

4 Safety Analysis

A Safety Analysis Report (SAR) was prepared by FDOT in October 2018 to document the crash statistics for the most recent five years and perform a quantitative safety analysis to predict the safety performance of the RFP Concept. The analysis follows the procedures promulgated in Chapters 18 and 19 of the Highway Safety Manual – 1st Edition Supplement 2014 by the American Association of State Highway and Transportation Officials (AASHTO) and uses the ISATe Safety Analysis tool developed under the auspices of the FHWA which is based on these HSM procedures. A copy of the SAR is provided in **Appendix E**.

4.1 Crash Summary

The following section summarizes the crash statistics provided in Section 2.1 and Section 2.3 of the SAR (**Appendix E**). On SR 836 during the five-year period of 2011 to 2015, 950 crashes were recorded with an average of 190 crashes per year. Front to rear and sideswipe (same direction) were the leading crash types for the five-year period with 532 crashes and 180 crashes, respectively. On I-95 during the same period 993 crashed were recorded with an average of 199 crashes per year, similar to SR 836, front to rear and sideswipe (same direction) were the leading crash types during the five-year period with 534 crashes and 206 crashes, respectively. Based on the safety ratio calculations performed on SR 836, the last five years resulted in safety ratios greater than 1.00, indicating that the crash rates on the segment are worse than the expected critical crash rates for similar segments, however the safety ratio for I-95 during the same time period reflect a safety ratio less than one indicating that the crash rates on the segment are better than the expected critical crash rates for similar segments.

4.2 Quantitative Safety Analysis

4.2.1 Methodology

A quantitative safety analysis of the New Concept is documented in this section and follows the methodology established in the SAR. The analysis was conducted using the ISATe tool which requires the identification of the following elements:

1. Segmentation of project

- a. Freeway
- b. Ramp and collector distributor (ramps/CD) roadways
2. Data Input Parameters
3. Traffic Data

4.2.1.1 Project Segmentation

4.2.1.1.1 Freeways

The freeway segments for SR 836 and I-95 under the New Concept were defined following the framework established in the SAR and consistent with the segmentation methods when using the ISATe. **Tables 4-1** and **4-2** summarizes the freeway segments of SR 836 and I-95 for the predictive analysis. A schematic for SR 836 and I-95 freeway segments are shown in **Figures 4-1** and **4-2**, respectively.

Table 4-1: SR 836 Freeway Segments

FW Segment No.	Mainline Segments Stationing		Segment Description
	From	To	
FW Segment 1	1402+86	1412+05	SR 836 lower level - viaduct entrance/exit to SB NW 17 Ave on-ramp
FW Segment 2	1412+05	1416+45	SR 836 lower level - SB NW 17 Ave on-ramp to NB NW 17 Ave on-ramp
FW Segment 3	1416+45	1451+20	SR 836 lower level - NB NW 17 Ave on-ramp to SB NW 12 Ave on-ramp
FW Segment 4	1451+20	1454+90	SR 836 lower level - SB NW 12 Ave on-ramp to NB NW 12 Ave on-ramp
FW Segment 5	1454+90	1462+85	SR 836 lower level - NB NW 12 Ave on-ramp to NW 12 Ave off-ramp (WB)
FW Segment 6	1462+85	1470+00	SR 836 lower level - NW 12 Ave off-ramp to EB SR 836 to I-95/I-395 diverge
FW Segment 7	1414+17	1469+85 (1000+88)	SR 836 viaduct - Miami River bridge to SB I-95 off-ramp
FW Segment 8	1000+88	1022+31	SR 836 viaduct - SB I-95 off-ramp to NW 12 Ave off-ramp (WB)

Table 4-2: I-95 Freeway Segments

FW Segment No.	Mainline Segments (Stationing)		Segment Description
	From	To	
FW Segment 1	70+00	84+00	I-95 from- EB SR 836/WB I-395 on-ramp to I-195 braided ramp
FW Segment 2	84+00	98+50	I-95 from - I-195 braided ramp to NW 29 St

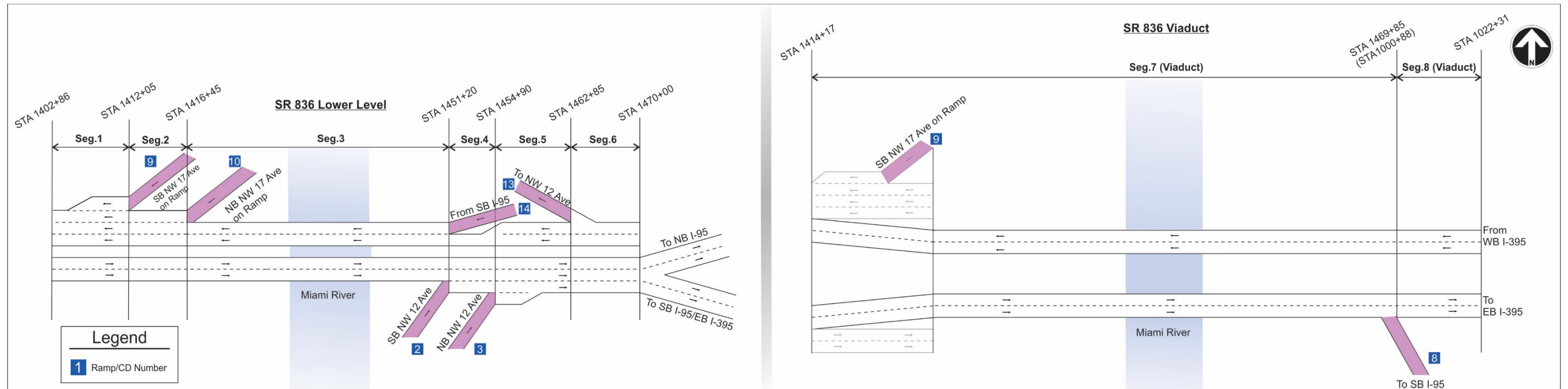


Figure 4-1: Freeway Segments Schematic – SR 836

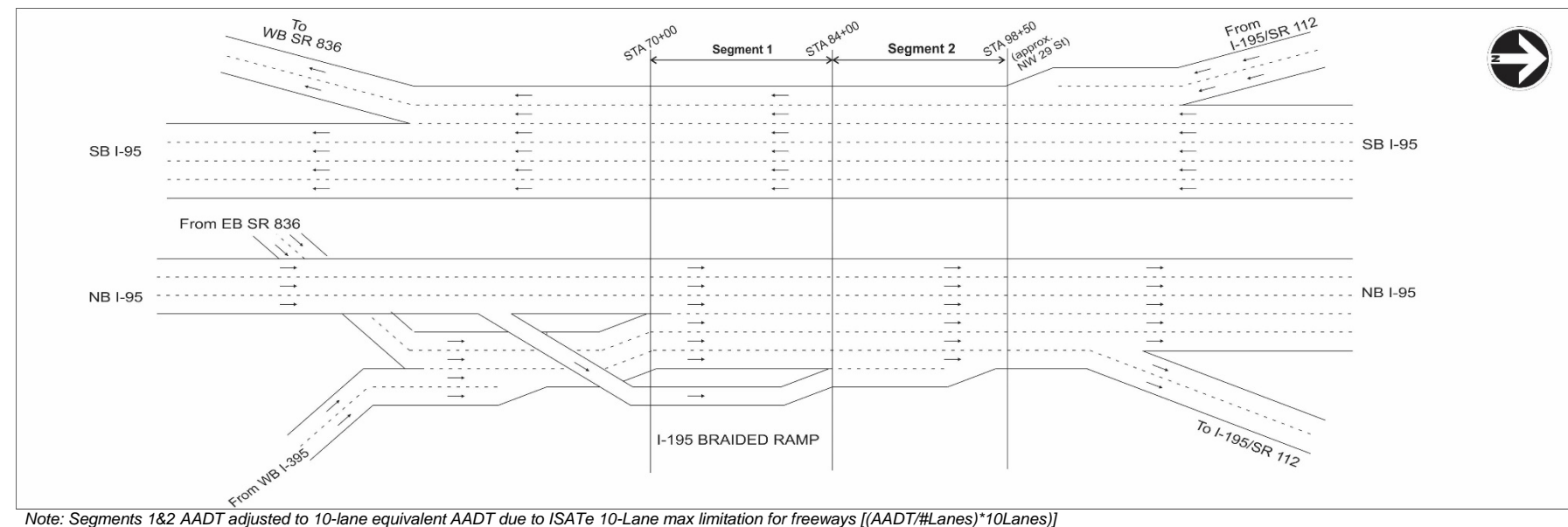


Figure 4-2: Freeway Segments Schematic – I-95

4.2.1.1.2 Ramps/CD Roadways – SR 836

The ramp/CD for SR 836 and I-95 under the New Concept were also defined following the framework established in the SAR and consistent with the segmentation methods when using the ISATe. **Tables 4-3** and **4-4** summarize the ramp/CD segments of SR 836 and I-95, respectively, for the predictive analysis. A schematic for SR 836 and I-95 ramp/CD segments are shown in **Figures 4-3** and **4-4**, respectively.

Table 4-3: Ramp/CD Segments – SR 836

CD Segment No.	Collector Distributor and Ramps			
	From	To	Dir.	Location
CD Segment 1	1453+00	1459+00	WB	SR 836 lower level - NW 12 Ave off-ramp
CD Segment 2	27+00	36+00	EB	SR 836 lower level - SB NW 12 Ave on-ramp
CD Segment 3	9447+00	9458+00	EB	SR 836 lower level - NB NW 12 Ave on-ramp
CD Segment 4	5470+00	5475+00	EB	SR 836 lower level – NB I-95/EB I-395 diverge to EB I-395/SB I-95
CD Segment 5	5475+00	5485+00	EB	SR 836 lower level – EB I- 395/SB I-95 diverge to SB I-95
CD Segment 6	5485+00 (6485+00)	6495+00	EB	SR 836 lower level - EB SR 836 off-ramp merge to SB I-95/NW 8 St
CD Segment 7	308+00	325+00	EB	SR 836 lower level – EB i-395/SB I-95 diverge to EB I-395
CD Segment 8	6475+00	6485+00	EB	SR 836 viaduct – SB I-95 off-ramp
CD Segment 9	4410+00	4419+00	WB	SR 836 lower level - SB NW 17 Ave on-ramp
CD Segment 10	4416+00	4422+00	WB	SR 836 lower level - NB NW 17 Ave on-ramp
CD Segment 11	6452+00	6460+00	WB	SR 836 lower level - SB I-95 to NW 12 Ave
CD Segment 12	3464+00	3476+00	WB	SB I-95 - NW 10 Ave /NW 14 St off-ramp
CD Segment 13	1458+00	1463+00	WB	SR 836 lower level - NW 12 Avenue off-ramp
CD Segment 14	1450+00	1470+00	WB	SR 836 collector distributor - SB I-95 to WB SR 836
CD Segment 15	4470+00	4495+00	WB	SR 836 lower level - NB I-95 to WB SR 836 Ramp
CD Segment 16	1473+00	1488+00	WB	SR 836 viaduct - WB I-395 to NW 12 Ave
CD Segment 17	1470+00	1476+00	EB	SR 836 collector distributor – NW 14 St to NW 12 Ave/WB SR 836
CD Segment 18	1476+00	1481+00	EB	SB I-95 – WB SR 836 collector distributor off-ramp
CD Segment 19	12470+00	12493+00	WB	SR 836 lower level - NB I-95 on-ramp

Table 4-4: Ramp/CD Segments – I-95

CD Segment No.	Collector Distributor and Ramps			
	From	To	Dir.	Location
CD Segment 1	12500+63.67	12508+39.83	NB	EB SR 836 lower level/WB I-395 – NB I-95 Mainline
CD Segment 2	12508+39.83	12509+45.43	NB	EB SR 836 lower level/WB I-395 – NB I-95 Mainline
CD Segment 3	58+87.24	87+91.24	NB	NB I-95 Mainline – EB I-195/SR112

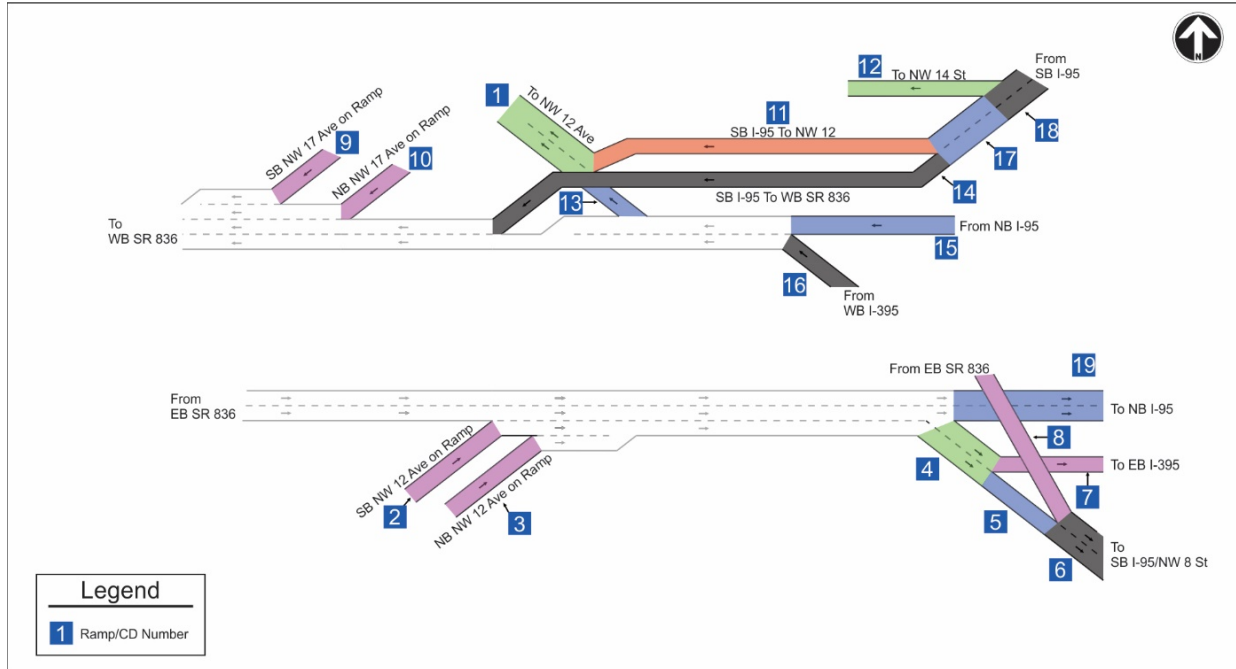
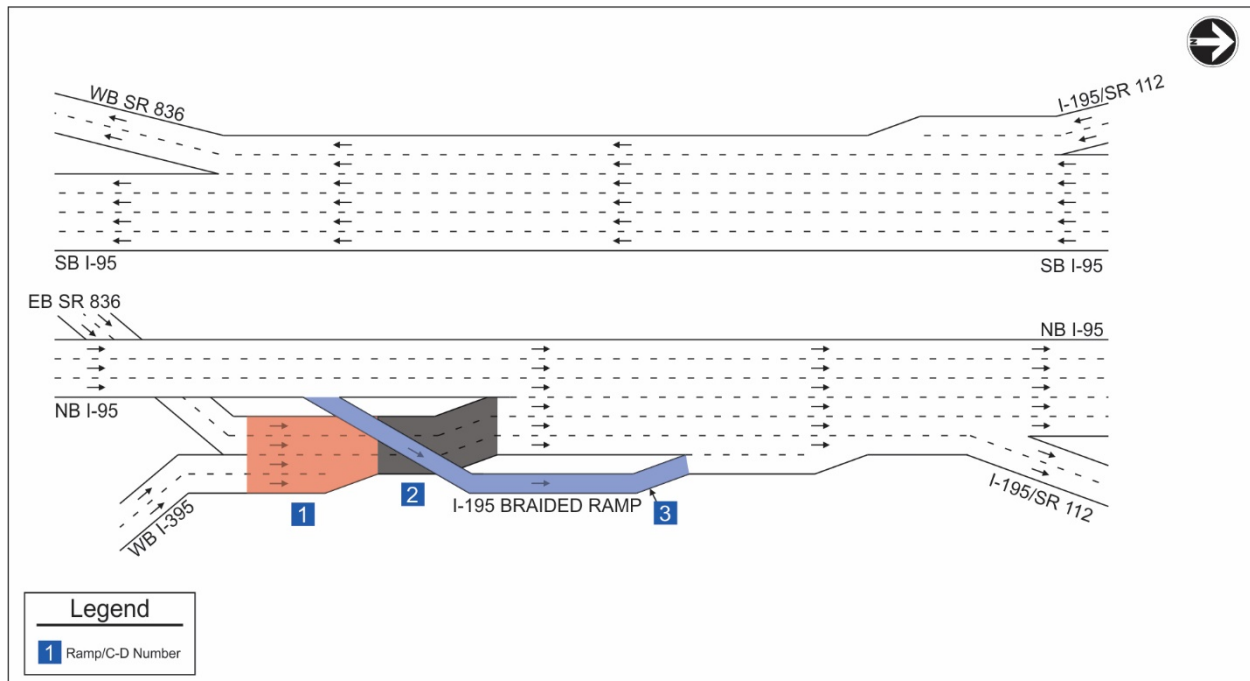


Figure 4-3: Ramp/CD Segments Schematic – SR 836



Note: Segment 1&2 AADT adjusted to 2-lane equivalent AADT due to ISATe 2-Lane max limitation for ramps $[(AADT/\#Lanes) * 2Lanes]$

Figure 4-4: Ramp/CD Segments Schematic – I-95

4.2.1.2 Data Input Parameters

For “apples to apples” comparison the input parameters from the SAR were maintained and are summarized in **Table 4-5**. It should be noted that the roadway geometry inputs were extracted from the New Concept final design Line and Grade Plans.

Table 4-5: Summary of Data Inputs and Parameters

Input Field	Freeway Segments	Ramp/CD Road
Number of through lanes	X	X
Length of segment	X	X
Presence of an entrance or exit speed-change lane	X	X
Length of speed-change lane	X	X
Average traffic speed	N/A	X
Presence of a horizontal curve, and curve information	X	X
Lane width	X	X
Outside and inside shoulder widths	X	X
Median width	X	N/A
Length of rumble strips on the inside (or median) shoulder and on the outside (or roadside) shoulder	X	N/A
Length of (and offset to) the barrier on the Left Shoulder and the barrier on the Right Shoulder	X	X
Width of median barrier	X	N/A
Presence and length of a Type B weaving section	X	N/A
Presence and length of a weaving section on a CD road segment	N/A	X
Distance to nearest upstream entrance ramp and nearest downstream exit ramp in each travel direction	X	N/A
Clear zone width	X	N/A
Proportion of AADT traffic volume in peak hours (K value)	X	N/A
Segment AADT volume	X	X
Upstream entrance ramp AADT volume	X	N/A
Downstream exit ramp AADT volume	X	N/A
Type of traffic control used at the crossroad ramp terminal to regulate intersecting traffic (none, yield, stop, signal)	N/A	X
Presence of lane added or dropped to the ramp or CD road, and length of the taper in the segment if present	N/A	X

4.2.1.3 Traffic Data

The future traffic volumes (year 2035) and traffic characteristics used in the analysis were obtained from the PM peak hour CORSIM analysis conducted for this SIMR re-evaluation. Furthermore, the peak to daily traffic volume ratio used in the analysis to estimate the Annual Daily Traffic (ADT) was $K=7.68\%$, as previously identified in **Section 2**. See **Appendix E** for traffic data summary table. AADTs for I-95 freeway and ramp/CD segments were adjusted due to ISATe number of lanes limitations. The freeway segments

were adjusted to 10-lane equivalent AADTs and the ramp segments were adjusted to 2-lane equivalent AADTs.

4.2.2 Future Safety Conditions

The following sections summarize the predicted crashes for SR 836 and I-95 freeway, ramp, and CD segments obtained from the ISATe spreadsheet. The detailed spreadsheet showing the inputs and breakdown of crashes is provided in **Appendix E**.

4.2.2.1 Freeway Segments

Following the same numbering system used in the previous figures, the summary of the expected number of crashes and the predicted crash rates [Crashes per Million Vehicle (Veh.) Miles per year] on the Freeway segments are summarized in **Tables 4-6** and **4-7**. It should be noted that AADTs for I-95 freeway segments 1 and 2 were adjusted to 10-lane equivalent AADTs due to ISATe 10-lane maximum limitation for freeway segments.

Table 4-6: Summary of SR 836 Expected Crashes on Freeway Segments

Segment Number	Predicted # Crashes	Length (Mile)	AADT	Predicted ¹ Crash Rate	Average ² Vehicle Exposure (M)	% of Network
FW Segment 1	4.19	0.17	82,852	0.82	5.14	6%
FW Segment 2	1.68	0.08	73,190	0.79	2.14	3%
FW Segment 3	13.72	0.66	68,815	0.83	16.58	24%
FW Segment 4	1.27	0.07	64,492	0.77	1.65	3%
FW Segment 5	3.27	0.15	78,659	0.76	4.31	5%
FW Segment 6	3.70	0.14	88,112	0.82	4.50	5%
FW Segment 7	25.31	1.05	66,979	0.99	25.67	38%
FW Segment 8	4.65	0.41	45,339	0.69	6.78	15%
Total	57.81	2.73	Wt. Avg.³	0.86		

¹Predicted Crash Rate = $(1 \times 10^6 \times \text{Predicted \# Crashes}) / (365 \times \text{AADT} \times 1 \times \text{Length})$; ² $(\text{AADT} \times \text{Length} \times 365) / (1 \times 10^6)$; ³ $(\text{Lengths} \times \text{Predicted Crash Rates}) / \sum \text{Lengths}$

Table 4-7: Summary of I-95 Expected Crashes on Freeway Segments

Segment Number	Predicted # Crashes	Length (Mile)	AADT	Predicted ¹ Crash Rate	Average ² Vehicle Exposure (M)	% of Network
FW Segment 1	20.31	0.27	207,313	0.99	20.43	50%
FW Segment 2	20.81	0.27	219,542	0.96	21.64	50%
Total	41.12	0.54	Wt. Avg.³	0.98		

¹Predicted Crash Rate = $(1 \times 10^6 \times \text{Predicted \# Crashes}) / (365 \times \text{AADT} \times 1 \times \text{Length})$; ² $(\text{AADT} \times \text{Length} \times 365) / (1 \times 10^6)$; ³ $(\text{Lengths} \times \text{Predicted Crash Rates}) / \sum \text{Lengths}$

³AADT adjusted to reflect 10-lane equivalent AADT due to ISATe 10-lane max limitation for freeway segments $[(\text{AADT} / \# \text{Lanes}) \times 10 \text{Lanes}]$

4.2.2.2 Ramps/CD Roadways

Following the same numbering system used in the previous figures, the summary of the expected number of crashes and the predicted crash rates [Crashes per Million Vehicle (Veh.) Miles per year] on the ramp/CD segments are summarized in **Tables 4-8** and **4-9**. It should be noted that AADTs for I-95 ramp/CD segments 1 and 2 were adjusted to 2-lane equivalent AADTs due to ISATe 2-lane maximum limitation for ramp/CD segments.

Table 4-8: Summary of SR 836 Expected Crashes on Ramp/CD Segments

Segment Number	Predicted # Crashes	Length (Mile)	AADT	Predicted ¹ Crash Rate	Average ² Vehicle exposure (M)	% of Network
CD Segment 1	3.11	0.95	8,620	1.04	2.99	20%
CD Segment 2	3.66	0.17	13,294	4.44	0.82	4%
CD Segment 3	4.26	0.21	14,141	3.96	1.08	4%
CD Segment 4	1.23	0.09	22,617	1.57	0.78	2%
CD Segment 5	0.21	0.19	3,216	0.93	0.22	4%
CD Segment 6	3.30	0.19	25,104	1.90	1.74	4%
CD Segment 7	2.01	0.32	19,427	0.88	2.28	7%
CD Segment 8	1.25	0.19	21,901	0.82	1.51	4%
CD Segment 9	2.23	0.17	9,648	3.72	0.60	4%
CD Segment 10	0.44	0.11	4,440	2.37	0.18	2%
CD Segment 11	0.57	0.15	2,865	3.62	0.16	3%
CD Segment 12	1.23	0.23	10,547	1.41	0.87	5%
CD Segment 13	0.19	0.09	5,768	0.93	0.20	2%
CD Segment 14	1.77	0.38	18,359	0.70	2.54	8%
CD Segment 15	4.26	0.47	19,974	1.24	3.45	10%
CD Segment 16	0.35	0.28	3,138	1.08	0.33	6%
CD Segment 17	1.04	0.11	21,198	1.19	0.88	2%
CD Segment 18	2.26	0.09	31,667	2.07	1.09	2%
CD Segment 19	11.24	0.44	38,477	1.84	6.12	9%
Total	44.61	4.85	Wt. Avg³	1.62		

¹Predicted Crash Rate = $(1 \times 10^6 \times \text{Predicted \# Crashes}) / (365 \times \text{AADT} \times 1 \times \text{Length})$; ² $(\text{AADT} \times \text{Length} \times 365) / 1 \times 10^6$; ³ $\sum (\text{Lengths} \times \text{Predicted Crash Rates}) / \sum \text{Lengths}$

Table 4-9: Summary of I-95 Expected Crashes on Ramp/CD Segments

Segment Number	Predicted # Crashes	Length (Mile)	AADT	Predicted ¹ Crash Rate	Average ² Vehicle exposure (M)	% of Network
CD Segment 1	1.69	0.15	33,757	0.93	1.81	21%
CD Segment 2	0.71	0.02	45,009	2.15	0.33	3%
CD Segment 3	1.91	0.55	14,714	0.65	2.95	77%
Total	4.31	0.72	Wt. Avg³	0.75		

¹Predicted Crash Rate = $(1 \times 10^6 \times \text{Predicted \# Crashes}) / (365 \times \text{AADT} \times 1 \times \text{Length})$; ² $(\text{AADT} \times \text{Length} \times 365) / 1 \times 10^6$; ³ $\sum (\text{Lengths} \times \text{Predicted Crash Rates}) / \sum \text{Lengths}$

³AADT adjusted to reflect 2-lane equivalent AADT due to ISATe 2-lane max limitation for ramp/CD segments $[(\text{AADT} / \# \text{Lanes}) \times 2 \text{Lanes}]$

4.2.3 Summary of Future Safety Conditions

As shown in **Table 4-6** and **Table 4-7**, the total expected crashes for SR 836 and I-95 freeway segments are 57.81 crashes and 41.12 crashes, respectively. As shown in **Table 4-8** and **Table 4-9**, the total expected crashes for SR 836 and I-95 ramp/CD segments are 44.61 crashes and 4.31 crashes, respectively.

In order to further evaluate the safety performance of the New Concept, the results obtained from this safety analysis were compared to the results of the RFP Concept provided in the SAR. **Table 4-10** summarizes the total predicted crashes and weighted predicted crash rates for the two concepts. Results from the comparison show that the total predicted crash rates increase under the New Concept as a result of the additional 1.5 miles of segments analyzed. In terms of weighted predicted crash rates, the New Concept and RFP Concept result in similar values for both SR 836 and I-95 freeway segments. For I-95 ramp/CD segments, the New Concept results in a weighted predicted crash rate reduction from 1.68 to 0.75 compared to the RFP concept. For SR 836 ramp/CD segments, the New Concept results in a weighted predicted crash rate minor increase from 1.21 to 1.62 compared to the RFP Concept. Given the overall increase in segments analyzed under the New Concept compared to the RFP Concept and similar results obtained from the quantitative safety analysis, it is determined that the safety performance of the New Concept is equal to the RFP Concept.

Table 4-10: RFP Concept vs New Concept Future Safety Performance

Safety Measure	SR 836				I-95			
	Freeway		Ramp/CD		Freeway*		Ramp/CD	
	RFP	NEW*	RFP	NEW*	RFP	NEW	RFP	NEW
Total Predicted Crashes	48.90	57.81	34.77	44.61	44.77	41.12	13.48	4.31
Weighted Predicted Crash Rate	0.90	0.86	1.21	1.62	0.94	0.98	1.68	0.75
Total Length (miles)	1.22	2.73	4.04	4.85	0.54	0.54	0.68	0.72

**For "apples to apples comparison" RFP statistics were based on SR 836 FW seg. 1-5, CD seg. 1-9 and 13-19; for I-95 FW seg. 19-20, CD seg. 40, 43-45*