SYSTEMIC SAFETY ANALYSIS

COLUMBIA AND JACKSON COUNTY

TASK 3 AND 4 REPORT SUPPLEMENT-3

Prepared for

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Contents

Chapter 1 – Identification and Characterization of Intersections

The Florida Unified Roadway Basemap (NAVTEQ) used for this project uses both single and dual lines to represent roadway centerlines. This leads to three basic geometries for the representation of intersections: point-intersections, line-intersections, and polygon-intersections. Figure 1 illustrates each intersection type. The point intersections are created when two single centerlines intersect (Figure 1, left). The line intersections are created when a dual centerline intersects a single centerline (Figure 1, middle). A polygon intersection is created when two dual centerline segments intersect (Figure 1, right).

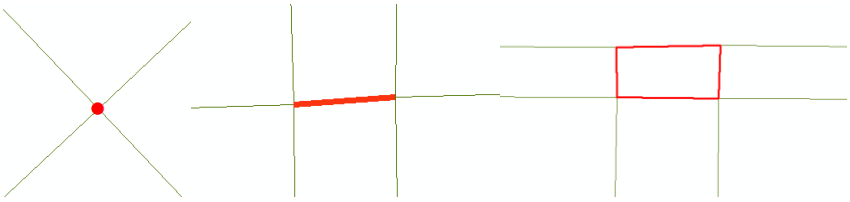

Figure 1. Three geometries of intersection: point, line, and polygon. The red shapes represent intersections; green lines represent roadway segments.

In most polygon-intersection situations, the maneuvers and the internal intersection segments can lead to a variety of irregular polygons. Figure 2 illustrates different shapes of polygon-intersections.

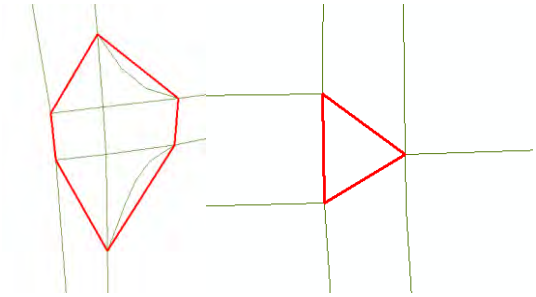

Figure 2. Polygon intersections of irregular shapes due to maneuvers and inter-inters

The method for determining intersection type and intersection angle varies by the intersection geometry type: point, line or polygon. We have developed an automated method to determine the type and the angle of point intersections, which represent the majority of county road intersections. The type and the angle for line and polygon intersections were obtained manually.

Determination of Intersection Type and Angle

The number of legs determines the type for each intersection. If it is a 3-leg intersection, it can only be of type T or Y; if it is a 4-leg intersection, it can be of type Cross, X, K, or Other; if it has 5 or more legs, it is a multi-leg intersection.

Calculate the angle between every pair of roadway segments in the intersection and compare the angle to the 90-degree angle.

For a 3-leg intersection: if two angles are approximately 90 degrees (the threshold used is 5 degrees), it is a T-intersection; if not, it is a Y-intersection.

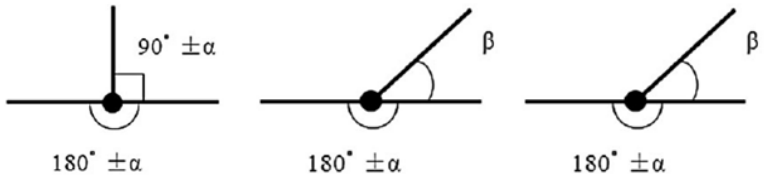

Figure 3. Diagram of T-intersection and two Y-intersections

For a 4-leg intersection: if the four angles are approximately equal to 90 degrees (the threshold used is 5 degrees), it is a Cross-intersection; if the angles show the intersection consists of two straight roadways, but not crossing at 90 degrees, it is an X-intersection; if the angles show the intersection consist of one straight roadway and is not crossed by the other roads at 90 degrees, it is a K-intersection; if the angle shows none of the above situations, it is an Other-intersection.

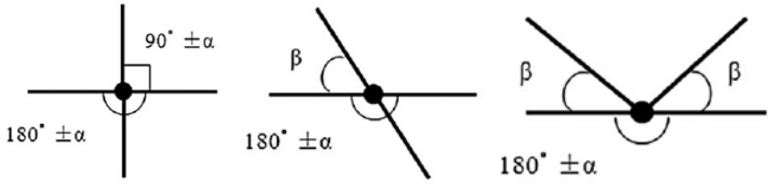

Figure 4. Diagram of Cross-intersection, X-intersection, and K-intersection

The intersection angle is the smallest of all angles between pairs of intersecting roads. The smallest angle for most of the intersections is between 30 degrees and 90 degrees.

Determination of Distance to the Nearest Intersection

For point intersections, the road network is traced from each intersection to the next intersection along each approach programmatically, and the distances are measured. There are three distances to the

nearest intersection if it is a 3-leg intersection and four distances to the nearest intersection if it is a 4-leg intersection. The smallest distance is recorded as the distance to the nearest intersection. For line and polygon intersections, the distances were measured manually.

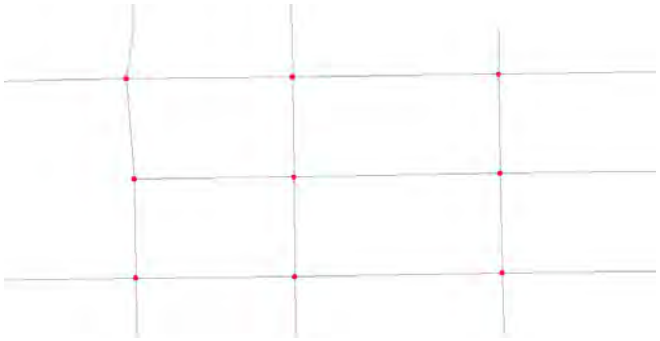

Figure 5. Diagram of the intersection to the nearest intersection along each approach

Determination of Relationships to Curves

There are three types of relationships between intersections and curves: the intersection is on a curve, the intersection has a distance to the nearest curve, and the intersection is not influenced by a curve (i.e., one has to travel through one or more other intersections before reaching any curve).

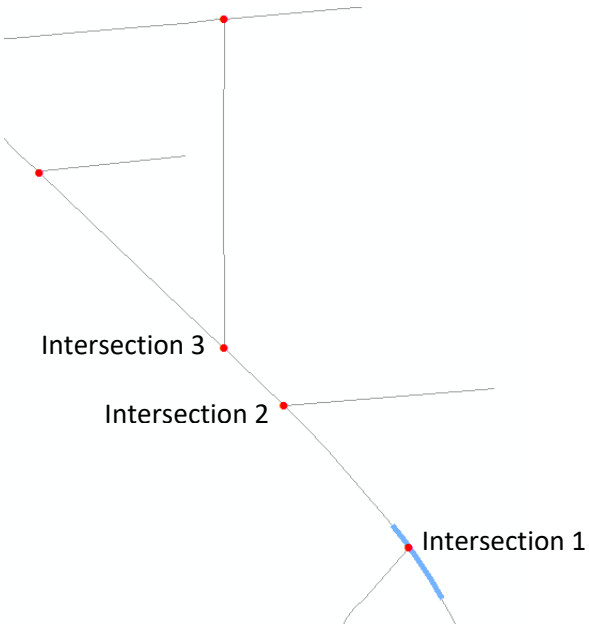

Figure 6. Diagram of intersection relationship to curves (red dots are intersections): Intersection 1 – the intersection is on a curve; Intersection 2 – the intersection has a distance to the nearest curve; Intersection 3 – the intersection is not influenced by a curve

Point intersections on curves can be determined using overlay procedures[1]. For intersections not on curves, the roadway network was traced along each approach until a curve or another intersection was reached. If all approaches lead to another intersection before reaching a curve, this intersection is classified as "not influenced by a curve." Otherwise, the nearest curve is determined to be the influencing curve. The distance to this curve and the characteristics of this curve are recorded. The same procedure was performed manually for line and polygon intersections.

Determination of Other Risk Factors

Two resources for traffic volume data for the county roads were considered: (1) the 2015 RCI data from FDOT, and (2) 2015 estimated AADT data on the All Road Basemap (ARBM). The former generally does not provide data for the minor approach of intersections, while the latter provides AADT values for minor roads as well (albeit estimates). The county also provides data on traffic counts at specific locations, but these do not cover all intersections. A correlation analysis using data from 215 location count stations in Columbia County indicated a correlation of 0.34 between local counts and RCI data and a correlation of 0.59 between local counts and ARBM data. Considering the availability of ARBM traffic data for minor roads and the stronger correlation with local counts, we used this data to represent the traffic volumes on the major and minor approaches of the intersections. We did notice that some intersections had very low AADTs. Therefore, based on AADT, we excluded the bottom 20 percentile of the intersections from the original dataset from further analysis.

The 5-level NAVTEQ functional classification of all the road segments ending on each intersection was recorded, and the maximum and minimum of these were calculated. This was used in turn to determine whether the intersecting roads were of the same or different functional classification.

The 5-level NAVTEQ functional classification scheme used is as follows:

Functional Class = 1 roads allow for high volume and maximum speed traffic movement between and through major metropolitan areas. Functional Class = 1 is applied to roads with very few, if any, speed changes. Access to the road is usually controlled.

Functional Class = 2 roads are used to channel traffic to Functional Class = 1 roads for travel between and through cities in the shortest amount of time. Functional Class = 2 is applied to roads with very few, if any, speed changes that allow for high volume, high-speed traffic movement.

Functional Class = 3 is applied to roads which interconnect Functional Class = 2 roads and provide a high volume of traffic movement at a lower level of mobility than Functional Class = 2 roads.

Functional Class = 4 is applied to roads which provide for a high volume of traffic movement at moderate speeds between neighborhoods. These roads connect with higher functional class roads to collect and distribute traffic between neighborhoods.

Functional Class = 5 is applied to roads whose volume and traffic movement are below the level of any functional class. In addition, walkways, truck-only roads, bus-only roads, and emergency-vehicle-only roads receive Functional Class = 5. The following also receive Functional Class = 5: access roads, parking lanes, and connections internal to select POIs in North America.

[1] The next chapter describes the process of creating a GIS layer of curves.

The 8-level NAVTEQ speed category of all the road segments ending on each intersection was recorded, and the maximum and minimum of these were calculated. This was used in turn to determine whether the intersecting roads had the same approach speed or not. The 8-level NAVTEQ speed category scheme used is as follows:

1: >80 MPH (>130 KPH)

2: 65–80 MPH (101–130 KPH)

3: 55–64 MPH (91–100 KPH)

4: 41–54 MPH (71–90 KPH)

5: 31–40 MPH (51–70 KPH)

6: 21–30 MPH (31–50 KPH)

7: 6–20 MPH (11–30 KPH)

8: <6 MPH (<11 KPH)

Correlation analyses were conducted on a subset of roadway locations between the NAVTEQ speeds and posted speed limits. For the roads under consideration, we determined that by aggregating NAVTEQ into fewer speed categories, we can get reasonably good consistency with posted speeds.

The 3-level NAVTEQ lane category of all the road segments ending on each intersection was recorded, and the maximum and minimum of these were calculated. This was used in turn to determine whether the intersecting roads have the same number of lanes or not. The 3-level NAVTEQ lane category scheme used is as follows:

1: one lane

2: two or three lanes

3: four or more lanes

Crash Data

The crashes associated with each intersection were determined by overlaying the crash data (for the period January 2013–December 2017) with the intersection layer and including all crashes within a 250-ft buffer of the intersection. The focus of this study was only on KABC crashes (property-damage-only crashes were excluded).

Overall, 6,067 intersections of interest were identified in the 27 small and rural counties. These are shown in Table 1.

Table 1. Descriptive statistics on intersections and roadway mileage by county

County	County road (miles)	On-system road (miles)	All road (miles)	Number of intersections	Number of intersection-related KABC crashes
BAKER	122.49	83.85	1,540.49	277	229
BRADFORD	122.36	69.20	1,073.70	248	160
CALHOUN	106.60	95.69	1,439.73	116	42
COLUMBIA	181.45	203.24	2,326.04	578	645
DESOTO	58.40	83.08	964.13	94	76
DIXIE	139.00	46.02	1,985.68	193	87
FRANKLIN	47.22	90.44	1,604.69	121	15
GADSDEN	232.05	138.60	1,256.73	448	324
GILCHRIST	109.16	60.06	945.18	165	90
GLADES	63.26	86.66	953.77	43	20
GULF	64.56	79.08	1,498.54	111	28
HAMILTON	162.81	90.55	1,312.22	174	40
HARDEE	137.04	94.62	806.42	121	135
HENDRY	136.31	64.84	1,382.99	191	163
HOLMES	174.82	104.88	1,074.74	261	86
JACKSON	270.44	242.22	2,516.27	485	190
JEFFERSON	114.32	110.78	1,031.06	179	53
LAFAYETTE	117.43	62.09	1,573.07	79	20
LEVY	314.24	182.51	3,215.41	505	304
LIBERTY	131.56	69.99	1,220.17	62	48
MADISON	157.73	138.45	1,719.86	204	59
OKEECHOBEE	57.69	103.43	1,081.71	84	73
SUWANNEE	191.18	129.14	1,873.63	426	264
TAYLOR	140.21	110.59	3,104.67	263	134
UNION	103.13	57.53	759.67	121	54
WAKULLA	127.66	81.72	1,311.41	223	121
WASHINGTON	144.35	119.68	1,802.82	295	122
Total	3,727.47	2,798.94	41,374.8	6,067	3,582

Chapter 2 – Identification and Characterization of Curves

The method for identifying where the curve starts and ends is based on the threshold of the deflection angle (Figure 7). The identifying procedure starts when the deflection angle is larger than the threshold and ends when the deflection angle is less than the threshold. The threshold of deflection angle is a critical value for curve identifying, usually from 0.5 degrees to 5 degrees.

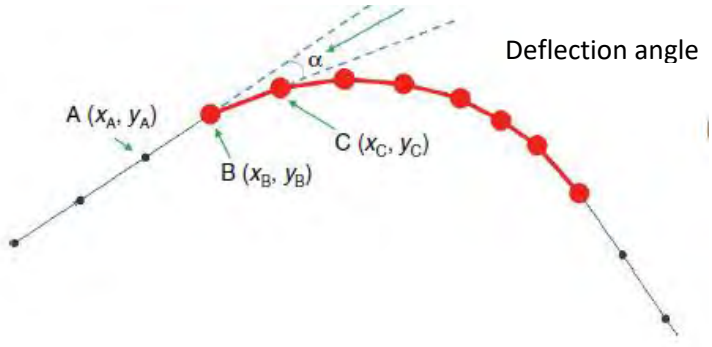

Figure 7. Diagram of identifying curves. The red line is the curve; black lines are roadway segments.

Four types of curves are defined in the Model Inventory of Roadway Elements (MIRE): horizontal angle point, independent horizontal curve (simple curve), compound curve, and reverse curve. Figure 8 illustrates each curve type. Horizontal angle point is the situation of two tangent segments joining together without a horizontal curve (Figure 8, top left). Independent horizontal curve (simple curve) is the curve of a series of consecutive roadway segments with a deflection angle larger than the threshold degree (Figure 8, top right). The compound curve is the curve of multiple simple curves connected with tangent segments that are less than a certain straight distance, usually 600 feet (Figure 8, bottom left). The reverse curve is the curve of two simple curves with an opposite deflection direction (Figure 8, bottom right).

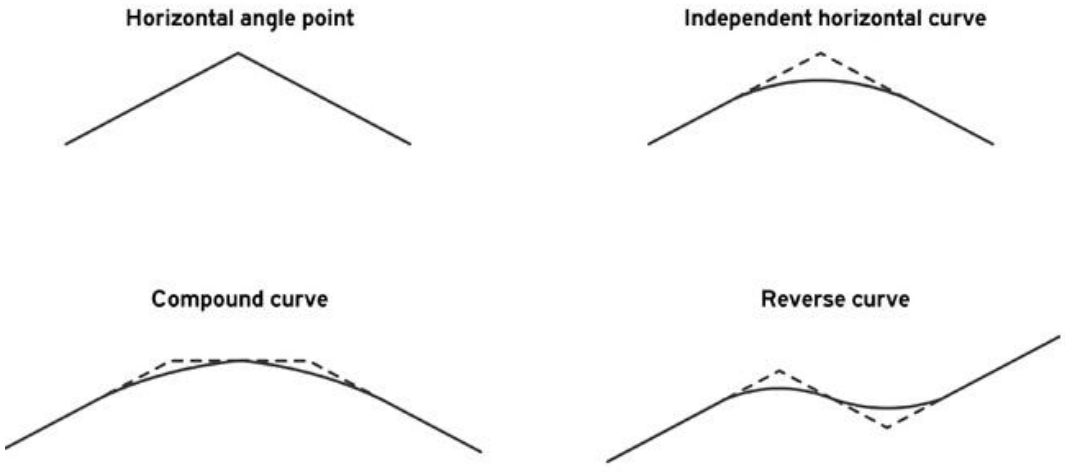

Figure 8. Four types of curve

The Navteq streets layer was prepared for identifying curves by extracting layers for DOT and non-DOT public roads and dissolving each on the ROADWAY field.

The curve identification method was iterated over dissolved roadway polyline. Each vertex of the polyline was analyzed for an angle of deflection that is greater than the threshold value. Currently, this is set to 3 degrees. When such a vertex is found, the curve is "started". Each curve will consist of one or more curve components.

A horizontal angle point segment (Figure 9, left) – a single vertex that exceeds the threshold angle of deflection, along with its two attached line segments.

A curved segment (Figure 9, middle) – two to n consecutive vertices that exceed the threshold angle of deflection in the same direction, along with the n + 1 attached line segments. A change in direction ends the curved segment.

A straight segment (Figure 9, right) – one to n consecutive vertices following a horizontal angle point or a curved segment that do not exceed the threshold angle of deflection, along with the n + 1 attached line segments. A straight segment cannot exceed 600 ft (183 m) in length, else the curve ends.

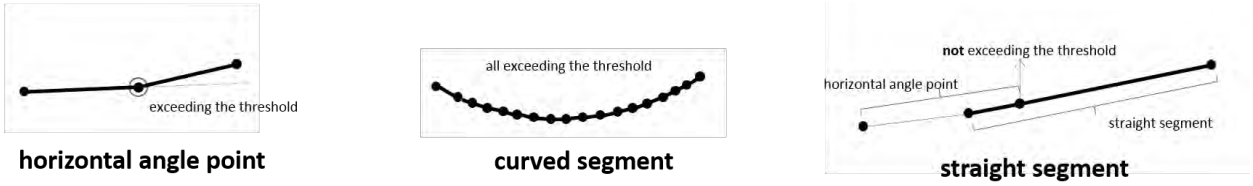

Figure 9. Three types of curve component

When a curve is a horizontal angle point, the attribute of the curve is the deflection angle. When a curve is a simple curve, the attributes of the curve are the central angle and radius. When a curve is a compound curve or a reversed curve, it has two or more curve components. The attributes of the curve are the number of horizontal angle point segments, the number of curved segments, the maximum and minimum of the deflection angle of these horizontal angle point segments, the maximum and minimum of the radius and central angle of these curved segments.

The method for detecting a spiral transition is to identify consecutive circular arcs of changing radii. For compound curves, if the two consecutive curved segments have a difference larger than 10% of the smaller radius, this curve is identified as a spiral curve (Figure 10).

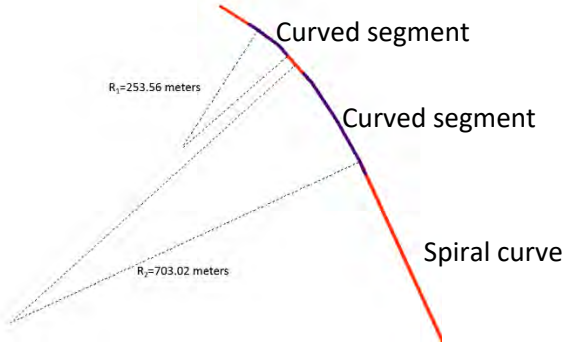

Figure 10. Diagram of spiral transition. The red line is the curve identified as spiral; purple lines are the curved segments.

Initial application of the algorithm resulted in a significantly large number of curves being identified as "compound curves." Normally, a simple curve has only one curved segment; a compound curve has multiple components including the curved segment, the straight segment, and the horizontal angle point (HAP) segment. Figure 11 shows some problematic compound curves, and Table 2 lists the corresponding curve components for each curve. Even though these curves match the above definition of compound curves, they don't have much difference with respect to the radii. A measurement of GOF (Goodness-Of-Fit), indicating how well the polyline represents the theoretical arc, is developed to check if the radius of the curved segment is reasonable. By randomly checking the compound curves with the GOF, the query "GOF>0.5" is used to pick up the promising compound curves to be reclassified as simple curves. Several others were visually inspected and reclassified. For example, curves such as 1, 2, 4, 6, and 7 in Figure 11 were re-categorized as simple curves. Overall, the process of curve determination and classification is a combination of automated and mechanical steps applied in an iterative manner with visual field inspections on subsets of data to identify and fix issues.

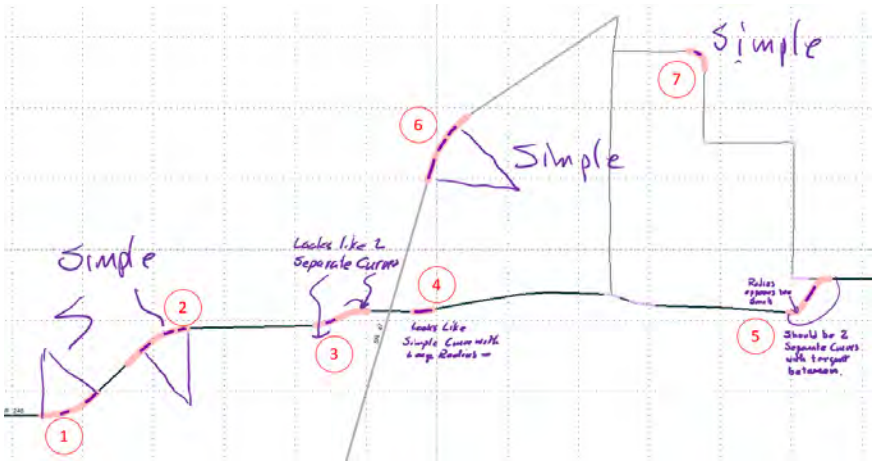

Figure 11. Issue with the identification of compound curves

Table 2. Detailed information for the compound curves in Figure 11

ID	Curve ID	Suggested type	Current curve type	Current curve component	Current radii (meter)	Diff radii (meters)	GOF
1	29540000-123-1	simple	compound	curved-straight-curved-straight-HAP	701 & 578	123	0.95
2	29540000-123-2	simple	compound	HAP-HAP-HAP-straight-curved-straight-curved-straight-HAP	427 & 592	165	-1.45
3	29540000-123-3	separated simples	compound	curved-straight-HAP-curved	264 & 406	142	-34
4	29540000-123-4	simple	compound	HAP-straight-HAP	--	--	0.15
5	29540000-123-8	separated simples	compound	curved-HAP-HAP-straight-curved	136 & 164	30	-120.52
6	29020000-36-13	simple	compound	HAP-straight-curved-straight-curved-straight-HAP-HAP-curved	476 & 473 & 452	24	Not On County Roads
7	29000014-12-5	simple	compound	curved-straight-curved	147 & 105	42	

Determination of Relationship of Curve to Intersections

Two types of relationships of a curve to the intersection are recorded: (1) the curve has one or more intersections on it; (2) the curve has a distance to the nearest intersection.

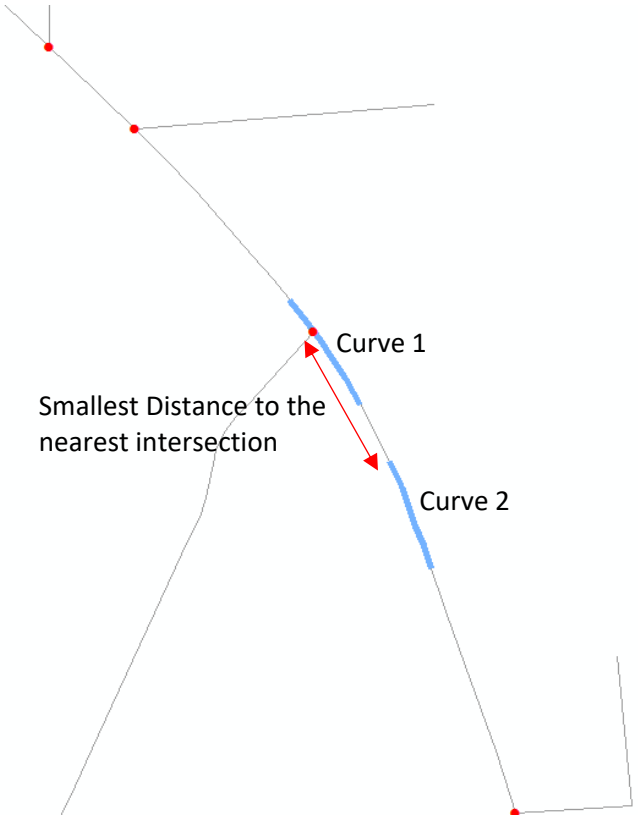

Figure 12. Diagram of curve relationship to intersections: Curve 1 – the curve has intersection; Curve 2 – the curve has a distance to the nearest intersection. Red dots are intersections; blue lines are curves; grey lines are Navteq road networks.

Curves containing intersections were determined using overlay procedures in GIS. If the curve has only one intersection on it, its characteristics were recorded. For curves not containing intersections, the roadway network was traced along both directions to determine the next intersection in each direction. The closer intersection was determined as the influencing intersection and its distance to the curve and other characteristics were recorded.

Determination of Other Risk Factors

AADT, functional class, speed limit category, and lane category (all from NAVTEQ) are recorded as other risk factors to curves. The used data sources are the same as those used for the intersections. A curve may involve multiple road segments with various attribute values. Therefore, the attribute values of the longest road segment of the curve were defined as the attribute of the curve. We excluded curves with very low values of AADT (bottom 10 percentile of the original dataset) from further analysis.

Crash Data

The crashes associated with each curve were determined by overlaying the crash data (for the period January 2013–December 2017) with the curve layer and including all crashes within a 700-ft buffer of either end of the curve. The buffer was chosen recognizing that run-off-the-road crashes, which are influenced by curves, can happen after the curve ends. The distance of 700 ft was empirically determined by looking at the distance from run-off-the-road crashes locations to the nearest curve. In addition to "all KABC" crashes, we also determined the number of lane departure crashes at each curve. Lane departure crashes are crashes on curves (including the 700-ft buffer) that have been classified as run-off-road, rollover, head-on, or sideswipe in the crash report.

Overall, 2,772 curves of interest were identified in the 27 small and rural counties. These are shown in Table 3.

Table 3. Descriptive statistics of curves and roadway mileage by county

County	County road (miles)	On-system road (miles)	All road (miles)	Number of curves	Number of curve-related KABC crashes	Number of curve-related KABC lane departure crashes
BAKER	122.49	83.85	1,540.49	107	117	62
BRADFORD	122.36	69.20	1,073.70	121	67	37
CALHOUN	106.60	95.69	1,439.73	79	32	27
COLUMBIA	181.45	203.24	2,326.04	141	220	80
DESOTO	58.40	83.08	964.13	39	67	39
DIXIE	139.00	46.02	1,985.68	85	78	58
FRANKLIN	47.22	90.44	1,604.69	39	12	6
GADSDEN	232.05	138.60	1,256.73	233	292	173
GILCHRIST	109.16	60.06	945.18	30	25	16
GLADES	63.26	86.66	953.77	18	15	10
GULF	64.56	79.08	1,498.54	66	34	20
HAMILTON	162.81	90.55	1,312.22	138	65	42
HARDEE	137.04	94.62	806.42	90	67	43
HENDRY	136.31	64.84	1,382.99	41	34	18
HOLMES	174.82	104.88	1,074.74	182	96	65
JACKSON	270.44	242.22	2,516.27	219	117	70
JEFFERSON	114.32	110.78	1,031.06	108	56	35
LAFAYETTE	117.43	62.09	1,573.07	69	10	10
LEVY	314.24	182.51	3,215.41	108	129	73
LIBERTY	131.56	69.99	1,220.17	142	44	30
MADISON	157.73	138.45	1,719.86	162	50	24
OKEECHOBEE	57.69	103.43	1,081.71	19	15	6
SUWANNEE	191.18	129.14	1,873.63	103	108	74
TAYLOR	140.21	110.59	3,104.67	103	115	67
UNION	103.13	57.53	759.67	65	50	40
WAKULLA	127.66	81.72	1,311.41	131	84	41
WASHINGTON	144.35	119.68	1,802.82	134	89	57
Total	3,727.47	2,798.94	41,374.8	2,772	2,088	1,223

Chapter 3 – Intersection Datasets

Table 4 shows the intersection count by the number of legs. 81.57% of intersections are 3-leg. Therefore, the study focuses on 3-way intersections for modeling analysis.

Table 4. Intersection count by relation to curve

Relation to Curve	Frequency	Percent
3 legs	4,949	100.00
— not on curve	3,318	67.04
— on curve	1,631	32.96
4 legs	1,104	100.00
— not on curve	791	71.65
— on curve	313	28.35
5 legs	13	100.00
— not on curve	5	38.46
— on curve	8	61.54
6 legs	1	100.00
— not on curve	1	100.00

Table 5 shows the number of 3-leg intersections on curves and 3-leg intersections not on curves by county.

Table 5. Intersection by county

County	On a Curve		Not on A Curve	
	Frequency	Percent	Frequency	Percent
BAKER	78	4.8	164	4.9
BRADFORD	72	4.4	134	4
CALHOUN	33	2	60	1.8
COLUMBIA	138	8.5	349	10.5
DESOTO	16	1	60	1.8
DIXIE	62	3.8	97	2.9
FRANKLIN	35	2.1	54	1.6
GADSDEN	164	10.1	226	6.8
GILCHRIST	16	1	108	3.3
GLADES	3	0.2	36	1.1
GULF	58	3.6	36	1.1
HAMILTON	63	3.9	65	2
HARDEE	16	1	78	2.4
HENDRY	37	2.3	118	3.6
HOLMES	97	5.9	110	3.3
JACKSON	151	9.3	231	7
JEFFERSON	55	3.4	106	3.2
LAFAYETTE	9	0.6	51	1.5
LEVY	103	6.3	301	9.1
LIBERTY	24	1.5	31	0.9
MADISON	66	4	104	3.1
OKEECHOBEE	10	0.6	49	1.5
SUWANNEE	88	5.4	225	6.8
TAYLOR	59	3.6	157	4.7
UNION	22	1.3	81	2.4
WAKULLA	68	4.2	130	3.9
WASHINGTON	88	5.4	157	4.7
Total	1,631	100	3,318	100

3-leg Intersections on Curves

Ninety-seven percent of these intersections are point intersections, 2.1% are line intersections, and 0.8% are polygon intersections. Y-intersection comprise 82.5% of the intersections, and the rest are “T” shaped. On-system intersections were 8.6%. Other intersections (mostly one other intersection) were within 250 feet for 24.2% of the intersections. Almost 96% of the intersections have a single lane on all approaches.

Table 6 shows the descriptive statistics of four key variables: max and min AADT, intersection angle, and distance to the nearest intersection.

Table 6. Descriptive statistics for continuous explanatory variables

		Distance to intersection (meters)	Intersection angle (degrees)	Maximum AADT	Minimum AADT
N		1,631	1,631	1,631	1,631
Mean		266.40	71.99	2,604.13	303.93
Median		140.71	77.20	1,700.00	111.00
Std. Deviation		382.50	18.23	4,087.14	597.00
Minimum		3.47	6.10	505	14
Maximum		4,995.07	112.30	55,000	11,000
Percentiles	10	31.94	45.06	650.00	24.00
	90	612.64	90.00	5,000.00	700.00

Table 7 shows a cross-tabulation of the functional classes of the intersecting major and minor street.

Table 7. Intersection count by max/min functional class

		Minimum Functional Class				
		2	3	4	5	Total
Maximum Functional Class	2	2	0	0	0	2
	3	0	3	0	0	3
	4	17	31	84	0	132
	5	19	67	1,065	343	1,494
Total		38	101	1,149	343	1,631

Table 8 shows a cross-tabulation of the speeds of the intersecting major and minor street.

Table 8. Intersection count by max/min speed category

		Minimum Speed Category (MPH)					
		65–80	55–64	41–54	31–40	21–30	Total
Maximum Speed Category (MPH)	55–64	4	23	0	0	0	27
	41–54	4	29	22	0	0	55
	31–40	5	520	307	374	0	1,206
	21–30	0	20	66	162	73	321
	6–20	0	1	6	10	4	21
	<6	0	0	1	0	0	1
Total		13	593	402	546	77	1,631

Among all intersection, 62.5% are on simple curves, while 34.9% are on compound curves, and 2.6% are on reverse curves. In about 75% of the cases, the curve is on the major approach to the intersection.

Table 9 shows the descriptive statistics of variables that describe the curve (length, angle, radius, and traffic volume) on which the intersection is located.

Table 9. Descriptive statistics for continuous explanatory variables

		Curve length (meters)	Simple radius combined max (meters)	Simple c-angle combined max (degrees)	AADT
N		1,631	1,631	1,631	1,631
Mean		684.10	673.35	38.77	1,988
Median		472.48	527.13	34.27	1,200
Std. Deviation		705.30	721.39	26.046	3,782
Minimum		6.65	0	0	0
Maximum		8,972.62	7,412	266	55,000
Percentiles	10	93.74	57.54	12.16	121
	90	1,488.34	1,353.55	70.93	3,800

Table 10 indicates that 72% of the intersections have no crashes; 18% have 1, and the rest have 2 or more.

Table 10. Intersection count by KABC crash

Number of KABC crashes	Frequency	Percent
0	1,181	72.40
1	290	17.80
2	96	5.90
3	34	2.10
4	16	1.00
5	2	0.10
6	3	0.20
7	2	0.10
8	3	0.20
10	2	0.10
11	1	0.10
23	1	0.10
Total	1,631	100

3-leg Intersections not on Curves

Ninety-nine percent of these intersections are point intersections. Y-intersections accounted for 43% of these intersections, and the rest are "T" shaped. On-system intersections were 6.5%. Other intersections (mostly one other intersection) were within 250 feet of 20% of these intersections. Almost 97% of the intersections have a single lane on all approaches.

Table 11 shows the descriptive statistics of five key variables: maximum and minimum AADT, intersection angle, distance to the nearest intersection, and distance to the nearest curve. Note that 45% of all these intersections are influenced by a curve, while the rest are not.

Table 11. Descriptive statistics for continuous explanatory variables

		Distance to curve (meters)	Distance to intersection (meters)	Intersection angle (degrees)	Maximum AADT	Minimum AADT
N		1,496	3,318	3,318	3,318	3,318
Mean		395.00	286.57	81.53	2,722.55	255.25
Median		243.00	176.10	90.00	1,700.00	99.00
Std. Deviation		563.00	361.86	13.57	4,849.589	487.069
Minimum		16.00	3.84	6.40	508	14
Maximum		8,092.00	4,879.88	97.60	55,000	8,700
Percentiles	10	43.00	36.60	61.10	700.00	25.00
	90	851.30	650.28	90.00	5,000.00	600.00

Table 12 shows a cross-tabulation of the functional classes of the intersecting major and minor street.

Table 12. Intersection count by maximum and minimum functional class

		Minimum Functional Class				Total
		2	3	4	5	
Maximum Functional Class	3	0	1	0	0	1
	4	21	82	111	0	214
	5	18	126	2,187	772	3,103
Total		39	209	2,298	772	3,318

Table 13 shows a cross-tabulation of the speeds of the intersecting major and minor street.

Table 13. Intersection count by maximum and minimum speed category

		Minimum speed category (MPH)					
		65–80	55–64	41–54	31–40	21–30	Total
Maximum speed category (MPH)	55–64	1	57	0	0	0	58
	41–54	3	65	24	0	0	92
	31–40	4	1,015	672	725	0	2,416
	21–30	0	62	149	341	170	722
	6–20	0	4	7	6	13	30
Total		8	1,203	852	1,072	183	3,318

Table 14 indicates that 76% of the intersections have no crashes; 17% have 1, and the rest have 2 or more.

Table 14. Intersection count by KABC crash

Number of KABC crashes	Frequency	Percent
0	2,523	76.00
1	561	16.90
2	136	4.10
3	43	1.30
4	23	0.70
5	15	0.50
6	2	0.10
7	6	0.20
8	1	0.00
9	1	0.00
10	1	0.00
11	2	0.10
12	1	0.00
13	2	0.10
14	1	0.00
Total	3,318	100.00

Chapter 4 – Curve Datasets

As shown in *Table 15***Error! Reference source not found.**, most of the curves are simple curves. Among these, curves with 0 or 1 intersections have substantial sample share. *Table 15* shows the distribution of these curves by county.

Table 15. Frequency distribution by curve type and intersection count

County	No intersections		One intersection	
	Frequency	%	Frequency	%
BAKER	47	3.79	24	3.14
BRADFORD	43	3.47	38	4.97
CALHOUN	30	2.42	26	3.4
COLUMBIA	57	4.6	39	5.1
DESOTO	25	2.02	7	0.92
DIXIE	38	3.06	21	2.75
FRANKLIN	16	1.29	9	1.18
GADSDEN	108	8.71	57	7.45
GILCHRIST	19	1.53	5	0.65
GLADES	14	1.13	1	0.13
GULF	15	1.21	21	2.75
HAMILTON	57	4.6	38	4.97
HARDEE	47	3.79	24	3.14
HENDRY	15	1.21	15	1.96
HOLMES	73	5.89	56	7.32
JACKSON	94	7.58	68	8.89
JEFFERSON	52	4.19	38	4.97
LAFAYETTE	39	3.15	15	1.96
LEVY	34	2.74	29	3.79
LIBERTY	78	6.29	35	4.58
MADISON	81	6.53	46	6.01
OKEECHOBEE	12	0.97	3	0.39
SUWANNEE	36	2.9	33	4.31
TAYLOR	53	4.27	25	3.27
UNION	27	2.18	21	2.75
WAKULLA	77	6.21	24	3.14
WASHINGTON	53	4.27	47	6.14
Total	1,240	100	765	100

Simple Curves without Intersections

Table 16 presents descriptive statistics on five key variables: curve length, radius, central angle, AADT, and distance to the nearest intersection.

Table 16. Descriptive statistics for continuous explanatory variables

		Curve length (meter)	Simple radius (meter)	Simple central angle (degree)	Distance to nearest intersection (meter)	AADT
N		1,240	1,240	1,240	1,240	1,240
Mean		347.13	626.05	29.71	622.21	1,274
Median		286.55	537.43	24.48	342.72	700
Std. Deviation		264.38	459.46	18.22	1,186.17	3,145
Minimum		25.50	18.84	1.79	4.71	121
Maximum		2,982.45	5,365.57	112.75	16,165.25	55,000
Percentiles	10	126.56	202.61	12.27	43.23	250
	90	622.22	1,080.19	52.81	1,274.50	2,500

Table 17 and Table 18 show the distribution of curves by functional class and speed. Practically all curves are on roadways with one lane each way.

Table 17. Curve count by functional class

Functional Class	Frequency	Percent
3	21	1.7
4	807	65.1
5	412	33.2
Total	1,240	100.0

Table 18. Curve count by speed category

Speed Category (MPH)	Frequency	Percent
55–64	443	35.7
41–54	285	23.0
31–40	487	39.3
21–30	24	1.9
6–20	1	0.1
Total	1,240	100.0

As shown in Table 19, 72% of the curves do not have any crashes and 77% of the curves do not have any lane-departure crashes.

Table 19. Curve count by KABC crash and lane departure crash

	All KABC Crashes		Lane Departure Crashes	
Number of KABC crashes	Frequency	Percent	Frequency	Percent
0	898	72.42	954	76.94
1	229	18.47	211	17.02
2	68	5.48	52	4.19
3	25	2.02	16	1.29
4	10	0.81	6	0.48
5	4	0.32	—	—
6	2	0.16	1	0.08
7	3	0.24	—	—
10	1	0.08	—	—
Total	1,240	100	1,240	100

Simple Curves with One Intersection

Table 20 presents descriptive stats on four key variables: curve length, radius, central angle, and AADT.

Table 20. Descriptive statistics for continuous explanatory variables

		Curve length (meter)	Simple radius (meter)	Simple central angle (degree)	AADT
N		765	765	765	765
Mean		433.34	681.20	36.59	1,392.88
Median		356.87	553.59	30.80	800.00
Std. Deviation		325.04	587.99	22.45	3,068.54
Minimum		30.24	9.10	3.2909	119.00
Maximum		3,214.31	7,411.89	131.87	55,000.00
Percentiles	10	133.98	200.52	13.61	300.00
	90	769.47	1,304.14	66.06	2,600.00

Table 21 and Table 22 show the distribution of curves by functional class and speed. Practically all curves are on roadways with one lane each way. As shown in Table 20, 72% of the curves do not have any crashes, and 77% of the curves do not have any lane departure crashes.

Table 21. Curve count by functional class

Functional Class	Frequency	Percent
3	19	2.5
4	539	70.5
5	207	27.1
Total	765	100.0

Table 22. Curve count by speed category

Speed Category (MPH)	Frequency	Percent
55–64	315	41.2
41–54	178	23.3
31–40	254	33.2
21–30	18	2.4
Total	765	100.0

In about 90% of the cases, the curve is on the major approach of the intersection. In 85 % of the cases, this intersection has 3 legs. Table 23 provides the statistics on two characteristics of the intersection on the curve: the intersection angle and the cross-street AADT (this is the AADT of the approach that does not contain the curve).

Table 23. Descriptive statistics for continuous explanatory variables of intersections on curve

		Intersection angle (degree)	Cross-street AADT
N		765	765
Mean		70.05	339.58
Median		74.50	56
Std. Deviation		17.61	1,032.312
Minimum		10.00	0
Maximum		101.00	13,310
Percentiles	10	45.36	3
	90	90.00	600

As shown in Table 24, 60% of the curves do not have any crashes and 70% of the curves do not have any lane-departure crashes.

Table 24. Curve Count by KABC Crashes and Lane Departure Crashes

	All KABC Crashes		Lane Departure Crashes	
# of KABC crashes	Frequency	Percent	Frequency	Percent
0	462	60.39	532	69.54
1	171	22.35	167	21.83
2	76	9.93	44	5.75
3	27	3.53	17	2.22
4	7	0.92	2	0.26
5	7	0.92	2	0.26
6	5	0.65	1	0.13
7	3	0.39	—	—
8	2	0.26	—	—
9	3	0.39	—	—
14	1	0.13	—	—
28	1	0.13	—	—
Total	765	100	765	100

Chapter 5 – Safety Performance Functions

SPF for three-leg intersections

Since 81.57% of the total intersections on the county roads are 3-way intersections, the systemic modeling focused on the 3-way intersections. The 3-way intersections were classified into two groups: the intersections not on a curve (3,318 locations) and the intersections on a curve (1,631 locations). The SPFs were developed using the total fatal and injury crashes (KABC) as the response variable. For each case, a base SPF with only the traffic volume (AADT on the major and minor approach of the intersection) and a full SPF with the significant risk factors were developed. The detailed equations of the SPFs are provided in the following summary table. In general, the traffic volume (AADT), functional classification, the distance of intersection to the nearest intersections were found to be significant risk factors in predicting the number of crashes on intersections not on a curve. The traffic volume of the curve and the curve characteristics such as the radius and the central angle of the curve on which the intersection is located were found to be significant risk factors in predicting the number of crashes on intersections on a curve.

Table 25. Safety performance functions (SPFs) for three-way intersections not on a curve

Base model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter
	3,318	4,870.3	-4,862.35	0.8748
Variable Description	UNITS	Variable	Estimate	z value
		Intercept	-7.03063	-21.32
LN(Major AADT)	Ln(daily traffic counts)	AADT.Max	0.52813	12.14
LN(Minor AADT)	Ln(daily traffic counts)	AADT.Min	0.38538	13.13

Full model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter
	3,318	4,738.4	-4,720.446	1.0937
Variable Description	UNITS	Variable	Estimate	z value
		Intercept	-5.60835	-14.891
LN(Major AADT)	Ln(daily traffic counts)	AADT.Max	0.44258	9.992
LN(Minor AADT)	Ln(daily traffic counts)	AADT.Min	0.27423	8.478
Are there other intersections within 250 ft	1/0	Close.Int.f1	0.73549	9.13
Is the intersection influenced by the curve	1/0	Dist.Curve.f1	-0.58576	-2.263
LN(Distance to the nearest curve if the curve is influenced by a curve)	Ln(meter)	Dist.Curve	0.12738	2.786
NAVTEQ Functional class 5 (Max across all approaches)	1/0	FunClass.Max.f5	-0.58516	-4.672
Is the intersection located on an on-system road	1/0	OnSys.fY	0.60578	4.776

Table 26. Safety performance functions (SPFs) for three-way intersections on a curve

Base model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter
	1,631	2,709	-2,701.038	0.9436
Variable Description	UNITS	Variable	Estimate	z value
		Intercept	-6.43729	-14.928
LN(Major AADT)	Ln(daily traffic counts)	AADT.Max	0.50219	8.54
LN(Minor AADT)	Ln(daily traffic counts)	AADT.Min	0.34168	9.018

Full model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter
	1,631	2,638.9	-2,614.948	1.2626
Variable Description	UNITS	Variable	Estimate	z value
		Intercept	-4.542322	-8.335
LN(Major AADT)	Ln(daily traffic counts)	AADT.Max	0.437509	7.395
LN(Minor AADT)	Ln(daily traffic counts)	AADT.Min	0.226145	5.419
Are there other intersections within 250 ft	1/0	Close.Int.f1	0.392154	3.874
Is the curve on the major approach of the intersection	1/0	Curve.AADT.fmajor	0.427709	3.556
The central angle of the curve on which the intersection is located	degree	Curve.CAngle.Comb.Max	0.005907	3.485
Radius of the curve on which the intersection is located	Ln(meter)	Curve.Radius.Comb.Max	-0.135368	-4.082
NAVTEQ Functional class 5 (Max across all approaches)	1/0	FunClass.Max.f5	-0.384495	-2.551
Is the intersection located on an on-system road	1/0	OnSys.fY	0.762359	5.069
Located in District 2	1/0	District.fD2	-0.493887	-2.865
Located in District 3	1/0	District.fD3	-0.531644	-3.049

SPF for Simple Curves

Since 82.86% of the total curves on the county roads are simple curves, the systemic modeling focused on the simples curves. The simple curves were classified into two groups: the curves without intersections (1,240 locations) and the curves with one intersection (765 locations). The SPFs were developed using the total fatal and injury crashes (KABC) and using the land departure fatal and injury crashes as the response variables. For each case, a base SPF with only the traffic volume (AADT on the curve) and a full SPF with the significant risk factors were developed. The detailed equations of the SPFs are provided in the following summary table. In general, the traffic volume (AADT), speed limit, the distance of curve to the nearest intersections, and the curve characteristics were found to be significant risk factors in predicting the number of crashes on curves without intersections. The functional classification and the speed limit of the intersection approaches and the intersection characteristics, such as the number of approaches of the intersection on the curve, were found to be significant risk factors in predicting the number of crashes on curves with one intersection.

Table 27. Safety performance functions (SPFs) for simple curves without intersections

		All crashes			Lane Departure Crashes		
Base model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter	AIC	2 x Log-Likelihood	Dispersion parameter
	1,240	2,073.4	-2,067.435	0.7533	1,723.2	-1,717.21	1.0415
Variable Description	UNITS	Variable	Estimate	z value	Variable	Estimate	z value
		Intercept	-5.19361	-12.74	Intercept	-5.07604	-12.093
LN(AADT)	Ln(daily traffic counts)	AADT	0.63688	10.95	AADT	0.57376	9.641

		All crashes			Lane Departure Crashes		
Full model	Sample Size	AIC	2 x Log-Likelihood	Dispersion parameter	AIC	2 x Log-Likelihood	Dispersion parameter
	1,240	2,012.2	-1,994.161	1.0403	1,689.8	-1,675.796	1.2939
Variable Description	UNITS	Variable	Estimate	z value	Variable	Estimate	z value
		Intercept	-2.60396	-2.95	Intercept	-2.95531	-4.033
LN(AADT)	Ln(daily traffic counts)	AADT	0.59159	10.421	AADT	0.56155	9.409
LN(Radius of curve)	Ln(meter)	Curve.Sim.Radius	-0.15856	-1.763	Curve.Sim.Radius	-0.44787	-4.054
LN(Central angle of curve)	Ln(degree)	Curve.Sim.CAngle	0.20387	1.831			
LN(Length of curve)	Ln(meter)				Curve.Len	0.32826	2.593
NAVTEQ speed category <40 MPH	1/0	SpeedCat.f5&more	-0.41382	-3.305	SpeedCat.f5&more	-0.52172	-3.809
LN(distance to nearest intersection)	Ln(meter)	Dist.Int	-0.27812	-6.937	Dist.Int	-0.17204	-3.965
Located in District 2	1/0	District.fD2	-0.27591	-1.469			
Located in District 3	1/0	District.fD3	-0.42694	-2.292			

Table 28. Safety performance functions (SPFs) for simple curves with one intersection

		All crashes			Lane Departure Crashes		
Base model	Sample Size	AIC	2xLogLikeli-hood	Dispersion parameter	AIC	2xLogLikeli-hood	Dispersion parameter
	765	1,792.6	-1,784.628	0.7223	1,326.4	-1,320.402	1.2309
Variable Description	UNITS	Variable	Estimate	z value	Variable	Estimate	z value
		Intercept	-4.01818	-8.168	Intercept	-3.0816	-6.124
LN(AADT)	Ln(daily traffic counts)	AADT	0.4642	6.691	AADT	0.3246	4.527
LN(AADT on cross-road of intersection)	Ln(AADT on cross-road of intersection)	Int.AADT.cross	0.12396	3.787			

		All crashes			Lane Departure Crashes		
Full model	Sample Size	AIC	2xLogLikeli-hood	Dispersion parameter	AIC	2xLogLikeli-hood	Dispersion parameter
	765	1,750.9	-1,726.887	0.9285	1,306.4	-1292.426	1.5771
Variable Description	UNITS	Variable	Estimate	z value	Variable	Estimate	z value
		(Intercept)	0.34026	0.446	Intercept	-1.47429	-2.133
LN(AADT)	Ln(daily traffic counts)	AADT	0.40531	5.835	AADT	0.34266	4.807
LN(AADT on cross-road of intersection)	Ln(AADT on cross-road of intersection)	Int.AADT.cross	0.06393	1.984			
LN(Radius of curve)	Ln(meter)	Curve.Sim.Radius	-0.22814	-2.889	Curve.Sim.Radius	-0.44893	-4.206
LN(Length of curve)	Ln(meter)	Curve length			Curve length	0.27469	2.124
LN(distance to nearest intersection)	Ln(meter)	Int.Dist.Int	-0.18083	-2.974			
NAVTEQ speed category <40 MPH (minimum across all approaches)	1/0	Int.SpeedCat.Min.f5 &more	-0.83278	-3.115	Int.SpeedCat.Min.f5 &more	-0.32547	-2.171
NAVTEQ functional class 5 (minimum across all approaches)	1/0	Int.FunClass.Min.f5	-0.48107	-1.994	Int.FunClass.Min.f5	-0.50305	-1.997
Difference of NAVTEQ speed category among all approaches	1/0	Int.SpeedCat.Diff.f1	-0.75794	-3.223			
Intersection has four or more approaches	1/0	Int.Leg.f4&more	0.51285	3.328			
Located in District 2	1/0	District.fD2	-0.55889	-2.47			
Located in District 3	1/0	District.fD3	-0.48387	-2.156			

Chapter 6 – Application for Crash Risk Ranking and Countermeasures

This chapter describes the approach adopted to rank locations (Table 29) in Columbia and Jackson counties based on crash risk.

Table 29. Number of curves and intersections by county

	Columbia	Jackson
Simple curves without intersections	57	94
Simple curves with one intersection	39	68
3-leg intersections not on curves	349	231
3-leg intersections on curves	138	151

The process is described in the context of curves without intersections, but the same applies to all types of locations.

- Apply the base model (with only AADT as the explanatory variable) to predict the expected number of crashes on the curves.
- Apply the full model (with AADT and other risk factors as explanatory variables) to predict the expected number of crashes on curves.
- Calculate the ratio of crashes from the full model to the crashes from the base model. If this ratio is larger than 1 this implies that the contribution of risk factors towards crashes is larger than the contribution of just traffic exposure (AADT).
- Rank the locations based on predictions from the full model. As AADT has a very strong impact on crashes in all models, ranking based on this approach is highly likely to pick locations that have high AADT.
- Rank the locations based on the ratio. This approach ranks the locations based on the relative effects of all crash risk factors to that of AADT. Therefore, the locations picked will have one or more critical risk factors that can be addressed. At the same time, this approach can also end up picking locations with low traffic volumes.

By considering locations from both ranked lists, it is possible to identify a subset of locations that have both a high risk of crashes overall that are significantly impacted by risk factors (and not just AADT). The spreadsheet attached to this report provides the rankings for all locations. For illustrative purposes, the top ten ranked locations are shown in the figures in the following sections.

Curve Countermeasures

The suggested curve countermeasures for the sites from the systemic approach include the following:

- Chevron
- Curve warning sign for both directions
- Raised pavement markers (RPMs) on center- and edge-line
- Standard thermoplastic pavement marking on center- and edge-line
- Bright sticks on signs.

The 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 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. Based on MUTCD, the RPMs need to be placed at a distance equivalent to 5 seconds of travel time before and after a curve. This distance was considered as 450 ft for speed category 3 and as 350 ft for speed categories of 4 and 5. The pavement markings are assumed to be placed 1000 ft in approach to curves. The FDOT item number for cost calculations is shown in Table 30. In the cost calculation, overhead costs were considered to be 10% mobilization, 10% maintenance of traffic, 30% construction engineering and inspection (CEI), and 15% engineering and contingencies.

The CMF published by the FDOT Roadway Design Office (on all crash types) for chevron, warning sign, RPM, and pavement marking are 0.70, 0.65, 0.90, and 0.89, respectively. The product of these CMFs is 0.36. It is noteworthy that some of the suggested countermeasures are already in place. The mentioned CMFs are supposed to be applied on all crash types. To be conservative in calculating the benefits, the CMF for the combination of these treatments was considered 0.6 instead of 0.36. This CMF was also applied to the lane departure crashes only, instead of 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. This is the maximum crash cost in the published report. Although not all the sites are classified under this category, the CMF and the crash type conservative calculations overcome the occasional diversion from the cost assumption.

Intersection Countermeasures

The suggested intersection countermeasures for the sites from the systemic approach include the following:

- Two large stop signs
- 1000-ft pavement marking on center- and edge-line of each approach
- 1000-ft center- and edge-line RPMs on each approach
- End-of-road signage, including three OM1-1 and one two-way arrow
- Two intersection-ahead signs on major approaches
- One stop-ahead sign
- Transverse rumble strip marking on minor approach
- Thermoplastic stop bar
- Bright stick on signs

The FDOT item number for cost calculations is shown in Table 30. The flat cost for all intersection was calculated as $ 12344.68. There is no CMF to match exactly to these combined countermeasures. The study team used 0.8 for the benefit calculations.

Table 30. Curve countermeasures unit cost

	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
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	---	Intersection	3,000.00
	Thermoplastic stop bar	0711 11125	Feet	3.66
	Bright sticks	0700 13 15	Each	95.35

Jackson County

Simple Curves without Intersections

There were 94 curves without intersections in Jackson County. Figure 13 shows the top 10 ranked curves based on full model predictions. Six of the 10 curves were also among the top 10 AADTs. Curves 1, 3, 5, and 9 were also picked in the hotspot analysis. Figure 14 shows the top 10 ranked curves based on the ratio. Of the 10, three were also among the top 10 AADTs. Curves 4 and 8 were also chosen by hotspot analysis. Six of the curves appear in both rankings.

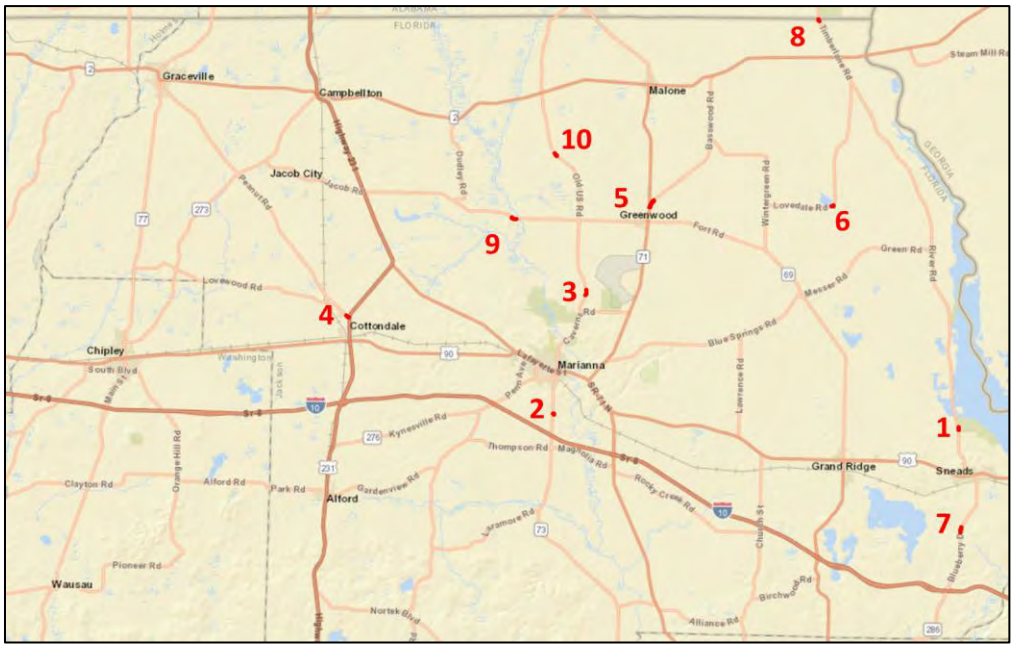

Figure 13. Top 10 curves without intersections ranked based on the full model

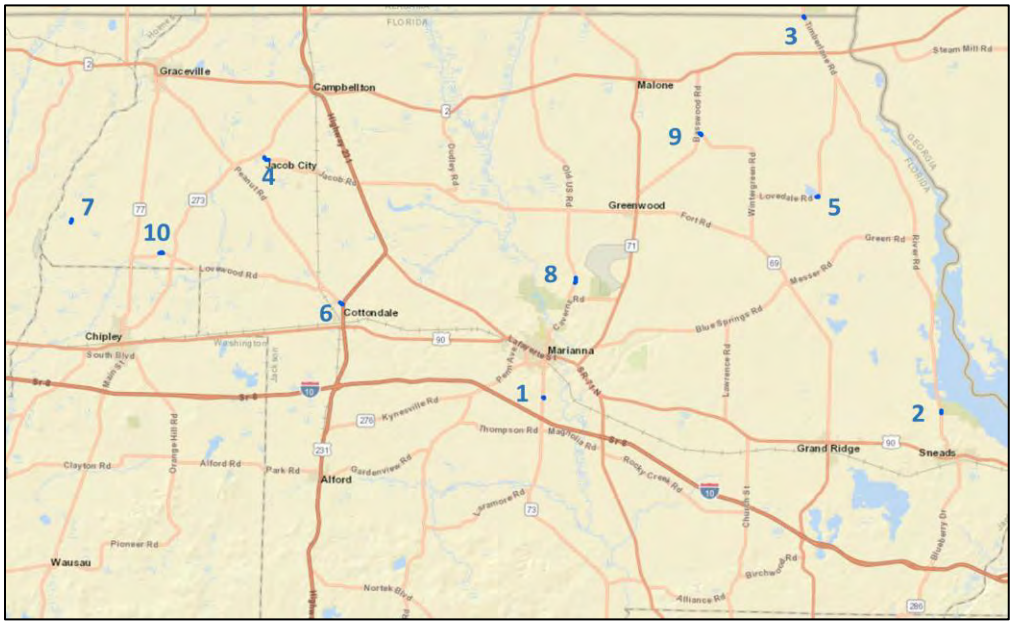

Figure 14. Top 10 curves without intersections ranked based on predicted crash ratio

Table 31 and

Table 32 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 31. Top 10 curves without intersections ranked based on the full model

Curve ID	Radius (ft)	KABC	Prediction	Rank_by full model	Rank_by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
53001000-82-4	1,816	2	1.55	1	2	10,738.50	166,589.12	16.8
53680002-217-1	3,407	1	1.52	2	1	10,715.90	177,860.74	18.0
53513000-188-3	3,348	1	1.37	3	8	15,845.74	202,444.21	13.8
53080000-154-1	1,420	3	1.26	4	6	8,893.21	173,979.60	21.2
53090001-156-1	1,637	3	1.13	5	11	12,419.85	183,418.38	16.0
53630000-209-7	2,816	0	0.94	6	5	21,329.01	113,544.89	5.8
53690000-224-3	3,868	0	0.89	7	18	17,832.07	147,327.55	9.0
53650000-212-16	5,402	0	0.82	8	3	19,535.58	113,324.56	6.3
53502000-176-10	1,192	1	0.79	9	12	18,953.14	118,652.75	6.8
53513000-188-9	2,528	0	0.76	10	30	19,266.47	108,819.77	6.1

Table 32. Top 10 curves without intersections ranked based on predicted crash ratio

Curve ID	Radius (ft)	KABC	Prediction	Rank_by full model	Rank_by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
53680002-217-1	1,816	1	1.52	2	1	10,665.99	177,860.74	18.08
53001000-82-4	3,407	2	1.55	1	2	10,788.42	166,589.12	16.74
53650000-212-16	3,348	0	0.82	8	3	15,918.25	113,324.56	7.72
53000029-29-1	1,420	1	0.63	14	4	8,893.21	97,620.44	11.90
53630000-209-7	1,637	0	0.94	6	5	12,492.37	113,544.89	9.85
53080000-154-1	2,816	3	1.26	4	6	21,256.49	173,979.60	8.87
53530000-194-4	3,868	0	0.36	40	7	17,759.56	44,914.10	2.74
53513000-188-3	5,402	1	1.37	3	8	19,463.06	202,444.21	11.28
53731000-229-4	1,192	1	0.59	18	9	18,880.62	92,387.41	5.30
53660000-213-4	2,528	0	0.37	38	10	19,338.98	65,388.34	3.67

Simple Curves with One Intersection

There are 68 curves with at least one intersection. Figure 15 demonstrates the top 10 based on full model predictions, of which eight are also among the top 10 AADTs. Sites 1, 4, and 6 were also chosen by hotspot analysis. Of the top 10 curves based on ratio ranking in Figure 16, only two were among high AADTs. Curves 1, 4, 7, and 9 were also picked by spot analysis. The two rankings had four curves in common.

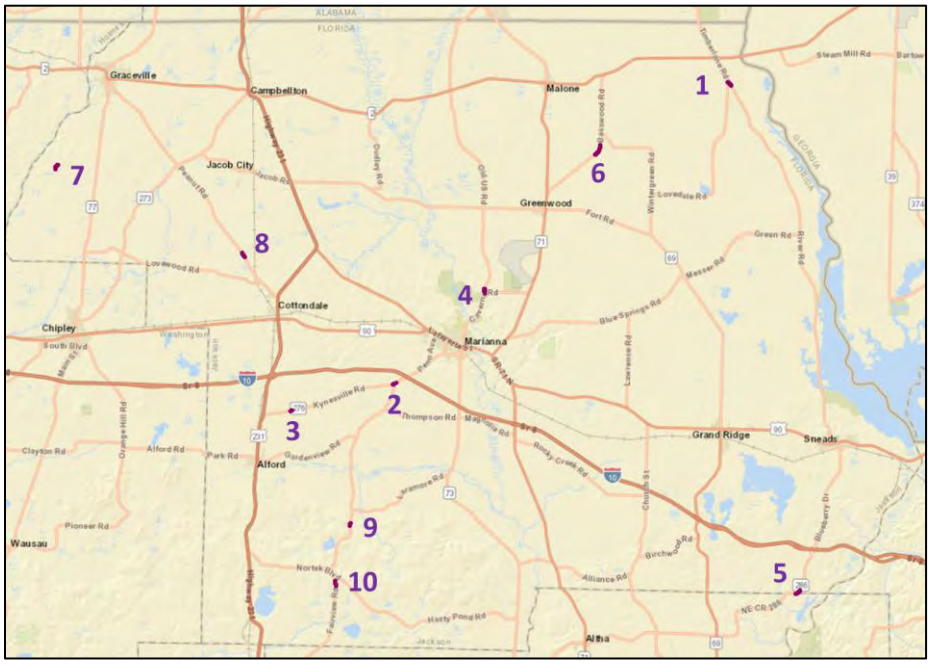

Figure 15. Top 10 curves with one intersection ranked based on the full model

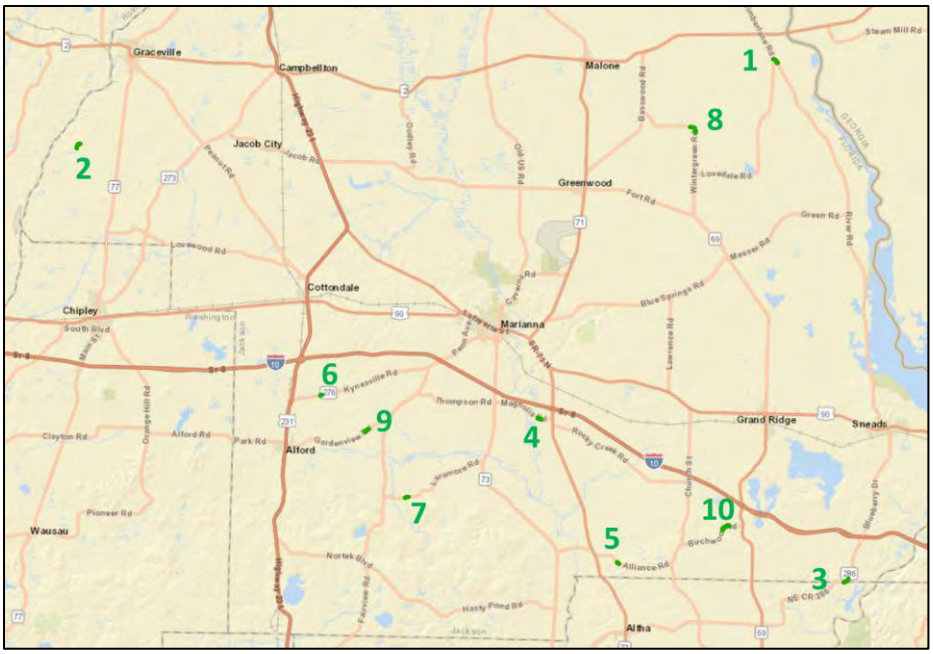

Figure 16. Top 10 curves with one intersection ranked based on predicted crash ratio

Table 33 and

Table 34 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 33. Top 10 curves with one intersection ranked based on the full model

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank_by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
53001000-82-33	1,329	1	3.69	1	1	19,427.97	231,663.49	12.93
53710000-225-4	3,902	2	1.73	2	59	18,346.31	197,820.95	11.69
53510000-185-8	2,150	2	1.68	3	6	10,473.42	90,547.95	9.37
53080000-154-8	1,110	5	1.53	4	15	20,992.10	154,405.86	7.97
53509000-183-1	1,162	0	1.41	5	3	25,168.35	120,102.62	5.17
53530000-194-7	2,932	1	1.22	6	11	42,145.54	125,772.29	3.23
53731000-229-1	1,153	0	1.04	7	2	35,175.97	80,441.27	2.48
53736000-236-1	5,075	0	1.02	8	23	27,892.50	80,708.29	3.14
53502000-176-2	1,946	0	0.99	9	29	21,611.96	102,778.17	5.16
53080000-154-9	2,360	0	0.99	10	44	29,383.77	110,108.55	4.06

Table 34. Top 10 curves with one intersection ranked based on the predicted crash ratio

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
53001000-82-33	1,329	1	3.69	1	1	19,427.97	231,663.49	12.93
53731000-229-1	1,153	0	1.04	7	2	31,541.68	80,441.27	2.76
53509000-183-1	1,162	0	1.41	5	3	23,714.64	120,102.62	5.49
53630000-209-6	1,564	1	0.78	21	4	19,822.70	65,208.84	3.57
53230000-170-7	699	0	0.57	36	5	16,558.71	93,084.89	6.09
53510000-185-8	2,150	2	1.68	3	6	12,654.00	90,547.95	7.76
53512000-187-3	3,197	1	0.49	44	7	18,614.14	33,463.38	1.95
53230000-170-1	1,250	1	0.95	13	8	29,775.59	109,715.77	3.99
53680004-219-2	3,319	0	0.78	22	9	25,352.94	63,978.24	2.74
53501000-171-5	1,639	0	0.57	37	10	33,093.89	86,291.57	2.83

Three-way Intersection Not on a Curve

There are 231 intersections not on a curve in Jackson County. Figure 17 shows the top 10 sites by full model ranking. Of the 10, nine are among the top 10 AADT sites. Figure 18 shows the top 10 intersections by ratio ranking, in which two are among the top 10 AADT sites. There are two intersections in common between these two rankings.

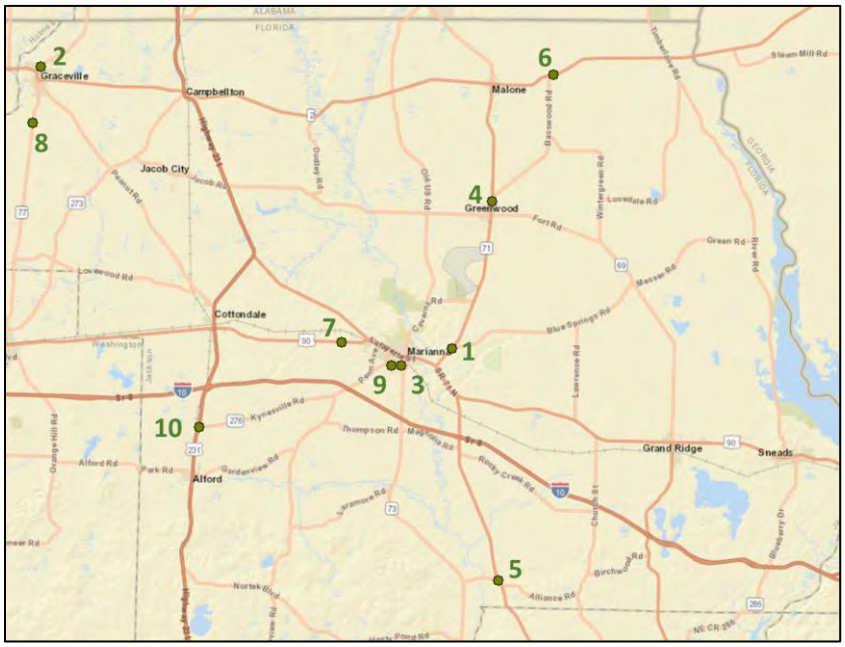

Figure 17. Top 10 intersections not on curves ranked based on the full model

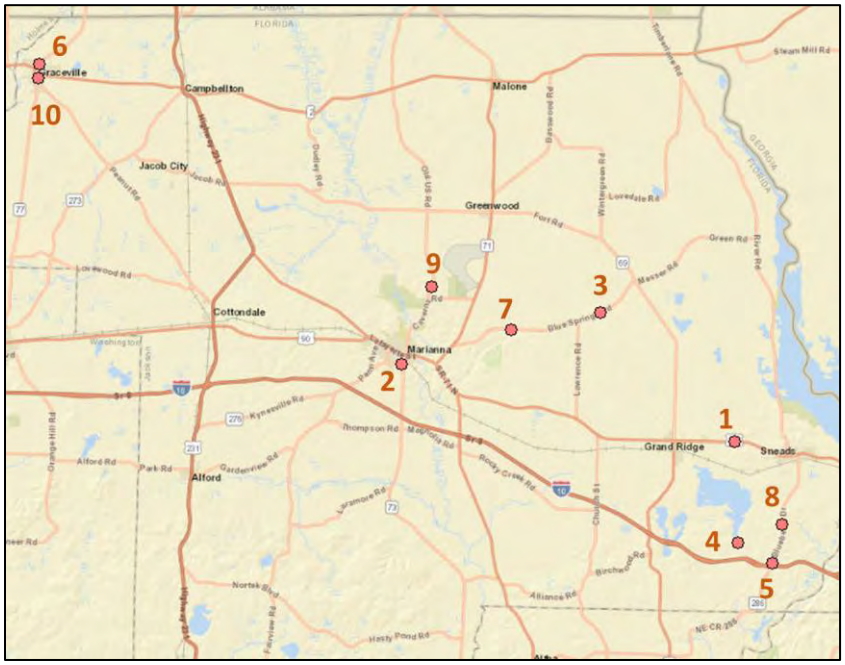

Figure 18. Top 10 intersections not on curves ranked based on predicted crash ratio

Table 35 and Table 36 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 35. Top 10 intersections not on curves ranked based on the full model

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
489402	38.6	3	3.49	1	32	12,344.68	352,904.26	30.99
231004	43.3	0	2.51	2	6	12,344.68	253,642.89	22.27
419606	76.3	1	2.35	3	2	12,344.68	237,907.07	20.89
436813	17.9	2	2.20	4	36	12,344.68	222,841.95	19.57
450344	66.7	2	1.73	5	31	12,344.68	175,262.42	15.39
234298	14.2	0	1.37	6	20	12,344.68	138,559.83	12.17
433701	90	0	1.28	7	112	12,344.68	130,024.50	11.42
467609	84.5	1	1.21	8	40	12,344.68	122,637.28	10.77
186608	90	0	1.05	9	57	12,344.68	105,994.94	9.31
572725	82.4	3	1.00	10	105	12,344.68	101,024.73	8.87

Table 36. Top 10 intersections not on curves ranked based on predicted crash ratio

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
77469	83	2	0.18	142	1	12,344.68	18,194.63	1.60
419606	76.3	1	2.35	3	2	12,344.68	237,907.07	20.89
382169	25.5	0	0.64	27	3	12,344.68	64,748.82	5.69
26739	90	0	0.19	131	4	12,344.68	19,093.77	1.68
586309	12	0	0.76	21	5	12,344.68	76,838.67	6.75
231004	43.3	0	2.51	2	6	12,344.68	253,642.89	22.27
315040	90	0	0.67	25	7	12,344.68	67,464.90	5.92
298205	56.1	1	0.23	95	8	12,344.68	22,896.95	2.01
111637	69.4	0	0.57	31	9	12,344.68	57,508.85	5.05
399465	90	1	0.33	58	10	12,344.68	33,714.55	2.96

Three-way Intersection on a Curve

There are 151 intersections on a curve in Jackson County. Figure 19 shows the top 10 sites by full model ranking. Of the 10, nine are among the top 10 AADT sites. Figure 20 shows the top 10 intersections by ratio ranking, of which one is among the top 10 AADT sites. There is one intersection in common between these two rankings.

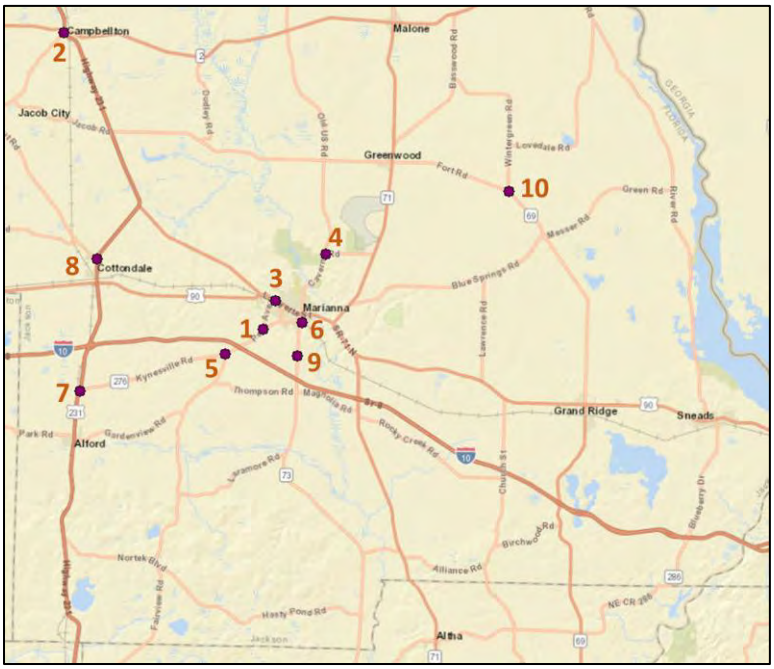

Figure 19. Top 10 intersections on curves ranked based on the full model

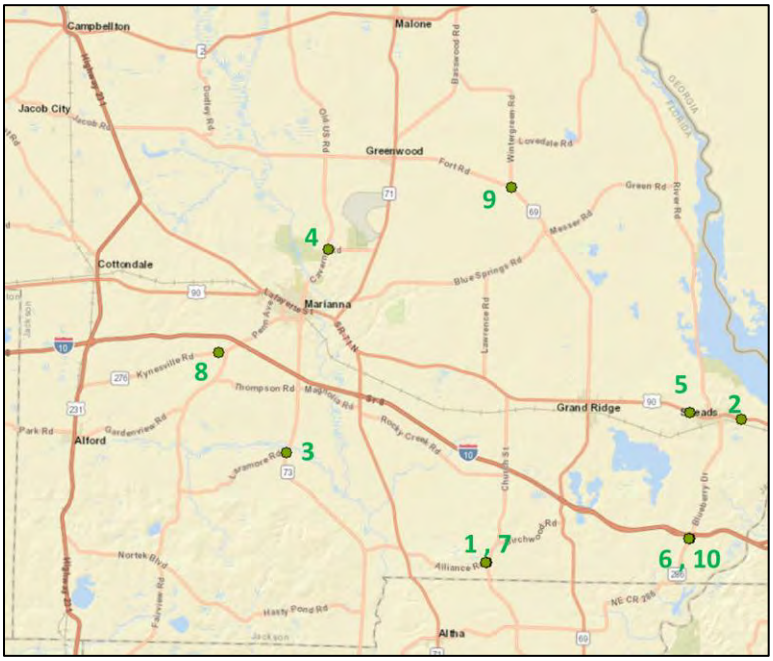

Figure 20. Top 10 intersections on curves ranked based on the predicted crash ratio

Table 37 and Table 38 show the top 10 sites by full model prediction and ratio respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 37. Top 10 intersections on curves ranked based on the full model

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
111930	86.4	1	4.07	1	13	12,344.68	412,343.67	36.21
20405	84.5	2	3.01	2	24	12,344.68	304,279.40	26.72
392979	82.8	10	2.71	3	68	12,344.68	274,831.03	24.13
399176	90	1	2.65	4	37	12,344.68	268,406.01	23.57
298231	56.2	2	2.28	5	20	12,344.68	230,688.17	20.26
399165	90	3	2.26	6	49	12,344.68	228,954.36	20.10
567628	60	3	2.13	7	15	12,344.68	215,972.44	18.96
518135	90	2	2.00	8	65	12,344.68	202,887.94	17.82
149480	90	1	1.62	9	23	12,344.68	163,858.59	14.39
224523	33.8	0	1.46	10	9	12,344.68	147,303.86	12.93

Table 38. Top 10 intersections on curves ranked based on the predicted crash ratio

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
410022	77.5	1	0.31	55	1	12,344.68	31,093.96	2.73
436854	90	0	0.97	15	2	12,344.68	98,476.31	8.65
416254	68.1	1	1.07	14	3	12,344.68	108,750.89	9.55
145533	63.5	3	0.94	16	4	12,344.68	94,888.88	8.33
410469	83.9	2	1.19	11	5	12,344.68	120,432.65	10.58
589842	6.4	0	0.56	27	6	12,344.68	57,156.27	5.02
299181	69.7	0	0.19	95	7	12,344.68	18,784.62	1.65
167021	68.3	0	0.81	19	8	12,344.68	82,040.24	7.20
224523	33.8	0	1.46	10	9	12,344.68	147,303.86	12.93
587819	18.9	0	0.40	39	10	12,344.68	40,718.39	3.58

Columbia County

Simple Curves without Intersections

There were 57 curves without intersection in Columbia County. Figure 21 shows the top 10 ranked curves based on full model predictions. Nine of the 10 curves, were also among the top 10 AADTs. Curve 4 was also picked by hotspot analysis. Figure 22 shows the top 10 ranked curves based on the ratio. Of the 10, three were among the top 10 AADTs too. Curve 8 was also chosen by hotspot analysis. Four of the curves are in common between the rankings.

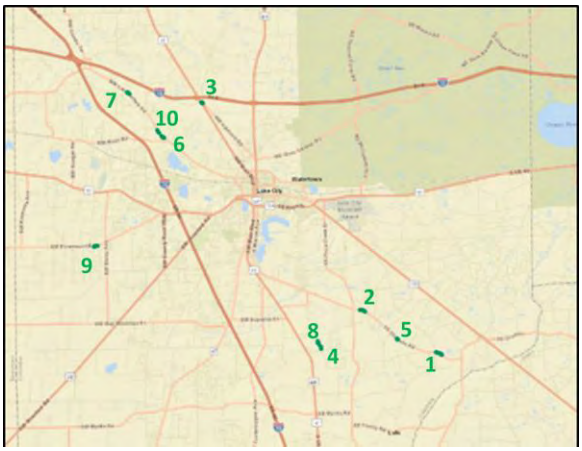

Figure 21. Top 10 curves without intersections ranked based on the full model

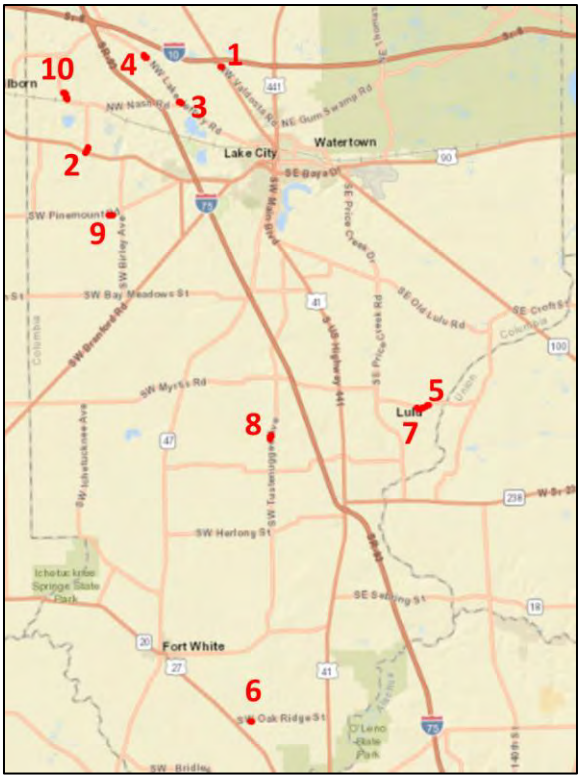

Figure 22. Top 10 curves without intersections ranked based on predicted crash ratio

Table 39 and Table 40 show the top 10 sites by full model prediction and ratio respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 39. Top 10 curves without intersections ranked based on the full model

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
29600000-128-11	1,794	0	8.12	1	14	22,873.98	1,089,435.19	51.6
29600000-128-5	1,841	0	5.07	2	37	19,239.62	750,174.23	42.3
29511000-110-3	202	1	4.06	3	1	10,146.86	386,625.47	41.3
29507000-107-3	785	1	3.55	4	24	10,547.85	382,257.84	39.3
29600000-128-8	1,226	0	3.10	5	54	8,791.36	454,876.88	56.1
29550000-124-10	2,026	1	2.44	6	3	12,506.81	251,208.07	21.8
29550000-124-7	1,716	1	2.20	7	4	10,652.57	219,632.88	22.3
29507000-107-4	1,216	0	1.82	8	55	10,461.72	230,347.77	23.9
29520000-112-2	1,655	5	1.67	9	9	12,234.66	195,757.54	17.3
29550000-124-9	3,656	3	1.15	10	21	12,246.39	124,932.08	11.1

Table 40. Top 10 curves without intersections ranked based on predicted crash ratio

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
29511000-110-3	202	1	4.06	3	1	10,146.86	386,625.47	41.30
29504000-105-1	1,054	1	1.02	12	2	19,042.39	128,572.28	7.32
29550000-124-10	2,026	1	2.44	6	3	12,506.81	251,208.07	21.77
29550000-124-7	1,716	1	2.20	7	4	10,652.57	219,632.88	22.35
29502000-103-4	1,915	0	0.27	51	5	12,246.85	32,944.64	2.92
29642001-137-2	986	0	0.88	16	6	8,778.16	106,706.87	13.18
29502000-103-3	1,496	0	0.23	54	7	17,488.34	34,738.62	2.15
29640000-136-5	1,798	0	0.78	18	8	17,816.55	115,024.27	7.00
29520000-112-2	1,655	5	1.67	9	9	12,234.66	195,757.54	17.34
29504000-105-4	1,377	0	0.56	30	10	21,121.05	89,797.55	4.61

Simple Curves with One Intersection

There are 39 curves with at least one intersection. Figure 23 demonstrates the top 10, based on full model predictions, of which five are among the top 10 AADTs. Site 5 was also chosen by hotspot analysis. Of the top 10 curves based on ratio ranking in Figure 24, only two were among high AADTs. Curve 7 was also picked by spot analysis. Five curves were in both rankings. In both figures, curves ranked 9 were on CR-131, which was chosen in spot analysis. However, due to not having a history of severe crashes, these curves were not selected in spot analysis.

Figure 23. Top 10 curves on intersections ranked based on the full model

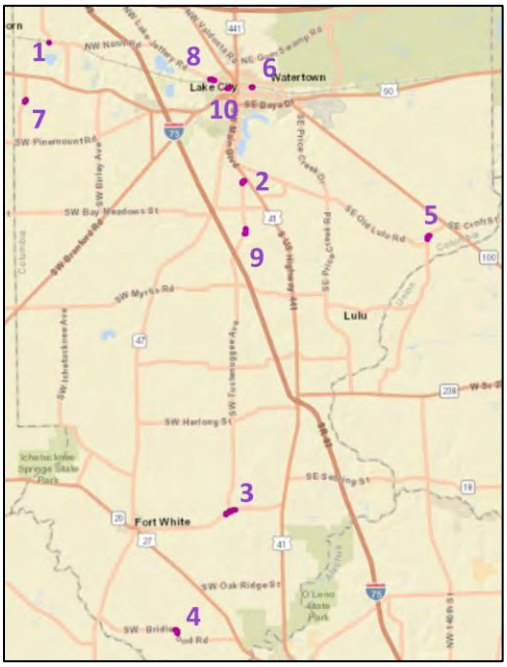

Figure 24. Top 10 curves on intersections ranked based on predicted crash ratio

Table 41 and Table 42 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 41. Top 10 curves with one intersection ranked based on the full model

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
29600000-128-10	2,441	0	3.74	1	33	17,566.53	321,182.89	19.8
29600000-128-12	1,982	0	2.77	2	32	23,508.06	321,182.89	14.8
29100000-60-2	3,694	3	2.18	3	3	33,158.38	119,270.62	3.9
29504000-105-3	112	0	2.07	4	1	16,650.20	77,902.79	5.1
29520004-117-1	958	2	1.85	5	21	13,336.68	137,170.73	11.1
29000004-4-4	472	3	1.58	6	6	12,259.13	112,975.34	10.0
29000004-4-2	705	2	1.48	7	8	16,432.73	112,975.34	7.5
29640000-136-13	581	2	1.47	8	2	20,304.10	90,213.16	4.8
29620101-132-1	2,582	28	1.38	9	17	16,312.58	122,174.50	8.1
29550000-124-13	2,844	0	1.35	10	10	22,394.86	131,352.20	6.4

Table 42. Top 10 curves with one intersection ranked based on the predicted crash ratio

Curve ID	Radius (ft)	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
29504000-105-3	112	0	2.07	4	1	14,469.63	77,902.79	5.84
29640000-136-13	581	2	1.47	8	2	15,942.95	90,213.16	6.13
29100000-60-2	3,694	3	2.18	3	3	33,158.38	119,270.62	3.90
29505000-106-3	607	1	1.33	11	4	27,040.28	87,464.92	3.51
29610000-129-4	843	0	0.54	32	5	20,138.98	64,962.58	3.50
29000004-4-4	472	3	1.58	6	6	12,259.13	112,975.34	9.99
29520001-114-5	942	3	0.54	31	7	16,450.52	67,494.33	4.45
29000004-4-2	705	2	1.48	7	8	17,159.59	112,975.34	7.14
29640000-136-11	1,762	0	1.03	17	9	21,716.51	90,213.16	4.50
29550000-124-13	2,844	0	1.35	10	10	22,394.86	131,352.20	6.36

Three-way Intersection Not on a Curve

There are 349 intersections not on a curve in Columbia County. Figure 25 shows the top 10 sites by full model ranking. Of the 10, two are among the top 10 AADT sites. Figure 26 shows the top 10 intersections by ratio ranking, in which none are among the top 10 AADT sites. There are three intersections in common between these two rankings. Intersection 3 in Figure 26 (CR-252A and CR-252) was also chosen by spot analysis.

Figure 25. Top 10 intersections not on curves ranked based on the full model

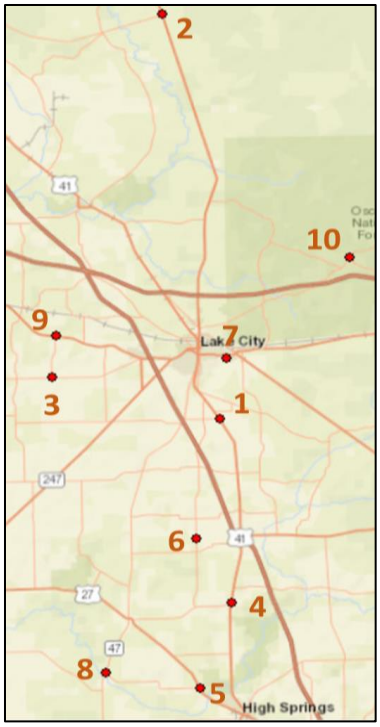

Figure 26. Top 10 intersections not on curves ranked based on predicted crash ratio

Table 43 and Table 44 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 43. Top 10 intersections not on curves ranked based on the full model

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
507966	64	2	5.22	1	1	12,344.68	528,427.89	46.40
454224	61	0	3.83	2	107	12,344.68	388,091.67	34.08
501178	83	3	3.71	3	47	12,344.68	375,239.64	32.95
247917	62	1	3.50	4	272	12,344.68	354,169.27	31.10
98281	63	2	3.19	5	5	12,344.68	323,413.69	28.40
538633	62	3	3.06	6	4	12,344.68	309,419.20	27.17
43474	84	13	2.95	7	124	12,344.68	298,353.43	26.20
507583	84	0	2.82	8	109	12,344.68	285,642.01	25.08
386009	90	3	2.78	9	16	12,344.68	281,478.06	24.72
551931	78	11	2.63	10	33	12,344.68	265,830.77	23.34

Table 44. Top 10 intersections not on curves ranked based on predicted crash ratio

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
507966	64	2	5.22	1	1	12,344.68	528,427.89	46.40
370540	90	2	0.59	86	2	12,344.68	59,586.84	5.23
132617	90	2	1.55	24	3	12,344.68	156,980.50	13.78
538633	62	3	3.06	6	4	12,344.68	309,419.20	27.17
98281	63	2	3.19	5	5	12,344.68	323,413.69	28.40
338702	90	1	0.22	220	6	12,344.68	22,615.22	1.99
484238	67	1	0.26	194	7	12,344.68	26,389.27	2.32
47306	77	0	1.35	31	8	12,344.68	136,853.48	12.02
454207	90	1	1.72	18	9	12,344.68	174,285.68	15.30
44416	71	1	0.31	152	10	12,344.68	31,051.19	2.73

Three-way Intersection on a Curve

There are 138 intersections on a curve in Columbia County. Figure 27 shows the top 10 sites by full model ranking. Of the 10, six are among the top 10 AADT sites. Figure 28 shows the top 10 intersections by ratio ranking, in which none are among the top 10 AADT sites. There are two intersections in common among the rankings.

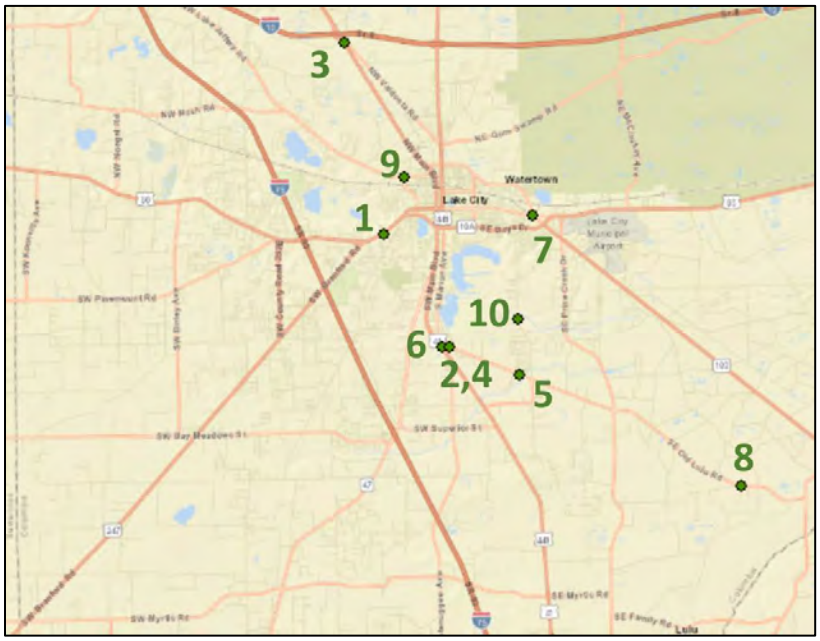

Figure 27. Top 10 intersections on curves ranked based on the full model

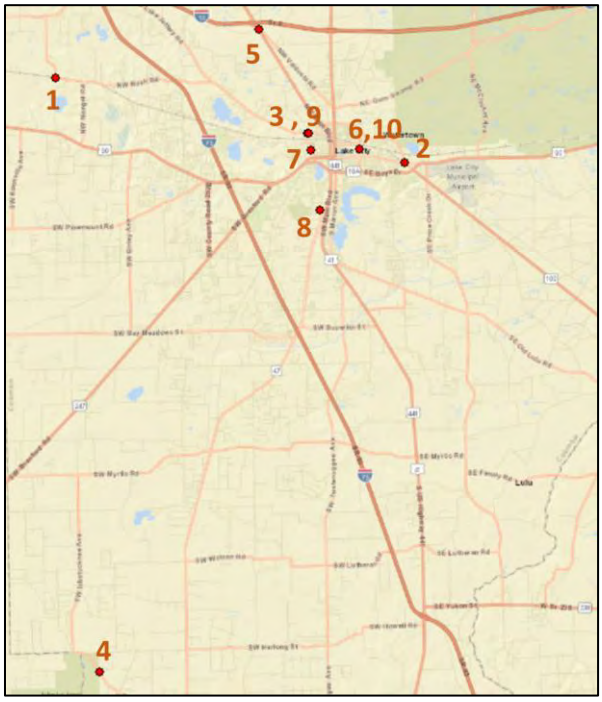

Figure 28. Top 10 intersections on curves ranked based on the predicted crash ratio

Table 45 and Table 46 show the top 10 sites by full model prediction and ratio, respectively. The complete list of the curves with their associated information will be delivered to the County Engineer.

Table 45. Top 10 intersections on curves ranked based on the full model

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
251748	90	23	5.72	1	87	12,344.68	579,415.78	50.88
286416	76	2	5.68	2	108	12,344.68	574,866.74	50.48
559292	79	1	1.36	3	5	12,344.68	137,439.41	12.07
82627	66	2	2.48	4	68	12,344.68	251,019.36	22.04
43372	90	1	3.15	5	101	12,344.68	318,794.71	27.99
569171	58	11	1.97	6	47	12,344.68	199,767.04	17.54
559293	84	3	0.78	7	2	12,344.68	78,582.69	6.90
423170	87	0	2.86	8	135	12,344.68	289,716.25	25.44
400764	82	3	1.00	9	19	12,344.68	101,591.48	8.92
484250	88	0	2.65	10	134	12,344.68	268,204.72	23.55

Table 46. Top 10 intersections on curves ranked based on the predicted crash ratio

Intersection ID	Intersection angle	KABC	Prediction	Rank by full model	Rank by ratio	Cost (dollars)	Benefit (dollars)	BC ratio
99633	84	0	0.18	69	1	12,344.68	18,571.56	1.63
559293	84	3	0.78	7	2	12,344.68	78,582.69	6.90
198002	90	1	0.18	89	3	12,344.68	18,182.36	1.60
286403	48	1	0.31	45	4	12,344.68	30,969.52	2.72
559292	79	1	1.36	3	5	12,344.68	137,439.41	12.07
79023	91	0	0.30	56	6	12,344.68	30,351.32	2.67
484304	73	0	0.23	79	7	12,344.68	23,074.05	2.03
9635	91	0	0.32	50	8	12,344.68	32,749.84	2.88
45089	90	1	0.29	60	9	12,344.68	29,550.78	2.59
405200	90	0	0.36	46	10	12,344.68	36,372.95	3.19