6.0 SAFETY ANALYSIS

A quantitative safety analysis of future conditions was conducted using the methods specified in the Highway Safety Manual (HSM). The anticipated change in crash frequency and severity due to changes in geometric features and traffic conditions resulting from the proposed project was determined based on the safety prediction methodologies in Part C of the HSM.

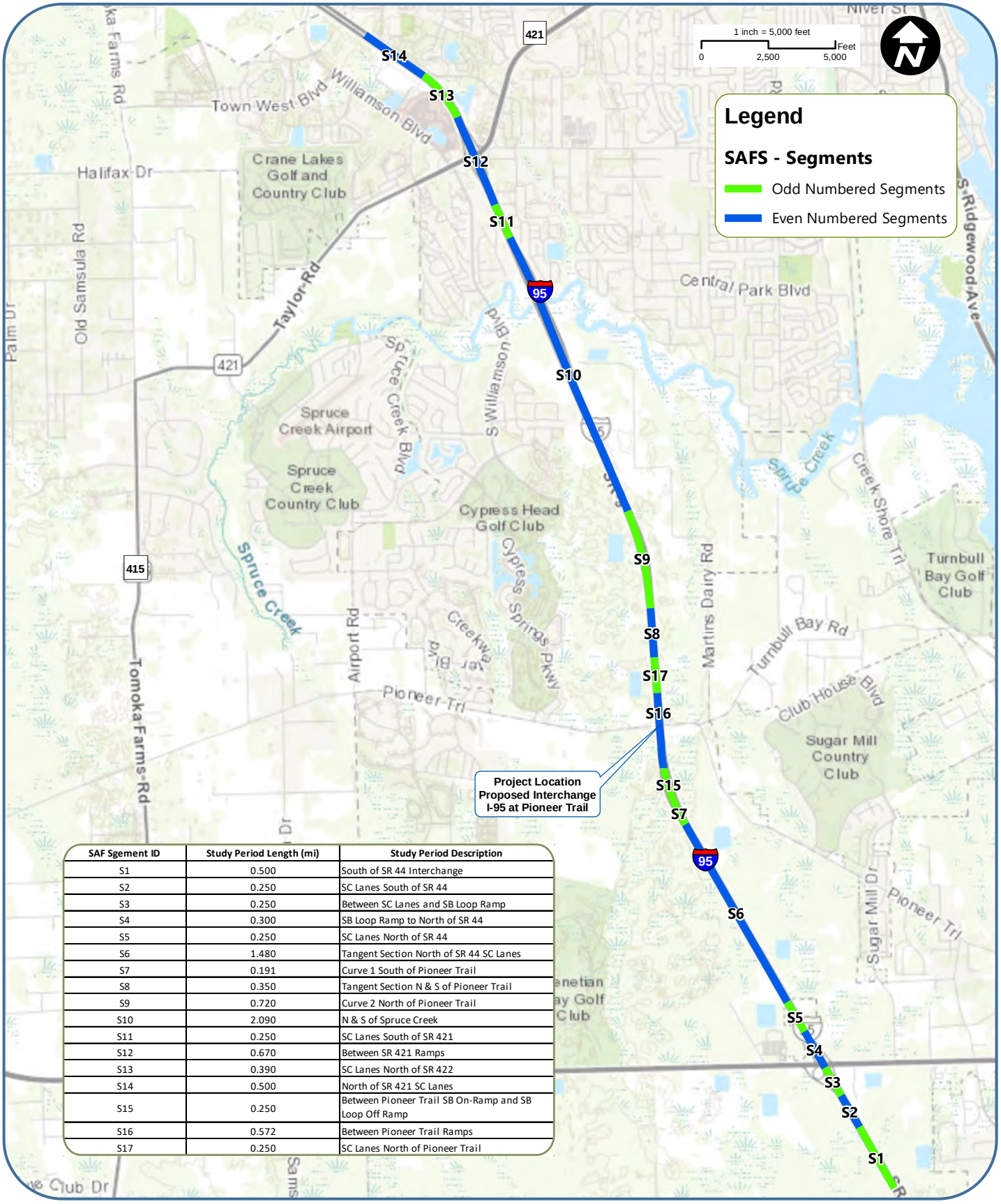
6.1 Predictive Safety Analysis

The Enhanced Interchange Safety Analysis Tool (ISATe), a spreadsheet-based program developed by the American Association of State Highway and Transportation Officials (AASHTO) and approved for use by FDOT, was used to evaluate freeway and interchange safety for the proposed I-95 and Pioneer Trail project. The ISATe tool implements the predictive methods in Part C of the HSM to develop Safety Performance Functions (SPFs) that predict crash frequency for a given set of site conditions. The predictive method utilizes traffic volumes and roadway characteristics such as horizontal alignment, cross section elements, roadside data and ramp access data as inputs to evaluate safety performance. The predictive model may be used with observed crash data by using the empirical Bayes (EB) Method to provide a more reliable estimate of the expected average crash frequency. Based on the established criteria, the EB Method is not applicable to this project since the I-95 cross section was recently modified to widen it from a four-lane to six-lane freeway. The historical crash data that was available for the project was from 2013-2017, prior to the widening. Since the widening is a major geometric improvement that added through lanes to the interstate, the observed crash data from the historical time period would not necessarily be indicative of the crash experience that is likely to occur after the widening. Therefore, the study period for the predictive model will include only future analysis years.

The ISATe tool provides a safety performance evaluation based on the predicted number of total crashes by facility type and by severity. Different severity levels are defined as follows: K- fatal, A- incapacitating injury, B- non-incapacitating injury, C- possible injury and PDO- property damage only. Both Partial Cloverleaf 1 and Partial Cloverleaf 2 Build alternatives were analyzed for the entire I-95 project corridor using the future year AADTs developed in this study as inputs into ISATe. Geometric data for the freeway segments was available from the I-95 widening construction plans and from desktop analysis. The previously approved IJR design concept (Partial Cloverleaf with single loop ramp) is the basis for comparison of the current preferred Build alternative (Partial Cloverleaf with double loop ramps).

For both Build alternatives the corridor was divided into 17 freeway segments with 22 ramp segments and 6 ramp terminals. The primary differences between the two Build alternatives were: location of speed change lanes and ramp access points in the freeway segment, the type of ramp segments and the ramp terminal configuration type in the Northbound direction at the Pioneer Trail interchange. For Partial Cloverleaf 1, the I-95 northbound off ramp is a diagonal ramp terminating into a type D4 four-leg ramp terminal. In the Partial Cloverleaf 2 alternative, the I-95 northbound exit is a loop ramp terminating into a type B2 three-leg ramp terminal. The overall I-95 freeway segmentation used in the analyses is shown in **Figure 23** with detailed ramp segmentation depicted in **Figure 24**.

Freeway segment, ramp segment and ramp terminal geometric and operational data inputs were based on the proposed concept plans and traffic analysis for each build alternative. The future geometry and traffic control are anticipated to be in place in the design year to meet the target LOS. Thus, the predictive safety analysis assumes full buildout/ ultimate ramp terminal configurations including future signalization for the full 20-year analysis study period from 2025-2045. It should be noted that the safety benefits will differ in the short term from those expected at full buildout.



SAF Sgement ID	Study Period Length (mi)	Study Period Description
S1	0.500	South of SR 44 Interchange
S2	0.250	SC Lanes South of SR 44
S3	0.250	Between SC Lanes and SB Loop Ramp
S4	0.300	SB Loop Ramp to North of SR 44
S5	0.250	SC Lanes North of SR 44
S6	1.480	Tangent Section North of SR 44 SC Lanes
S7	0.191	Curve 1 South of Pioneer Trail
S8	0.350	Tangent Section N & S of Pioneer Trail
S9	0.720	Curve 2 North of Pioneer Trail
S10	2.090	N & S of Spruce Creek
S11	0.250	SC Lanes South of SR 421
S12	0.670	Between SR 421 Ramps
S13	0.390	SC Lanes North of SR 422
S14	0.500	North of SR 421 SC Lanes
S15	0.250	Between Pioneer Trail SB On-Ramp and SB Loop Off Ramp
S16	0.572	Between Pioneer Trail Ramps
S17	0.250	SC Lanes North of Pioneer Trail

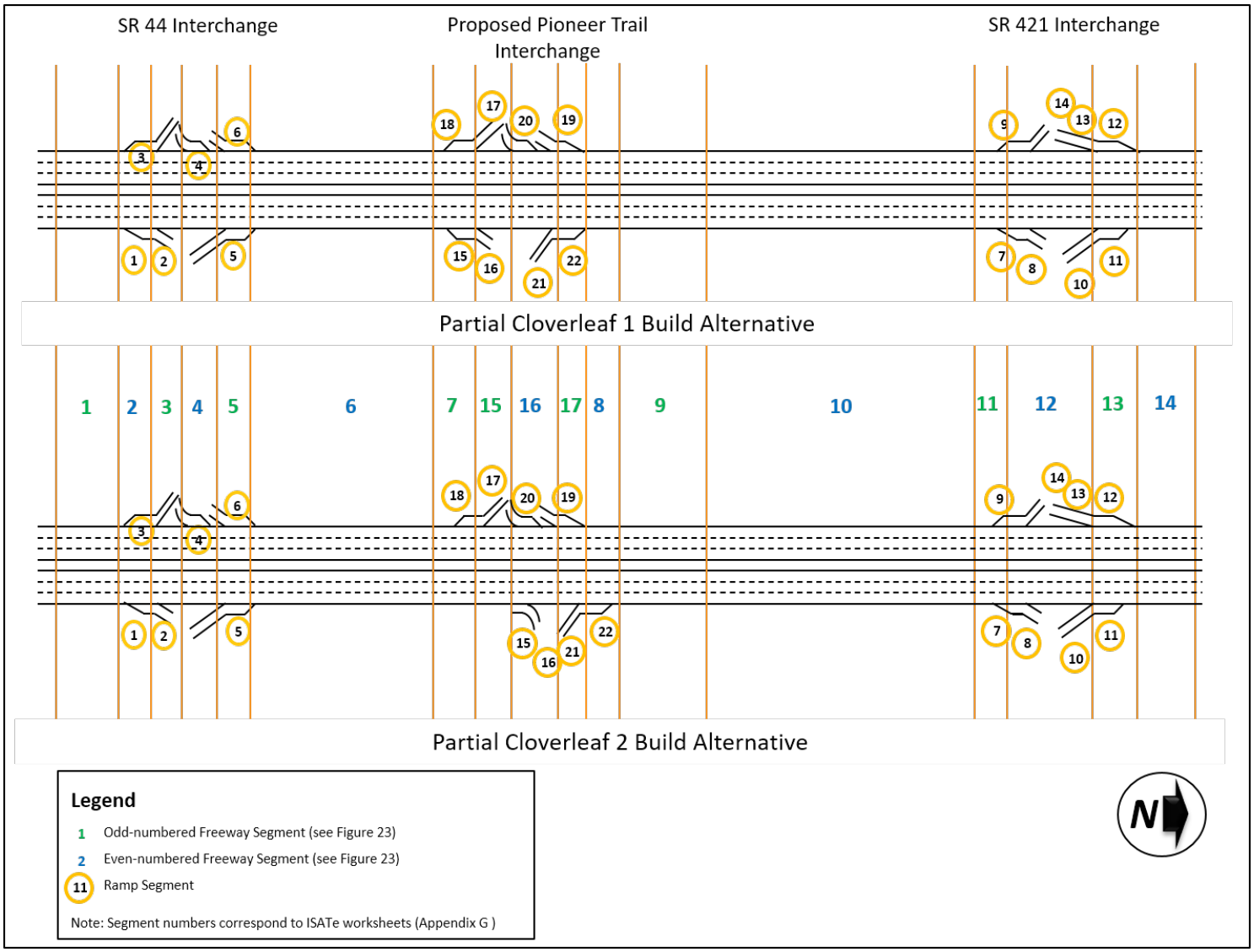


Figure 24: Safety Analysis Ramp Segmentation

Based on the input data, ISATe calculations were performed to determine the predicted number of crashes for future year buildout conditions. The HSM crash distribution values from Table 122.6.4 of the FDOT Design Manual (FDM, January 2020) were applied to the total crashes from ISATe, with crashes rounded to the nearest 0.1. The resulting estimated crashes for the future year Build alternatives are summarized in **Table 34** and **Table 35** for the individual study years and for the entire study period, respectively. Additionally, the estimated average number of crashes per year are summarized in **Table 36**. The ISATe calculations are provided in Appendix G.

Table 34: Predictive Crash Statistics by Study Year

	K	A	B	C	PDO	KABC	Total
Build Alternative - Partial Cloverleaf 1 (Single Loop Ramp) Interchange							
Opening Year 2025	0.8	4.8	15.5	28.2	87.8	49.3	**137.1**
Design Year 2045	1.2	7.2	23.1	42.2	131.2	73.7	**204.9**
Build Alternative - Partial Cloverleaf 2 (Double Loop Ramps) Interchange							
Opening Year 2025	0.8	4.9	15.8	28.7	89.4	50.2	**139.6**
Design Year 2045	1.2	7.2	23.4	42.6	132.6	74.4	**207.0**

Notes: K- fatal, A- incapacitating injury, B- non-incapacitating injury, C- possible injury, KABC- fatal & injury, PDO- property damage only

Table 35: Predictive Crash Statistics by Facility Component

Study Period Years: 2025 - 2045	K	A	B	C	PDO	KABC	Total
Build Alternative - Partial Cloverleaf 1 (Single Loop Ramp) Interchange							
Freeway Segments	13.1	76.4	246.7	449.8	1399.6	786.0	**2185.6**
Ramp Segments	1.5	8.7	28.2	51.4	159.8	89.8	**249.6**
Ramp Terminals	6.9	40.4	130.6	238.1	740.7	416.0	**1156.7**
Total	**21.5**	**125.5**	**405.5**	**739.3**	**2300.1**	**1291.8**	**3591.9**
Build Alternative - Partial Cloverleaf 2 (Double Loop Ramps) Interchange							
Freeway Segments	13.2	76.9	248.2	452.5	1408.1	790.8	**2198.9**
Ramp Segments	1.8	10.5	33.8	61.6	191.6	107.7	**299.3**
Ramp Terminals	6.9	40.0	129.2	235.6	733.0	411.7	**1144.7**
Total	**21.9**	**127.4**	**411.2**	**749.7**	**2332.7**	**1310.2**	**3642.9**

Notes: K- fatal, A- incapacitating injury, B- non-incapacitating injury, C- possible injury, KABC- fatal & injury, PDO- property damage only

Table 36: Estimated Annual Average Crash Frequency

Study Period Years: 2025 - 2045	K	A	B	C	PDO	KABC	Total
Build Alternative - Partial Cloverleaf 1 (Single Loop Ramp) Interchange							
Average Crash Frequency	1.0	6.0	19.3	35.2	109.5	61.5	**171.0**
Build Alternative - Partial Cloverleaf 2 (Double Loop Ramps) Interchange							
Average Crash Frequency	1.0	6.1	19.6	35.7	111.1	62.4	**173.5**

Notes: K- fatal, A- incapacitating injury, B- non-incapacitating injury, C- possible injury, KABC- fatal & injury, PDO- property damage only

The predictive analysis shows the total estimated number of crashes for the entire facility is 3591.9 for Partial Cloverleaf 1 and 3642.9 for Partial Cloverleaf 2 over the 20-year study period. The crossroad ramp terminal crashes in the Partial Cloverleaf 2 alternative (1144.7 crashes) are less than those predicted for Partial Cloverleaf 1 (1156.7 crashes). Under Partial Cloverleaf 2, the northbound ramp terminal is a type B2, three-leg configuration which has an increased distance from the adjacent southbound ramp terminal (approximately 300 feet further to the east along the crossroad) and with the right turn from the exit ramp occurring at the signal.

6.2 Crash Cost Analysis

The FDM (January 2020) was also used to determine the comprehensive crash costs for each crash severity level. The estimated total crash costs are $505,718,000 for Partial Cloverleaf 1 and $513,991,000 for Partial Cloverleaf 2 over the 20-year study period as shown in **Table 37**. FDOT crash costs are provided in Appendix G.

Table 37: Crash Cost Comparison

K	A	B	C	PDO	Crash Cost over Study Period
Build Alternative - Partial Cloverleaf 1 (Single Loop Ramp) Interchange					
$ 229,405,000	$ 109,513,000	$ 70,564,000	$ 78,525,000	$ 17,711,000	$ 505,718,000
Build Alternative - Partial Cloverleaf 2 (Double Loop Ramps) Interchange					
$ 233,673,000	$ 111,171,000	$ 71,556,000	$ 79,629,000	$ 17,962,000	$ 513,991,000
Notes: K- fatal, A- incapacitating injury, B- non-incapacitating injury, C- possible injury, KABC- fatal & injury, PDO- property damage only Crash Costs rounded to nearest $1,000					

6.3 Predictive Safety Analysis Summary

Based on the ISATe analysis, overall, there is not a significant difference in the estimated total number of predicted crashes between the Partial Cloverleaf 1 and Partial Cloverleaf 2 alternatives (a difference of approximately one percent during the 20-year period). Additionally, the crossroad ramp terminal crashes in the Partial Cloverleaf 2 alternative (1144.7 crashes) are less than those predicted for Partial Cloverleaf 1 (1156.7 crashes). Under Partial Cloverleaf 2, the northbound ramp terminal is a type B2, three-leg configuration which has an increased distance from the adjacent southbound ramp terminal (approximately 300 feet further to the east along the crossroad). Furthermore, there is not a significant difference in the average annual crash frequency with an estimated 171.0 crashes per year for Partial Cloverleaf 1 and an estimated 173.5 crashes per year for Partial Cloverleaf 2. Furthermore, the difference in annual total crashes between the two alternatives decline from 2.5 crashes in opening year 2025 to 2.1 crashes in design year 2045. Based on this safety evaluation, the difference in total crashes and the estimated average crash frequency between the two Build alternatives during the study period is approximately one percent. Thus, it is anticipated that the Partial Cloverleaf 2 with Double loop ramps Build alternative will not have a significant adverse impact on the overall safety and operation of the Interstate facility for the planned future traffic projections when compared to the Partial Cloverleaf 1 with Single Loop Ramp Build alternative. Note that the ISATe predictive model utilizes HSM-default SPFs that were developed based on national averages. Calibration factors are typically utilized to improve the accuracy of crash predictions and to account for differences in safety performance due to regional characteristics such as climate, driver population, crash reporting thresholds, etc. Calibration factors were not applied since FDOT currently has not developed local jurisdiction-specific calibration factors for Florida freeway facilities.