7.0 Safety Analysis

7.1 I-95 Predictive Crashes

The Highway Safety Manual Predictive methodology provides procedures to estimate crashes for a given facility, test the effectiveness of proposed alternatives on estimated crashes and evaluate the economic impact of crashes. The first step in this evaluation is to establish a prediction of annual crashes, based on existing traffic volumes, facility types, geometric characteristics and observed crashes. This is followed by an estimate of futures crashes with projected traffic volumes for the future alternatives.

The safety analysis was performed utilizing AADT projections from the Project Traffic Forecasting Memorandum which can be found within **Appendix B**.

7.1.1 I-95 No Build Alternative Crashes

The No Build Alternative uses the same network geometry and historic crash data as the existing conditions but utilizes future volumes. The ISATe was used to predict the total number of crashes between 2030 and 2050.

Table 44 summarizes the total Fatal, Injury, and Property Damage Only crashes for the existing geometry with opening year (2030) volumes and design year (2050) volumes and interpolated volumes between the opening and design year. Summary tables for existing conditions and No Build Alternative are included in **Appendix C.**

Table 44: No Build Alternative Crash Severity

	Fatal and Injury	PDO	Total
Freeway Segments	335.6	767.2	**1102.8**
Ramp Segments	225.5	320.4	**545.8**
Totals	**561.1**	**1087.6**	**1648.6**

7.1.2 Diverging Diamond Interchange Alternative

This Build Alternative utilizes the DDI configuration with opening year (2030) and design year (2050) traffic volumes interpolated to derive interim year traffic volumes. The Highway Safety manual predictive model is used without the EB methodology due to geometric changes, increase number of lanes, and ramp configurations. The existing crash history is not applicable at the crossroad terminals. These will be addressed through a qualitative analysis. DDI alternative output sheets can be found in **Appendix C**.

Tables 45 summarizes the total Fatal Injury and Property Damage Only crashes for the DDI configuration.

Table 45: DDI Crash Severity

	Fatal and Injury	PDO	Total
Freeway Segments	152.4	351.3	**503.7**
Ramp Segments	24.4	29.1	**53.5**
Totals	**176.8**	**380.4**	**557.2**

7.2 Arterial Roadway Predictive Crashes

An intersection safety analysis (predictive crashes) was performed for all intersections with a different geometry than the No Build condition. The *HSM Urban and Suburban Arterials Spreadsheet* Tool was used to analyzed intersections and segments along US 1. **Table 46** and **47** summarizes predictive crashes by severity for both the opening and design year. Arterial output sheets can be found in **Appendix C.** Although the Build Alternative shows an increase in fatal and injury crashes, it is expected that the lower operating speeds (35 mph in Build condition against 45 mph in No Build condition) will reduce the fatalities and the severity of the injury crashes thereby resulting in safer operations. The analysis summary shows an increase in the total number of fatal and injury crashes, combined, in the Build condition. The distribution of the severity changes with the Build condition showing an overall decrease in fatal crashes but an increase in injury crashes. This trend is expected for the intersection and segments, alike.

Table 46: Year 2030- Intersection Crash Severity

Year 2030	No Build			Build		
	Fatal and Injury	PDO	Total	Fatal and Injury	PDO	Total
Broadway Ave.	1.8	3.2	5.0	3.2	2.8	6.0
Benton St.	2.3	3.0	5.2	0.2	0.8	1.0
Rosemary St.	1.5	2.1	3.7	0.1	0.5	0.6
Destination Daytona Ln.	1.4	2.6	4.0	2.5	2.3	4.8

Table 47: Year 2050- Intersection Crash Severity

Year 2050	No Build			Build		
	Fatal and Injury	PDO	Total	Fatal and Injury	PDO	Total
Broadway Ave.	3.7	6.3	10.0	4.7	4.0	8.7
Benton St.	3.7	4.5	8.2	0.3	1.8	2.1
Rosemary St.	2.6	3.3	5.9	0.2	1.1	1.3
Destination Daytona Ln.	2.5	4.4	6.9	3.2	2.7	5.9

Lane geometry along US 1 is consistent throughout the entire segment, therefore only one segment was considered. **Table 48** summarizes the predictive crashes for this segment.

Table 48: US 1 Segment- Crash Severity

Severity	Year 2030		Year 2050	
	No Build	Build	No Build	Build
Fatal and Injury	1.8	4.3	3.3	7.5
PDO	4.7	6.4	8.6	10.4
Total	6.5	10.7	11.8	17.9

7.3 Crash Discussion

The Build alternative crash predictions were compared to the No Build predicted crashes. In the Diverging Diamond Interchange (DDI) alternative the crashes decrease on from 1648.6 (No Build) to 557.2 (DDI) for freeways and ramp segments. This reduction is most likely a result of eliminating substandard loops and increasing the spacing between merge and diverge points.

Table 49 shows the comparison of the Build against the No Build predicted crashes.

The Enhanced Interchange Safety Analysis Tool (ISATe) does not include an interchange option specifically for diverging diamond interchanges and does not include Crash Modification Factor (CMF) values to predict crashes.

The DDI research presented in National Cooperative Highway Research Program (NCHRP) Report 959 Diverging Diamond Interchange Information Guide Second Edition (2021) was utilized for this qualitative assessment. The following bullets outline the qualitative safety assessment of a DDI vs a partial cloverleaf interchange:

- Conflict Points –
    - The existing partial cloverleaf configuration has 15 total conflict points: 5 merging, 5 diverging, and 5 crossing.
    - The proposed DDI configuration has 14 total conflict points: 6 merging, 6 diverging, and 2 crossing.
    - While the DDI only has one less total conflict point, it has 3 less crossing conflict points. Crossing conflict points are typically locations where higher severity crashes are more likely to happen (like angle crashes). Thus, it would be expected the DDI would have less severe crashes than the diamond configuration of the partial cloverleaf interchange.
- Wrong-way maneuver concerns are more common at a diamond interchange, but the design of the DDI, mainly the channelization of movements, may decrease the likelihood of wrong-way maneuvers at freeway exit ramps.
- Lower speeds should reduce the total number of crashes and also reduce the number of severe injury crashes through the interchange area.

DDIs have been proven to reduce crashes and crash severity. It is anticipated the I-95 and US 1 interchange modification to a DDI will reduce the total number of crashes, the number of fatalities, and potentially reduce wrong-way maneuver crashes through the I-95 and US 1 interchange area from a qualitative perspective.

Table 49: No-Build vs. DDI Alternative Total Predicted Crashes

Facility	No Build	DDI
Freeway Segments	1102.8	503.7
Ramp Segments	545.8	53.5
Total	1648.6	557.2

Table 50 provides a breakdown of crashes by facility for the No Build and Build condition in 2050. Using Table 122.6.4 of the FDM Section 122 Design Exceptions and Design Variations, the crash distribution rate based on each injury type was applied to the total number of crashes to determine the breakdown by crash type.

Table 50: 2050 Crash Total by Facility

Facility	No Build	DDI
Broadway Ave.	10.0	8.7
Benton St.	8.2	2.1
Rosemary St.	5.9	1.3
Destination Daytona Ln.	6.9	5.9
US 1 Segment	11.8	17.9
Freeway Segments	62.0	27.8
Ramp Segments	30.7	3.0
Total	**130.2**	**66.7**

The cost provided in Table 122.6.2 was used to calculate the total cost per crash injury type. Based on these calculations, the cost of crashes in 2050 are shown in **Table 51**. The Build Alternative is expected to be 49% less than the No Build.

Table 51: 2050 Crash Cost by Facility

All Type Facilities	HSM Crash Distribution for Florida	FDOT KABCO Crash Costs	No Build		Build	
			Crashes	Cost	Crashes	Cost
Fatal	0.007	$10,890,000	0.91	$9,925,146	0.47	$5,084,541
Incapacitating Injury	0.041	$888,030	5.34	$4,740,482	2.73	2,428,496
Non-Incapacitating Injury	0.124	$180,180	16.14	$2,908,970	8.27	$1,490,233
Possible	0.217	$103,950	28.25	$2,936,941	14.47	$1,504,562
Property Damage Only	0.611	$7,700	79.55	$616,552	40.75	$313,803
Total			**130.2**	**$21,124,091**	**66.7**	**$10,821,635**

8.0 Recommended Alternative

Based on the operational and safety analysis for the study area, the Diverging Diamond Interchange is the recommended alternative.

Traffic operational analysis, as described in Section 6, shows the Build Alternative improves operations and delays through the design year 2050 in all intersections within the study area except at Rosemary St. where the design year 2050 AM peak LOS for this unsignalized intersection is F. However, Rosemary St. will be converted to a right in/right out configuration rather than a full median opening. This reconfiguration will enhance the safety at this location. Freeway, merge, and diverge segments all continue to operate at LOS D or better through the Design Year for the Build Alternative.

The safety analysis shows an overall decrease in total predicted crashes in the Build Alternative compared to the No-Build Alternative; freeway segments crashes decrease, ramp segment crashes decrease, and