



Hillsborough County Metropolitan Planning Organization

Congestion Management/Crash Mitigation Process

Crash Severity Reduction Report



January 2013

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Executive Summary

The Hillsborough County Metropolitan Planning Organization's (MPO) Congestion Management/Crash Mitigation Process (CM/CMP) provides information on transportation system performance and alternative strategies to alleviate congestion and enhance mobility for all users. The CM/CMP has established a set of goals and objectives that align with the long-range transportation plan and other growth management plans and policies. The success of many of the CM/CMP's goals and objectives rely upon the improvement of the county's overall safety performance and the ability to shift trips, specifically "peak-hour" trips, to non-single occupancy automobiles.

This Safety/Mobility Strategies Study was designed to specifically address two of the CM/CMP's objectives—Objective 1.1, *Reduce the frequency and severity of crashes focusing on the highest crash areas*, and Objective 2.2, *Improve the safety and comfort of bicycling and walking trips*—while complementing the MPO's ongoing efforts to evaluate innovative infrastructure strategies. Addressing these objectives will help to improve the overall safety and reliability of travel throughout the county by reducing crashes, which are a major cause of nonrecurring congestion, and encouraging non-single occupancy automobile trips.

The Safety/Mobility Strategies Study comprises three sections:

- Section 1 focuses on the county's crash history and provides a summary of the current state and local agency safety programs and policies.
- Section 2 identifies and evaluates alternative roadway infrastructure strategies that could complement existing safety programs and policies in efforts to reduce severe injury crashes and improve mobility.
- Section 3 provides the study's recommendations.

Section 1 looked at the county's crash history and identified the areas within the county that have the highest frequency of "severe" injury (incapacitating injury and fatal crashes) crashes. In addition to identifying the location of the county's severe injury crashes, the crash history analysis also looked at the types of crashes that generate the highest frequency of severe injury crashes. The study's crash history analysis concluded that more than half of the county's severe injury crashes were occurring on major roads (arterials and collectors) within the county's urban area and that nearly one-third of the severe injury crashes were categorized as an angle or left-turn crash. Therefore, the primary focus of the crash history analysis was on the county's urban major roadways. Following is a list of the intersections and corridors with the highest frequency of severe injury crashes; these locations are also shown on Map X.1.

High Frequency Severe Crash Intersections:

- Dale Mabry Hwy at Bearss Ave/Ehrlich Rd
- Dale Mabry Hwy at Fletcher Ave
- Brandon Blvd at Grand Regency Blvd
- Waters Ave at Hanley Rd
- US 301 at Boyette Rd
- Gunn Hwy at Anderson Rd
- Adamo Dr at Falkenburg Rd
- Fletcher Ave at 15th St
- Fletcher Ave at Florida Ave

High Frequency Severe Injury Crash Corridors:

- Fletcher Ave – Nebraska Ave to Bruce B Downs Blvd
- Hillsborough Ave – Memorial Hwy to Hanley Rd
- Brandon Blvd – Valrico Rd to Dover Rd

- Dale Mabry Hwy – Busch Blvd to Fletcher Ave
- Bloomingdale Ave – Providence Rd to Bell Shoals Rd
- Hillsborough Ave – Longboat Blvd to Memorial Hwy
- Dale Mabry Hwy – Bearss Ave/Ehrlich Rd to North Lakeview
- Hillsborough Ave – Hanley Rd to Frontage Rd

The county’s crash history was also compared to similar sized counties throughout the state, and while Hillsborough County has seen a reduction in the frequency and rate of severe injury crashes, it remains near the top of the list when compared to its peers. Figure X.1 shows Hillsborough County’s severe injury crash rate (red line) from 2006–2010 compared with the rates from six other counties and the state.

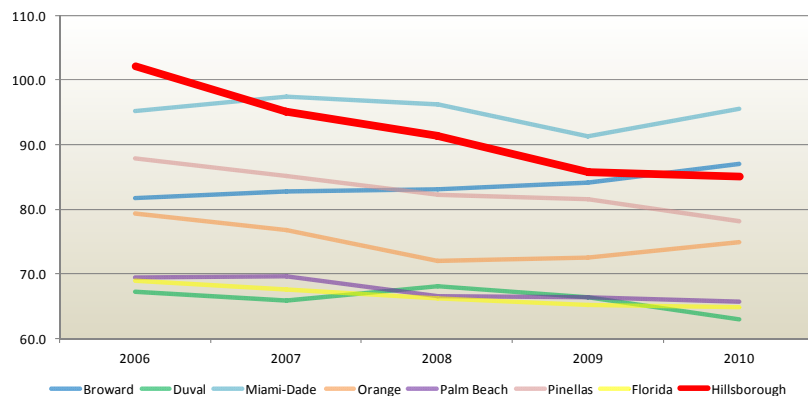


Figure X.1: Injury and Fatal Crashes per 100 Million VMT

Section 1 also contains an overview of the programs and processes that promote safety through engineering measures including safety retrofits, incorporation of safety in project development, and safety measures implemented through maintenance programs of the three major roadway infrastructure agencies in Hillsborough County: Florida Department of Transportation District 7, Hillsborough County, and the City of Tampa.

Section 2 identifies and evaluates innovative and alternative roadway infrastructure strategies that have the potential to address those crash issues that are not easily mitigated through current safety retrofit programs and typical design approaches. The crash history analysis showed that nearly one-third of the severe injury crashes were the result of an angle or left turn crash. Therefore, many of the identified strategies are designed specifically to deal with the mitigation of angle and left-turn crashes, especially those occurring at signalized intersections. The study identified a number of alternative intersection and interchange strategies along with a number of corridor strategies that are aimed at enhancing safety while, at the same time, improving overall mobility. The strategies identified in Section 2 include the following:

- Alternative Intersection Treatments
 - Modern Roundabouts
 - Quadrant Intersections
 - Continuous Flow Intersections
 - Median U-Turn Intersections
- Alternative Interchange Treatments
 - Single-Point Urban Interchange
 - Diverging Diamond/Double Crossover Interchange
- Complete Streets/Road-Diet/Multi-Way Boulevard Strategies
- Mid-Block Crossings
- Speed-Reduction Strategies
- ATMS/ITS Strategies

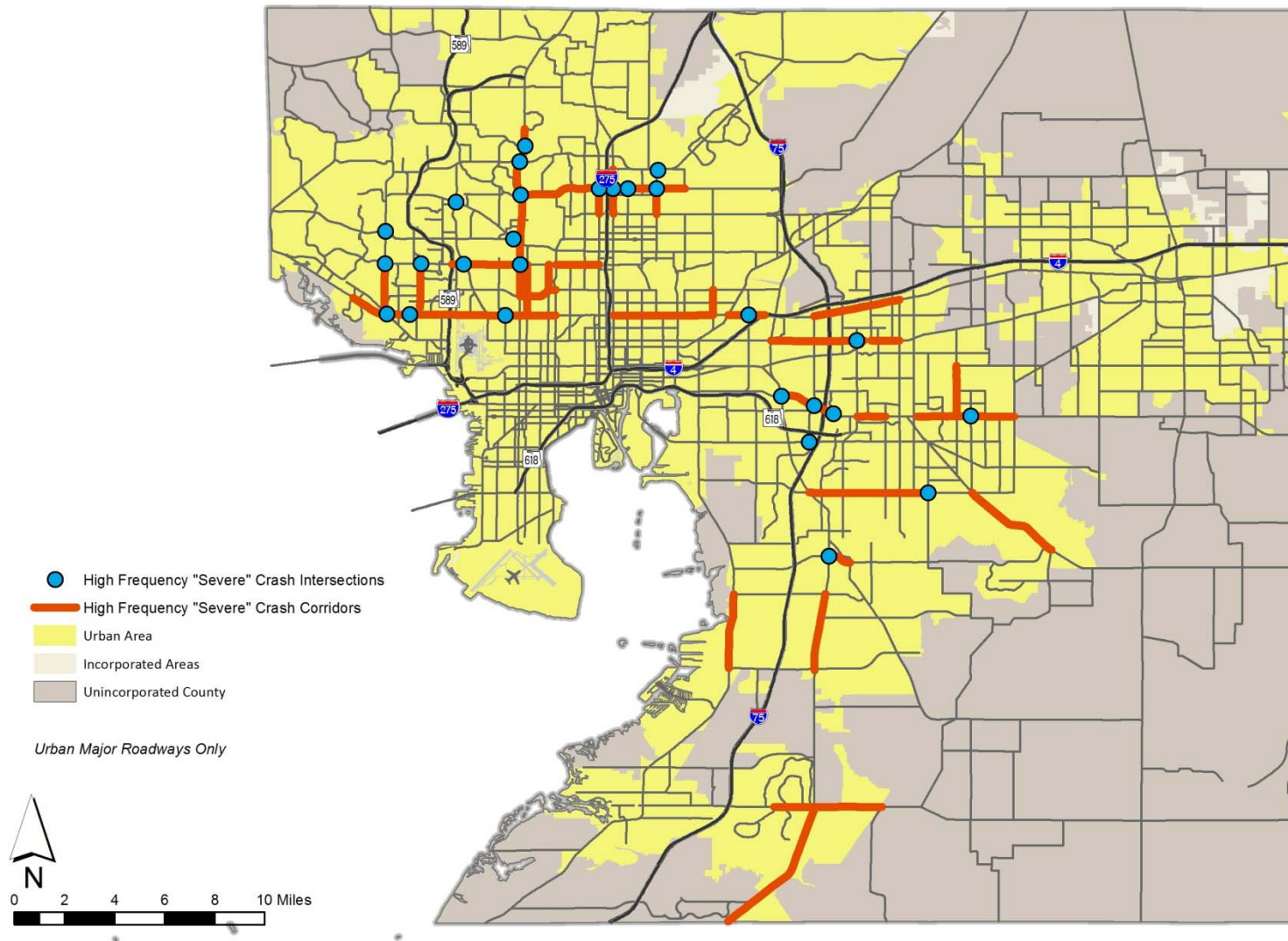
Section 3 contains the recommendations of the Safety/Mobility Strategies Study. It is recommended that the Hillsborough MPO identify specific locations for further detailed study. The complexity and uniqueness of individual locations demand a detail look at the proper approach to deal with safety and mobility. The study has provided a list of potential location for further study; the list was created based on a number of factors,

including severe injury crash history, operational and geometric considerations, and context-sensitive qualities (i.e., targeted redevelopment area). The locations recommended for further study are:

- Dale Mabry Hwy at Waters Ave
- Dale Mabry Hwy at Fletcher Ave
- Waters Ave at Hanley Rd
- SR 60/Adamo Dr at Falkenburg Rd
- Hillsborough Ave at Lois Ave
- Bruce B Downs Blvd at 138th Ave
- Fowler Ave (I-275 to I-75)
- Hillsborough Ave (I-275 to I-4)
- SR 60/Brandon Blvd (I-75 to Valrico Rd)
- Waters Ave (Dale Mabry Hwy to Nebraska Ave)
- Dale Mabry Hwy (Kennedy Blvd to Gandy Blvd)

The study is also recommending that the Hillsborough MPO incorporate alternative roadway infrastructure strategies, including but not limited to the strategies identified in Section 2, into their study and long range planning process. These strategies should be used to complement the existing safety programs, policies, and design standards that are already practiced by state and local agencies.

Map X.1: High Frequency "Severe Injury" Crash Intersections and Corridors



Introduction

The Hillsborough County Metropolitan Planning Organization (MPO) has developed a Congestion Management/Crash Mitigation Process (CM/CMP) that has defined goals and objectives that have been carefully aligned with the goals and objectives found in the Long Range Transportation Plan and other adopted growth management policies and plans. The CM/CMP's goals and objectives are as follows:

- **Goal #1: Improve Reliability of Travel**
 - *Objective 1.1: Reduce the frequency and severity of crashes focusing on the highest crash areas*
 - *Objective 1.2: Minimize the effect of unscheduled incidents*
- **Goal #2: Shift Peak-Hour Trips to Modes of Travel Instead of Single-Occupant Cars**
 - *Objective 2.1: Improve the attractiveness of transit and HOV trips*
 - *Objective 2.2: Improve the safety and comfort of bicycling and walking trips*
- **Goal #3: Reduce Peak-Hour Impacts**
 - *Objective 3.1: Improve peak-hour operations*
 - *Objective 3.2: Reduce peak-hour demand on our roadways*
- **Goal #4: MPO System-Wide Trends**
 - *Objective 4.1: Ensure that the MPO as a whole is moving in the right direction*
 - *Objective 4.2: Understand our congestion management performance compared to our peers*

To achieve these overall goals, several objectives directly rely on improving the County's overall safety performance, specifically Objectives 1.1 (*Reduce the frequency and severity of crashes focusing on the highest crash areas*) and 2.2 (*Improve the safety and comfort of bicycling and walking trips.*) Implementing these objectives will not only reduce incident-related delay and encourage non-single-occupancy vehicle trips, but will have a direct benefit on saving lives and moving the county closer to the national goal of "Zero Deaths."

The CM/CMP Safety/Mobility Strategies Study will develop recommendations for implementing Objectives 1.1 and 2.2 while complementing the MPO's ongoing efforts to evaluate innovative uses of limited right-of-way, especially during morning and afternoon traffic, through the consideration of alternative strategies including High Occupancy Vehicle (HOV) lanes, reversible lanes, and off-peak parking strategies. The Safety/Mobility Strategies Study is structured around the following two sections:

1. Baseline Assessment (Crash Data and Program Analysis)
2. Crash Reduction Strategies

Section 1: Baseline Assessment

The purpose of the baseline assessment is to understand and evaluate the major driving factors of Hillsborough County’s crash history and compare these with existing infrastructure strategies to better understand how the CM/CMP process can supplement/complement current crash reduction efforts. The baseline assessment will develop a clear analysis of the county’s crash history and will document existing/ongoing efforts to reduce crash frequency and severity by the Florida Department of Transportation (FDOT) District 7, Hillsborough County, and the cities of Tampa, Temple Terrace, and Plant City. The baseline assessment is organized into the following sub-sections:

- Peer/Trend Comparison
- Crash History Analysis
- Roadway Infrastructure Safety Program Summary

Peer/Trend Comparison

Hillsborough County’s crash data trends and distributions were compared with those of the state of Florida and other comparable Florida counties in an effort to see how the county’s crash trends stack-up to similar counties across the state. Figure 1.1 shows the counties selected for the trend comparison. Figures 1.2–1.5 show the comparable crash rates for the follow categories:

- Total Crashes per 100 Million Vehicle Miles Traveled (VMT)
- Injury and Fatal Crashes per 100 Million VMT
- Bicycle and Pedestrian Injuries and Fatalities per 100,000 Population
- Fatalities per 100 Million VMT (includes national comparison)

Figures 1.2–1.5 show that the rate of total, injury and fatal, bicycle/pedestrian injury, and fatal crashes in Hillsborough County have been declining steadily since 2006. Between 2006 and 2010, Hillsborough County’s total crash rate (Figure 1.2) decreased by more than 25 percent, compared to an average 1 percent decrease by the other peer counties and a 4 percent decrease statewide. In addition to a decrease in total crashes, Hillsborough County also experienced a decrease in the rate of injury and fatal crashes (17%) and per capita bicycle/pedestrian injuries and fatalities (15%).

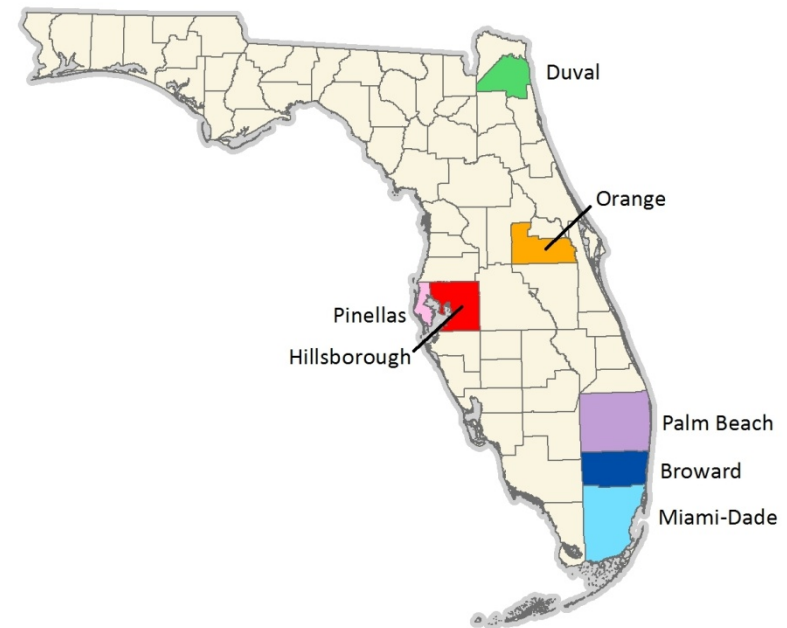
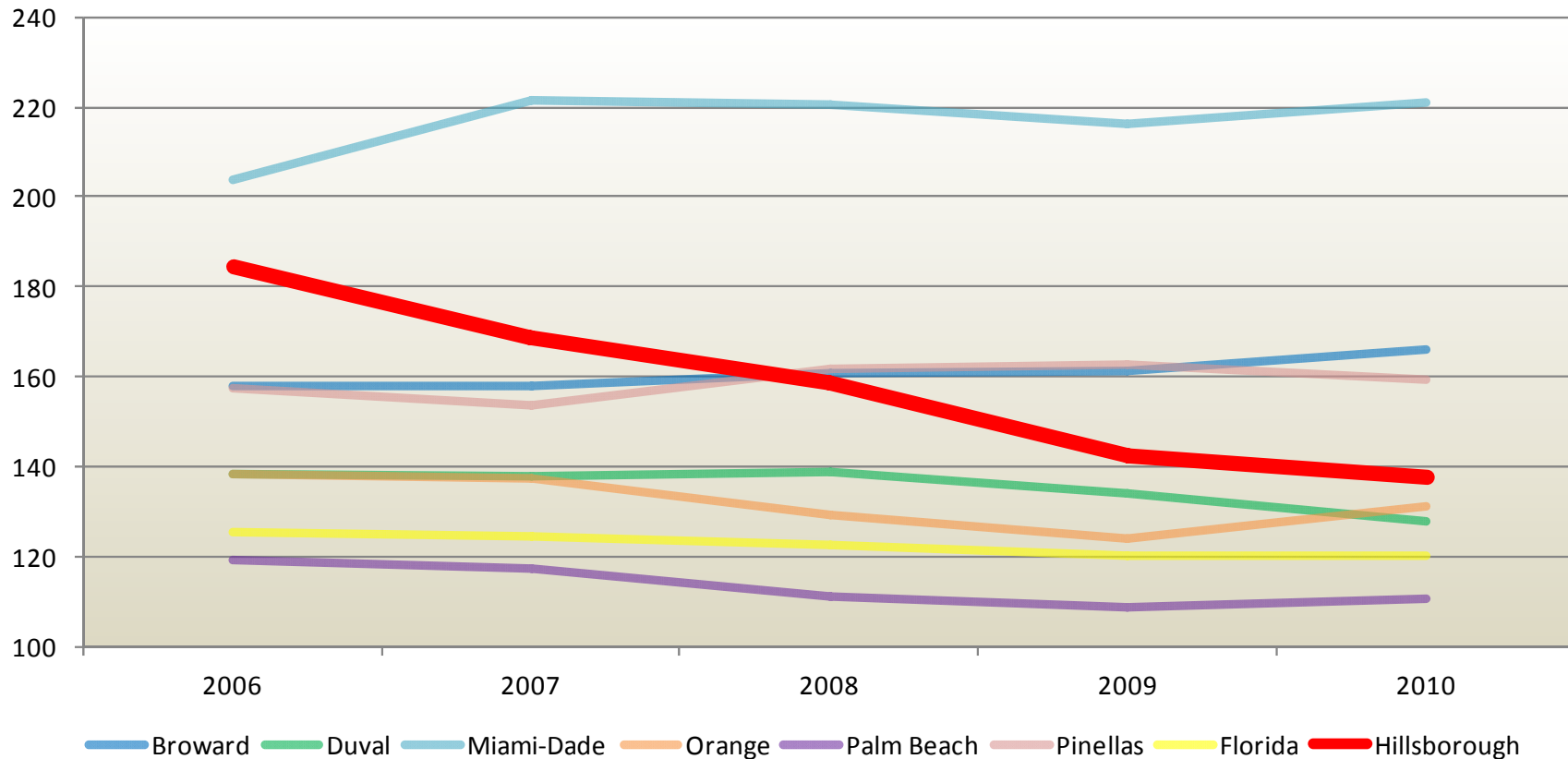
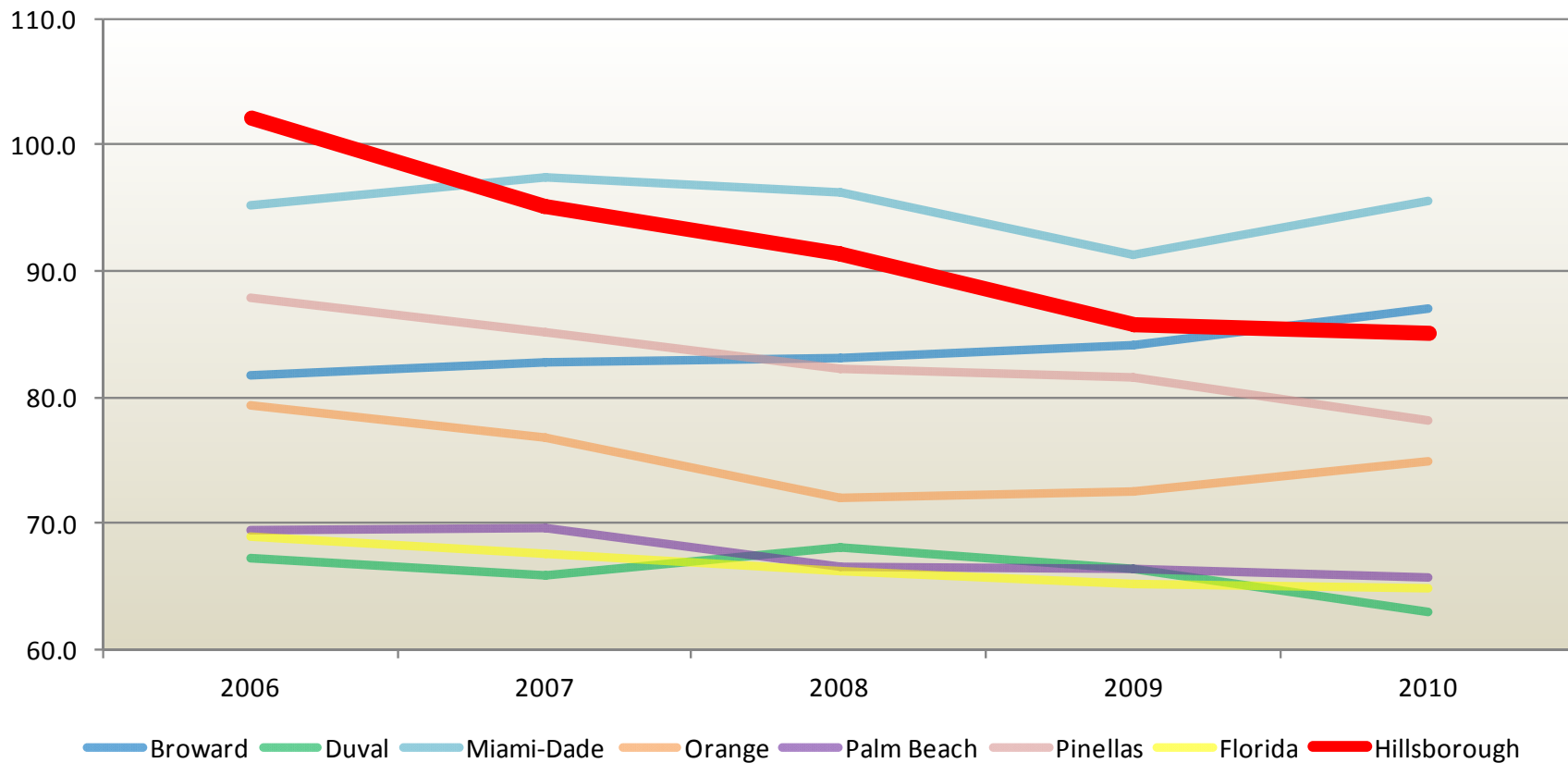


Figure 1.1: Comparison Counties



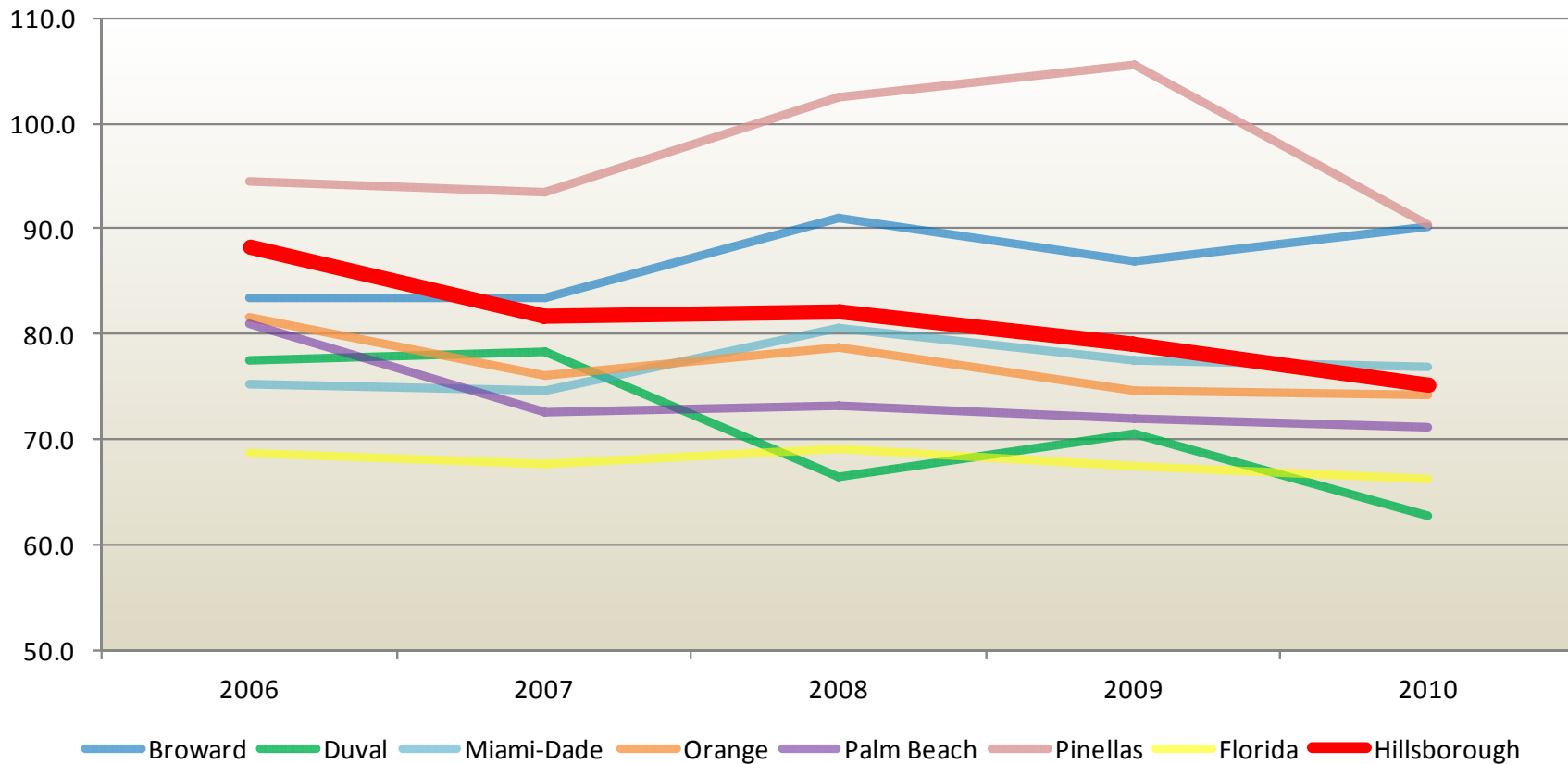
Sources: Florida Highway Safety and Motor Vehicles, *Traffic Crash Statistics Report 2010*; Florida Department of Transportation, *Public Road Mileage and Miles Traveled Report, 2006–2010* (long-form crashes only)

Figure 1.2: Total Crashes per 100 Million VMT



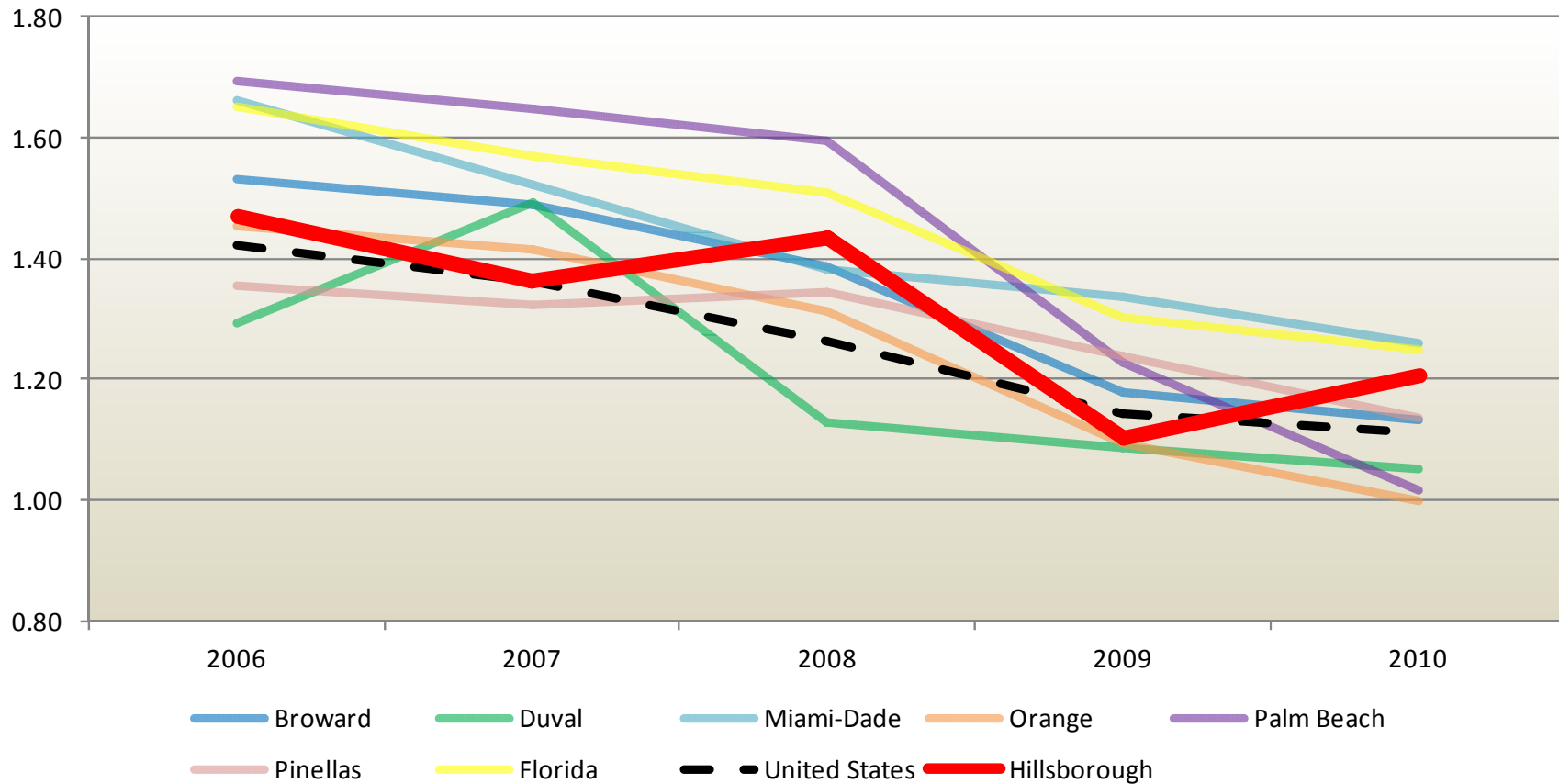
Sources: Florida Highway Safety and Motor Vehicles, *Traffic Crash Statistics Report 2010*; Florida Department of Transportation, *Public Road Mileage and Miles Traveled Report, 2006–2010*

Figure 1.3: Injury and Fatal Crashes per 100 Million VMT



Sources: Florida Highway Safety and Motor Vehicles, *Traffic Crash Statistics Report 2010*; U.S. Census Bureau; Florida Bureau of Economic and Business Research

Figure 1.4: Bicycle/Pedestrian Injuries and Fatalities per 100,000 Population



Sources: Florida Highway Safety and Motor Vehicles, *Traffic Crash Statistics Report 2010*; Florida Department of Transportation, *Public Road Mileage and Miles Traveled Report, 2006–2010*; National Highway Traffic Safety Administration, Fatality Analysis Reporting System

Figure 1.5: Fatalities per 100 Million VMT

Crash History Analysis

Objective 1.1 of the MPO’s CM/CMP is to reduce the frequency and severity of crashes by focusing on the highest crash areas. Therefore, the Crash History Analysis looks at the county’s five-year (2006–2010) crash history and identifies the crash locations and types that most significantly comprise the county’s severe (incapacitating injury and fatal) crashes. Reducing the frequency and severity of crashes has many benefits, including economic and quality of life benefits, but also moves the county closer to the national goal of “Zero Deaths.”

For analysis purposes, the county’s crash data were analyzed based on whether a crash occurred in an urban or rural area and along what type of roadway the crash occurred. Using the 2010 U.S. Census Bureau Urban Area boundary,¹ crashes were categorized as either urban or rural, based on the location of the crash. Crashes were also assigned one of three roadway types based on the functional classification of the roadway where the crash occurred. Crashes that occurred within an intersection were assigned to the highest roadway class of the intersection; for example, a crash that occurred within the intersection of a collector road and a local road was assigned to the Collector Road classification. The three roadway types and their corresponding classifications are as follows:

- Limited Access
 - Highways (Interstates and Expressways)
- Major Roads
 - Principal Arterials
 - Minor Arterials
 - Major Collectors
 - Collectors

¹ <http://www.census.gov/geo/www/ua/2010urbanruralclass.html>

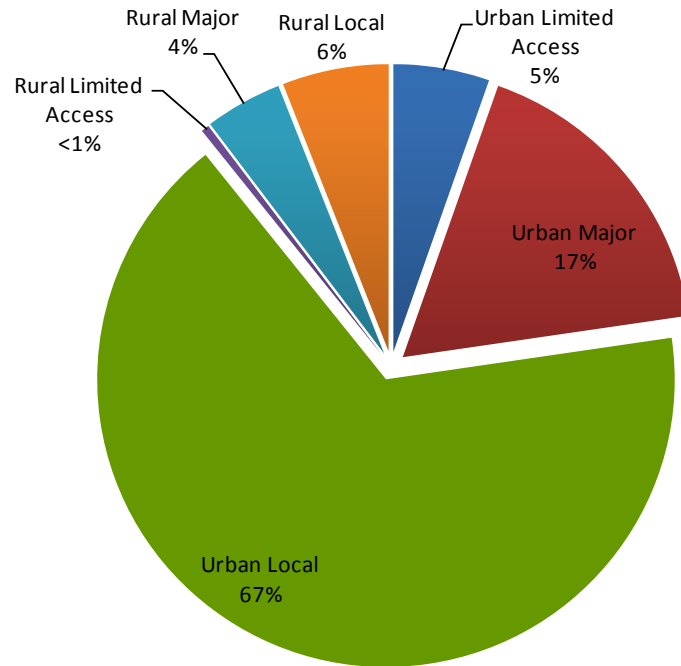
- Local Roads
 - Local (all remaining roadways)

Since the engineering strategies used to mitigate crashes often vary by roadway and area type, six crash location categories were created based on crash location (urban/rural) and roadway classification. Each crash in the database was assigned to one of the following six crash location categories:

- Urban Major
- Urban Limited Access
- Urban Local
- Rural Major
- Rural Limited Access
- Rural Local

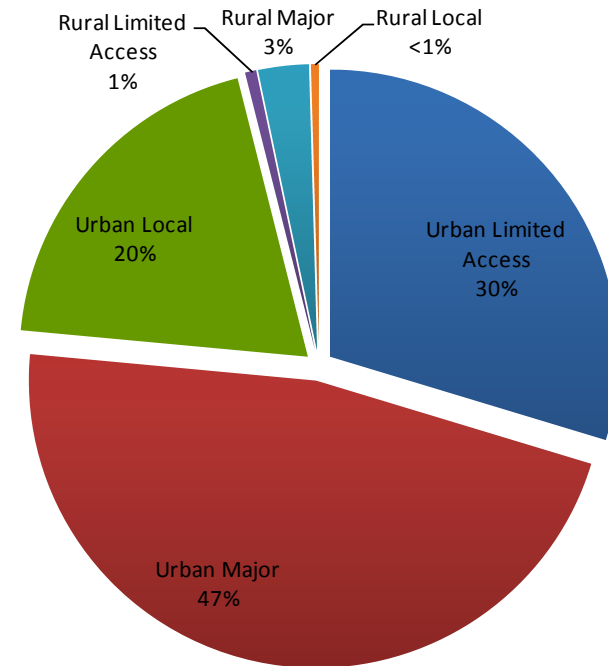
Figures 1.6 and 1.7 show the breakdown of the six crash location categories based on miles of roadway (centerline miles) and vehicle miles of travel (VMT). As shown in Figure 1.7, Urban Limited Access and Urban Major roadways carry the majority of the county’s traffic, with more than 75 percent of the VMT, but account for less than 25 percent of the roadway network in terms of centerline miles (Figure 1.6).

Map 1.1 shows the 2010 U.S. Census Bureau Urban Area Boundary and the county’s limited access, major, and local roadways.



Source: GIS based selection

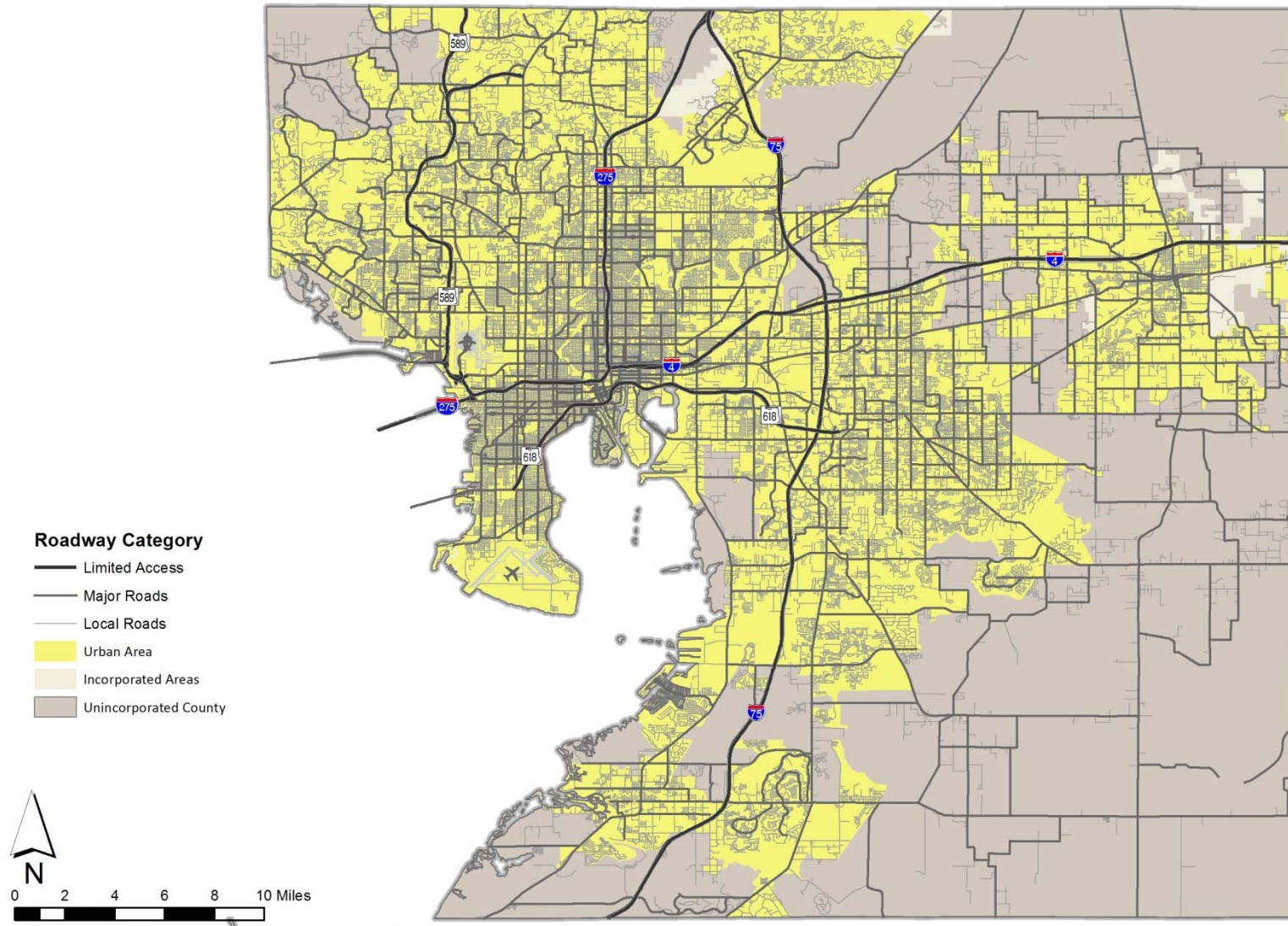
Figure 1.6: Percent of Centerline Miles by Crash Location Category



Source: FDOT Public Road Mileage and Miles Traveled, 2010 Report

Figure 1.7: Percent of VMT by Crash Location Category

Map 1.1: Roadway Categories and Urban Boundary



Crash Distribution

A five-year (2006–2010) history of the county’s severe crashes was used to understand what types of crashes along roadway categories contribute most significantly to the county’s crash history. Based on where the crash occurred, each crash was assigned to one of the six crash location categories discussed previously. The crashes were then grouped into five crash categories based on “first harmful event” information available in the crash data:

- Rear-End
- Angle/Left Turn
- Lane Departure
- Bicycle/Pedestrian
- Other

As previously mentioned, the crash history analysis was performed on the county’s severe crashes, which consist of crashes that resulted in either an incapacitating injury or a fatality. From 2006– 2010, there were almost 11,000 severe crashes in Hillsborough County, with nearly 800 of those crashes resulting in a fatality. Figures 1.8–1.11 show the distribution of severe crashes and fatal crashes by crash location category and by crash category. Maps 1.2 and 1.3 show the where the county’s severe crashes and fatal crashes occurred. The crashes in Maps 1.2 and 1.3 have been grouped to the nearest node (intersection/interchange) as a way to highlight the locations with the highest concentrations of crashes.

Figure 1.8 and Figure 1.10 show that more than half of the severe crashes and fatal crashes in Hillsborough County occurred along a major urban roadway. The distribution of crashes, on the other hand, is relatively evenly distributed among the five crash categories for both severe crashes and fatal crashes.

The crash location and crash categories were combined to identify the location (crash location category) and type (crash category) of crashes that contribute the most to the county’s severe crash and fatal crash total. For analysis purposes, crash location/crash categories that contribute more than five percent to the county’s severe crash total are considered significant. Table 1.1 shows the percent of severe crashes by crash location and crash category, and Table 1.2 shows the percent of fatal crashes by crash location and crash category. The combined categories that contribute five or more percent to the county’s severe and fatal crash totals are highlighted in yellow.

Table 1.1: Percent Severe Crashes by Crash Location and Crash Category

Roadway Category	Rear-End	Angle/Left Turn	Lane Departure	Bike/Ped	Other	Total
Urban Major	14.4%	19.1%	10.1%	6.1%	6.1%	55.8%
Urban Limited Access	4.5%	1.9%	4.3%	0.4%	1.6%	12.6%
Urban Local	1.9%	3.4%	4.5%	1.2%	1.6%	12.5%
Rural Major	0.7%	1.4%	2.4%	0.1%	0.6%	5.3%
Rural Limited Access	0.2%	0.2%	0.3%	0.0%	0.1%	0.9%
Rural Local	1.9%	3.2%	4.0%	2.1%	1.8%	12.9%
Total	23.6%	29.2%	25.5%	9.9%	11.8%	100%

Table 1.2: Percent Fatal Crashes by Crash Location and Crash Category

Roadway Category	Rear-End	Angle/Left Turn	Lane Departure	Bike/Ped	Other	Total
Urban Major	3.0%	14.0%	11.5%	17.4%	10.1%	56.0%
Urban Limited Access	0.8%	0.8%	3.2%	2.0%	3.9%	10.6%
Urban Local	0.6%	3.4%	4.2%	2.4%	2.3%	12.9%
Rural Major	0.1%	1.8%	3.7%	0.5%	2.6%	8.7%
Rural Limited Access	0.0%	0.3%	0.5%	0.0%	0.4%	1.1%
Rural Local	0.5%	2.0%	4.5%	2.1%	1.5%	10.7%
Total	5.0%	22.2%	27.5%	24.5%	20.8%	100%

Severe Crashes

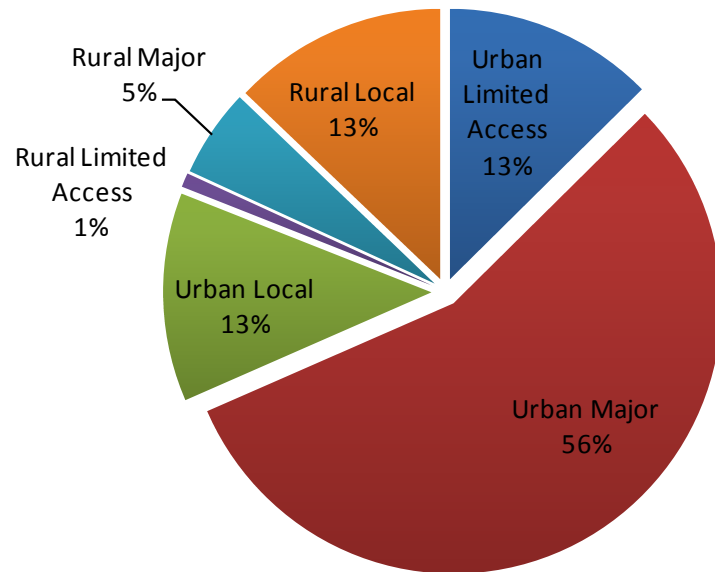


Figure 1.8: Countywide Severe Crashes by Crash Location Category

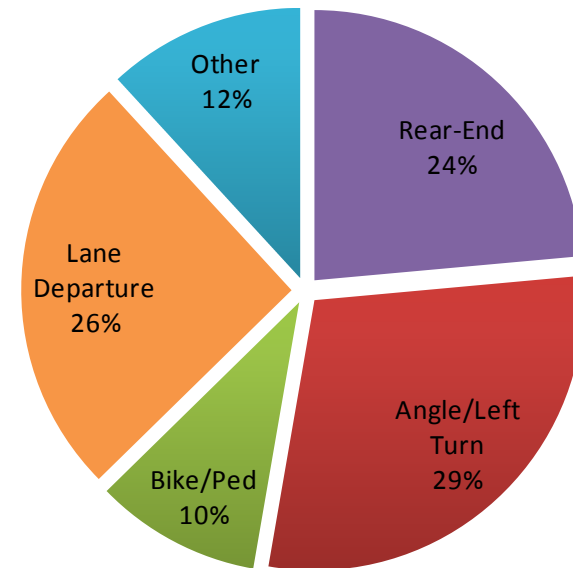


Figure 1.9: Countywide Severe Crashes by Crash Category

Fatal Crashes

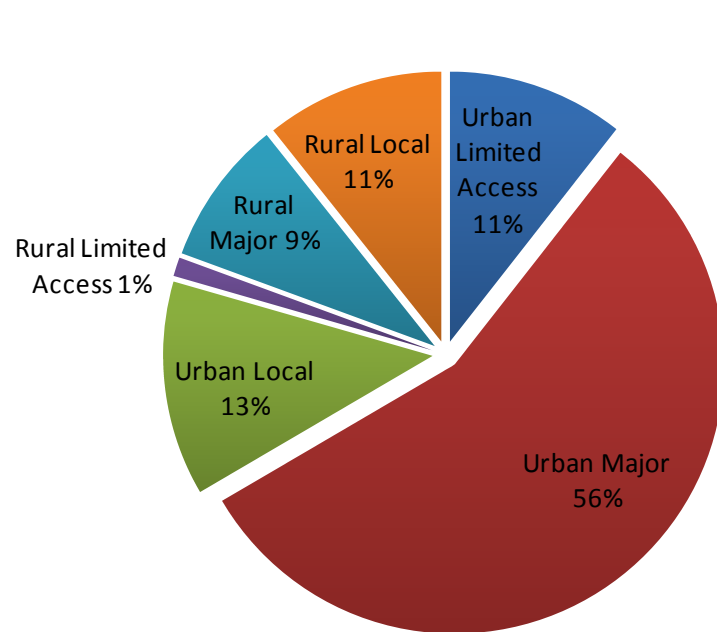


Figure 1.10: Countywide Fatal Crashes by Crash Location Category

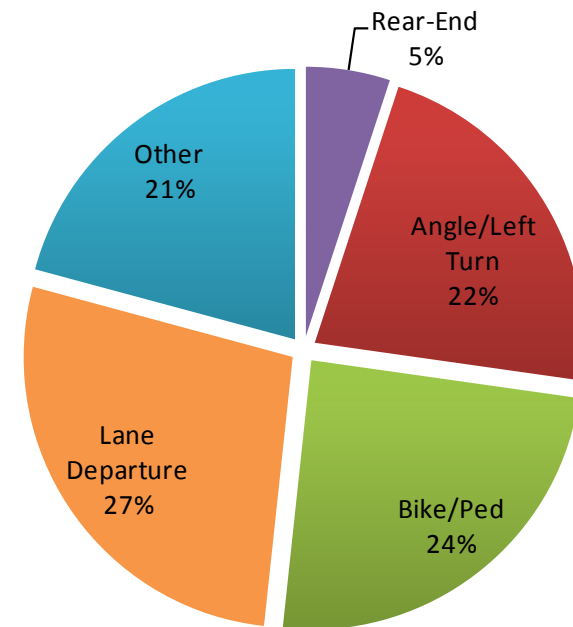
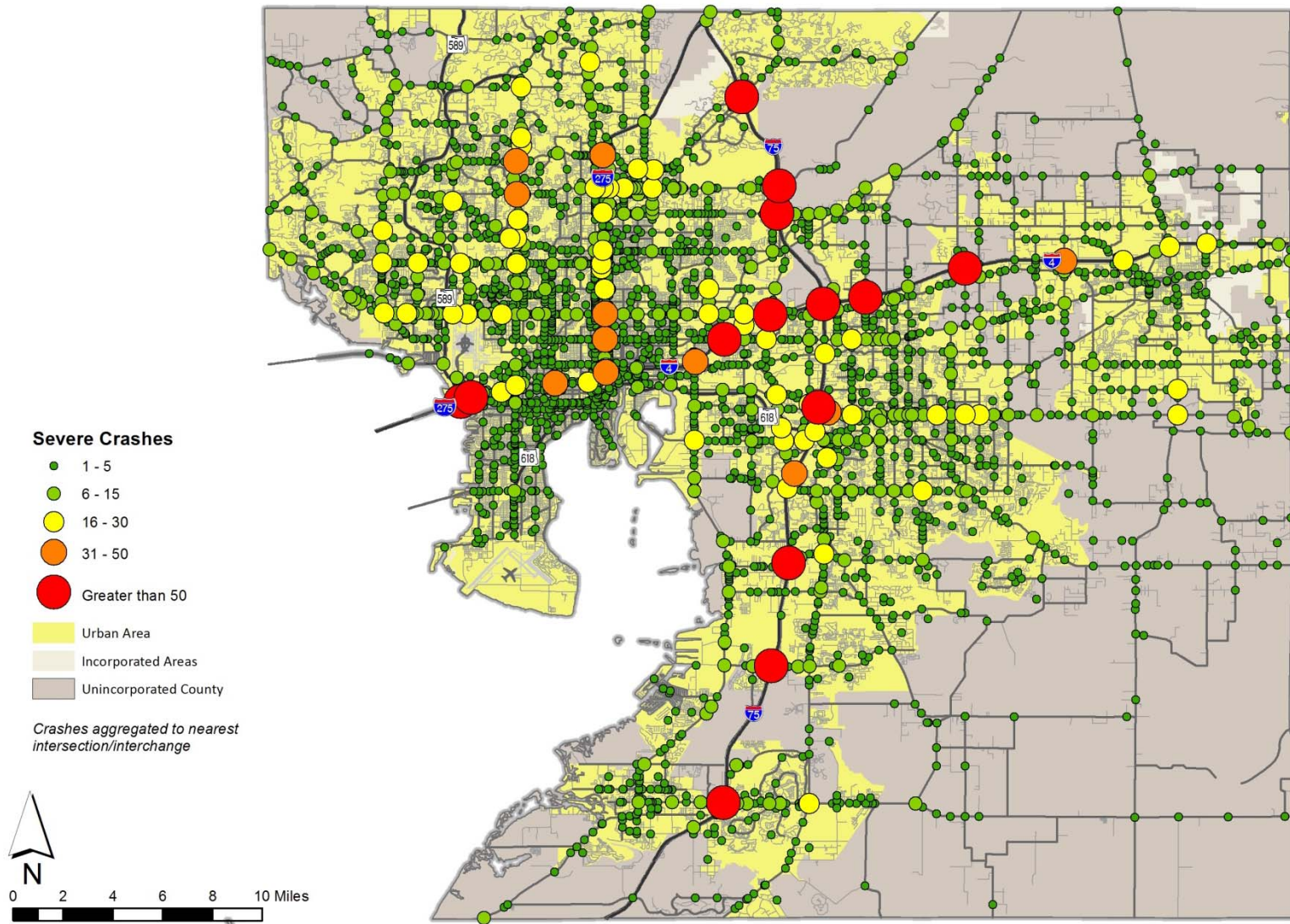


Figure 1.11: Countywide Fatal Crashes by Crash Category

Map 1.2: Severe Crash Node Summary



Urban Major Roadways

As shown in Tables 1.1 and 1.2, the majority of the county’s severe crashes occur along urban major roadways. In an effort to focus on the areas with the highest frequency of severe crashes, the following pages look at urban major roadway crashes in more detail. Figure 1.12 and Figure 1.13 show the distribution of severe and fatal crashes by crash category along the urban major roadways.

As seen in Figure 1.12, 34 percent of the severe crashes occurring on major urban roadways are angle/left turn crashes. Rear-end and lane departure crashes are the next highest crash categories, with 26 percent and 18 percent of the severe crashes. Bicycle/pedestrian and other crashes categories each accounted for 11 percent of the county’s severe crashes. Compared to the countywide severe crash distribution, urban major roadways have a slightly higher percentage of severe angle/left turn, rear-end, and bicycle/pedestrian crashes, with considerably fewer lane departure crashes.

Figure 1.13 shows that bicycle/pedestrian crashes account for 31 percent of the fatal crashes, compared to just 11 percent of the severe crashes (Figure 1.12); countywide bicycle/pedestrian crashes account for 24 percent of the fatal crashes. Angle/left turn crashes are the second deadliest crash type, with 25 percent of the fatal crashes. Also notable is that rear-end crashes, which account for 26 percent of the severe crashes, only account for 5 percent of the fatal crashes.

Figures 1.14–1.21 look at some of the contributing conditions related to severe and fatal crashes along the county’s urban major roadways.

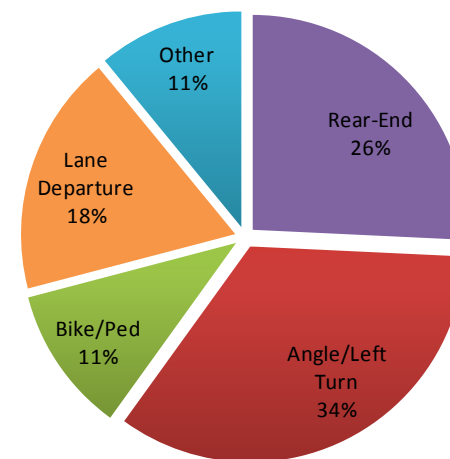


Figure 1.12: Urban Major Severe Crashes by Crash Category

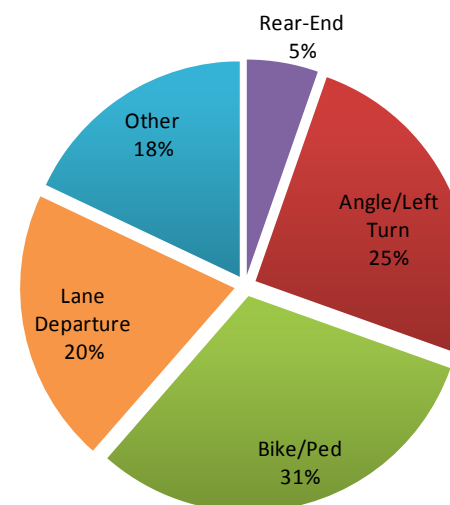


Figure 1.13: Urban Major Fatal Crashes by Crash Category

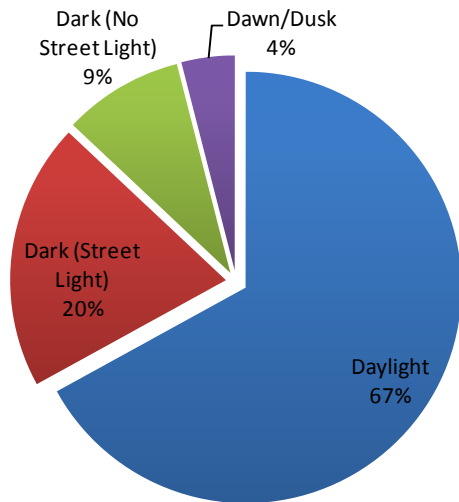


Figure 1.14: Urban Major Severe Crash Lighting Condition

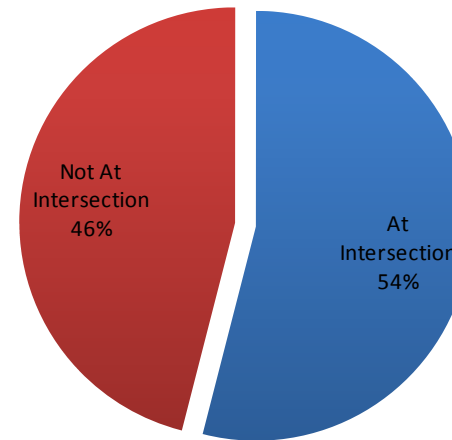


Figure 1.16: Urban Major Severe Crash Site Location

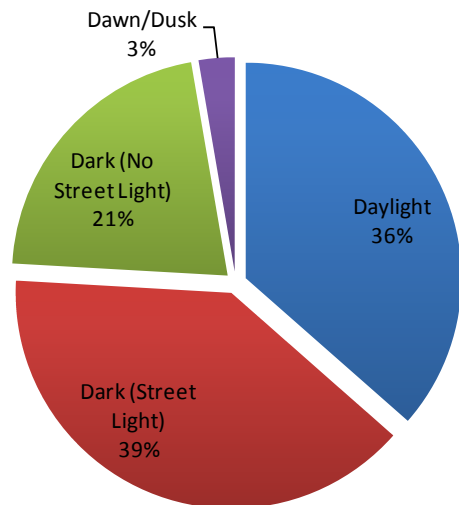


Figure 1.15: Urban Major Fatal Crash Lighting Condition

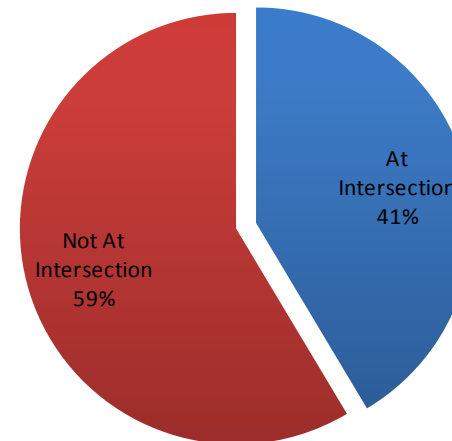


Figure 1.17: Urban Major Fatal Crash Site Location

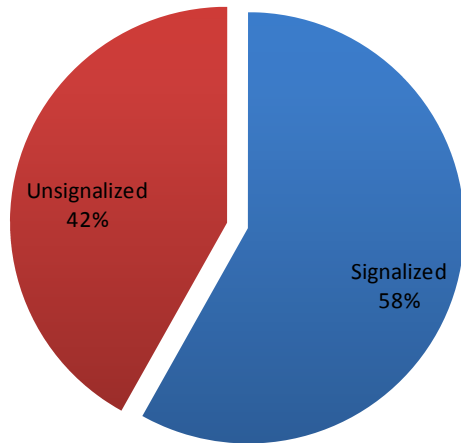


Figure 1.18: Urban Major Severe Crash “At Intersection” Traffic Control

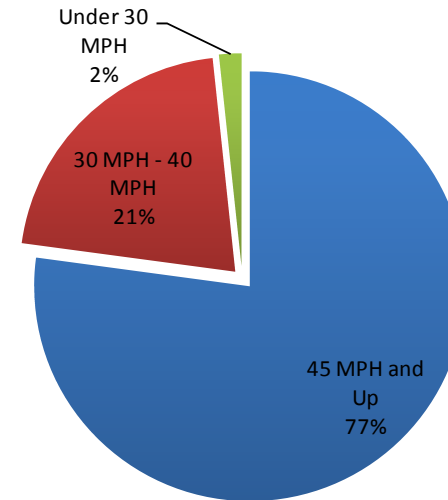


Figure 1.20: Urban Major Severe Crash by Posted Speed Limit

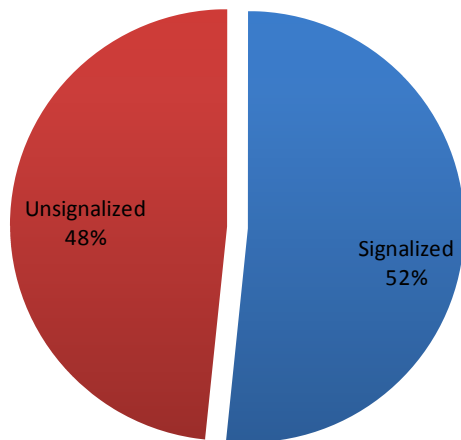


Figure 1.19: Urban Major Fatal Crash “At Intersection” Traffic Control

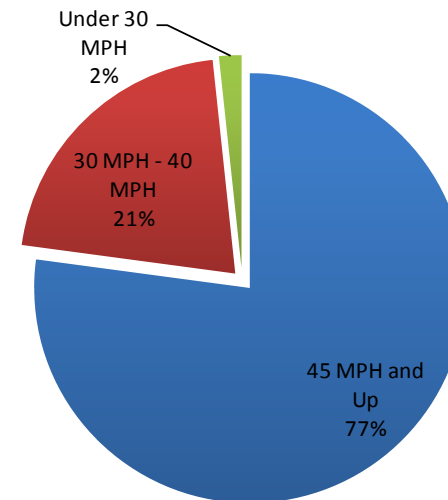


Figure 1.21: Urban Major Fatal Crashes by Posted Speed Limit

Figures 1.14 and 1.15 show the distribution of severe and fatal crashes by lighting condition: daylight, dark (street light), dark (no street light), and dawn or dusk. Figure 1.14 shows that two-thirds of the severe crashes occurred during daylight conditions. Figure 1.15 shows that 60 percent of the fatal crashes along the county's urban major roadways occurred in dark conditions, with 39 percent occurring on roadways with street lighting.

Figures 1.16–1.19 show the relationship between crash location, traffic control, and severe and fatal crashes. Figure 1.16 shows that more than half of the urban major severe crashes occurred at an intersection, and Figure 1.18 shows that, of those crashes, nearly 60 percent were at signalized intersections. Figure 1.17 shows that 41 percent of the fatal crashes occurred at an intersection, and Figure 1.19 shows that 52 percent of the intersection crashes were at signalized intersections.

Figures 1.20 and 1.21 show that 77 percent of both severe and fatal crashes occurred on roadways with a posted speed limit of at least 45 miles per hour. It is important to note that these were along urban major roadways, which are primarily roads with speed limits of at least 45 mph.

Table 1.3 lists the urban major roadway intersections with 20 or more severe crashes during the five-year analysis period. Also included in Table 1.3 is the total number of all injury crashes, which includes possible injuries, non-incapacitating injuries, and severe (incapacitating injury and fatal) crashes.

Table 1.4 lists the urban major roadway corridors with the highest frequency of severe crashes. The list includes corridors with 35 or more severe crashes. The list also includes a severe injury crash rate that was calculated using roadway volumes from the Hillsborough MPO's March 2011 Level of Service Report.

Map 1.4 illustrates the county's high frequency severe crash intersections and corridors.

Appendix A contains a summary of the severe crashes by crash category for the other crash location categories. Appendix B contains additional tables and maps showing the intersections with the highest frequency of severe crashes for each individual crash category.

Table 1.3: Urban Major Roadway – Top “Severe Injury” Crash Locations (Intersections with ≥20 Severe Crashes)

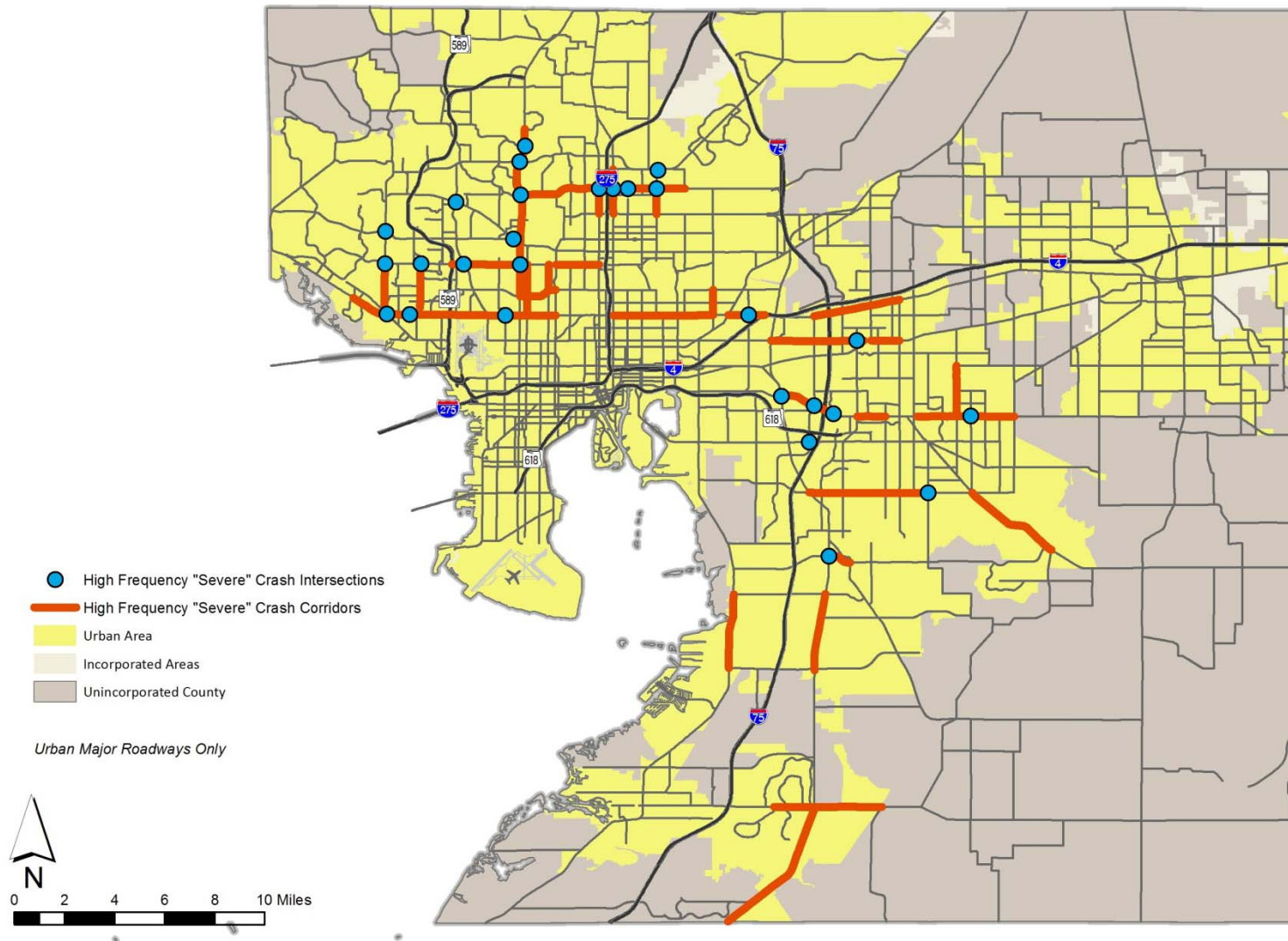
Intersection/Node	"Injury Crashes"			"Severe Injury" Crashes			Crash Summary	
	Possible Injury Crashes	Non-Incapacitating Injury Crashes	Total "Injury" Crashes	Incapacitating Injury Crashes	Fatal Crashes	Total "Severe Injury" Crashes	Total Injury Related Crashes	Percent "Severe Injury" Crashes
Dale Mabry Hwy @ Bearss Ave/Erlich Rd	120	43	163	40	0	40	203	19.7%
Dale Mabry Hwy @ Fletcher Ave	70	28	98	37	0	37	135	27.4%
Brandon Blvd @ Grand Regency Blvd	110	49	159	34	0	34	193	17.6%
Waters Ave @ Hanley Rd	46	54	100	26	4	30	130	23.1%
US 301 @ Boyette Rd	65	33	98	28	0	28	126	22.2%
Gunn Hwy @ Anderson Rd	41	35	76	26	1	27	103	26.2%
Adamo Dr @ Falkenburg Rd	62	33	95	25	1	26	121	21.5%
Fletcher Ave @ 15th St	58	20	78	25	0	25	103	24.3%
Fletcher Ave @ Florida Ave	62	43	105	23	2	25	130	19.2%
Brandon Blvd @ Miller Rd	37	24	61	21	3	24	85	28.2%
Bell Shoals Rd @ Bloomingdale Ave	64	19	83	23	1	24	107	22.4%
Dale Mabry Hwy @ Waters Ave	95	42	137	22	2	24	161	14.9%
Causeway Blvd @ Falkenburg Rd	45	15	60	21	2	23	83	27.7%
Fletcher Ave @ Nebraska Ave	55	23	78	23	0	23	101	22.8%
Gunn Hwy @ Linebaugh Ave	22	22	44	21	1	22	66	33.3%
Bruce B Downs Blvd @ Fletcher Ave	84	29	113	21	1	22	135	16.3%
Sheldon Rd @ Linebaugh Ave	27	34	61	20	1	21	82	25.6%
Bruce B Downs Blvd @ Bearss Ave	46	18	64	20	1	21	85	24.7%
US 301 @ Adamo Dr	59	22	81	21	0	21	102	20.6%
Waters Ave @ Anderson Rd	32	33	65	21	0	21	86	24.4%
Hillsborough Ave @ Lois Ave	55	34	89	21	0	21	110	19.1%
Hillsborough Ave @ Orient Rd	56	19	75	19	2	21	96	21.9%
Hillsborough Ave @ Memorial Hwy	45	32	77	21	0	21	98	21.4%
Dr Martin Luther King Jr Blvd @ Lakewood Dr	26	15	41	18	2	20	61	32.8%
Water Ave @ Sheldon Ave	35	48	83	19	1	20	103	19.4%
Hillsborough Ave @ Town N Country Blvd	26	11	37	18	2	20	57	35.1%
Dale Mabry Hwy @ Northdale Blvd	64	27	91	20	0	20	111	18.0%

Table 1.4: Urban Major Roadway – Top “Severe Injury” Crash Corridors

Corridor	Corridor Length	Total "Severe" Crashes	Severe Crash Rate	Corridor	Corridor Length	Total "Severe" Crashes	Severe Crash Rate
Fletcher Ave - Nebraska Ave to 30th St/Bruce B Downs Blvd	1.53	123	179.12	Hillsborough Ave - 40th St to 56th St	1.26	43	52.36
Hillsborough Ave - Memorial Hwy to Hanley Rd	1.17	99	104.32	Florida Ave - Fowler Ave to Fletcher Ave	1.01	42	90.25
SR 60/Brandon Blvd - Valrico Rd to Dover Rd	2.03	95	136.99	Waters Ave - Armenia Ave to Florida Ave	1.52	42	82.26
Dale Mabry Hwy - Busch Blvd to Fletcher Ave	1.99	88	72.51	M L King Jr Blvd - US 301 to I-75	2.11	42	67.69
Waters Ave - Veterans Expwy to Dale Mabry Hwy	2.41	81	87.89	Fletcher Ave - Dale Mabry Hwy to Florida Ave	2.86	42	67.22
Dale Mabry Hwy - Fletcher Ave to Bearss Ave/Ehrlich Rd	1.35	77	69.74	SR 60/Brandon Blvd - I-75 to Grand Regency Blvd	0.68	42	26.15
Bloomingtondale Ave - Providence Rd to Bell Shoals Rd	3.01	74	91.12	Himes Ave - Hillsborough Ave to Waters Ave	2.03	41	150.89
Hillsborough Ave - Longboat Blvd to Memorial Hwy	1.38	71	67.08	Lambright Rd - Dale Mabry Hwy to Armenia Ave	1.35	40	2,739.73
Dale Mabry Hwy - Bearss Ave/Ehrlich Rd to S North Lakeview	1.33	67	58.74	Boyette Rd - US 301 to Balm Riverview	0.83	39	98.23
Hillsborough Ave - Hanley Rd to Frontage Rd	1.01	63	56.59	56th St - Hillsborough Ave to Sligh Ave	1.00	39	64.76
30th St/Bruce B Downs Blvd - Fowler Ave to Fletcher Ave	1.02	60	68.26	Hillsborough Ave - Veteran's Frontage Rd to Westshore Blvd	1.34	39	34.19
Hillsborough Ave - Dale Mabry Hwy to Armenia Ave	1.34	60	49.81	US 41 - Big Bend Rd to Symmes Rd	2.95	38	99.15
Dale Mabry Hwy - Lambright St to Waters Ave	1.27	60	45.98	SR 674 - US 301 to CR 579	2.40	38	90.53
US 301 - Manatee County Line to SR 674	5.69	52	838.03	Hillsborough Ave - Nebraska Ave to 22nd St	1.00	38	43.38
SR 60/Brandon Blvd - Ridgewood Ave to Valrico Rd	1.39	52	54.27	Valrico Rd - SR 60 to Sydney Rd	2.01	37	128.37
M L King Jr Blvd - I-75 to Broadway Ave	1.17	51	78.72	Nebraska Ave - Fletcher Ave to Skipper Rd	0.77	37	82.75
Fletcher Ave - 30th St/Bruce B Downs Blvd to 46th St	0.99	51	65.03	SR 60/Brandon Blvd - Lakewood Dr to Kings Ave	1.00	37	29.38
Sheldon Rd - Jackson Springs to Old Memorial Hwy	0.07	50	60.57	Habana Ave - Sligh Ave to Waters Ave	1.02	36	172.84
Nebraska Ave - Fowler Ave to Fletcher Ave	1.01	48	109.59	Bloomingtondale Ave - US 301 to Providence Rd	1.19	36	49.72
Hillsborough Ave - 22nd St to 40th St	1.26	48	51.07	SR 60/Adamo Dr - US 301 to Falkenburg Rd	1.27	36	45.35
Dale Mabry Hwy - Waters Ave to Busch Blvd	0.79	48	38.68	Hillsborough Ave - Westshore Blvd to Dale Mabry Hwy	1.05	36	26.84
M L King Jr Blvd - CR 579 to Parsons Ave	1.00	45	89.66	Lithia Pinecrest Rd - Bloomingtondale Ave to Boyette Rd	3.70	35	107.67
Sheldon Rd - Old Memorial Hwy to Waters Ave	1.91	44	76.72	Hanley Rd - Henry Ave to Waters Ave	1.73	35	91.32
US 92 - Falkenburg Rd to Parsons Ave	3.08	43	173.25	US 301 - Big Bend Rd to Symmes Rd	3.06	35	87.17
Hillsborough Ave - Harney Rd to US 301	1.29	43	53.55	SR 674 - Valley Forge Blvd to US 301	1.41	35	79.91

Severe Crash Rate is the number of Severe Injury Crashes per 100,000,000 VMT; roadway volumes are from the Hillsborough County MPO Level of Service Report, March 2011.

Map 1.4: High Frequency "Severe Injury" Crash Intersections and Corridors



Safety Program Summary

The three major roadway infrastructure agencies in Hillsborough County are FDOT District 7, Hillsborough County, and the City of Tampa. Each of these agencies implements programs and processes that promote safety through engineering measures including safety retrofits, incorporation of safety in project development, and safety measures implemented through maintenance programs. The major traffic safety initiatives of these agencies are as follows.

FDOT District 7

FDOT is responsible for design, maintenance, and operations along the State Highway System (SHS), which includes the county's limited-access highways, principal arterial roadways, and some minor arterial roadways. FDOT enhances the safety of the roadway network through three basic functions, which are generalized as follows:

1. *Highway Capacity Projects:* The District implements modern design standards and processes as specified in the *Florida Greenbook, Design Standard Indices, and Plans Preparation Manual*. As new roadways are constructed or widened and reconstructed, the nominal safety of the SHS is improved through the implementation of these design standards. Examples included provision of adequate acceleration/deceleration lanes and clear zones, appropriate sight distances, auxiliary lanes (as necessary), implementation of access management standards, provision of multimodal facilities (bike lanes, sidewalks, bus bays), and context-sensitive design features as appropriate. Because most of the county's urban roadway network is "built out," relatively few of the high-crash locations shown in Map 1.4 are likely to be addressed by major capacity projects. The recent and planned

reconstruction of the east-west interstate highway system through Tampa (I-275 from the Howard Frankland Bridge to Downtown and I-4 from Downtown to 50th Street) has/will help to reduce crashes on this high-volume facility by eliminating the hills and valleys in the current system and by separating merge and diverge movements to avoid weave conditions.

2. *Maintenance Program:* Among other elements, the District's maintenance program includes roadway Resurfacing, Restoration, and Rehabilitation (3R) projects. While the prioritization of 3R projects is primarily based on the roadway pavement conditions, and these projects do not, as a rule, fully reconstruct roadways, they nonetheless provide an important opportunity for the District to improve roadway safety. Examples of 3R project-related safety enhancements include enhanced pavement friction; improved drainage; new and often enhanced signage and pavement markings; implementation of safety devices such as guardrail, advanced warning beacons, and curve delineators; minor access management and auxiliary lane modifications; reconstruction of driveway aprons, curb ramps, pedestrian signal push-buttons, and sidewalks to comply with the ADA; provision of marked bicycle lanes when pavement width is adequate, and, when necessary, reconstruction of signals to include conspicuity and operational enhancements. While the 3R program has been used to effect transformative safety improvements (such as Nebraska Avenue "road diet"), this program generally does not include significant modification to roadway geometrics and cross-sections.
3. *Traffic Operations, Access Management, and Safety Programs:* These program areas provide a means for the District to identify and address problem locations and to implement systemic safety improvements. Some initiatives include:

- a. Signal Reconstruction Program – The District is systematically reconstructing diagonal span-wire signals with either mast-arm or “box-span” signals. When signals are reconstructed, signal conspicuity can be improved by optimizing the placement and increasing the number of signal heads. If modifications to signal phasing (i.e., provision of protected left-turn phases) are necessary, this may be accomplished as well.
- b. Signal Timing – The District uses a mix of State funds and federal Highway Safety Improvement Program (HSIP) funds to improve signal timing in key corridors. Improved signal coordination not only allows roads to operate more efficiently, but reduces crashes by allowing more cars to pass through signalized intersections without stopping – reducing the likelihood of rear-end crashes. Signal timing improvements can also result in tighter “platoons,” which can result in more uniform travel speeds and provide for better gaps for traffic attempting to turn onto/off of the main roadway.
- c. Access Management Modifications – If a safety issue is related to a median opening, in many cases the District is able to either close the median opening or provide for directional left turns. In some cases, a temporary median revision can be affected while a permanent modification is being programmed. Replacement of two-way-left-turn lanes, with raised medians along six-lane roadways was a major Department-wide access management initiative; however, most “seven-lane” roadway sections in Hillsborough County have already been treated including recent projects on Dale Mabry Highway and East Hillsborough Avenue.
- d. Safety Program – The District’s safety program manages the district-wide programming of federal HSIP funds. These funds are used to fund safety projects to target “hot-spots;” to provide for “goes-with” safety enhancements as part of capacity and 3R projects; to implement systemic safety improvements; and to conduct safety studies, reduce crashes through improved signal coordination, and affect other traffic operational improvements. Three important aspects of the District’s Safety Program are the Design-Build/Push Button (DBPB) contracting mechanism, the Off-System Safety Program, and the Road Safety Audit (RSA) program.
 - i. The DBPB contract enables the District to respond quickly to correct observed safety issues and is also used to implement systemic countermeasures such as enhanced audible/reflective pavement markings along rural highways, high-emphasis crosswalk markings, and left-turn lane geometric improvements.
 - ii. The Off-System Safety Program is a formalized process for local agencies to submit safety project candidates to the District to be constructed with HSIP funds. These projects may be implemented through the LAP process or can be constructed directly by FDT using the DBPB contract or other contracting mechanisms if circumstances permit.
 - iii. The District 7 RSA Program is a formalized process for using RSAs to identify potential safety improvements that can be integrated into work-program and to investigate problem

locations both on and off the SHS. RSAs follow a format developed by the Federal Highway Administration (FHWA) and entail multidisciplinary, independent reviews of roadway plans, existing roadways, and post-construction projects.

Under SAFETEA-LU, the District's Safety Program also managed Safe Routes to School (SRTS) and High-Risk Rural Roads (HRRR) set-asides. HRRR provided funding for rural collector and local roads and SRTS primarily funded sidewalk construction to provide access to primary schools. HRRR has been blended with HSIP under MAP-21 and although SRTS has been blended with Transportation Alternatives, FDOT will continue to operate SRTS as a district program.

As a rule, HSIP-funded projects are intended to be relatively low cost (\$500,000 to \$1 million) and, for the most part, do not require right-of-way acquisition or significant environmental review. Recently, larger-scale projects have included HSIP funds including widening of overpasses along I-275 from Floribraska Avenue to Yukon Street to provide for adequate shoulders and construction of fly-over ramps at the I-275/I-75 apex to correct a "weave" issue associated with the SR-56 northbound exit ramp. Because of increased HSIP funding through MAP-21 and guidance to allow for more systemic safety projects, it is possible that future HSIP-funded projects will include larger-scale modifications to problem intersections and corridors.

Hillsborough County

Hillsborough County is responsible for design, maintenance and operations of minor arterial roadways and major and minor collectors throughout the county and for local streets in the unincorporated portion of the county. Similar to FDOT, Hillsborough County works to advance roadway safety through capacity-building projects, roadway maintenance, and traffic operations functions.

1. *Capacity Projects:* In addition to applying modern design standards to roadway widening and new roadway construction projects, Hillsborough County has been implementing a series of intersection reconstruction projects under the Transportation Task Force (TTF) program, which considered potential crash reduction as primary prioritization criteria. As part of the County's Strategic Safety Goal monitoring process, tracking of high-crash intersections has shown that the TTF program has resulted in reduced crashes as several sites—principally through the provision of dual left-turn lanes with protected-only left-turn signal phasing and adequate space for deceleration and queue storage. These projects have also included right-turn lanes, which reduce rear-end crashes; reconstruction of signals with improved conspicuity; and provision of intersection lighting.
2. *Maintenance Projects:* As with most local agencies, the County's resurfacing program is generally more basic than FDOT's 3R process. Nonetheless, Hillsborough County reviews rural resurfacing projects for opportunities to reduce lane widths in order to provide for bicycle lanes.
3. *Traffic Operations:* The County's Traffic Services Division (TSD) enhances safety through the following functions:

- a. School Safety Program – County TSD staff coordinate with the Hillsborough County School Board to identify and respond to safety issues in and around school zones. These can include both safety related to student bicycle and pedestrian access to schools as well as issues related to parent pick-up and drop-off queuing.
 - b. Access Management – TSD identifies and responds to safety issues related to median openings and will effect modifications to close medians or provide for directional left turn access if a crash pattern is apparent.
 - c. Signal Timing – Similar to FDOT, TSD works to improve signal coordination along corridors to improve traffic flow and reduce crashes.
 - d. Road Safety Audits – TSD conducts RSAs and participates in FDOT-funded RSAs to identify short- and longer-term solutions for safety problem locations.
 - e. Neighborhood Traffic Calming – TSD coordinates development and implementation of traffic calming projects for neighborhoods that elect to assess themselves in order to fund the necessary studies and traffic calming measures.
4. *Special Projects/Programs:* Recently, Hillsborough County has engaged in several projects to specifically reduce pedestrian and bicyclist crashes. These include:
- a. Enhancements to 22nd Street to reduce travel speeds and improve pedestrian safety.
 - b. Fletcher Avenue Complete Street Project to provide median refuge islands, mid-block crosswalks, bicycle lanes and left-turn median separators at signalized intersections.

- c. Implementation of Pedestrian and Bicycle Strategic Plan to implement measures along key corridors to enhance safety and mobility of pedestrians and cyclists.

City of Tampa

The City of Tampa is responsible for the design, maintenance, and operation of collector roadways and local streets within the City limits and engages in cooperative funding and design of some County-maintained minor arterial roadways within the City limits (e.g., 40th Street, Manhattan Avenue, Bayshore Boulevard, etc.).

1. Maintenance of City streets falls under the Department of Public Works and, like Hillsborough County and most local government agencies, the City’s resurfacing program is more basic than FDOT’s 3R process. Recently, however, Public Works has coordinated with the City’s Transportation Division to implement several “road diet” and bike lane marking projects in conjunction with City resurfacing projects. Bike facility projects provide a separate space for cyclists, which has a safety and mobility benefit. Road diets, comprising the conversion of 4-lane undivided roads to 2-lane divided roads, have an overall crash reduction of at least 25 percent.
2. The City’s Transportation Division is responsible for planning, design/construction, and operations of City streets. Examples of crash reduction strategies implemented by the Transportation Division include:
 - a. Consideration of crash reduction potential in developing candidate Mobility Plan projects.
 - b. Implementation of the City of Tampa Walk-Bike Plan as part of the City’s overall Mobility Plan (to provide

- facilities for cyclists and pedestrians along collector roadways).
- c. Development of roadway widening/reconstruction projects that incorporated raised medians, bike lanes, bus bays, sidewalks, and in some cases, modern roundabouts.
 - d. Implementation of street-lighting enhancements based on crime data and nighttime crash history.
 - e. Coordination with Hillsborough County Schools within the city to address school zone bicycle and pedestrian access and traffic circulation issues.

Section 2: Crash Reduction Strategies

Based on the findings of the Baseline Assessment, the Crash Reduction Strategies section looks to identify and evaluate the relevance of roadway infrastructure strategies that have the potential to address those crash issues that are not easily mitigated through current safety retrofit programs and typical design approaches. As outlined in Section 1, the State of Florida, Hillsborough County, and the relevant City(s) all have existing programs to address safety issues. It is important to recognize that some of the strategies identified in this section are currently considered as part of the existing safety programs and planning processes.

The intention of this section is to identify strategies that could supplement the programs that are currently in place. This section has been divided into three sub-sections:

- Roadway Infrastructure Strategies
- Case Study and Example Projects
- Local Demonstrator Site Conceptual Designs

Roadway Infrastructure Strategies

Today, many innovative roadway and intersection designs are being implemented across the country in an attempt to improve mobility in locations where conventional roadway and intersection designs have proven insufficient in mitigating transportation and safety issues. This section explores some potential roadway and intersection infrastructure strategies that have the potential to increase both safety and mobility on Hillsborough County's roadways. The roadway and intersection infrastructure strategies identified in this section have been organized into the following categories:

- Alternative Intersection Treatments
- Alternative Interchange Treatments
- Complete Streets/Road-Diets/Boulevard Strategies
- Mid-Block Crossings
- Speed Reductions Strategies
- ATMS/ITS Strategies

Alternative Intersection Treatments

The traditional intersection is responsible for processing through movements, left turns, u-turns, and right turns. At signalized intersections, these movements typically are processed using four-phased signal timing, with two phases dedicated to the through movements for both roadways and another two phases for left turns. Figure 2.1 diagrams the movements of a typical four-phase signal intersection.



Figure 2.1: Traditional Four-Phase Intersection Schematic
Source: www.MetroAnalytics.com

The typical traditional four-phase intersection has 32 conflict points; the alternative intersection treatments discussed in this section essentially look to reduce the number of conflicts points, especially those related to left-turn movements. These intersection treatments may also be used as strategies to increase intersection capacity and efficiency. The following intersection treatments are discussed in further detail on the following pages:

- Modern Roundabouts
- Quadrant Intersections
- Continuous Flow Intersections
- Median U-Turn Intersections

Modern Roundabouts

The modern roundabout is a circular intersection in which traffic flows continuously in one direction around a center island to one of several exits onto intersecting streets. Two of the main benefits of the modern roundabout are that they eliminate left-turn movements and manage speed, both of which are commonly associated with severe injury and fatal crashes. Aside from increased safety, roundabouts help to reduce traffic congestion and delay by not requiring traffic to come to a complete stop at the intersections; typically, traffic entering a roundabout must yield to the traffic already in the circle, which often does not require the entering vehicle to come to a complete stop. Roundabouts also operate more efficiently than traditional intersections by allowing traffic to flow continuously through the intersection. This increased efficiency can increase capacity and travel speeds, and are beneficial to the environment by reducing greenhouse gas (GHG) emissions.

For all of the benefits, the modern roundabout does not come without its own set of challenges. Right-of-way is often the biggest challenge to building roundabouts. Roundabouts typically require a larger footprint than a traditional intersection, and the costs of obtaining the needed right-of-way for roundabouts often make them cost-prohibitive. Roundabouts can also be challenging on multiple lane roadways, especially at locations where two multiple-lane roadways intersect. Bicyclists and pedestrians may also find roundabout more challenging due to the continuous flow of traffic and the greater travel distances around the circle.

Modern roundabouts have been successfully implemented throughout Florida and the United States. According to the *Highway Safety Manual*, converting from a two-way stop-controlled intersection to a roundabout can lead to an 82 percent reduction in injury and fatal crashes and a 44 percent reduction in overall crashes, and converting from a signalized intersection to a roundabout can lead to a 78 percent reduction in severe crashes and a 48 percent reduction in overall crashes.² Figure 2.2 shows the Five Points Roundabout in downtown Sarasota.

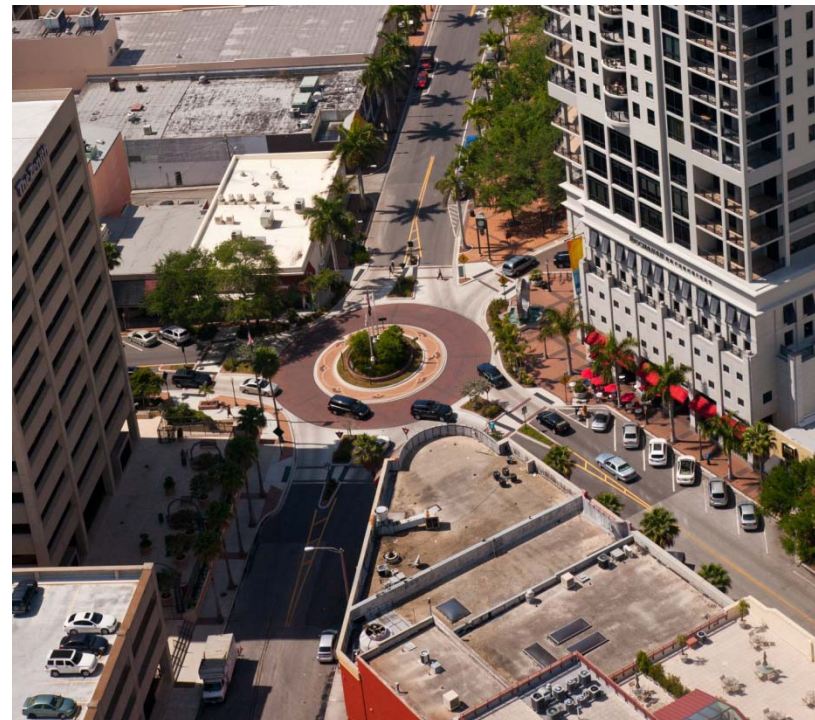


Figure 2.2: Five Points Roundabout, Sarasota, FL

² FHWA-SA-12-005

Quadrant Intersections

A quadrant intersection includes the use of at least one extra roadway between two legs of an intersection. The additional roadway, or quadrant roadway, can be operated as a traditional roadway or could be used as a bypass so the left-turn movement and phase can be eliminated at the main intersection. Removing the left-turn movements from the main intersection reduces the signal phasing from four to two phases, which results in an increase in the through green times and reduction in overall delay. The elimination of left-turn movements at the main intersection could have a significant safety benefit by significantly reducing the number of left turn crashes. Also, compared to a traditional intersection, a quadrant intersection contains fewer overall conflict points.

One of the greatest benefits of a quadrant intersection is that it provides flexibility and options once in place. Initially, quadrant roadway(s) and intersections can operate as traditional roadways, with the main intersection still accommodating left-turn movements. Over time, traffic can be rerouted to the quadrant roadway(s) to help alleviate congestion at the main intersection by eliminating the main intersection's left-turn movement and phases. Figures 2.3 and 2.4 illustrate the movement options for vehicles traveling through an intersection with one quadrant roadway. The more quadrant roadways available, the greater the number of available options; an intersection with 4 quadrant roadways provides a driver with upward of 10 movement options, whereas the traditional intersection limits the driver to 3.

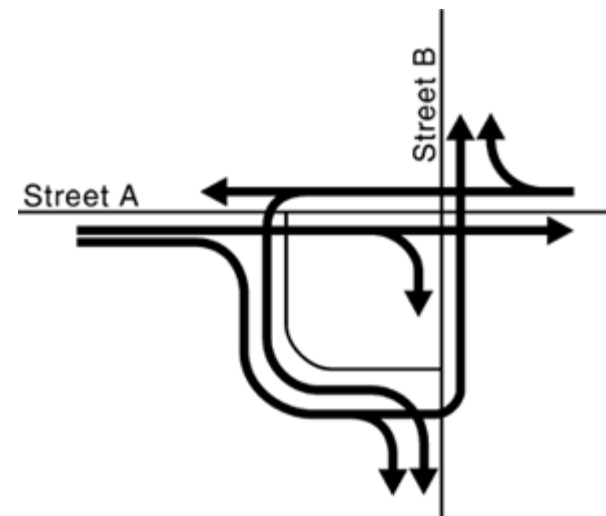


Figure 2.3: Single Quadrant Available Movements, Street A

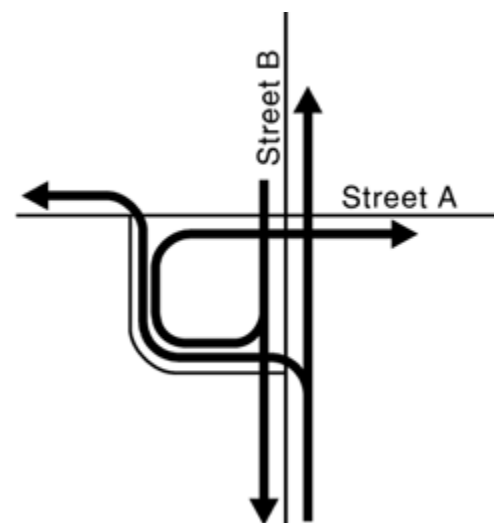


Figure 2.4: Single Quadrant Available Movements, Street B

Continuous Flow Intersections

The continuous flow intersection (CFI), also known as the displaced left-turn or crossover displaced left, moves left-turning traffic across opposing through traffic at a controlled mid-block location prior to the main intersection. By moving the left-turning traffic to the opposite side of the road all through and left-turn movements at the main intersection can occur at the same time. Figure 2.5 shows a CFI intersection in Missouri, with the left-turn lanes crossing over the opposing lanes prior to the main intersection. While they appear complex, CFIs have been shown to increase capacity, reduce delay, and reduce severe injury crashes. Due to higher right-of-way and infrastructure costs, CFIs may not always be cost-effective. Other challenges that are posed by CFIs are driveway access and difficult navigation for pedestrians and bicyclists.



Figure 2.5: Continuous Flow Intersection in Fenton, MO

Source: FHWA AIIR

Median U-Turns

Median U-turn intersections (MUT), also known as thrU-turns, Michigan lefts, bowties, and right U-through intersections, are intersections that eliminate direct left turns at major and typically minor approaches. To maintain driver expectancy, MUTs are typically applied throughout an entire corridor but may be used at a single intersection. Left turns from the main corridor to side streets are completed by passing through the main intersection, performing a U-turn at a median opening downstream from the main intersection, and then completing a right turn onto the cross street at the main intersection. MUTs have been shown to provide safety and operation benefits over traditional intersections, especially when used along a corridor. Some of the benefits include increased capacity and efficiency and enhanced safety. MUTs have half the number of crossing conflict points compared to a traditional four-phased intersection. MUTs eliminate all of the left-turn conflicts and reduce the number of conflict points related to merging and diverging. Another advantage of the MUT intersection is that they free up right-of-way for transit vehicles and stations. The biggest drawback for MUT intersections is the potential for higher right-of-way and construction costs. MUTs have been successfully implemented in several states, but are most commonly associated with Michigan, particularly in the Detroit metro area. Figure 2.6 shows a MUT intersection and corridor in Michigan.

Alternative Interchange Treatments

Single-Point Urban Interchange

The single point urban interchange, or SPUI, is basically a variation of the compressed diamond interchange. The turning movements of the major road ramps and all the movements of the minor road are executed in one central area that is located either on the overpass or underpass. Figure 2.7 illustrates the configuration of a typical SPUI.

Research has shown that SPUIs can increase capacity and, since there is only one signalized intersection, it is easier to coordinate the signal timing with other signals along a corridor, thus increasing the efficiency along the corridor. Currently, there is limited research on the potential safety benefits of SPUIs over traditional diamond interchanges. Cost may be a challenge in constructing SPUIs; the space required for the intersection movements associated with the SPUI requires a larger bridge deck, which costs more to construct.



Figure 2.6: Median U-Turn in Michigan
Source: AAA, Michigan

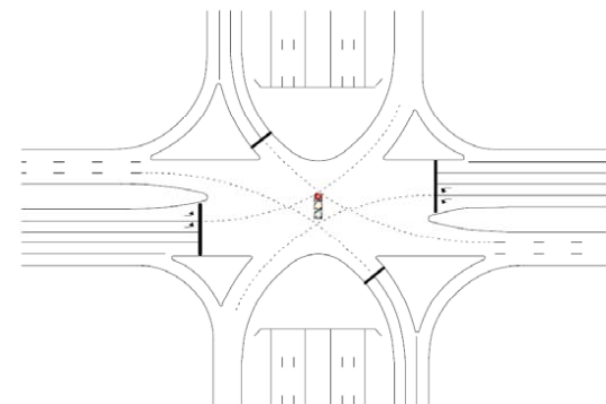


Figure 2.7: Single Point Urban Interchange Configuration
Source: Transportation Research Board

Diverging Diamond Interchange

Also known as the double crossover diamond interchange, the diverging diamond interchange (DDI) has shown that it can improve traffic flow and reduce congestion compared to a typical interchange. By eliminating the left-turn movement and reducing the number of conflict points, the DDI theoretically provides a safety benefit over the typical diamond interchange. However, one of the biggest challenges and safety concerns of DDIs is the lack of familiarity to drivers, which could result in an initial crash increase. To help move traffic safely through an interchange, DDIs should be well signed and include other roadway design features such as lane markings, enhanced geometry, and visual barriers such as glare screening, to minimize the feeling of being on the wrong side of the road. When designed and implemented properly, a DDI can also increase capacity, eliminating the two left-turn signal phases; reduce the through delay time; and allow more vehicles to travel through the intersection. Figure 2.8 illustrates the typical DDI configuration; Figure 2.9 is a photo of the first DDI constructed in the U.S., located in Springfield, MO.



Figure 2.9: Diverging Diamond Interchange in Springfield, MO

Source: FHWA, AIIR

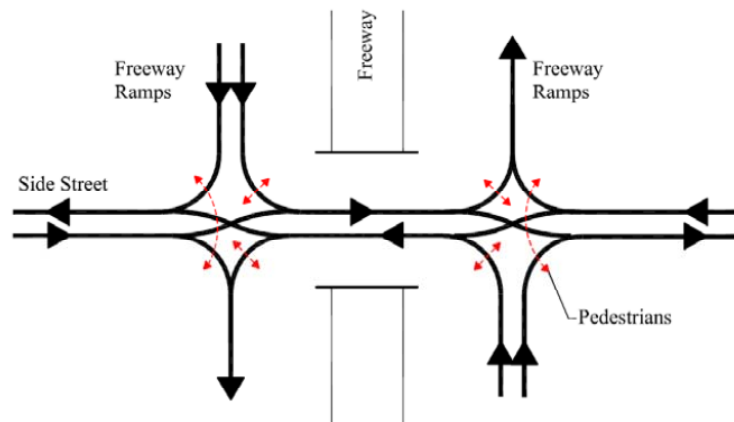


Figure 2.8: Typical Diverging Diamond Interchange Configuration

Source: FHWA, AIIR

Complete Street/Road Diet/Multi-Way Boulevard Strategies

Complete Streets

Complete streets and road diet strategies look to use, and in some instances repurpose, the existing right-of-way and/or pavement width to accommodate all road users. The approaches to both strategies vary, but they share an overall purpose of providing a safe and comfortable environment for all roadway users, which include automobiles, transits, bicyclists, and pedestrians.

Complete streets are roadways that accommodate all users. They include design features such as bike lane, sidewalks, crosswalks, and transit amenities. Complete streets enhance safety and may encourage the use of alternative modes. A Federal Highway Administration safety review found that “streets designed with sidewalks, raised medians, better bus stop placement, traffic calming measures, and treatments for disabled travelers improve pedestrian safety. Some features, such as medians, improve safety for all users: they enable pedestrians to cross busy roads in two stages, reduce left-turning motorist crashes, and improve bicycle safety.”³ Figure 2.10, shows a complete street in an urban setting. The image emphasizes the inclusion of bike lanes and sidewalks set back from the roadway, with a landscape buffer, crosswalks, and transit service.

When available right-of-way or existing pavements width limits the ability to adequately accommodate all road users, a road diet can be performed to provide a better balance within the available space. A road diet typically involves the repurposing of existing travel lanes to provide the space needed for other needs, such as:

- Bicycle lanes
- Median/center turn lane
- Dedicated transit lane(s)
- Wider pedestrian area for landscaping/amenities and larger sidewalks
- On-street parking
- Safer motor vehicle and multimodal operating conditions



Figure 2.10: Complete Street, Charlotte, NC

Source: www.smartgrowthamerica.org

³ National Complete Streets Coalition, Complete Streets: Fundamentals Brochure

Road Diets

Although there are many types of road diet projects, the most common is the conversion of a four-lane undivided roadway to a two-lane divided roadway that includes bike lanes, a center turn lane and/or a raised median, and bus bays. This conversion improves safety for all users; road diets have been shown to reduce rear-end, sideswipe, and left-turn crashes, and the provision of bike lanes, medians, and enhanced pedestrian amenities improves bicycle and pedestrian safety. Figure 2.11 shows “before” and “after” photos of a road diet project in Urbana, IL. This particular project took a four-lane undivided roadway and transformed it to a two-lane roadway with center turn lanes, bike lanes, and a mid-block crossing with a pedestrian refuge island at a transit stop.

A related approach to a road diet is a lane diet, in which the number and purpose of automobile lanes is not changed but overly-wide lanes are restriped to create space for bicycle lanes, convert a painted median to a raised median, or clearly define an informal on-street parking lane.

Another benefit of many complete street and road/lane diet projects is that they are designed to involve minimal reconstruction of the existing curb and drainage structures and can be accomplished as part of a planned roadway resurfacing with minimal marginal cost.



Figure 2.11: Road Diet – Before and After, Philo Rd, Urbana, IL
 Source: www.vtpi.org

Multi-Way Boulevards

A multi-way boulevard accommodates both high-speed automobile traffic and transit traffic in the center lanes while also accommodating slower speed local traffic and bicycle traffic in separated access lanes. Multi-way boulevards also provide a more desirable pedestrian environment by providing a greater distance between the sidewalk and higher speed through traffic. By separating the through traffic and local traffic, the roadway is able to operate more efficiently and safely. The access points to the local side lanes are limited, which creates a more free-flow environment within the center lanes and reduces the potential for high-speed crashes resulting from vehicles turning in and out of local driveways. The greatest challenge in creating a multi-way boulevard is the right-of-way needed to accommodate all of the boulevard’s amenities.

Multi-way boulevards have long been used in European cities such as Paris and Barcelona, but only recently have gained traction in the U.S. as an alternative to high-speed highways. There are only a handful of multi-way boulevards in the U.S., but those few have been considered successful from an operations and land-use stand point. Figure 2.12 is an illustration of the relationship between the center lanes and the access lanes of a multi-way boulevard. Figure 2.13 is an example of a multi-way boulevard in Berkeley, CA.

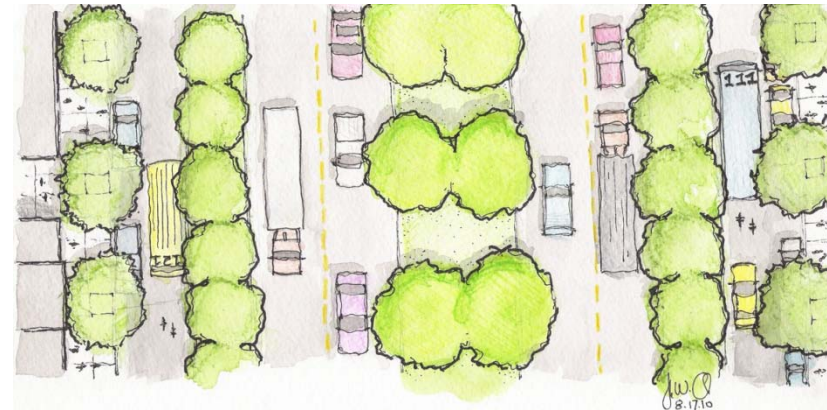


Figure 2.12: Illustration of Generic Multi-Way Boulevard

Source: OlsenPlanning.com



Figure 2.13: Multi-Way Boulevard, Shattuck Avenue, Berkeley, CA

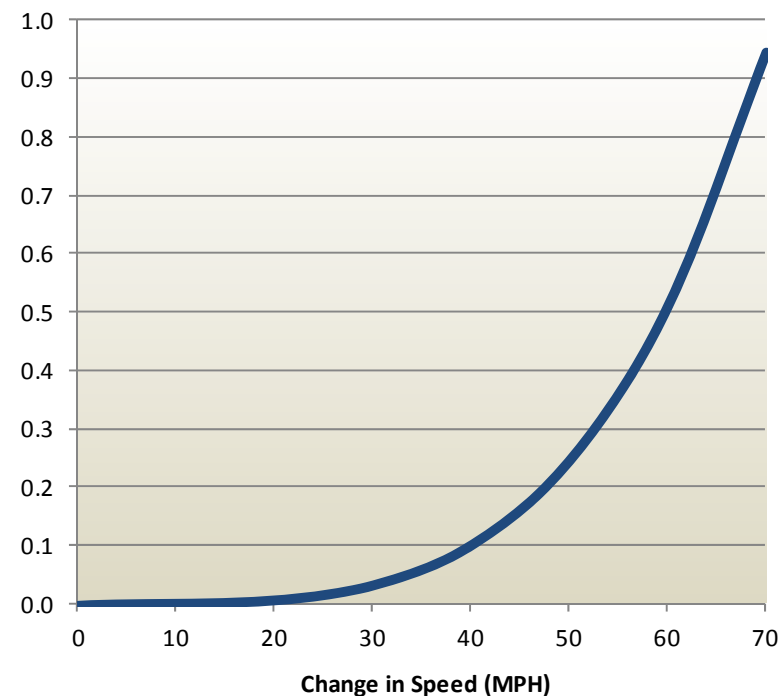
Source: placemakers.com

Speed Reductions Strategies

While the relationship between speed and safety is often complex and unclear, undeniable data exist that indicate a relationship between travel speed and the risk of injury and death. In 1993, a study by H. C. Joksch found a consistent relationship between the fatality risk for a driver in car-car collisions and change in speed. His analysis found that the risk of a fatality begins to rise when the change in speed at the moment of impact exceeds 30 mph. The study's findings indicated that the probability of death from an impact speed of 50 mph is 15 times the probability of death from an impact speed of 25 mph. Figure 2.14 shows the relationship between change of speed and fatality risk.

The relationship between speed and crash severity is even more critical for pedestrian crashes. Unlike in car-car collision, a pedestrian does not have the physical or safety features of an automobile. Numerous studies have documented the relationship between vehicle speed and the injury severity sustained by the pedestrian. Table 2.1 shows the relationship between vehicle speed and pedestrian injury severity. Research has also shown that lower speeds, in addition to reducing pedestrian injury severity, may also reduce overall crashes. This is credited primarily to the relationship between driver and pedestrian reaction and braking distance and speed. Figure 2.15 shows the relationship between speed and stopping distance; at 20 mph, the average stopping distance is 63 feet; at 40 mph, the stopping distance is 164 feet, more than 2.5 times the distance at 20 mph.

Strategies for reducing speed can range from education and enforcement efforts, engineering and roadway design efforts, and policy efforts that lower posted speed limits. The City of Fort Myers, FL, recently passed an ordinance⁴ that lowered the speed limit on all local roads within the city from 30 mph to 25 mph. While the actual speed reduction was minor, the potential safety benefits could be significant. The probability of a fatality at 25 mph is nearly half that of the probability at 30 mph; this is true for both car-car collisions and pedestrian crashes.



**Figure 2.14: Probability of Fatality (Joksch, 1993)
Effect of Change in Speed at Impact on Fatality Risk**

⁴ City of Fort Myers, Florida Code of Ordinances, Chapter 86, Section 295

Table 2.1: Vehicle Speed and Fatality Probability in Pedestrian Crashes

Vehicle Speed (MPH)	Fatality Probability
20	5%
30	40%
40	80%
50+	100%

Source: Pasanen (1992)

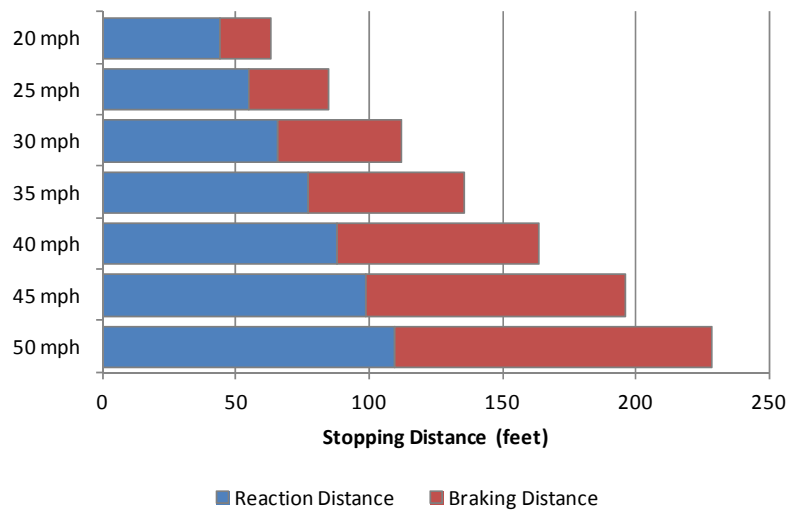


Figure 2.15: Speed and Stopping Distance

ATMS/ITS Strategies

ATMS (Advanced Traffic Management Systems) and ITS (Intelligent Transportation Systems) technologies are best used to minimize the effects of unscheduled traffic incidents. Both are technology-driven strategies that may be used to monitor, inform, respond, and re-route traffic. Unlike many of the other strategies listed in this report, ATMS/ITS do not typically require a physical change to the design of the roadway and do not directly increase capacity and/or enhance safety. However, they may increase efficiency, especial when implemented throughout the transportation network.



Figure 2.16: Message Sign

Advancements in technology and new technologies will continue to play a role in increasing safety and reducing congestion on roadways. ATMS/ITS strategies will continue to become a major component and strategy in the reduction of crashes and congestion.

Infrastructure Strategies Summary

The roadway infrastructure strategies identified in this section have the potential to increase overall safety and mobility on Hillsborough County’s roadways. Table 2.2 provides an overview on the potential benefits and challenges associated with each discussed strategy.

Table 2.2: Summary of Roadway Infrastructure Strategies

Strategy	Safety		Operations		Multimodal	
	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges
Modern Roundabout	Potential major reduction in left-turn collisions.	Potential minor increase in merging/diverging collisions.	Potential reduction in delay.	None identified.	Reduced conflicts during pedestrian crossing.	Increased pedestrian travel distance. May require additional treatments for visually impaired pedestrians.
Quadrant Intersection	Potential major decrease in left-turn collisions.	Potential minor increase in rear-end collisions.	Potential reduction in delay and queuing.	None identified.	Pedestrian crossing distance at each intersection may decrease.	Number of intersections to cross increases.
Continuous Flow Intersection	Left turns removed from main intersection.	None identified.	More green for through.	More stops and delay for left turns.	No conflicts during pedestrian crossing.	Two-stage pedestrian crossing. Layout may not be immediately apparent, especially for visually impaired pedestrians.
Median U-Turn Intersection	Potential major reduction in left-turn collisions. Potential minor reduction in merging/diverging collisions.	None identified.	Potential reduction in overall travel time. Reduction in stops for mainline through movements. Mixed findings with respect to overall stops.	Mixed findings with respect to overall stops.	Number of conflicting movements at intersections is reduced.	Increased crossing distance for pedestrians. Turning paths of the median U-turn may encroach in bike lanes.
Single-Point Interchange	Potential for decrease in all types of collisions.	None identified.	Mixed results.	Mixed results.	None identified.	Pedestrians cannot be served on all movements without adding a pedestrian phase.

Source: Some information from FHWA, *Signalized Intersections: Informational Guide*, Chapter 10

Table 2.2: Summary of Roadway Infrastructure Strategies (continued)

Strategy	Safety		Operations		Multimodal	
	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges
Diverging Diamond Interchange	Elimination of left turn collisions, also the reverse curvature of the intersections acts as a traffic calming feature.	None identified.	Potential reduction in delay and overall travel time.	Potential minor increase in travel time during off-peak periods due to slower speeds through the crossovers.	None identified.	None identified.
Complete Streets/Road Diet/Boulevard Treatment	Potential for decrease in all types of collisions.	Potential increase in bicycle and pedestrian crashes due to increased activity.	Mixed results.	Mixed results.	Potential increase in multimodal facilities, including sidewalks, bike lanes, and transit facilities.	None identified.
Speed Reduction	Potential decrease in crash frequency and severity.	None identified.	Mixed results - may improve efficiency as part of a system-wide strategy	Potential minor increase in travel time due to slower travel speeds.	Slower speeds more conducive to pedestrian and bicycle activity.	None identified.
ATMS/ITS	Potential increase in incident response times.	None identified.	Potential increase in incident response times and potential reduction in delay due to demand response and alternative routing.	None identified.	Potential signal preference for transit vehicles.	None identified.

Source: Some information from FHWA, *Signalized Intersections: Informational Guide*, Chapter 10

Table 2.2: Summary of Roadway Infrastructure Strategies (continued)

Strategy	Physical		Socioeconomic		Enforcement, Education, and Maintenance	
	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges
Modern Roundabout	None identified.	Right-of-way needed. Larger footprint than conventional intersection. Access management.	Air quality.	Likely has a higher cost due to needed right-of-way. Access management.	None identified.	Public information campaign may be needed.
Quadrant Intersection	None identified.	If the quadrant roadway does not exist, may be high construction and right-of-way costs.	None identified.	None identified.	None identified.	Greater potential for driver confusion.
Continuous Flow Intersection	Smaller footprint than interchange alternative.	Right-of-way needed. Larger footprint than conventional intersection. Access management.	Air quality.	Construction cost. Access management.	None identified.	Public information campaign may be needed.
Median U-Turn Intersection	None identified.	May be additional right-of-way needs depending on width of existing median.	None identified.	Access may need to be restricted within the influence of the median U-turn locations.	None identified.	Enforcement and education may be necessary to prevent illegal left turns at the main intersection.
Single-Point Interchange	May be constructable in confined right-of-way.	None identified.	None identified.	Likely has a higher cost due to the structure.	None identified.	None identified.

Source: Some information from FHWA, *Signalized Intersections: Informational Guide*, Chapter 10

Table 2.2: Summary of Roadway Infrastructure Strategies (continued)

Strategy	Physical		Socioeconomic		Enforcement, Education, and Maintenance	
	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges	Potential Benefits	Potential Challenges
Diverging Diamond Interchange	May be constructed within existing right-of-way.	None identified.	Potentially lower construction costs due to utilization of existing right-of-way.	None identified.	None identified.	Public information campaign may be needed.
Complete Streets/Road Diet/Boulevard Treatment	May be constructed within existing right-of-way.	None identified.	Potentially lower construction costs due to utilization of existing right-of-way.	Access management.	None identified.	Potential increase in maintenance cost.
Speed Reduction	Does not require physical change to roadway.	None identified.	Air quality and noise reduction - quality of life.	None identified.	None identified.	Enforcement and education may be necessary to make drivers aware of speed reduction.
ATMS/ITS	None identified.	Cost of related to infrastructure.	None identified.	Installation cost.	None identified.	Potential increase in maintenance cost.

Source: Some information from FHWA, *Signalized Intersections: Informational Guide*, Chapter 10

Case Study and Example Projects

Quadrant Intersection – Cary, NC

In Cary, NC, the intersection of Cary Parkway and High House Road is known as one of the town’s most aesthetically pleasing intersections, with well-manicured landscaping and distinct landmark features. However, as the town has continued to grow, the intersection has become more and more congested. Initially, traditional ways to improve the intersection were considered, including adding additional right-/left-turn lanes, but there was concern with the impact that the additional lanes would have on the look and function of the intersection. As a result, a study was conducted of site-specific alternatives that would alleviate congestion at the intersection while also improving traffic efficiency, enhancing safety, and promoting multimodal travel, all while protecting the community’s character and environment.

The intersection study examined the benefits, impacts, and feasibility of possible intersection alternatives. Initially, the study looked at seven potential alternatives, three of which were studied in more detail:

1. Traditional Widening
2. Single Quadrant Roadway
3. Double Quadrant Roadway

Ultimately the single quadrant roadway was determined to be the most innovative, effective solution to the capacity and congestion issues at Cary Parkway and High House Road, based on the findings that it could increase intersection capacity by reducing signal phasing, enhance safety by reducing the number of conflict points (reduced from 32 to 12, if left-turns are removed), and could be completed at a relatively low cost (estimated at \$1.8 million.) Figure 2.17 shows the current intersection configuration.



Figure 2.17: Cary Parkway at High House Road, Existing Conditions

Source: Bing Maps

Diverging Diamond Interchange – Springfield, MO

The first DDI in the U.S. opened in 2009, in Springfield, Missouri at the interchange of I-44 and the Kansas Expressway (MO-13). Prior to the diverging diamond interchange (DDI) conversion, the Rte 13/I-44 interchange was experiencing severe congestion and delay associated with the left turn queue onto the interstate. The Missouri Department of Transportation (MoDOT) was faced with three options to deal with the growing congestion at the interchange.

1. Widen the existing bridge and add dual left turn lanes
2. Replace the existing bridge with a single-point urban interchange over I-44
3. Convert the existing interchange to a DDI

After a detailed evaluation of the three options, the decision was made to convert the interchange to a DDI. Because the option to convert the interchange to a DDI utilized the existing bridge structure and ROW the cost and time needed to complete the improvement was significantly less than the other available options. The DDI conversion cost around \$3 million, whereas the estimate for constructing a SPUI was around \$9 million. Also, the construction time was significantly less for the DDI conversion, 6 months, compared to 1-2 years for the other options.

Since its opening in 2009, the DDI at Rte 13 and I-44 in Springfield, MO has experienced a noticeable decrease in overall traffic delay. Off-peak through-movements within the interchange have experienced slightly slower travel speeds, which are due to drivers slowing down to negotiate the crossover movements, but overall travel speeds through the interchange have increased. There has also been a significant reduction in crashes at the interchange. A before and after study looking at conditions in the year before construction and the year after construction found that

there has been a 46 percent decrease in overall crashes at the interchange. Also, a survey of drivers was completed and the DDI has been highly accepted and has a very high public perception. Figures 2.18 and 2.19 show images of the Rte 13/I-44 interchange before and after the DDI conversion.



Figure 2.18: Rte 13/I-44 Interchange before Conversion



Figure 2.19: Rte 13/I-44 Diverging Diamond Interchange

Multi-Way Boulevard – San Francisco, CA

Octavia Boulevard (Figure 2.20) in San Francisco’s Hayes Valley neighborhood is an urban 4 lane multi-use boulevard with separated side lanes that provide local access and on-street parking. Octavia Boulevard is the result of the demolition of the double-decked Central Freeway spur that was damaged in the 1989 Loma Prieta earthquake. The damaged freeway was closed in 1992 and had become a blighted eyesore within the historic neighborhood. In 2002 construction on a new at grade multi-way boulevard was started. Since it’s opening in 2005, Octavia Boulevard and the Hayes Valley neighborhood have experienced a significant land-use and demographic shift, with increased redevelopment and gentrification occurring around the boulevard.

Initially the neighborhood was concerned that the new roadway would be complete gridlock and lead to the further decline of the surrounding neighborhood. While Octavia Boulevard operates at capacity during the peak hours, that gridlock has so far been unrealized.



Figure 2.20: Octavia Boulevard, Source: sfbetterstreets.org

Local Demonstrator Site Conceptual Designs

Six local locations were chosen to demonstrate a few of the roadway infrastructure strategies identified earlier on in this section. The sites were chosen based on a series of factors including crash history, geometric design, current operations, and contextual qualities. The sites and strategies shown are for demonstration purposes only, and in many cases assume significant redevelopment of private property and the ability to obtain right-of-way as a part of that redevelopment. This process is designed to show how some of the roadway infrastructure strategies could look in Hillsborough County. The following strategies were chosen for the local demonstrator conceptual designs:

- Quadrant Intersection
- Modern Roundabout
- Diverging Diamond Interchange
- Multi-Way Boulevard

Demonstrator Site #1

The intersection of Dale Mabry Highway (SR 597) and Waters Avenue (CR 584) in Tampa was chosen as the location for Demonstrator Site #1. In addition to being on the list of intersections with the highest frequency of severe crashes, this intersection is also one of unincorporated Hillsborough County's most congested intersections.⁵ Figure 2.21 is an aerial image of the intersection; key statistics about the existing conditions at this location include the following:

- Crash History (2006–2010)
 - 24 Total Severe Crashes
 - 29% rear-end
 - 25% angle/left turn
 - 17 % lane departure
 - 17% bicycle/pedestrian
 - 13% other
- Average Daily Volumes
 - Dale Mabry Hwy
 - 66,500 AADT north of intersection
 - 71,500 AADT south of intersection
 - Waters Ave
 - 33,000 AADT east of intersection
 - 45,900 AADT west of intersection
- Lane Arrangement
 - Dale Mabry Hwy, north side
 - 6 lanes
 - dual left-turn lanes (protected signal phase)
 - right-turn lane

- Dale Mabry Hwy, south side
 - 6 lanes
 - dual left-turn lanes (protected signal phase)
 - right-turn lane
- Waters Ave, east side
 - 4 lanes
 - dual left-turn lanes (protected signal phase)
- Waters Ave, west side
 - 6 lanes
 - dual left-turn lanes (protected signal phase)
 - right-turn lane

Figure 2.22 shows the intersection of Dale Mabry Highway and Waters Avenue as a double quadrant intersection on the northeast and southwest quadrants. The new roadways in the northeast and southwest quadrants could allow for the left turn movements along Dale Mabry to be eliminated from the main intersection. Removing the left-turn movements would provide more time for the through movement on Dale Mabry and potentially reduce delay at the intersection. Also, depending on how the intersections are operated, a potential exists to significantly reduce or eliminate northbound and southbound left-turn crashes from the intersection.

The quadrant intersection design is also more pedestrian-friendly as it provides greater connectivity and reduces the distance between protected crossings. If the left-turn movements from Dale Mabry onto Waters were removed from the main intersection, the pedestrian crossing wait times also could potentially be reduced due to the elimination of the left-turn signal phase.

⁵ Hillsborough MPO – Congestion Management and Crash Mitigation Process: State of the System, June 2012, Table 2

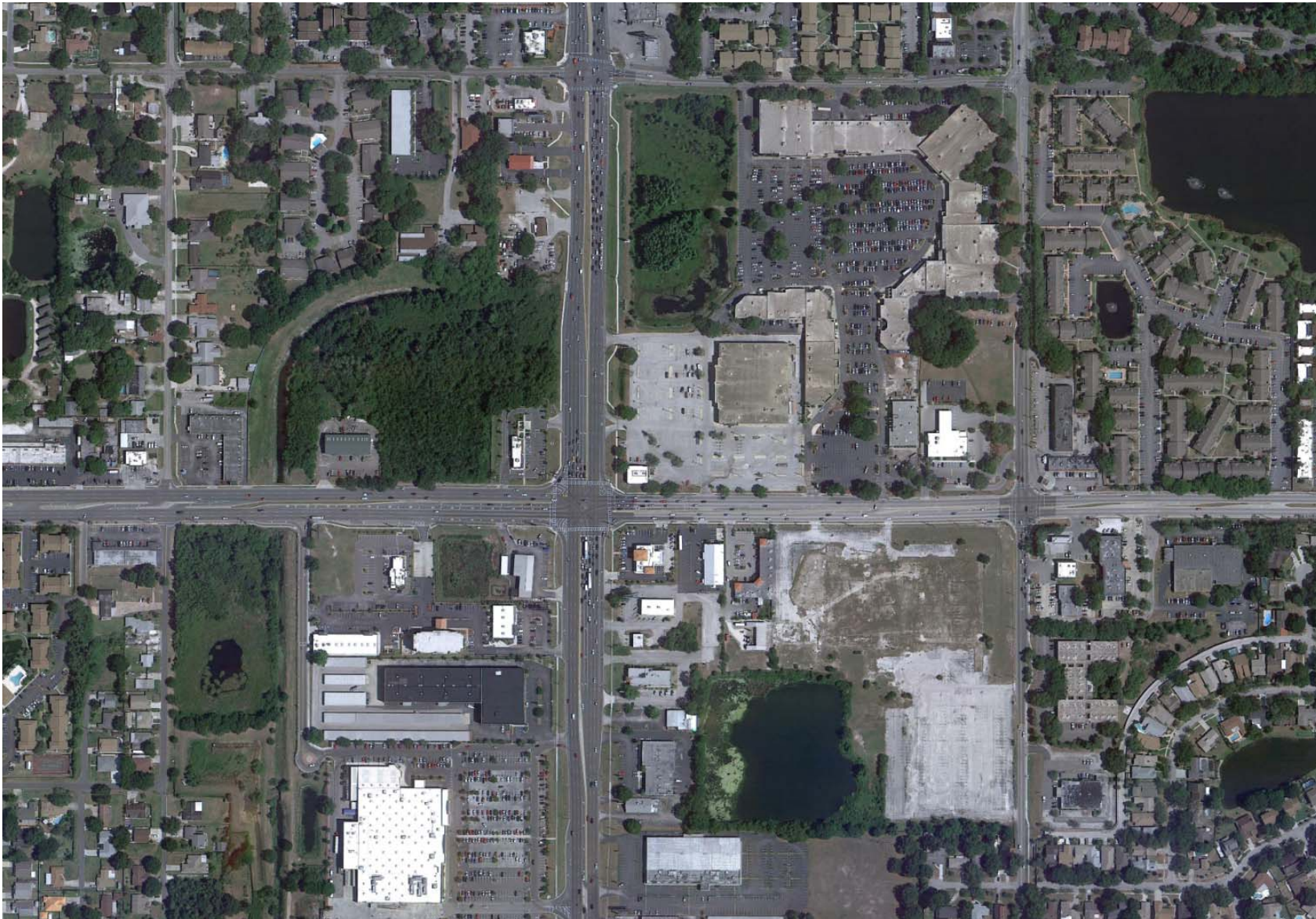


Figure 2.21: Demonstrator Site #1 – Existing



Figure 2.22: Demonstrator Site #1 – Conceptual Quadrant Intersection

Demonstrator Site #2

The intersection of Waters Avenue and Hanley Road was chosen as Demonstrator Site #2. Similar to the intersection of Dale Mabry and Waters, this intersection is one of the county's most congested intersections and is at the top of the severe injury crash list. Figure 2.23 provides an aerial image of the intersection and the surrounding area. Statistics on the intersection of Waters and Hanley include:

- Crash History (2006–2010)
 - 30 Total Severe Crashes
 - 43% angle/left turn
 - 20% other
 - 17% rear-end
 - 17% bicycle/pedestrian
 - 3% lane departure
- Average Daily Volumes
 - Hanley Rd
 - 30,500 AADT north of intersection
 - 30,500 AADT south of intersection
 - Waters Ave
 - 34,050 AADT east of intersection
 - 34,050 AADT west of intersection
- Lane Arrangement
 - Hanley Rd, north side
 - 4 lanes
 - single left-turn lane (protected/permissive signal phase)
 - Hanley Rd, south side
 - 4 lanes
 - single left-turn lane (protected/permissive signal phase)

- right-turn lane
- Waters Ave, east side
 - 6 lanes
 - dual left-turn lanes (protected signal phase)
- Waters Ave, west side
 - 6 lanes
 - single left-turn lane (protected signal phase)

Figure 2.24 provides a conceptual illustration of the Waters and Hanley intersection as a full quadrant intersection. This intersection design could allow for the complete elimination of left-turn movements at the intersection. The left-turn movements would be routed along the quadrant roadways, and, depending on the operation of the secondary intersections, this design could provide drivers with multiple options for completing the desired left-turn movement. Eliminating the left-turn movement at the main intersection would also eliminate all left-turn crashes at the main intersection. Currently, 43 percent of the severe crashes that occur at this location are angle or left-turn crashes, so there is a great potential to significantly reduce the overall severe crash frequency by incorporating a quadrant intersection design. This design also allows the main intersection to move from a four-phased to a two-phased signal, which could significantly reduce congestion and delay at the intersection.

Figure 2.24 also shows redevelopment of the properties surrounding the intersection. This intersection design leads to more urban land uses and functions by establishing a more compact roadway grid. Also, by eliminating the left-turn movement at the main intersection, the right-of-way that is currently dedicated for left turn lanes could potentially be repurposed for bicycle facilities and/or wider sidewalks, thus creating a friendlier and more comfortable pedestrian and bicyclist environment.

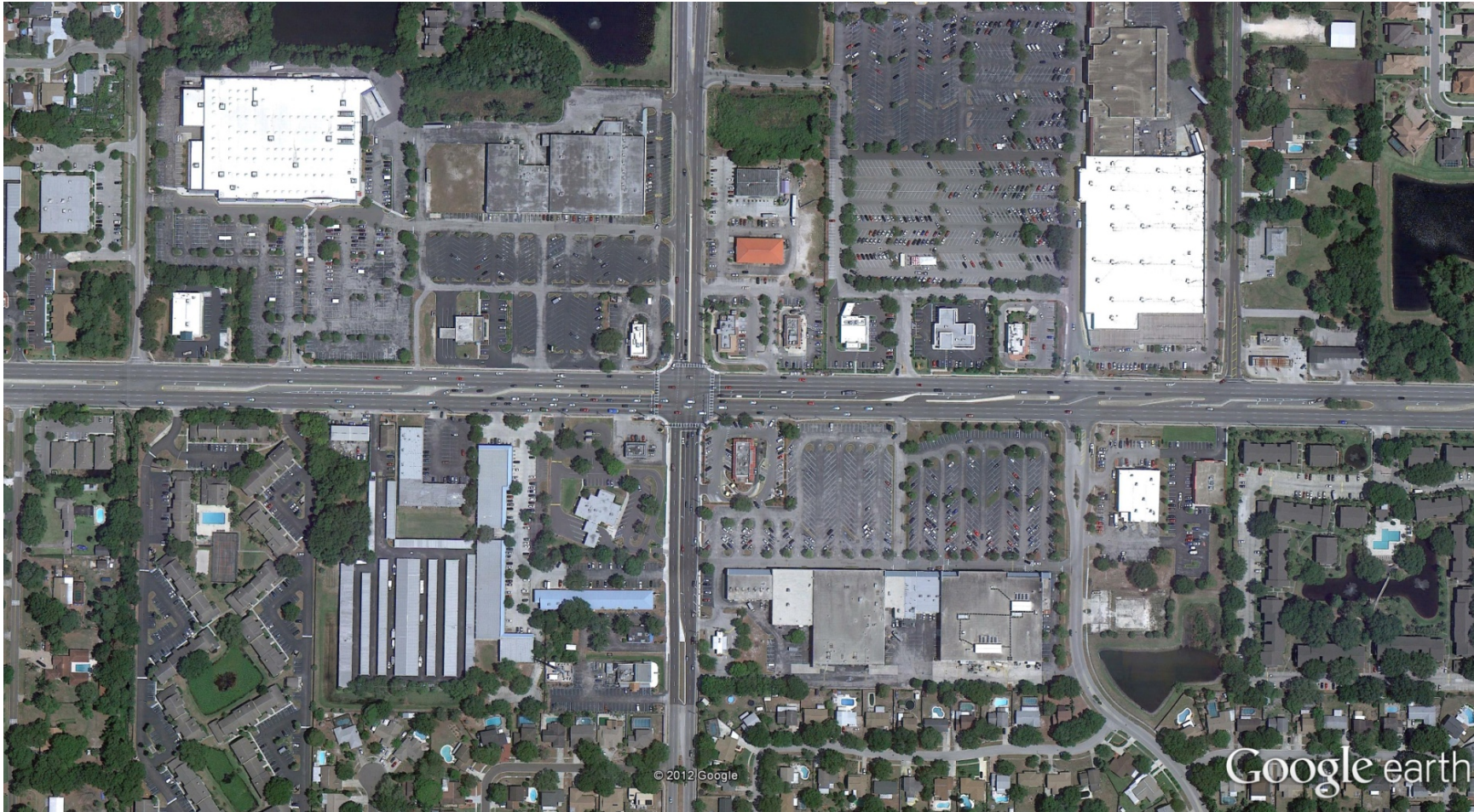


Figure 2.23: Demonstrator Site #2 – Existing



Figure 2.24: Demonstrator Site #2: – Conceptual Quadrant Intersection

Demonstrator Site #3

The intersection of Hillsborough Avenue and 22nd Street was selected for Demonstrator Site #3. Unlike the previous two demonstrator sites, this intersection is not on the list of top severe crash intersections. However, East Hillsborough Avenue is on the list of top severe crash corridors and has been targeted for redevelopment by the City of Tampa. Statistics on the intersection are listed below, and Figure 2.25 shows the existing conditions of the intersection and surrounding area.

- Crash History (2006–2010)
 - 9 Total Severe Crashes
 - 33% angle/left turn
 - 33% lane departure
 - 22% bicycle/pedestrian
 - 11% rear-end
- Average Daily Volumes
 - 22nd St
 - 5,700 AADT north of intersection
 - 12,300 AADT south of intersection
 - Hillsborough Ave
 - 50,600 AADT east of intersection
 - 46,900 AADT west of intersection
- Lane Arrangement
 - 22nd St, north side
 - 2 lanes
 - single left-turn lane (protected/permissive signal phase)

- 22nd St, south side
 - 2 lanes
 - single left-turn lane (protected/permissive signal phase)
- Hillsborough Ave, east side
 - 6 lanes
 - single left-turn lane (protected/permissive signal phase)
- Hillsborough Ave, west side
 - 6 lanes
 - single left-turn lane (protected/permissive signal phase)

Figure 2.26 shows the Hillsborough Ave 22nd St intersection as a quadrant intersection with modern roundabouts at many of the secondary intersections. This design would eliminate all of the left-turning movements from the intersection of Hillsborough Ave and 22nd St and would reroute them along the quadrant roadways. Since many of the quadrant roadways intersect with existing local streets, modern roundabouts are used to help circulate traffic through the area safely and efficiently. Eliminating the left-turn movements from the Hillsborough Ave and 22nd St intersection could allow the right-of-way that was dedicated for left-turn lanes to be repurposed as bicycle facilities, wider sidewalks, or for transit facilities.

Figure 2.26 also illustrates significant redevelopment of the sites around the intersection. The roadway design and establishment of a formal grid could encourage the area to develop more “urban” land use patterns (e.g., smaller blocks, increased mix of use, public space, etc.).

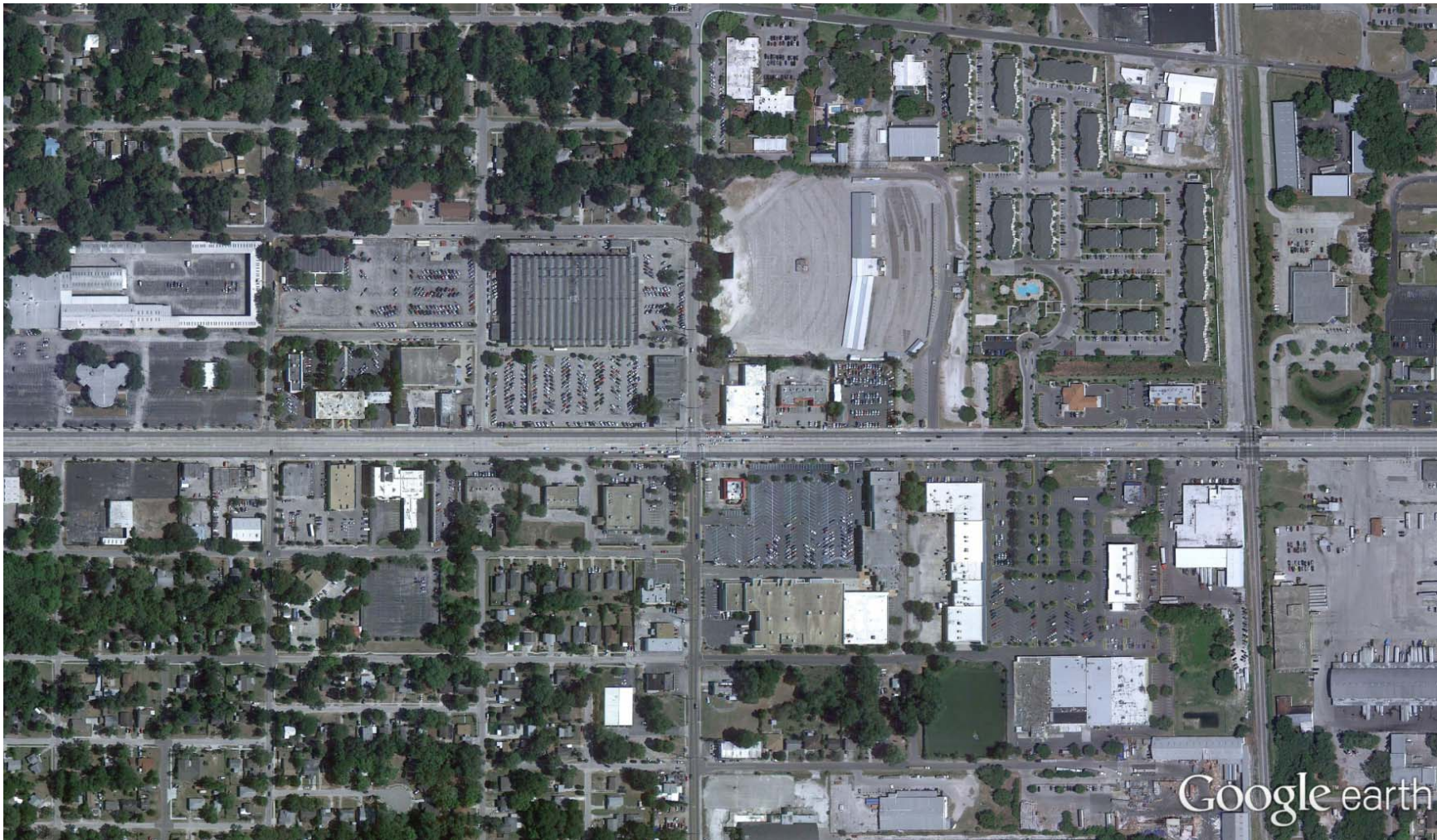


Figure 2.25: Demonstrator Site #3: – Existing

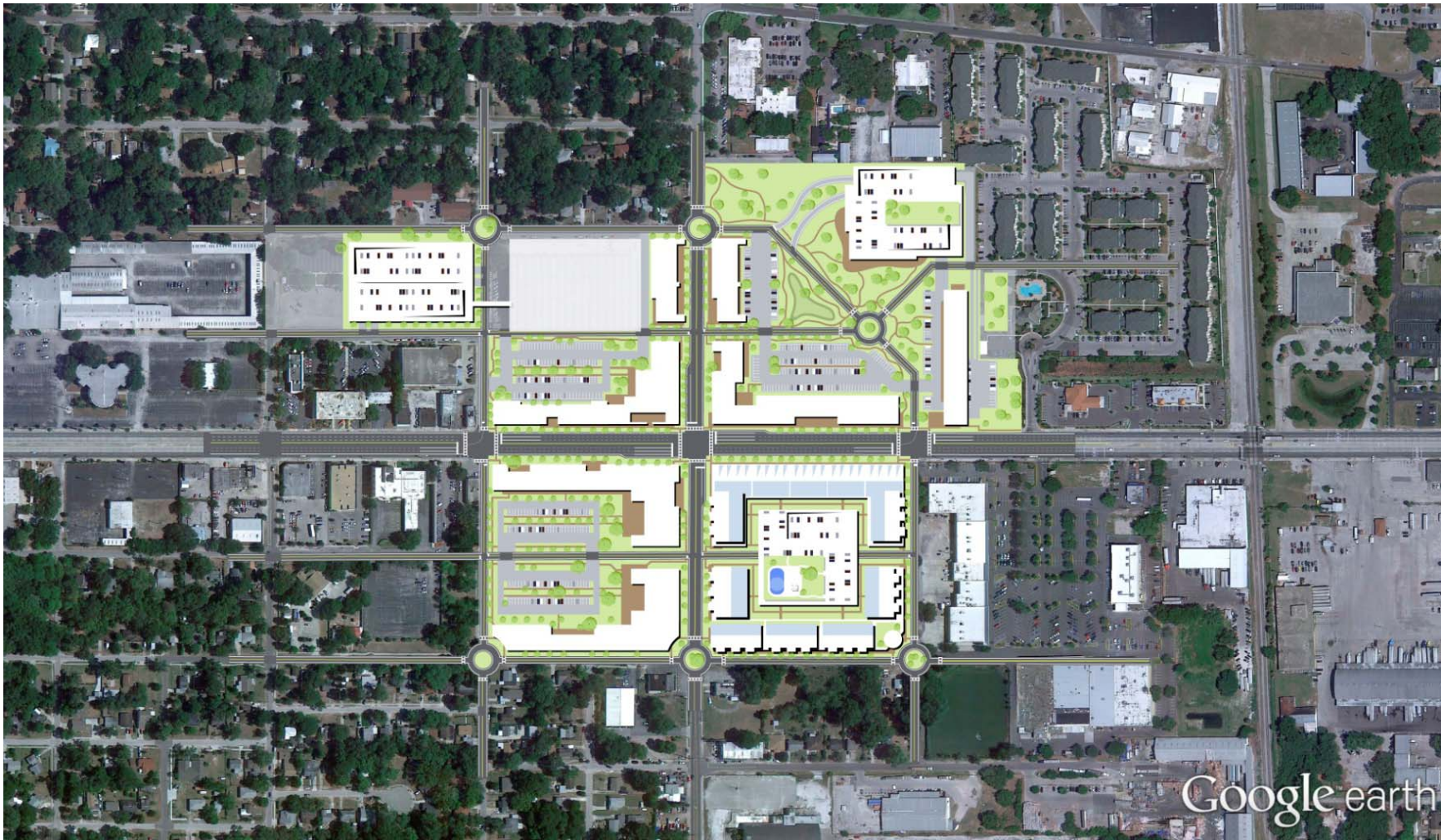


Figure 2.26: Demonstrator Site #3 – Conceptual Quadrant Intersection

Demonstrator Site #4

The intersection of Hillsborough Avenue and Memorial Highway was chosen for Demonstrator Site #4. This site was chosen in part because of the high frequency of severe crashes and as a way to showcase how alternative designs could work at intersections with unconventional geometric design. Some of the existing statistics of this intersection are listed below, and Figure 2.27 is an aerial image of the intersection and surrounding area today.

- Crash History (2006-2010)
 - 21 Total Severe Crashes
 - 33% angle/left turn
 - 29% rear-end
 - 24% lane departure
 - 14% other
- Average Daily Volumes
 - Memorial Hwy
 - 47,100 AADT north of intersection
 - 24,300 AADT south of intersection
 - Waters Ave
 - 56,500 AADT east of intersection
 - 54,300 AADT west of intersection
- Lane Arrangement
 - Memorial Hwy, north side
 - 4 lanes
 - dual left-turn lanes (protected signal phase)
 - right-turn lane
 - Memorial Hwy, south side
 - 4 lanes
 - triple left-turn lanes (protected signal phase)
 - right-turn lane

- Hillsborough Ave, east side
 - 6 lanes
 - left-turn lane (protected signal phase)
- Hillsborough Ave, west side
 - 6 lanes
 - dual left-turn lanes (protected signal phase)
 - dual right-turn lanes

Figure 2.28 is a conceptual illustration of the Hillsborough Avenue and Memorial Highway intersection as a double quadrant intersection with grade-separated left-turn fly-overs for the northbound to westbound and southbound to eastbound movements. This intersection design would allow the intersection to operate in two signal phases, which would increase the intersection's throughput, increasing capacity. The elimination of at-grade left turns would also eliminate left-turn crashes, which would improve the safety of the intersection.

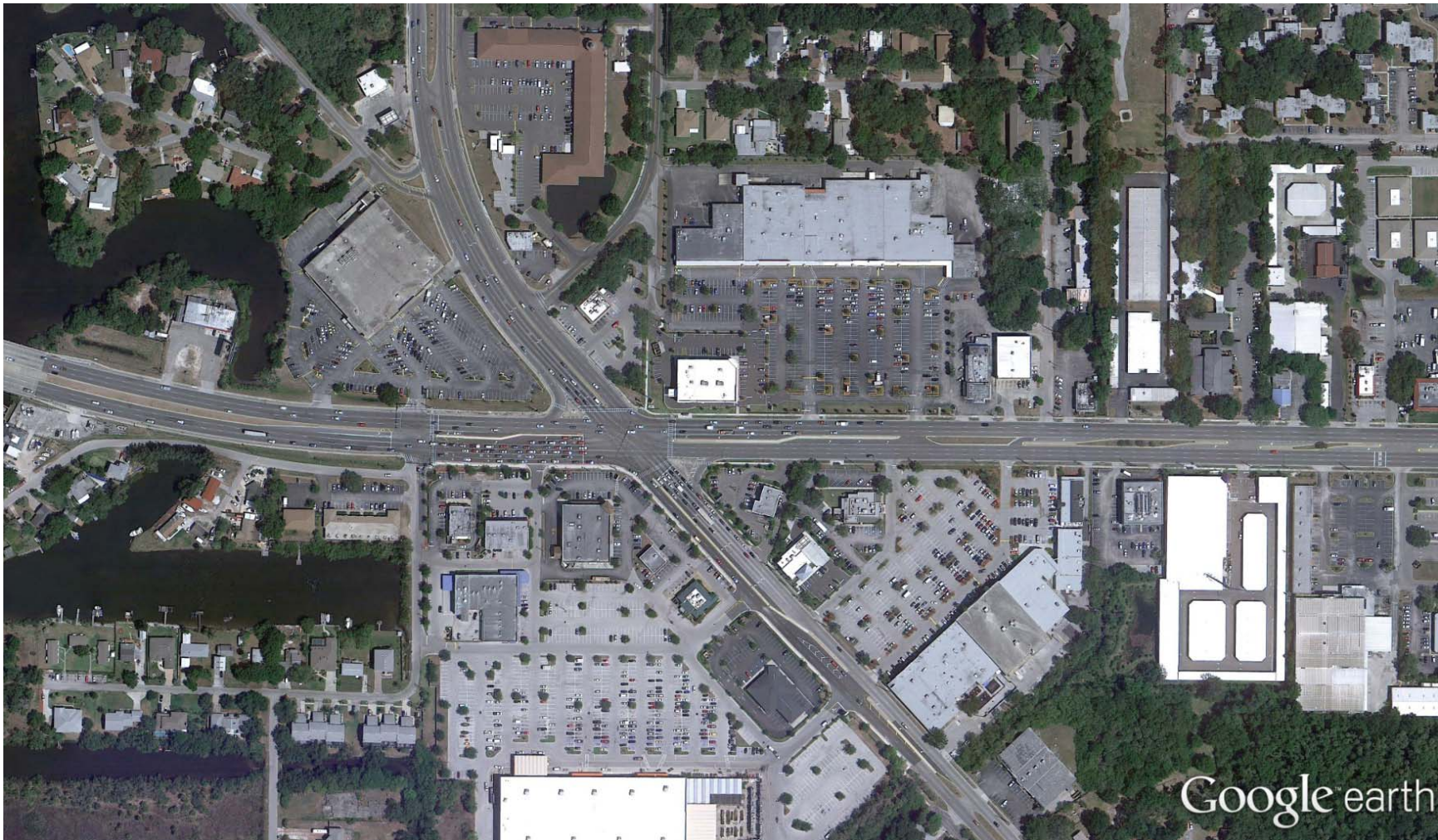


Figure 2.27: Demonstrator Site #4 – Existing



Figure 2.28: Demonstrator Site #4 – Conceptual Quadrant Intersection with Left-Turn Fly-Over

Demonstrator Site #5

The interchange of Interstate 4 and Mango Road (SR 579) was selected for Demonstrator Site #5. This location was chosen to demonstrate an alternative interchange design. The current interchange operates as a typical diamond interchange. Mango Road carries between 13,000 and 15,000 vehicles a day, but these numbers may not truly reflect the number of vehicles that travel through the interchange. This interchange does have a relatively high number of severe crashes, with 17 severe injury crashes during the study period, nearly half (47%) of which were angle or left-turn crashes. Mango Road through the interchange is a four-lane road, with dual left-turn lanes (with protected signal phase) for the northbound to westbound turning movement and with a single left-turn lane (protected/permissive signal phase) for the southbound to eastbound movement onto I-4. Figure 2.29 is an aerial image of the existing I-4 and Mango Road interchange.

Figure 2.30 shows a conceptual rendering of the interchange as a diverging-diamond interchange. The diverging-diamond interchange is designed to eliminate the traditional left-turn movement associated with more severe crashes. Eliminated the left-turn movements would also eliminate the left-turn crashes associated with the interchange. Also, by eliminating the left turn signal phase, the interchange can process more through vehicles and, therefore, increase capacity without adding additional travel lanes.

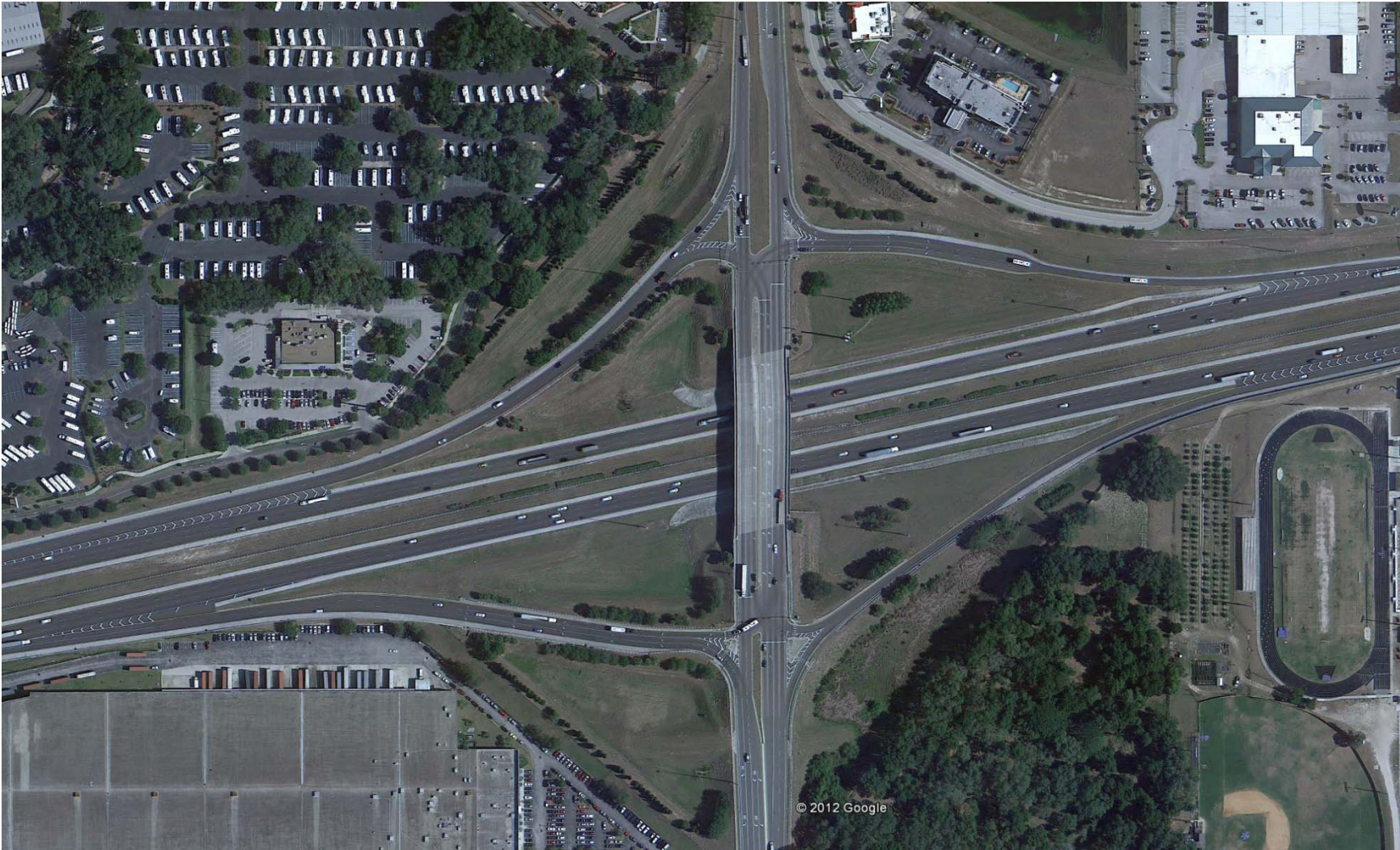


Figure 2.29: Demonstrator Site #5 – Existing

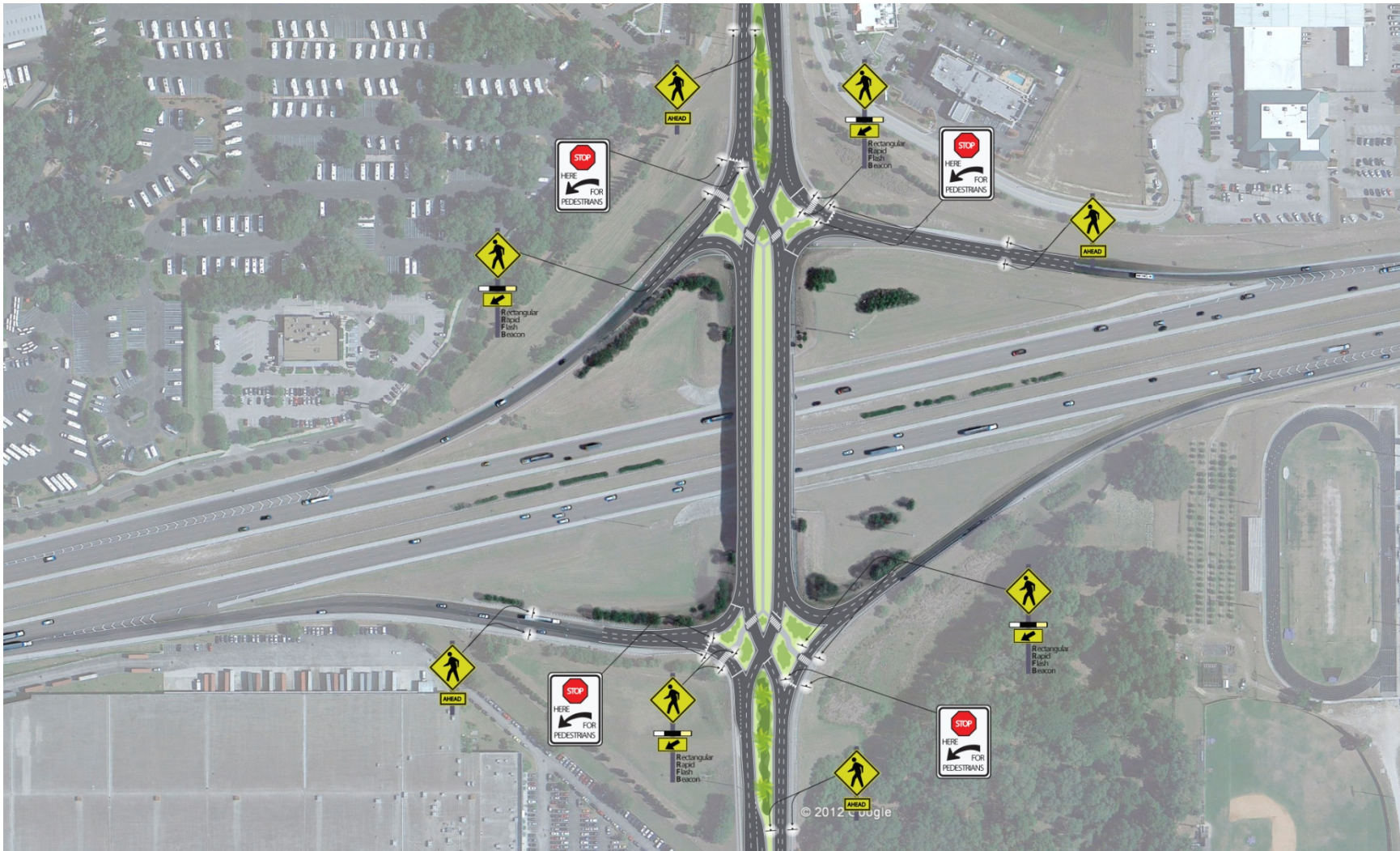


Figure 2.30: Demonstrator Site #5 – Conceptual Diverging Diamond Interchange

Demonstrator Site #6

Fowler Avenue from Nebraska Avenue to Bruce B Downs Boulevard/30th Street was chosen as Demonstrator Site #6. Fowler Avenue is an 8-lane roadway with divided medians and has about 180 feet of right-of-way. The approximately 1.5-mile stretch of road handles more than 50,000 trips on the average day and, between 2006 and 2010, there were 50 severe injury crashes associated with this corridor, about a quarter of which were bicycle or pedestrian crashes. Figure 2.31 is an illustration of the corridor's typical cross-section, and Figure 2.32 provides an illustrated overhead view of what the corridor looks like today. One aspect of the corridor that is evident in Figure 2.32 is the number of driveways along the corridor and the number of median opening that provide access to those driveways.

Figure 2.33 is a conceptual cross-section rendering of the Fowler Avenue corridor as a multi-way boulevard. By using the available right-of-way, the illustrated boulevard is able to provide wider sidewalks, enhanced landscaping, and separated side lanes that serve as local business access roads (or eventually on-street parking) as well as bicycle facilities (either through marked bicycle lanes or shared-use arrows), a wider median that could support enhanced transit service such as bus rapid transit (BRT) or light rail, and six lanes for general travel, with room for left-turn lanes at major intersections. Figure 2.34 is an overhead rendering of the conceptual boulevard.

The multi-way boulevard design could significantly reduce the number of conflict points between traffic traveling through the corridor and traffic accessing local streets and businesses along the corridor. This design provides a more comfortable pedestrian and bicycle environment by providing better separation between the higher speed traffic using the general travel lanes and the bicyclists and pedestrians. The boulevard design would also eliminate the unsignalized left turns throughout the

corridor. All left-turn movements would occur at a signalized intersection, which would reduce the total number of angle and left-turn conflict points along the corridor.

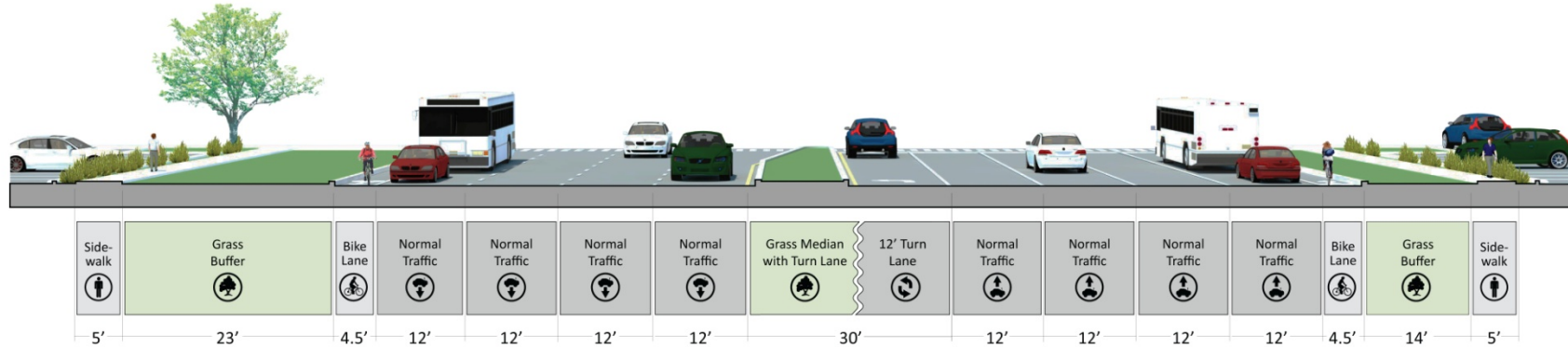


Figure 2.31: Demonstrator Site #6 – Existing Cross-Section



Figure 2.32: Demonstrator Site #6 – Existing Overview

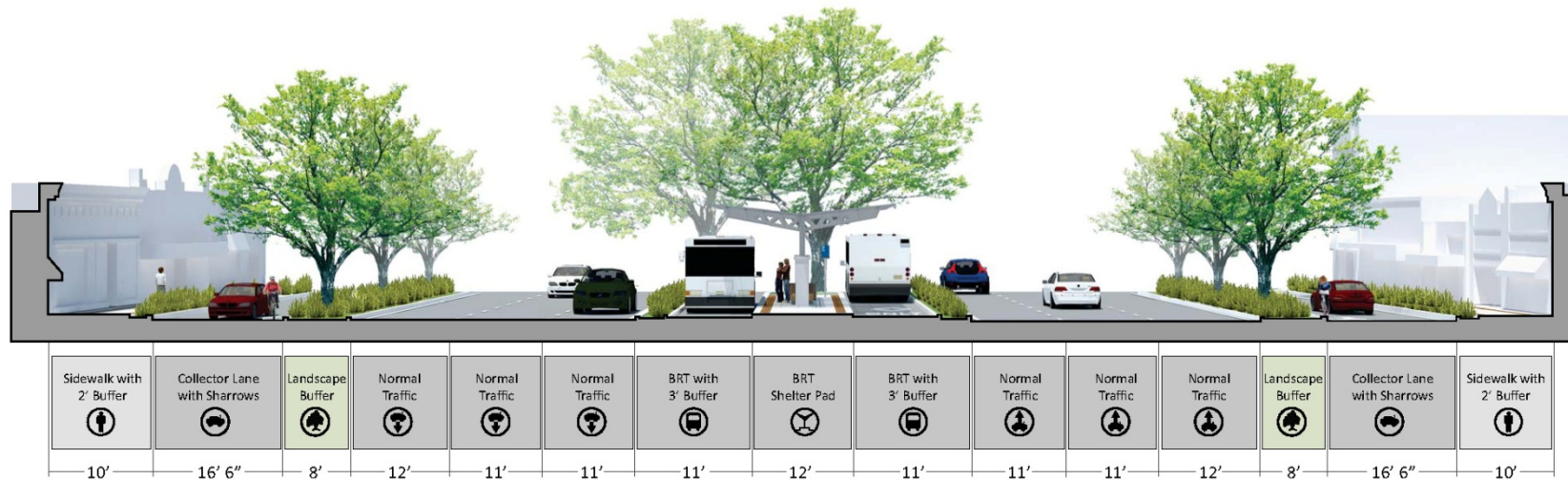


Figure 2.33: Demonstrator Site #6 – Conceptual Multi-Way Boulevard Cross-Section

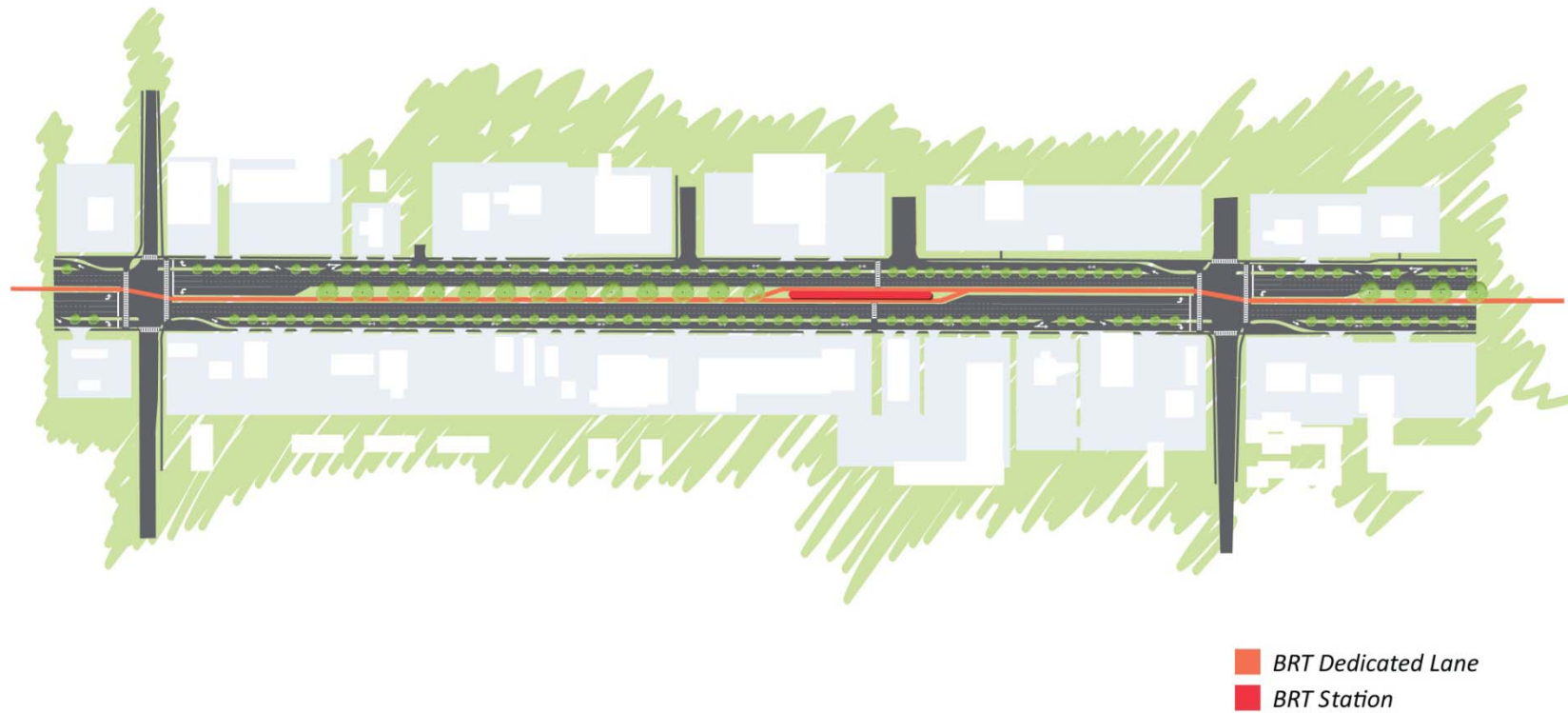


Figure 2.34: Demonstrator Site #6 – Conceptual Multi-Way Boulevard Overview

Section 3 – Recommendation

The Safety/Mobility Strategies Study has sought to develop recommendations that will help the MPO implement the objectives within their CM/CMP, specifically Objective 1.1, *Reduce the frequency and severity of crashes focusing on the highest crash areas*, and Objective 2.2, *Improve the safety and comfort of bicycling and walking trips*, all while complementing the MPO’s efforts to evaluate innovative uses of existing right-of-way. Accomplishing these objectives will not only reduce incident-related delay and encourage non-single-occupancy automobile trips, but will have a direct benefit on saving lives and moving the county closer to the national goal of “Zero Deaths.”

The recommendations developed as part of the Safety/Mobility Strategies Study are the following.

Recommendation #1: Conduct further detailed studies of selected locations.

Due to the uniqueness and complexity of each intersection and corridor on the high frequency “severe” crash lists, it is recommended that the MPO identify locations (intersections and corridors) for further detailed study. The detailed location studies should include an in-depth look at each location’s crash history, geometrics, operations, and context-related qualities (i.e., targeted redevelopment areas). Some potential locations for further study include the following:

- Dale Mabry Hwy at Waters Ave
- Dale Mabry Hwy at Fletcher Ave
- Waters Ave at Hanley Rd
- SR 60/Adamo Dr at Falkenburg Rd
- Hillsborough Ave at Lois Ave
- Bruce B Downs Blvd at 138th Ave

- Fowler Ave (I-275 to I-75)
- Hillsborough Ave (I-275 to I-4)
- SR 60/Brandon Blvd (I-75 to Valrico Rd)
- Waters Ave (Dale Mabry Hwy to Nebraska Ave)
- Dale Mabry Hwy (Kennedy Blvd to Gandy Blvd)

Recommendation #2: Consider alternative roadway infrastructure strategies.

In addition to the selection of locations for further detailed study, it is recommended that the MPO include, to the extent that they are not currently considered, alternative roadway infrastructure strategies, including those identified in Section 2 of this study, as part of the study and long range planning process and to complement the existing safety programs, policies, and design standards that are already practiced by state and local agencies. These strategies should be evaluated as project alternatives, understanding that the feasibility will be determined at the project study level. Also, the long range planning process should work to evaluate and identify locations suitable for specific strategies, especially given that some of the strategies identified are contingent upon the redevelopment or attainment of private property.

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Appendix A: Severe and Fatal Crashes by Roadway and Crash Category

Urban Major Roadway Crashes

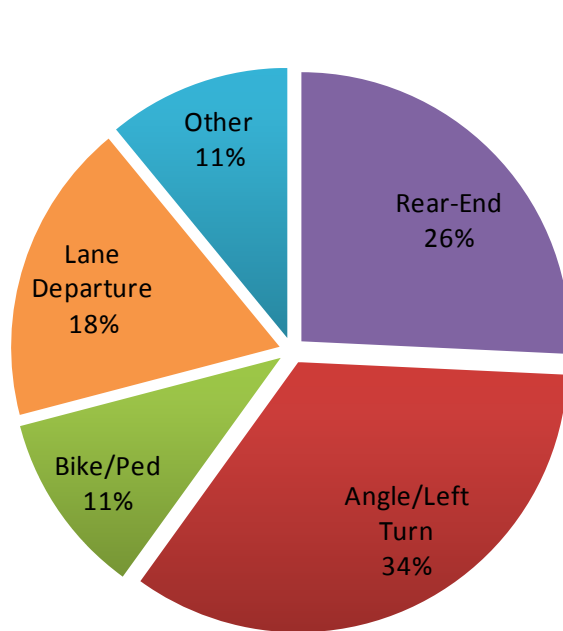


Figure A-1: Urban Major Roadway Severe Crashes by Crash Category

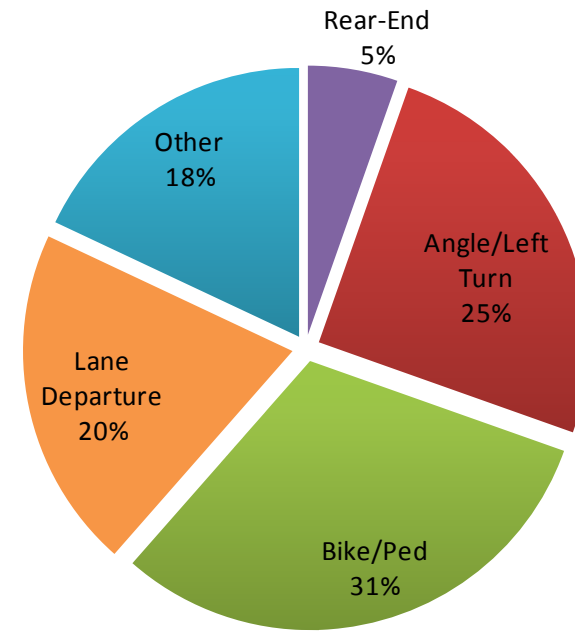


Figure A-2: Urban Major Roadway Fatal Crashes by Crash Category

Urban Local Roadway Crashes

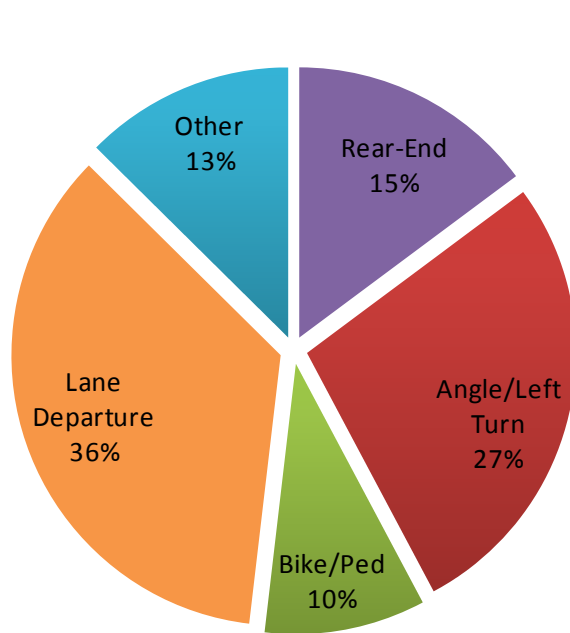


Figure A-3: Urban Local Roadway Severe Crashes by Crash Category

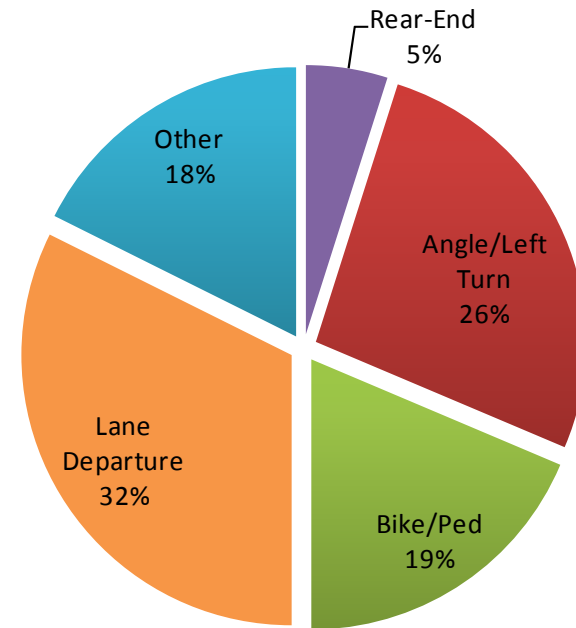


Figure A-4: Urban Local Roadway Fatal Crashes by Crash Category

Urban Limited Access Roadway Crashes

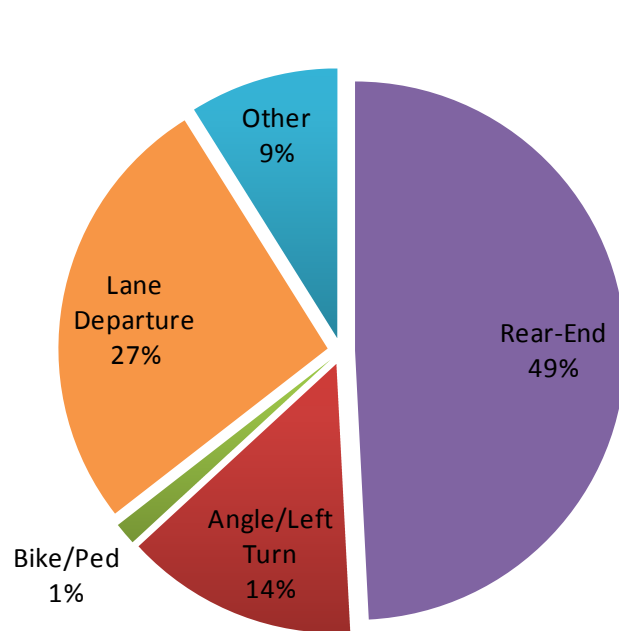


Figure A-5: Urban Limited Access Roadway Severe Crashes by Crash Category

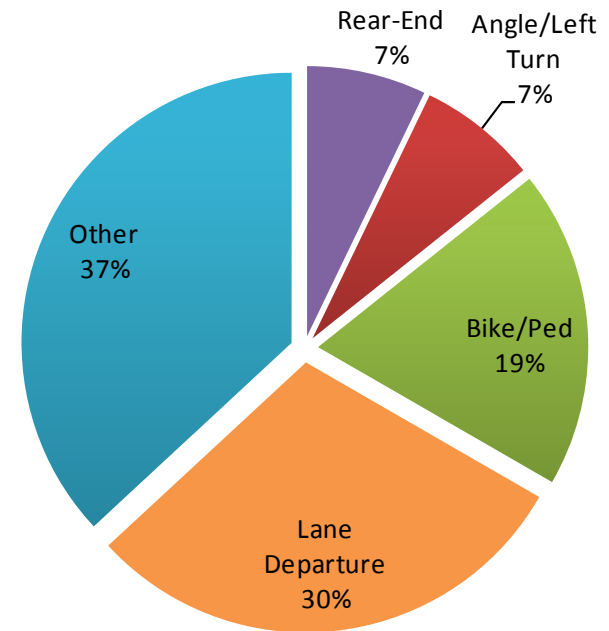


Figure A-6: Urban Limited Access Roadway Fatal Crashes by Crash Category

Rural Major Roadway Crashes

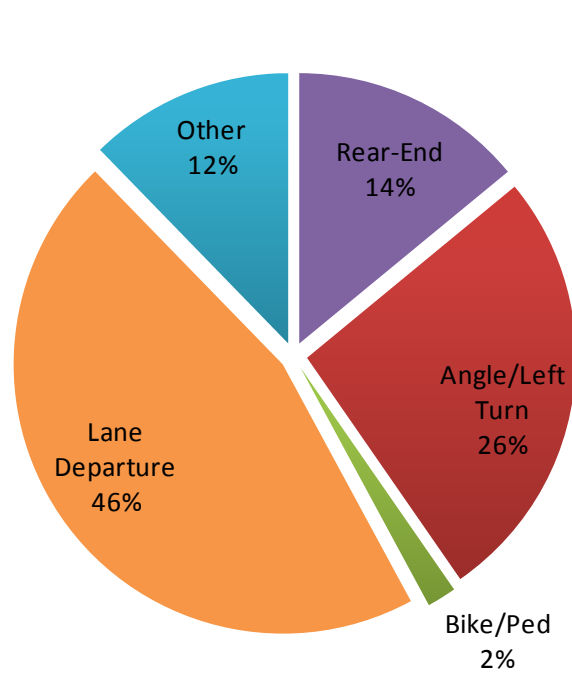


Figure A-7: Rural Major Roadway Severe Crashes by Crash Category

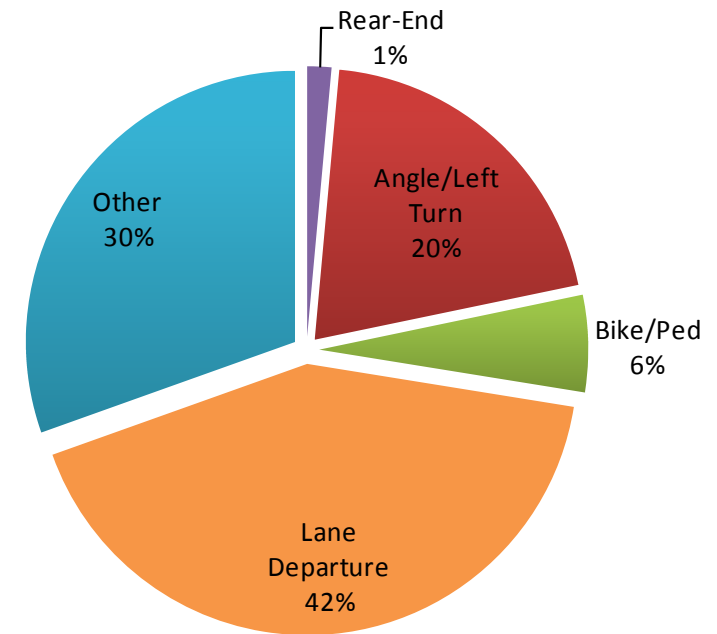


Figure A-8: Rural Major Roadway Fatal Crashes by Crash Category

Rural Local Roadway Crashes

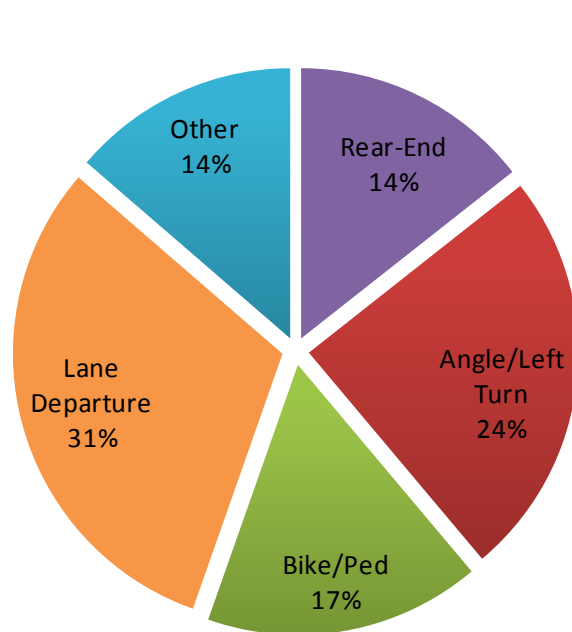


Figure A-9: Rural Local Roadway Severe Crashes by Crash Category

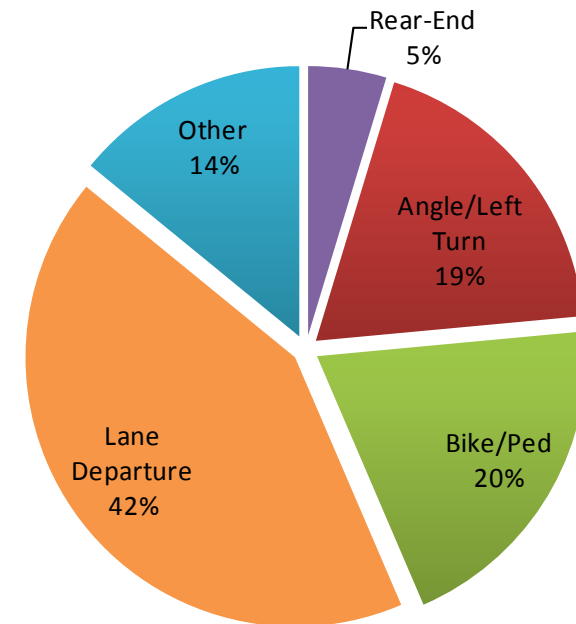


Figure A-10: Rural Local Roadway Fatal Crashes by Crash Category

Rural Limited Access Roadway Crashes

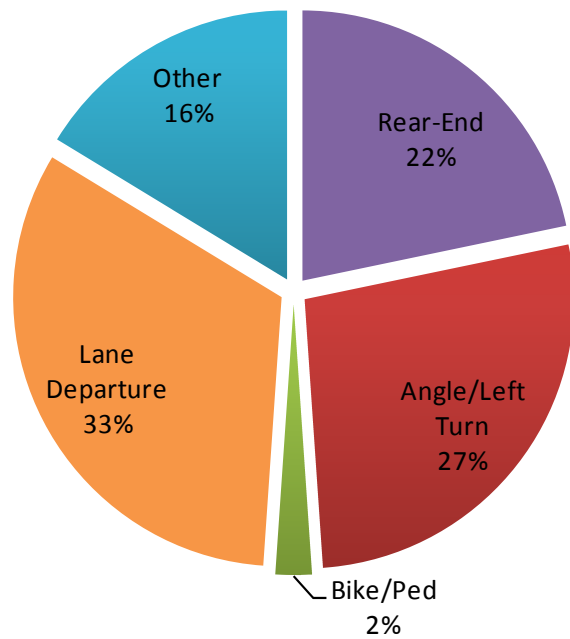


Figure A-11: Rural Limited Access Roadway Severe Crashes by Crash Category

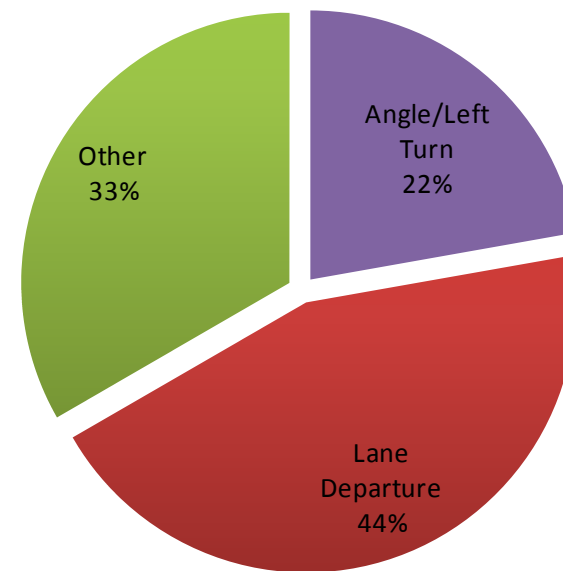


Figure A-12: Rural Limited Access Roadway Fatal Crashes by Crash Category

Appendix B: High Frequency “Severe Injury” Crash Locations by Crash Type

Table B-1: Top Angle/Left Turn Severe Crash Intersections

Intersection	Total Severe Crashes
Dale Mabry Hwy @ Fletcher Ave	18
Anderson Rd @ Gunn Hwy	14
Bloomington Ave @ Bell Shoals Rd	14
Dale Mabry Hwy @ Hudson Ln	14
SR 60/Brandon Blvd @ Miller Rd	14
Waters Ave @ Hanley Rd	13
SR 60/Brandon Blvd @ Oakwood Ave	12
SR 39 @ Colson Rd	12
Hillsborough Ave @ Orient Rd	11
US 301 @ Boyette Rd	11
SR 60 @ St Cloud Ave	11
Gronto Lake Rd @ Providence Lakes Blvd	11
Dale Mabry Hwy @ Bearss Ave/Ehrlich Rd	11
M L King Jr Blvd @ Lakewood Dr	11
Causeway Blvd @ Falkenburg Rd	10

Crash grouped by First Harmful Event; crashes aggregated to the nearest intersection; does not include limited access facilities

Table B-2: Top Rear-End Severe Crash Intersections

Intersection	Total Severe Crashes
SR 60/Brandon Blvd @ Grand Regency Blvd	16
Dale Mabry Hwy @ Bearss Ave/Ehrlich Rd	16
Dale Mabry Hwy @ Fletcher Ave	14
US 301 @ SR 60/Adamo Dr	12
Hillsborough Ave @ Hoover Blvd	12
Fletcher Ave @ Florida Ave	12
SR 60/Adamo Dr @ Falkenburg Rd	12
Hillsborough Ave @ 56th St	11
Dale Mabry Hwy @ Hudson Ln	11
US 301 @ Causeway Blvd	11
Hillsborough Ave @ Sawyer Rd	10
Dale Mabry Hwy @ Van Dyke Rd	10
Dale Mabry Hwy @ Northdale Blvd	10

Crash grouped by First Harmful Event; crashes aggregated to the nearest intersection; does not include limited access facilities

Table B-3: Top Lane Departure Severe Crash Intersections

Intersection	Total Severe Crashes
Cross Creek Blvd @ Morris Bridge Rd	10
SR 60/Brandon Blvd @ Grand Regency Blvd	7
SR 60 @ Smith Ryals Rd	7
Sligh Ave @ Williams Rd	7
SR 60/Courtney Campbell Cswy @ Rocky Point Dr	6
Dale Mabry Hwy @ Bearss Ave/Ehrlich Rd	6
SR 60 @ SR 39/James Redman Pkwy	6
Gunn Hwy @ Linebaugh Ave	6
Bruce B Downs Blvd @ Bearss Ave	6
US 301 @ Boyette Rd	5
Gunn Hwy @ Mobley Rd	5
Morris Bridge Rd @ High Meadow Ave	5
Sheldon Rd @ Linebaugh Ave	5
US 301 @ Big Bend Rd	5
Hillsborough Ave @ Memorial Hwy	5

Crash grouped by First Harmful Event; crashes aggregated to the nearest intersection; does not include limited access facilities

Table B-4: Top Bicycle and Pedestrian Severe Crash Intersections

Intersection	Total Severe Crashes
Hillsborough Ave @ Lois Ave	6
Hillsborough Ave @ Town N County Blvd	6
Bruce B Downs Blvd @ 138th Ave	5
Waters Ave @ Hanley Rd	5
Fletcher Ave @ 15th St	5
Bruce B Downs Blvd @ Fletcher Ave	5
Fowler Ave @ 15th St	5
Bearss Ave @ Livingston Ave	4
SR 60/Brandon Blvd @ Brandon Town Center Dr	4
Baker St @ Walter Rd	4
Fletcher Ave @ 22nd St	4
SR 574 @ Taylor Rd	4
Fowler Ave @ Nebraska Ave	4
Fletcher Ave @ Florida Ave	4
Nebraska Ave @ Floribraska Ave	4
Fowler Ave @ 30th St/Bruce B Downs Blvd	4
Dale Mabry Hwy @ Waters Ave	4
Waters Ave @ Sheldon Rd	4

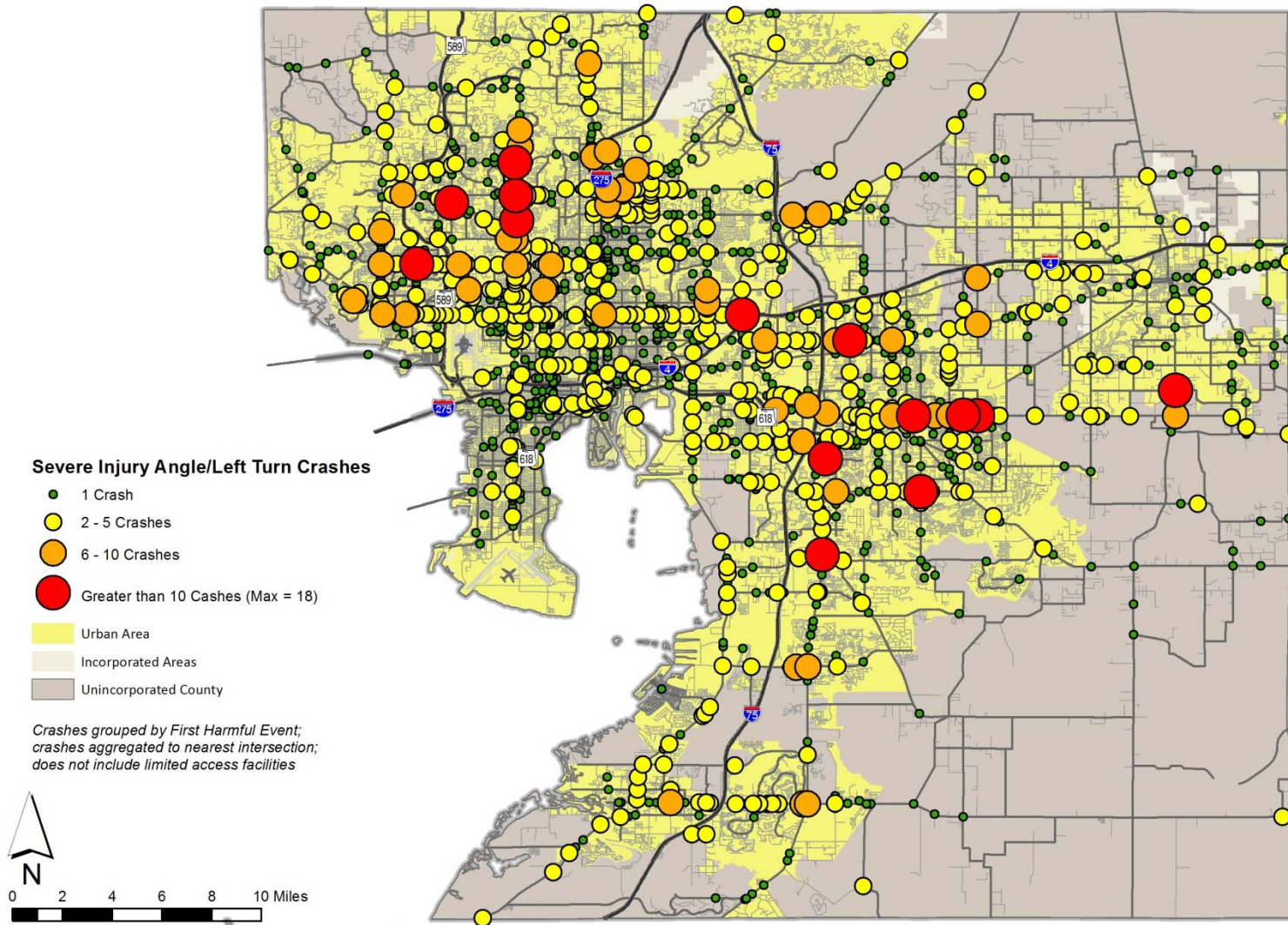
Crash grouped by First Harmful Event; crashes aggregated to the nearest intersection; does not include limited access facilities

Table B-5: Top Other Severe Crash Intersections

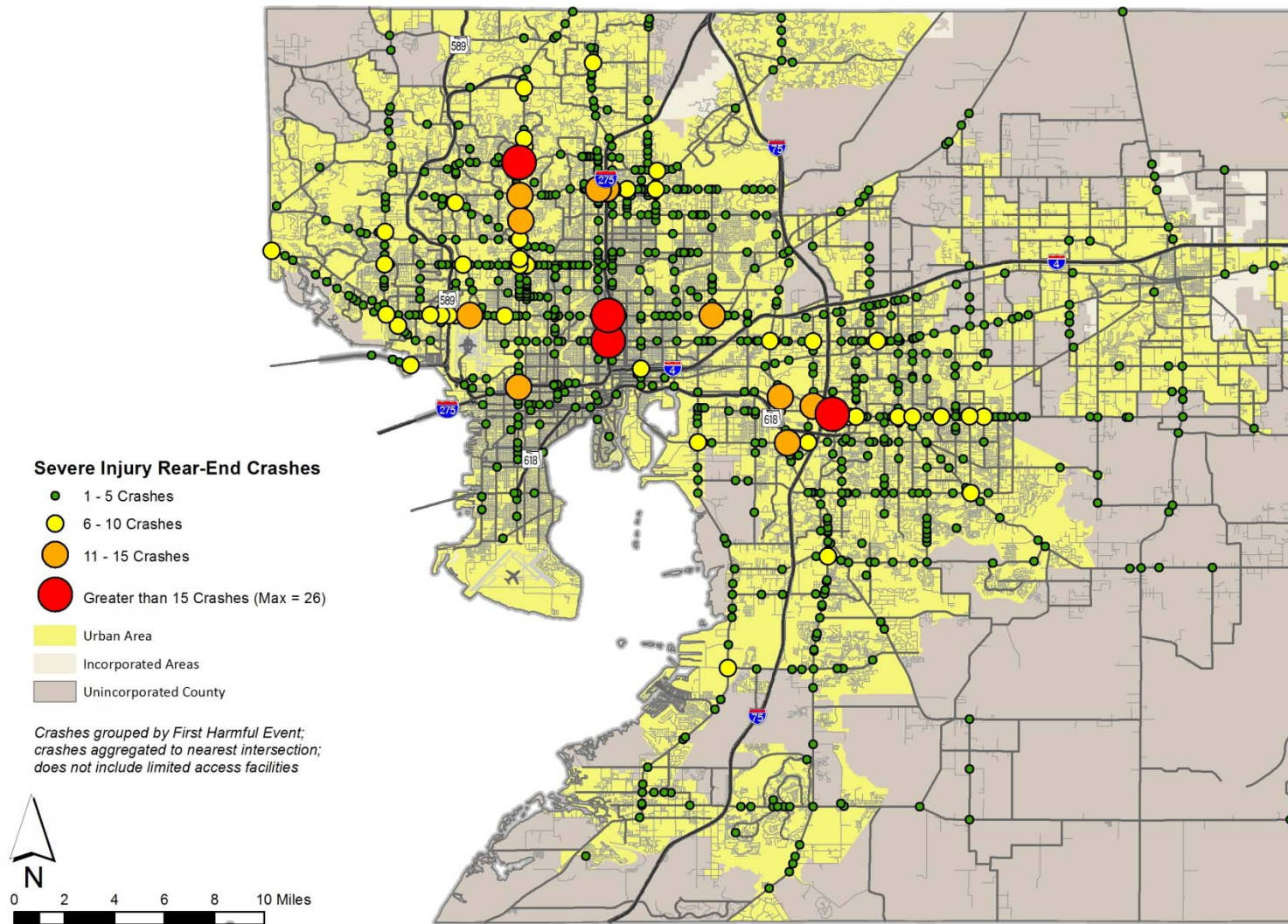
Intersection	Total Severe Crashes
Bloomingdale Ave @ Bell Shoals Rd	6
Waters Ave @ Hanley Rd	6
Dale Mabry Hwy @ Van Dyke Rd	5
Bruce B Downs Blvd @ 131st Ave	5
US 301 @ Gibsonton Rd	5
Fletcher Ave @ 42nd St	5
Dale Mabry Hwy @ Bearss Ave/Ehrlich Rd	5

Crash grouped by First Harmful Event; crashes aggregated to the nearest intersection; does not include limited access facilities

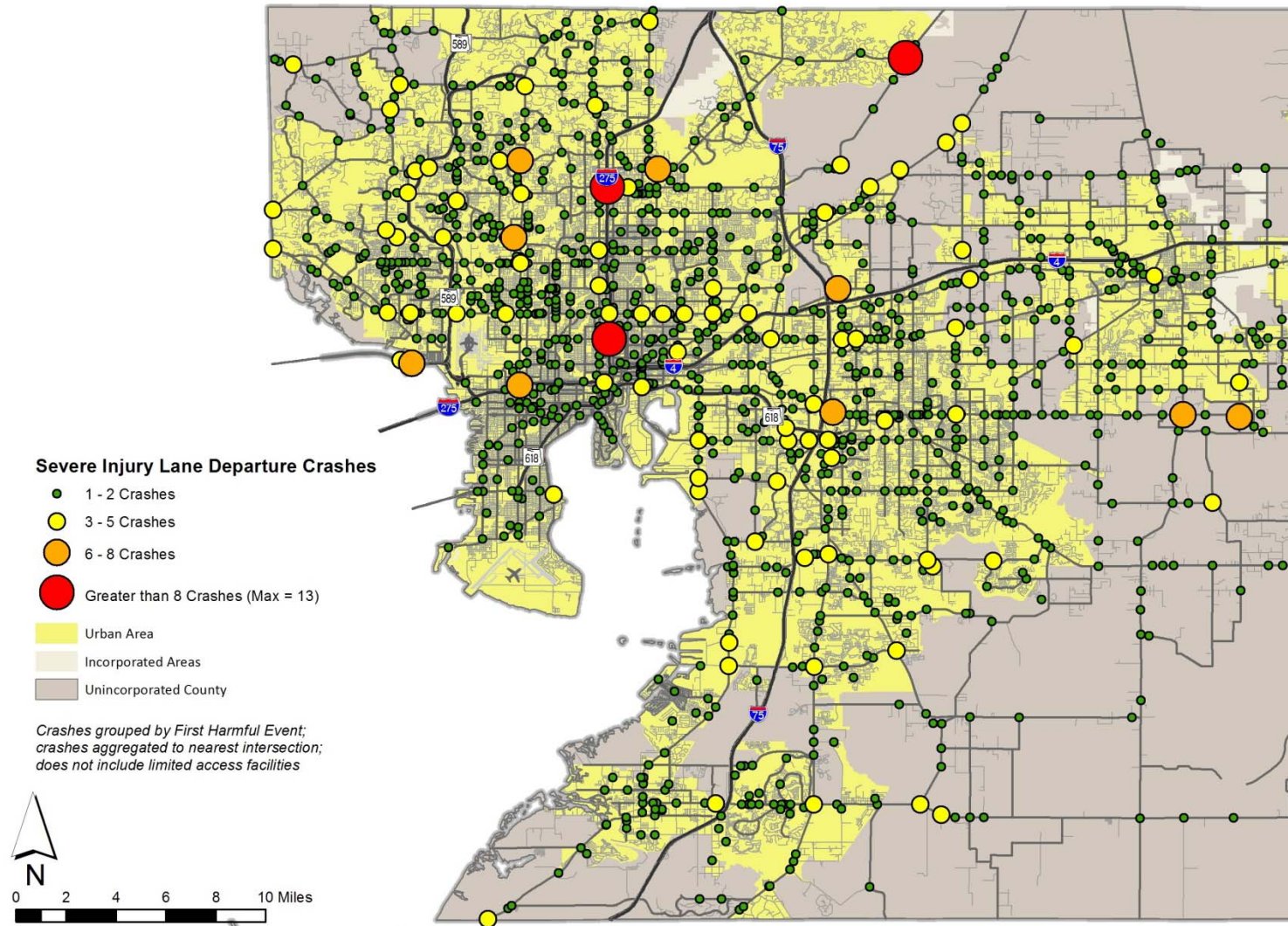
Map B-1: Severe Angle/Left Turn Crash Intersection Summary



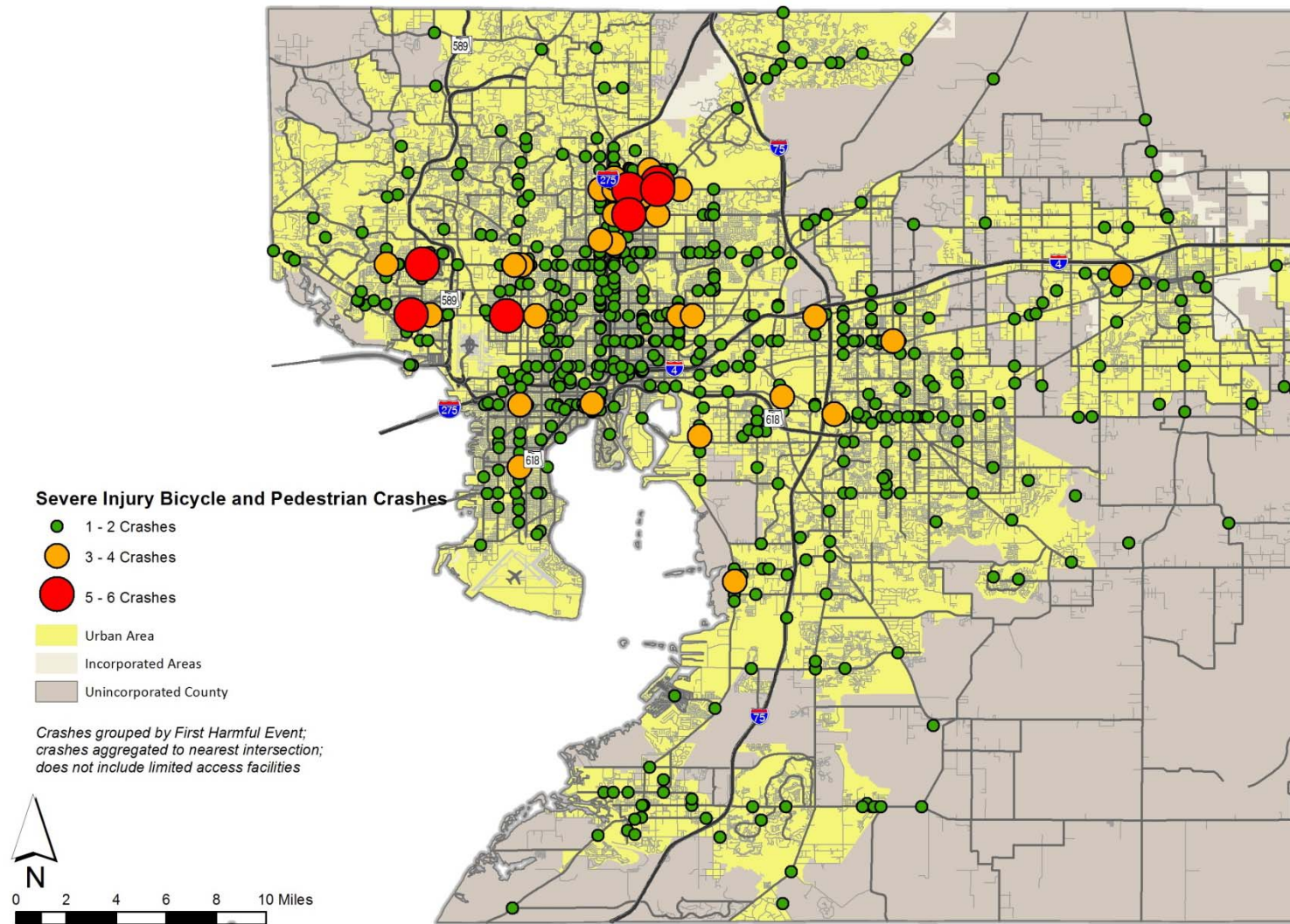
Map B-2: Severe Rear-End Crash Intersection Summary



Map B-3: Severe Lane Departure Crash Intersection Summary



Map B-4: Severe Bicycle/Pedestrian Crash Intersection Summary



Map B-5: Severe Other Crash Intersection Summary

