6.0 Future Safety Analysis

6.1 Quantitative Safety Analysis

The Highway Safety Manual procedures and historic crash data were used to quantitatively analyze the safety impacts of No-Build and Build Alternatives. The quantitative safety analysis for the proposed Build Alternative conditions follows the Countermeasure Crash Reduction Factor (CRF) methodology and demonstrates the impact of the facility's safety within the AOI. The quantitative safety analysis complies with the guidelines of the FDOT Interchange Access Request User's Guide Safety Analysis Guidance in determining the estimated change in the expected number of crashes due to the proposed modifications of the project.

The Countermeasure CRF methodology utilizes CRFs to compute the expected number of crashes after implementing a selected countermeasure. CRFs were selected from the FHWA Crash Modification Factors (CMF) Clearinghouse (www.cmfclearinghouse.org). The selected applicable CRF for the I-275 and Hillsborough Interchange has a higher star rating than the minimum requirement of three stars to provide a greater level of confidence when estimating the safety performance by determining the reduction of crashes and the annual cost of the crash reduction. A summary of the applied CRFs and their impact on reducible crashes, the estimated CRF for the study area, and resultant benefit-to-cost (B/C) analysis can be found in **Table 6.1**, **Table 6.2**, and **Table 6.3**, respectively.

Table 6.1: Crash Reduction Factor Application

Location	Improvement	CRF ID[1]	Stars	CRF	Crash Types Impacted	Severity	Number of Reducible Crashes	Total Reduced Crashes
SB Ramp Terminal	Change from permitted-protected to protected only WBL operation.	2326	4	100%	Angle, Left-Turn[2]	All	121	121
	SBR Protected Phase	3057	3	73.3%	All Types	All	67[3]	49
NB Off-Ramp	NBR Protected Phase	3057	3	73.3%	All Types	All	29	21
NB On-Ramp	Signalize and allow protected only EBL operation	2326	4	100%	Angle, Left-Turn[2]	All	18	18

1 CRF Source: https://www.cmfclearinghouse.org/
2 Left-Turns included in this CRF application upon review of the associated white paper.
3 Crashes impacted for the application of CRF 3057 reflect those remaining after the application of CRF 2326 to prevent double counting.

Table 6.2: Cumulative Crash Reduction Factor Estimation

Calculations	5-year Totals	Per Year
Total AOI Crashes[1]	506	101.2
Total Reducible Crashes[2]	235	47
Total Reduce Crashes[3]	209	41.78
Calculated CRF[4]	88.9%	

1 Total crashes observed from 2016 to 2020 as documented in Section 2.3 of the Hillsborough Avenue IOAR.
2 Total reducible crashes summed from Table 6.1 .
3 Total reduced crashes summed from Table 6.1.
4 Calculated by dividing total reduced crashes by total reducible crashes.

Table 6.3: Future Benefit-to-Cost Ratio Summary

Benefit-to-Cost Factors	Values
Total number of Crashes (5-year Total)	506
Number of Reducible Crashes (5-year Total)	235
Avg. Number of Reducible Crashes per year	47
Calculated CRF	88.9%
Number of Reduced Crashes per year (C)	41.78
Estimated Cost per crash (CPC)[1]	$123,406.00
Annual Benefit Total (C x CPC)	$5,156,272.90
Estimated Construction Cost (ECC)	$4,490,456.00
Interest Rate	4.00%
Service Life Years of Project[2]	10
Capital Recovery Factor (RF)[2]	0.1233
Annual Cost of Project (ECC x RF)	$533,673.22
Benefit-to-Cost Ratio	9.31

1 FDOT Average Crash Cost from FDOT Design Manual Table 122.9.1 for 4-5 Lanes, published January 2022.
2 Factor based on FDOT Benefit/Cost Analysis Spreadsheet Tool, Source: https://www.fdot.gov/roadway/qa/tools.shtm

Out of the 235 reducible crashes within the AOI, the presented B/C analysis indicates that the proposed improvements under the Build Alternative are expected to reduce 209 crashes over a 5-year period (41.78 crashes per year). Based upon the average cost per crash of $123,406.00, per the FDM Table 122.6.1 for four to five lane urban facilities, an annual benefit of a reduction of $5,156,272.90 in economic loss from crashes is estimated annually if the Build Alternative improvements are implemented. When compared to the $553,673.22 annual project cost of the Build Alternative, based on a 4 percent interest rate and life cycle of 10 years, a safety B/C ratio of 9.31 was estimated. For context, any project with a B/C ratio greater than 1.0 is considered economically justifiable from a highway safety prospective. The CRF Details, CRF calculations, and the B/C worksheet used to determine the annual cost and benefit of the crash reduction are presented in **Appendix K**.

6.2 Qualitative Safety Analysis

While several improvements were able to be quantified for use in the estimation of the B/C ratio of the project, some improvements lack research to provide CRFs but still provide safety improvements that require examination. The two most notable improvements with no associated CRF are the impacts of the elimination of the free flow loop ramp operations and the elimination of eastbound Hillsborough Avenue queue spillback due to the signalization of the eastbound left turn at the northbound ramp terminal.

Westbound Hillsborough Avenue under the No-Build Alternative experienced an operational bottleneck as the northbound I-275 to westbound Hillsborough Avenue free flow loop ramp attempted to merge into westbound Hillsborough Avenue through traffic as it approached the westbound right turn lane drop at the Central Avenue intersection. This merge condition results in slowdown in the outside lanes of westbound Hillsborough Avenue. Under the Build Alternative, this condition is eliminated entirely and brought under signal control which will improve flow and safety through the interchange.

Eastbound Hillsborough Avenue under the No-Build Alternative was impacted by queue spillback resulting from the unsignalized eastbound left turn at the northbound I-275 ramp terminal. Queueing stacked in the inside lane of eastbound Hillsborough Avenue and created an unsafe speed differential between the inside and outside lanes through the Central Avenue intersection. The speed differential

also heavily impacts the ability for westbound left turn movements at the southbound I-275 ramp terminal to safely cross traffic under the movement's permitted phase, which leads to a significant number of collisions. While the impacts of the elimination of the westbound left turn at the southbound I-275 ramp terminal were eliminated via CRF quantifiable improvement, the speed differential between the inside and outside lanes of eastbound Hillsborough Avenue was also eliminated due to the improvements of storage and signalization of the eastbound left turn movement at the northbound I-275 ramp terminal.