane roadway with several horizontal curves. Figure 15 below shows the historical crashes with three fatal crashes on CR-347 section (indicated by red cross; note one red cross on the north end is not within this study section).

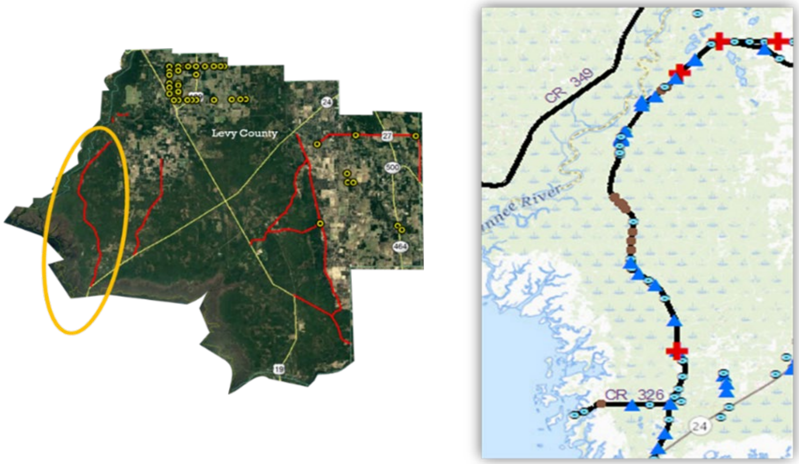


Figure 11. Section 1: Study area overview for CR-347

5.1.1 Crash History

Figure 16 below shows the aerial of the CR-347 (section in red) with historical crash numbers. This section of study area had 45 total crashes between 2015 and 2019 with three fatalities and 22 injury crashes (Table 10).

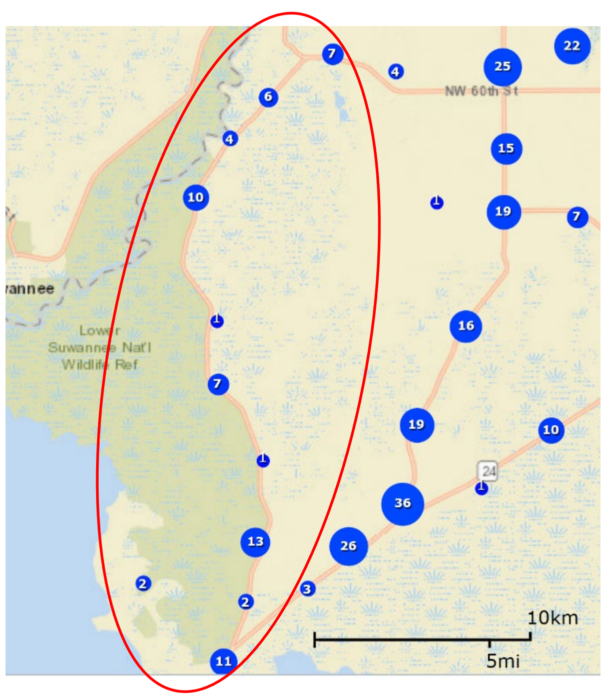


Figure 12. Section 1: Study area overview for CR-347 (red)

Table 9. Crash data related to Section 1 study area on CR-347

Crashes	**Year**					**Total**
Severity	**2015**	**2016**	**2017**	**2018**	**2019**	
Fatality			3			3
Injury	2	5	7	4	4	22
Property Damage Only	6	6	3	4	1	19
Total	**8**	**11**	**13**	**8**	**5**	**45**

Table 10 below shows the historical crash data by crash type which indicate that over 62% of crashes were lane departure.

Table 10. Section 1: Historical crash data by crash type

Crash Type	Severity			Total
	Fatality	Injury	Property Damage Only	
Intersection related	0.00%	6.67%	0.00%	6.67%
Lane departure	6.67%	37.78%	17.78%	62.22%
Other	0.00%	4.44%	26.67%	31.11%
Total	6.67%	48.89%	44.44%	100.00%

Table 11 shows the crash history by light condition, indicating that about 37% of the crashes occurred in non-daylight conditions. Note that in this study, non-daylight conditions include dusk and dawn.

Table 11. Section 1: Crash history by light condition

Light Condition	Severity			Total
	Fatality	Injury	Property Damage Only	
Daylight	4.44%	31.11%	26.67%	62.22%
Nighttime	2.22%	17.78%	17.78%	37.78%
Total	6.67%	48.89%	44.44%	100.00%

Overall, the crash data reveal that the study area has high historical crashes and a high proportion of lane departure and crashes in non-daylight conditions.

5.1.2 Field Observations

The following observations were made during the road safety audit:

- The terrain in this area is relatively flat, but there are numerous horizontal curves, which increases the risk during non-daylight conditions.
- Pavement edge drop-offs were noted at various locations, but the shoulders in these areas appear to be well maintained.
- Guardrail at bridges is obsolete. FDOT bridge inspection has identified the bridge approaches at a few of the locations as deficient.

5.1.3 Suggested Countermeasures

Based on the crash history and the field observations, the following countermeasures are recommended to reduce the crash risk for lane departure and nighttime crashes:

- Upgrade curve signing and marking
- Upgrade pavement markings through entire corridor
- Upgrade or replace guardrail at bridges
- Widen pavement to include paved shoulder.

As detailed in Chapter 4, the team proposes a priority list which the county and the districts could consider based on available funding and alternative resources to accomplish.

- Priority 1: Upgrade signs for "critical curves" as described in Chapter 4 (see Figure 17)
- Priority 2: In addition to the above countermeasures, upgrade pavement markings for "critical curves" as described in Chapter 4.
- Priority 3: Upgrade pavement markings for straight segments.
- Priority 4: As funding becomes available, consider widening the pavement and upgrading the guardrails.

Table 12 provides an overview of the CR-347 study area where the improvements are recommended on select curves as well as for the overall corridor. To prioritize investments, the study recommends level 1 and 2 improvements on select curves, and if funding is available, then corridor-wide improvement using level 3 and 4 improvements is recommended.

Table 12. Section 1: CR-347 analysis

Roadway feature	Site	Crashes on curves 2015–2019	Count	Total length curves (miles)
Curves	CR-347 from SR-24 to CR-330	23	12	2.74
All corridor	CR-347 from SR-24 to CR-330	45	1	19.65

Figure 13. CR-347 corridor improvement location overview

5.1.4 Benefit-Cost Analysis

Based on the priority recommendation detailed above, the Table 13 provides the benefit-cost (B-C) analysis along with the net present value (NPV) for each scenario.

Table 13. CR-347 benefit-cost analysis

Priority	Countermeasure	Cumulative		
		Cost	B-C	NVP
1	Upgrade signs, enhance warning signs, chevron in selected curves	$139,668	30.78	$3,510,763
2	#1 + pavement markings and rumble strips	$179,051	45.03	$6,667,380
3	Upgrade signs[5], markings through entire corridor, rumble strips	$393,301	92.41	$11,017,417
4	#3 + pavement shoulders	$16,212,570	2.57	$ 25,385,479

[5] Signs and markings at curves is recommended for upgrades however for tangents, these are mostly in place. While some may need replacement, this may be a maintenance activity and not an upgrade.

5.2 Section 2: CR-345 from SR-24 to CR-332

This section of CR-345 is a typical two-lane rural roadway with several horizontal curves and intersections. This section runs parallel to the previous study area of CR-347, and the roadway has similar characteristics. Figure 18 shows the overview of the study locations (left) and historical crash location on the overall corridor (right). The red cross indicates a fatal crash.

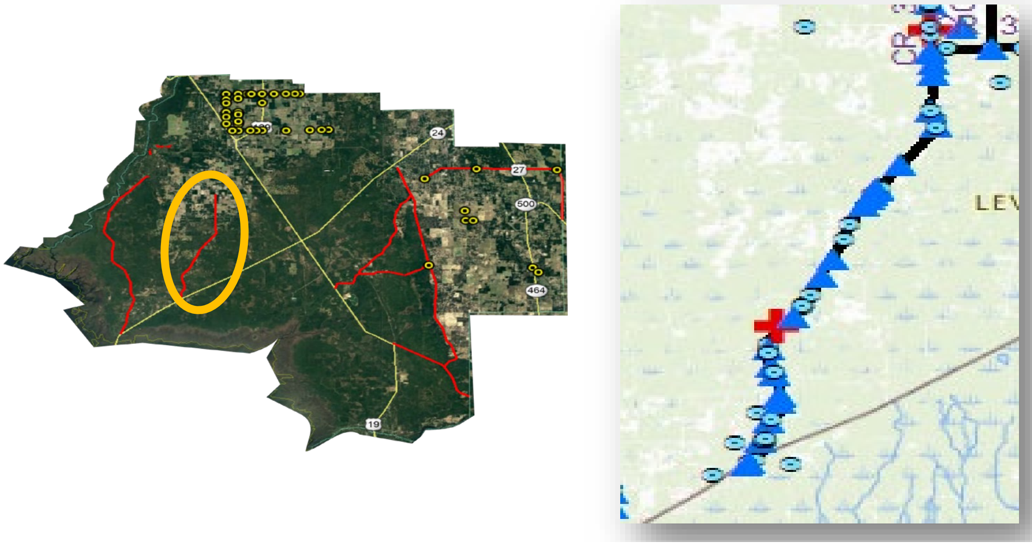


Figure 14. Study area (left), historical crash location (middle), and historical crashes on the north end of the corridor (right)

5.2.1 Crash History

Figure 19 shows the historical crash location on CR-345 (red outline). There are 70 crashes that are distributed across the corridor.

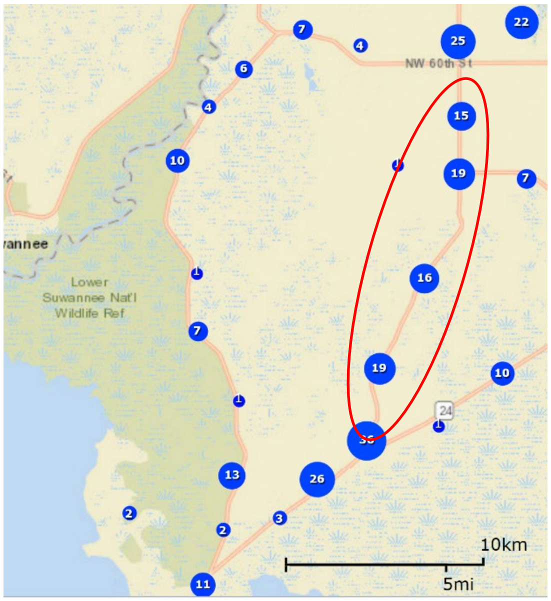


Figure 15. Section 1: Study area overview for CR-345 (red)

This section experienced 70 total crashes with 3 fatalities and 27 injury crashes (Table 14). About 60% of the crashes were lane departure crashes (Table 15), and about 37% of the crashes occurred during non-daylight condition (Table 16).

Table 14. Crash data related to Section 2 study area on CR-345

Crashes	**Year**					
Severity	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Fatality		1		2		3
Injury	6	4	8	5	4	27
Property Damage Only	13	7	9	4	7	40
Total	**19**	**12**	**17**	**11**	**11**	**70**

Table 15. Crash data related to Section 1 study area on CR-345

Crash Type	Severity			Total
	Fatality	Injury	Property Damage Only	
Intersection related	0.0%	5.7%	0.0%	5.7%
Lane Departure	4.3%	28.6%	27.1%	60.0%
Other	0.0%	4.3%	30.0%	34.3%
Total	4.3%	38.6%	57.1%	100.0%

Table 16. Crash data related to Section 1 study area on CR-345

Light Condition	Severity			Total
	Fatality	Injury	Property Damage Only	
Daylight	4.44%	31.11%	26.67%	62.22%
Nighttime	2.22%	17.78%	17.78%	37.78%
Total	6.67%	48.89%	44.44%	100.00%

Based on crash data analysis, this section of roadway has high overall crashes with a high proportion of lane departure crashes and significant nighttime crashes. This is consistent throughout the county.

5.2.2 Observations

The following observations were made during the road safety audit:

- South of CR-336, the road passes through a rural area. Curves are frequent and most crashes involve lane departures. These were frequently associated with curves.

  The road safety audit was performed during a rainy day, and the team observed water standing in wheel paths. Several of the crash reports also referred to water on the road. Overall, the pavement appears to be near end of service life, and these issues should be corrected when the road is resurfaced.

- North of CR-336, the adjacent land use is a mix of residential and agricultural land use. The road is a long tangent. Although there were intersection crashes, a significant number of the serious crashes involved lane departures in the tangent sections.

5.2.3 Suggested Countermeasures

Based on the crash history and the field observations, the following countermeasures are recommended to reduce the crash risk for lane departure and nighttime crashes:

- Install new warning signs
- Upgrade pavement markings through entire corridor
- Consider widening pavement to cross-section matching state segment north of CR-332. If resurfacing is scheduled soon, widening should be coordinated with that project.

Table 17 provides an overview of the CR-345 study area where the improvements are recommended on select curves as well as for the overall corridor. The analysis of this corridor recommends level 1 and 2 improvements described above for curves and level 3 and 4 for overall corridor section.

Table 17. Section 1: CR-345 analysis

Roadway feature	Site	Crashes on curves 2015–2019	Count	Total length curves (miles)
Curves	CR-345 from SR-24 to CR-332	23	7	2.8
All corridor	CR-345 from SR-24 to CR-332	70	1	12.6

Figure 16. CR-345 corridor improvement location overview

5.2.4 Benefit-Cost Analysis

Table 18 below shows the benefit-cost analysis for projects on CR-345. Based on available funding, the agency can decide to prioritize the implementation of the projects.

Table 18. Benefit-cost analysis for projects on CR-345

Priority	Countermeasure	Cumulative		
		Cost	**B-C**	**NVP**
1	Upgrade signs in selected curves	$128,029	41.04	$4,333,609
2	#1 + include rumble strips	$166,623	59.14	$8,201,237
3	Upgrade signs, markings through entire corridor	$290,797	9.37	$22,530,640
4	Pave shoulders	$10,397,306	6.22	$ 54,310,770

5.3 Section 3: CR-343 from CR-326 to CR-337

This section of the CR-343 is a typical two-lane rural roadway with several horizontal curves and intersections. There are three main sections: CR-343 runs southwest to north east, CR-326 runs east-west, and CR-337 runs north-south. CR-337 was studied separately and is detailed in the Section 4 (report section 5.4, below). This project deals with only CR-343 and CR-326. Figure 20 shows the overview of the study location (left) and the historical crash location (right).

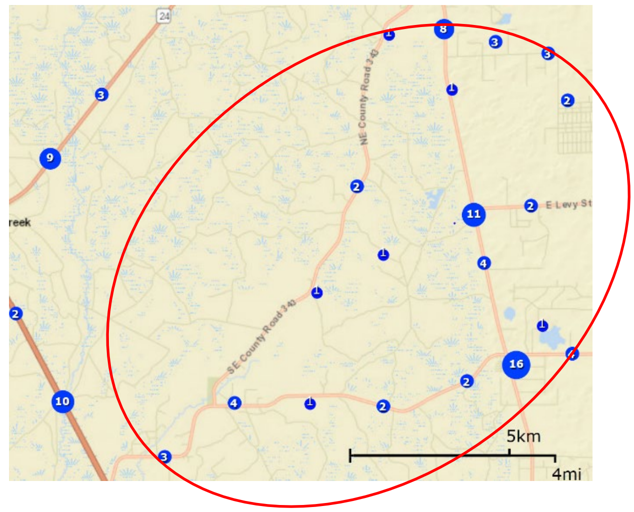


Figure 17. CR-343 Study area (left); crash history on two sections (right)

5.3.1 Crash history

The CR-343 section had a total of 7 crashes, with 2 injury crashes (Table 19). The section on CR-326 had a total of 35 crashes, with 1 fatality and 14 injury crashes (Table 20). Lane departure was the predominant crash type on both corridors, with over 57% on CR-343 (Table 21) and over 42% on CR-326 (Table 22). As seen with previous two study areas, nighttime crashes were an issue with this study area, with over 42% on CR-343 (Table 23) and over 37% on CR-326 (Table 24).

Table 19. Section 3: CR-343 number of crashes by year and severity

Crash	Year				
Severity	**2015**	**2016**	**2017**	**2018**	**Total**
Injury	2				2
Property Damage Only		2	1	2	5
Total	**2**	**2**	**1**	**2**	**7**

Table 20. Section 3: CR-326 number of crashes by year and severity

Crash	Year					
Severity	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Fatality	1					1
Injury	2	4	2	2	4	14
Property Damage Only	2	5	4	4	5	20
Total	**5**	**9**	**6**	**6**	**9**	**35**

Table 21. Section 3: CR-343 crashes by crash type and severity

Crashes	Severity		
Type	**Injury**	**Property Damage Only**	**Total**
Lane Departure	28.57%	28.57%	57.14%
Other	0.00%	42.86%	42.86%
Total	**28.57%**	**71.43%**	**100.00%**

Table 22. Section 3: CR-326 crashes by crash type and severity

Crashes	Severity			
Type	**Fatality**	**Injury**	**Property Damage Only**	**Total**
Intersection related	0.00%	5.71%	5.71%	11.43%
Lane Departure	0.00%	25.71%	17.14%	42.86%
Other	2.86%[6]	8.57%	34.29%	45.71%
Total	**2.86%**	**40.00%**	**57.14%**	**100.00%**

Table 23. Section 3: CR-343 crashes by time of day and severity

Crashes	Severity		
Type	**Injury**	**Property Damage Only**	**Total**
Daylight	0.00%	57.14%	57.14%
Nighttime	28.57%	14.29%	42.86%
Total	**28.57%**	**71.43%**	**100.00%**

[6] This was an intersection related crash based on a detailed review of the crash report.

Table 24. Section 3: CR-326 crashes by time of day and severity

Crashes	**Severity**			
Type	**Fatality**	**Injury**	**Property Damage Only**	**Total**
Daylight	2.86%	22.86%	37.14%	62.86%
Nighttime	0.00%	17.14%	20.00%	37.14%
Total	**2.86%**	**40.00%**	**57.14%**	**100.00%**

5.3.2 Observations

CR-343 and CR-326 in the subject area pass through sparsely developed areas. There are few driveways or intersections, but both roads have numerous curves.

Although no fatal crashes have been reported since 2015, there were two fatalities in the previous five years on CR-343. These involved lane departures at curves. Similarly, the serious crashes on CR-326 involved lane departures at curves.

Both roads have centerline and edge line markings. For CR-343, no RPMs were observed during the field visit. The field review for CR-326 was conducted during inclement weather, and pavement markings were difficult to see.

FDOT bridge inspection reported deficient approaches to a bridge on CR-326 between US-98 and CR-343.

5.3.3 Suggested countermeasures

The following recommendations are listed for this study area:

- Priority 1: Upgrade signs for "critical curves" as described in Chapter 4 (see Figure 21).
- Priority 2: In addition to the above countermeasures, upgrade pavement markings for "critical curves" as described in Chapter 4.
- Priority 3: Upgrade pavement markings for straight segments.

The study recommends that selected curves (Figure 22) be treated with low-cost countermeasures, starting with signs and then marking. Based on funding availability, priority 3 can be considered.

Table 25. Section 1: CR-343 and CR-326 feature analysis

Roadway feature	Site	Crashes on curves 2015–2019	Count	Total length of curves per segment (miles)
Curves	CR-343 and CR-326	37	15	4.9
All corridor	CR-343 and CR-326 US-19 to CR-337	42	1	21.15
Guardrail	CR-326 various locations	——	4	0.05

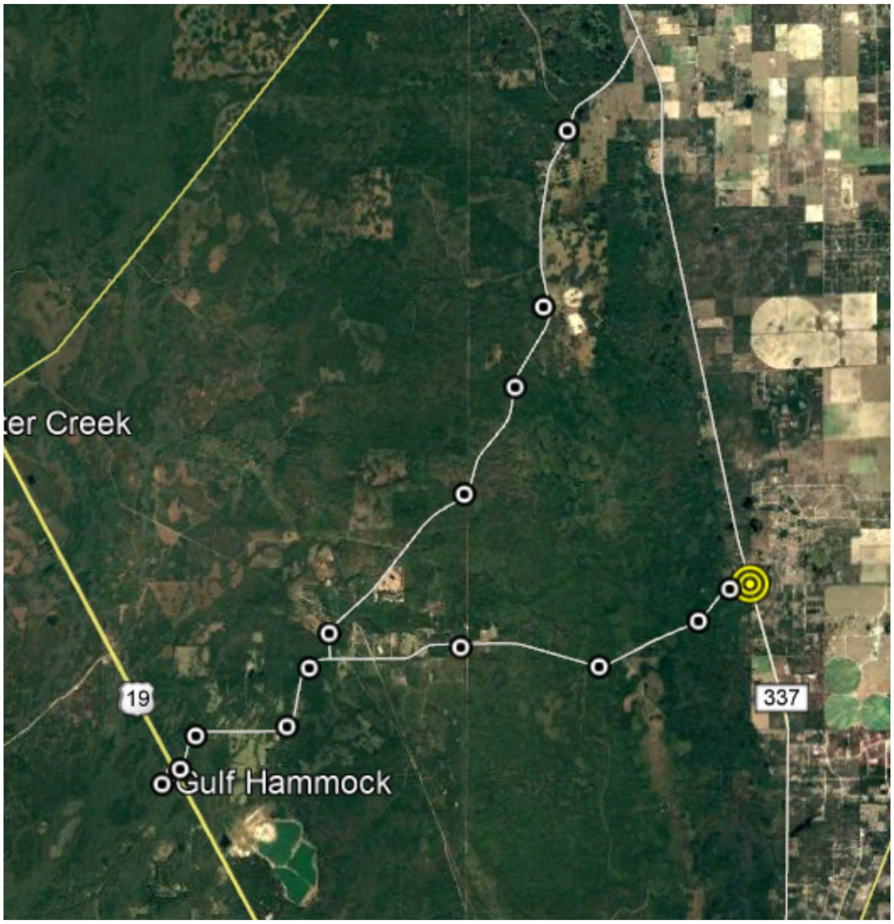


Figure 18. CR-343and CR-326 curves recommended for improvements

5.3.4 Benefit-Cost Analysis

Table 26 shows the benefit-cost analysis for projects on CR-343 and CR-326.

Table 26. Benefit-cost analysis for projects on CR-343 and CR-326

Priority	Countermeasure	Cumulative		
		Cost	B-C	NVP
1	Upgrade signs, enhance warning signs, chevron in selected curves	$235,689	24.99	$4,766,753
2	#1 + pavement markings, rumble strips	$303,594	36.39	$9,078,552
3	Upgrade signs, markings through entire corridor, rumble strips, guardrail	$509,020	36.55	$1,551,878

5.4 Section 4: CR-337 between US-98 and county line

CR-337 runs north south and is a typical two-lane roadways with several intersections and few curves. Figure 22 shows an overview of the study area (left) and the location of historical crashes (right).

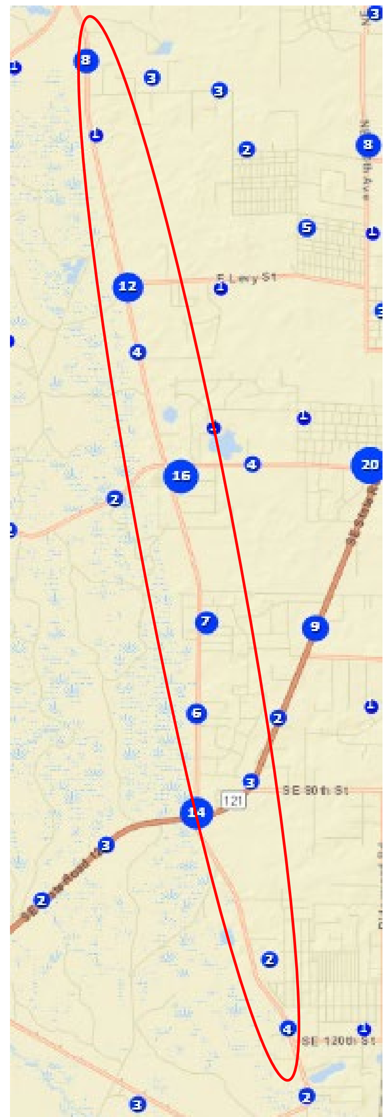


Figure 19. CR-337 overview (left) and historical crash locations (right)

5.4.1 Crash history

This section had over 94 total crashes between 2015 and 2019 with three fatalities and 28 injury crashes (Table 27). Over 37% of the crashes were lane departure crashes (Table 28) and over 46% of the crashes occurred in non-daylight conditions (Table 29).

Table 27. Crash history on CR-337

Crash	**Year**					
Severity	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**
Fatality	2				1	3
Injury	3	6	5	3	11	28
Property Damage Only	6	19	13	13	12	63

Total	11	25	18	16	24	94

Table 28. Crashes by severity on CR-337

Crashes	Severity			
Type	**Fatality**	**Injury**	**Property Damage Only**	**Total**
Intersection related	0.00%	4.26%	11.70%	15.96%
Lane Departure	2.13%	17.02%	18.09%	37.23%
Other	1.06%	8.51%	37.23%	46.81%
Total	**3.19%**	**29.79%**	**67.02%**	**100.00%**

Table 29. Crashes by light condition on CR-337

Crashes	Severity			
Time	**Fatality**	**Injury**	**Property Damage Only**	**Total**
Daylight	2.13%	18.09%	32.98%	53.19%
Nighttime	1.06%	11.70%	34.04%	46.81%
Total	**3.19%**	**29.79%**	**67.02%**	**100.00%**

5.4.2 Observations

CR-337 traverses an area that is largely rural with some scattered residential and occasional business land uses. The road is mostly straight with occasional curves. There are occasional driveways and intersections. There are at least two locations where potential "visual traps" (locations where the rolling terrain obstructs the view of the road ahead) have been identified. One is a curve just south of the intersection with CR-343; the other is at the southbound approach to the intersection with CR-326. Fatal crashes at both of these locations appear to be associated with difficulty the driver had in recognizing the conditions of the roadway ahead.

CR-336 includes a straight section between US-98 and CR-337. Between CR-337 and the Marion County line, the road includes some curves. Throughout this entire segment, CR-336 has paved shoulders.

5.4.3 Suggested Countermeasures

The study recommends the following priorities for countermeasure implementation:

- Priority 1: Add flashing beacon southbound on CR-337 at intersection with CR-326.
- Priority 2: Upgrade signs for "critical curves" as described in Chapter 4.
- Priority 2: In addition to the above countermeasures, Upgrade pavement markings for "critical curves" as described in Chapter 4.
- Priority 3: Upgrade pavement markings for corridor.

The study identified three curves and one intersection (Figure 23) detailed in Table 30 below.

Table 30. CR-337 features at selected sites

Roadway feature	Site	Crashes on curves 2015–2019	Count	Total length of curves (miles)
Curves	CR-337	11	3	2.01
All corridor	CR-337	94	1	32.23
Intersection	CR-326 and CR-337	6	1	

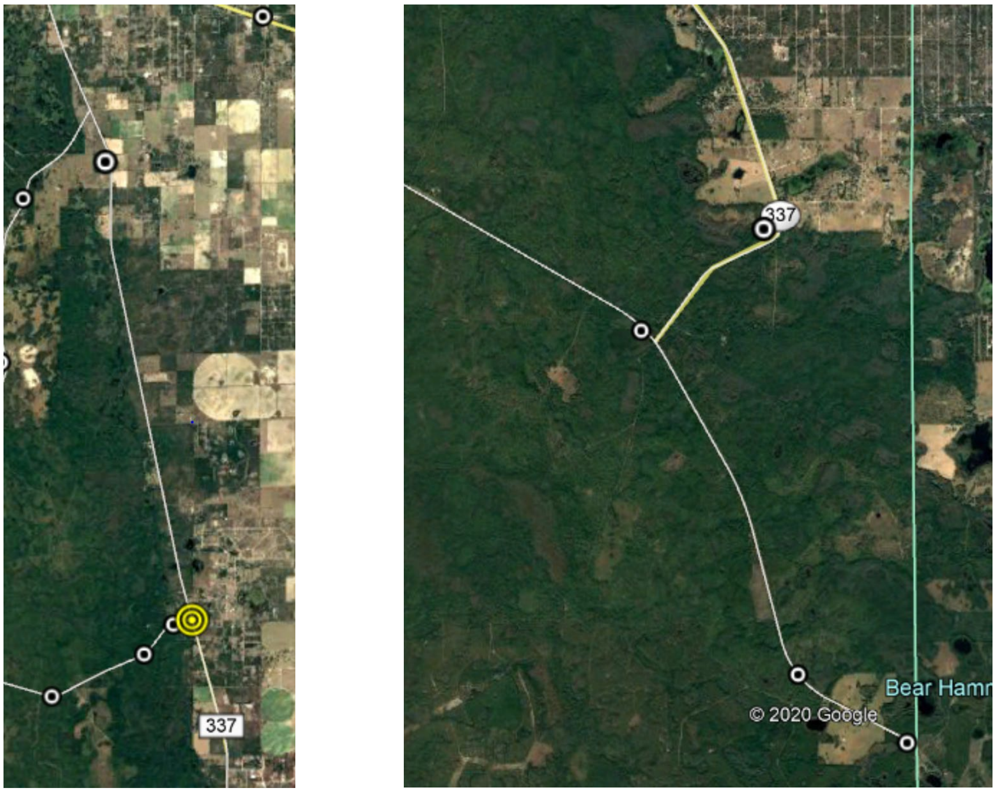


Figure 20. Selected curves on CR-337 (left) and one intersection (right)

5.4.4 Benefit-Cost Analysis

Table 31 shows the results of the benefit-cost analysis for the improvements on CR-337.

Table 31. CR-337 improvements: benefit-cost analysis

Priority	Countermeasure	Cumulative		
		Cost	B-C	NPV
1	Upgrade signs, enhance warning signs, chevron in selected curves	$94,017	33.89	$2,204,402
2	#1 + pavement markings, rumble strips	$123,530	48.27	$4,187,186
3	Upgrade signs, markings through entire corridor	$567,631	68.88	$8,589,106

5.5 Section 5: CR-335 from US-27 to NE 11th Avenue

This section of CR-335 is a typical two-lane rural roadway that runs east-west from US-41 past US-121 and then runs north-south. The study section has several intersections, curves, and the change in direction is facilitated with a 90-degree curve that has an intersection at NW 160th Avenue. Figure 24 shows the overview of the study locations and the historical crashes, with red cross indicating a fatal crash.

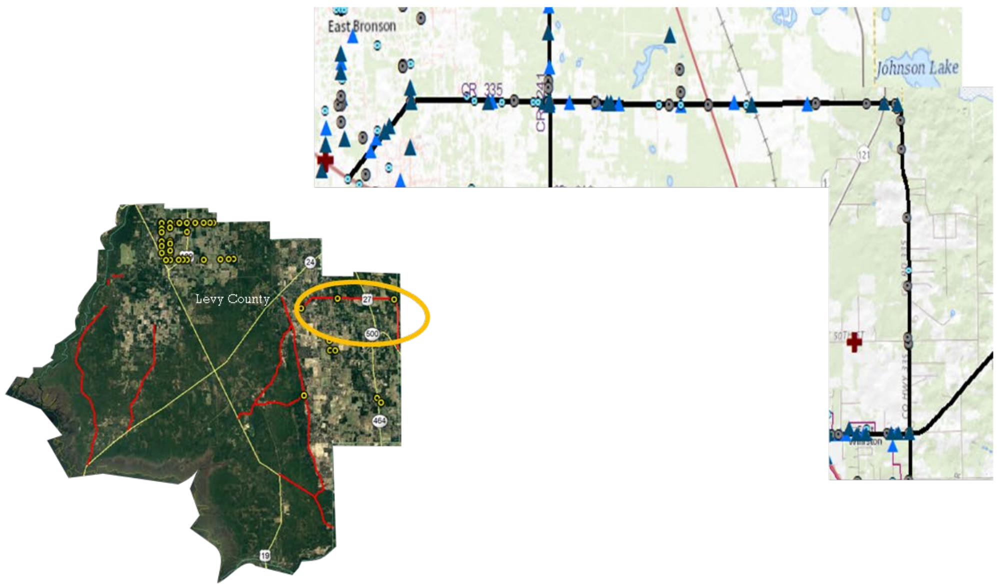


Figure 21. CR-335 study area (left) and crash history (right)

Table 32 lists the historical crashes by severity in the study area and Figure 24 shows the locations of crashes on the corridor.

Table 32. Crash history by severity on CR-335 study area

Crash Severity	Year					Total
	2015	2016	2017	2018	2019	
Fatality		1		1	1	3
Injury	11	9	9	15	6	50
Property Damage Only	11	11	16	24	15	77
Total	22	21	25	40	22	130

5.5.2 Observations

The road is predominantly straight with two major curves (near US-27 and SR-121) and minor curves just south of the SR-121 intersection. Three major intersections involve state highways: US-27, US-41, and SR-121. The other major intersection is at CR-241.

The intersection at SR-121 is immediately west of a 90-degree curve and involves a stop condition on the CR-335 approaches. For eastbound traffic, a hill just before the intersection limits the view of the intersection. A review of the crashes identifies two problems at this location: (1) vehicles on CR-335 fail to stop at the intersection and (2) northbound vehicles lose control at the 90-degree curve south of the intersection. There is a high frequency of nighttime crashes at this location.

Emphasis in addressing crashes at this location should include improving nighttime visibility of roadway features and providing more advanced alert to the driver of the intersection ahead and the sharp curve.

At CR-241, CR-335 is the through movement and CR-241 is controlled by basic stop signs and stop bar. Intersections crashes at this location include failure to observe the stop sign. Emphasis should be on improving driver recognition of the stop condition on CR-241.

The intersections at US-41 and US-27 involve major state highways and were not reviewed in detail during this study.

Along the tangent sections of US-335, crashes were associated mainly with lane departures. Some pavement edge drop-offs were observed.

5.5.3 Suggested Countermeasures

Suggested countermeasures include:

- At intersection with SR-121
    - Add flashing beacons
        - Eastbound at approximately the location of the advanced warning sign
        - Northbound in advance of the 90-degree curve
    - Upgrade pavement markings to include:
        - Refreshed centerline and edge line (with rumble strip) through the 90-degree curve south of SR-121
        - RPMs Through the entire curve and both approaches to SR-121 Intersection
- At intersection with CR-241 (two-way stop control) (see Figure 26)
    - Upgrade approaches as detailed in Chapter 4 for intersection improvements
- Entire corridor
    - Upgrade pavement markings to include audible centerline and edge line and RPMs as described for straight segments in Chapter 4.

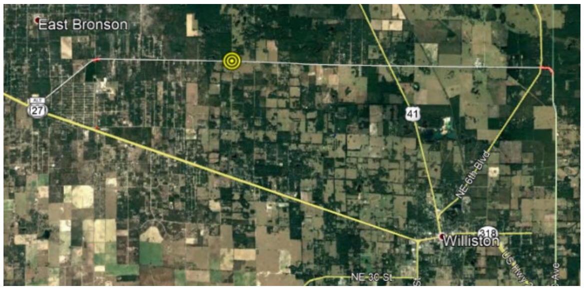


Figure 22. Location of two curves for improvement (left) and location of Intersection of CR-335 and CR-241 for improvement

The countermeasure priority first recommended in the study includes two curves as detailed in the table below. Based on available funding and resources, the corridor and intersections are recommended for improvement.

Table 33. Crash history by severity on CR-335 study area

Roadway feature	Site	Crashes on curves 2015–2019	Count	Total length curves (miles)
Curves	CR-335	36	2	0.5
All corridor	CR-335	130	1	17.22
Intersection	CR-335 at NE 150th Ave	13	1	

5.5.4 Benefit-Cost Analysis

Table 34 below shows the results of the benefit-cost analysis for the improvements on CR-337.

Table 34. Crash history by severity on CR-335 study area

Priority	Countermeasure	Cumulative		
		Cost	**B-C**	**NPV**
1	Upgrade signs, enhance warning signs, chevron in selected curves and intersections including flashing beacons on CR 335 and CR 241	$24,738	148.32	$3,204,696
2	#1 + pavement markings Include rumble strips	$34,690	205.60	$6,022,157
3	Upgrade signs, and markings through entire corridor	$274,718	68.88	$8,589,106

5.6 Section 6: NW 102nd Place – 2 curves

This section of NW 102nd Place is a two-lane roadway, and the study area mainly focuses on two curves as shown in Figure 27, an aerial overview of the location within the county (left) and crash history (right). The red cross indicates a fatality at the left curve.

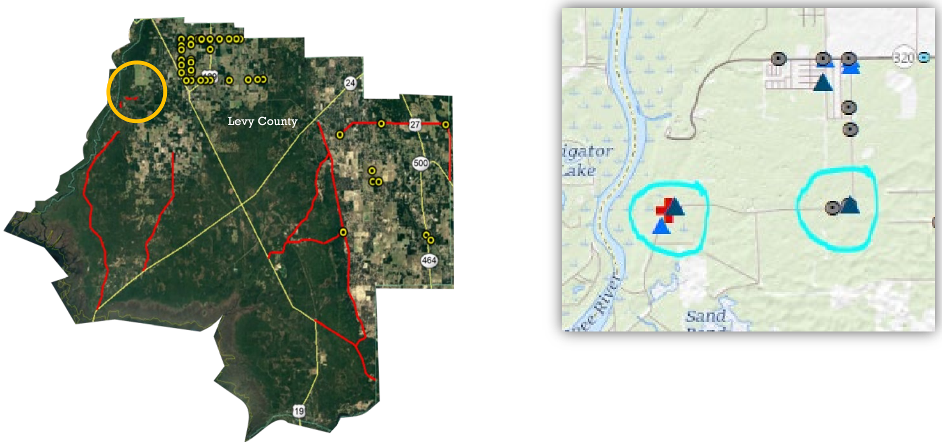


Figure 23. NW 102nd Place study location (left) and historical crash locations (right)

5.6.1 Crash history

Crash data indicate a total of four crashes with one fatality, one injury crash, and two property damage crashes (Table 35). Three of the four were non-daylight crashes.

Figure 24. Crash location on two curves on NW 102nd Place (red = fatality; blue = injury; teal = PDO)

Table 35. NW 102nd Place crash history by crash type and severity

Crashes	Severity			
Type	**Fatality**	**Injury**	**Property Damage Only**	**Total**
Lane Departure	25.00%	25.00%	50.00%	100.00%
Total	**25.00%**	**25.00%**	**50.00%**	**100.00%**

5.6.2 Observations

- This is a minor, low volume road, but severe crashes have occurred at these two curves. This is predominantly a residential area.

5.6.3 Suggested Countermeasures

The two curves in the study area include a total curve length of 0.61 miles.

- Upgrade signing for two curves as described for "critical curves" in Chapter 4.
- Further evaluation of potential advisory speeds may be appropriate if this has not been previously considered.

5.6.4 Benefit-Cost Analysis

Table 36. Benefit-cost analysis of countermeasures for Study Area 6

Priority	Countermeasure	Cumulative		
		Cost	B-C	NPV
1	Upgrade signs, enhance warning signs, chevron in selected curves and intersections	$29,097	26.65	$511,707
2	#1 + pavement markings[7]	$37,684	38.59	$976,602

[7] Further evaluation of pavement width for pavement marking and presence of residential neighborhood for rumble strip must be considered before implementation

5.7 Section 7: CR-326 at SE 200th Ave

CR-326 (Figure 29) is a typical two-lane roadway that runs east-west and north-south. As you approach westbound, the roadway has a sharp horizontal curve which then changes the alignment to north-south direction.

Figure 25. CR-326 study area location (left) and crash history (right)

5.7.1 Crash History

The site of concern is the 90-degree curve on CR-326 where the east leg of CR-326 intersects with SE 200th Ave. South of the intersection, SE 200th Ave is unpaved, but the major problem involves westbound vehicles on CR-326. Overall, there was one fatality, two injury crash, and two property damage crashes (Table 37). Three of the five crashes in this study area were on westbound approach (Figure 30). Four of the five crashes were in non-day light conditions (Table 38) and four of the five were lane departure crashes (Table 39).

Table 37. Crashes on CR-326 at SE 200th Ave

Severity	Count
Fatality	1
Injury	2
Property Damage Only	2
Grand Total	5

Figure 26. Crash location and direction on CR-326

Table 38. Crash history by crash type at CR-326 at SE 200th Ave

Crash type	Count
Off Road	2
Other	1
Rollover	1
Sideswipe	1
Grand Total	5

Table 39. Crash history by light condition at CR-326 at SE 200th Ave

Light conditions	Count
Dark - Not Lighted	4
Daylight	1
Grand Total	5

5.7.2 Observations

The serious crashes at this location occurred in non-daylight conditions. Most were westbound vehicles that failed to recognize the curve and travelled into a wooded area. The emphasis in countermeasures for this site should be on enhancing the nighttime visibility of the curve.

The curve (Figure 31) is marked with a 15 mph advisory speed, a horizontal alignment sign (westbound to northbound), and rumble strips on the westbound approach. Pavement markings through the curve are worn and do not include RPMs. The condition of the shoulder on the inside of the curve suggest that vehicles frequently approach the curve at excessive speeds.

Figure 31. Intersection of CR-326 with SE 200th Ave

5.7.3 Suggested Countermeasures

Priority 1:

- Install flashing beacon for westbound approach.
- Upgrade signs for the 90-degree curve on CR-326 curve at the intersection as described for “critical curves” Chapter 4.

Priority 2:

- In addition to the above countermeasures, upgrade pavement markings for “critical curves” as described in Chapter 4

5.7.4 Benefit-Cost Analysis

Table 40. Benefit-cost analysis of countermeasures for Study Area 7

Priority	Countermeasure	Cumulative		
		Cost	B-C	NPV
1	Upgrade signs, enhance warning signs, chevron in selected curves and intersections	$1,370	270.10	$312,786
2	#1 + pavement markings	$8,065	268.55	$1,831,175

5.8 Section 8: Intersections

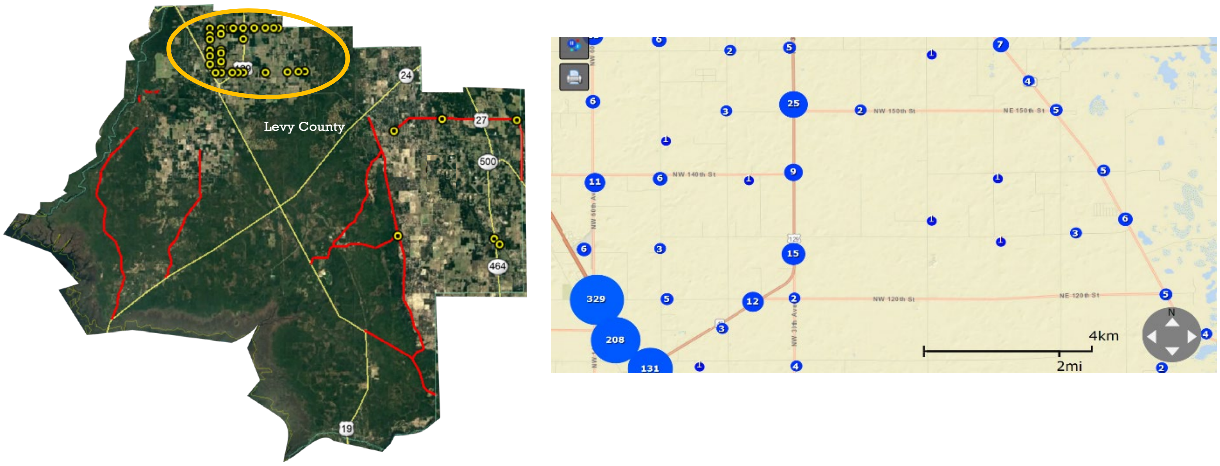


Figure 27. List of intersection for systematic improvements

Much of the county road system in Levy County is arranged in a well-defined grid pattern, with major county roads along section lines. The area north and east of Chiefland is typical of this pattern. Roads in this area are two lanes, and intersections are stop controlled with a mix of two- and four-way stops. Signing and marking for these intersections is variable. Some approaches have basic stop signs, while other approaches have been upgraded to include advanced warning signs and transverse rumble strips.

For the intersections observed during the field study, the intersection and stop signs were visible to vehicles approaching the intersection; however, the frequency of crashes associated with vehicles that fail to stop suggests that drivers fail to recognize the stop condition. The spacing between major intersections (a mile or more) with no change in road alignment, few driveways, and relatively uniform roadside environment often appears to lead some drivers to relax their attention to warning signs and markings. Moreover, variations between signing and marking patterns between intersections in the same area may exacerbate violations of stop controls for intersections with less robust markings.

Crashes reported for major intersections (generally roads designated with a CR number) include several fatalities and serious injuries. One such intersection, CR-346A at US-129, has been upgraded to include enhanced signing and pavement markings.

5.8.1 Suggested countermeasures

Upgrade signing and marking at major stop controlled intersections for enhanced conspicuity as described in **Chapter 4: Upgrade signing and marking at Intersections.** Intersections suggested for this improvement are shown in Figure 33, but further review may indicate the desirability of including others.

Note that all of the countermeasure estimation in this report are based on digitized maps that may not correspond to the field conditions. Designer will need to verify the measurements in the field for accurate estimation.

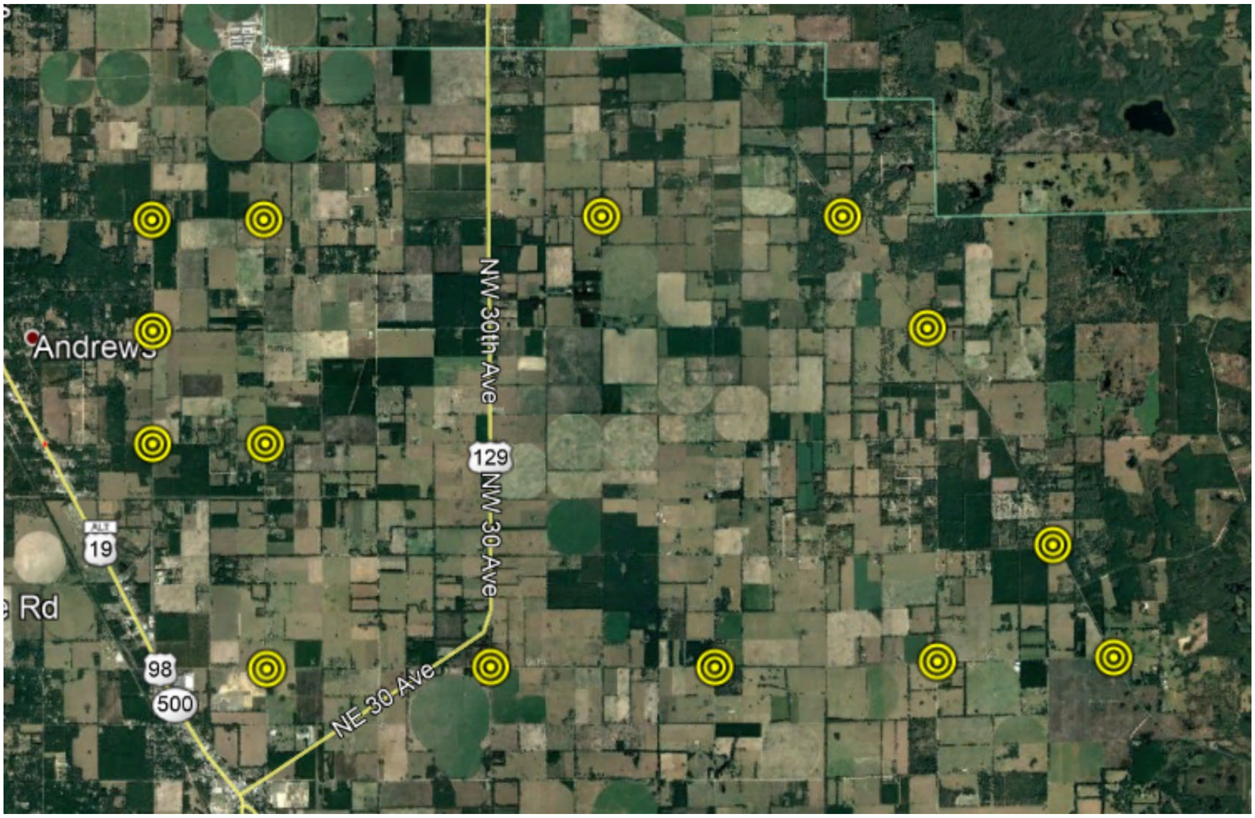


Figure 28. Locations for select intersection improvements

5.8.2 Benefit-Cost Analysis

Table 41. Benefit-cost analysis of countermeasures for Study Area 8

Priority	Countermeasure	Cumulative		
		Cost	B-C	NPV
1	Upgrade signing at major stop-controlled intersections	$10,910	59.99	$544,904
2	#1 + upgrade pavement markings, include transverse rumble stripes	$19,715	194.36	$3,234,325

5.9 Systematic Curves Improvement Program

The study also recommends that the county implement a curve improvement program based on curve radius. The threshold recommended by the team based on the data available is 1,000 feet. Since the GIS data and road inventory are constantly changing, the study recommends that the designer utilize the latest data in order to screen such locations that meet the threshold.

Table 42 below lists the curve IDs and attributes for selected curves that is not listed in the previous sections. These curve IDs correspond to the curve database developed for the FDOT. These are the curves independent of the locations identified in individual projects in previous sections. Table 43 lists the benefit-cost analysis for the curve improvements for more few locations that was not included in the previous sections.

Table 42. Attributes of additional curves selected for improvements

Curve ID	Radius (feet)	Shape Length (feet)
34521000-62-1	875.8	498.7
34544000-78-1	244.6	220.5
34550000-79-58	348.9	695.5
34620000-86-1	221.5	287.1
34501000-43-1	3284.1	1748.7
34100000-34-9	433.5	477.6
34100000-34-15	492.1	223.1
34100000-34-26	984.3	3061.1

Table 43. Benefit-cost analysis for other selected curves improvements

Site	Section	Level 1		
		Estimated Cost	B-C Ratio	NPV
Other selected curves	Various	$86,054	12.24	$860,354