Technical Memo

Date: June 29, 2018

Project: I-229 Exit 9 (Benson Road) Interchange Modification Justification Report
Project # PL0100(82) P, PCN 06MF

To: Study Advisory Team

From: HDR

Subject: Predictive Crash Analysis for Interstate 229 Interchange at Benson Road

1. Introduction

The South Dakota Department of Transportation (SDDOT) is proposing to reconstruct the existing Interstate 229 (I-229) / Benson Road interchange in Sioux Falls. The build alternatives are a dual-lane loop ramp (DLLR) and a Diverging Diamond Interchange (DDI), which would replace the existing diamond interchange. In accordance with The Federal Highway Administration (FHWA) requirements, a change in Interstate access requires an Interchange Modification Justification Report (IMJR), including a safety analysis assessing the no-build and proposed build interchange alternatives. This memorandum presents a summary of the methodology and findings for the predicted safety performance analysis for the no-build and build alternatives for the I-229 / Benson Road project.

The analysis limits for this study are focused on the immediate interchange area as shown in **Figure 1**. On I-229, the limits extend from the interchange of I-229 / Rice Street to the interchange of I-229 / I-90, for a total distance of 2.3 miles. In addition to the freeway, the four interchange ramps and the two ramp terminals were analyzed.

Three alternatives were evaluated with this predictive safety analysis. The “No-Build” alternative maintains the existing diamond interchange layout. The second alternative adds a dual-lane loop ramp in the northeast quadrant to serve northbound I-229 traffic turning west onto Benson Road. This alternative would also reconfigure the alignments and lane layouts for other ramps, but they would still maintain the traditional diamond interchange layout. The third alternative would convert the interchange to a diverging diamond interchange. Within these general configurations, the IMJR includes review of several variations of the DLLR and DDI. However, the crash prediction analysis herein is based on the DLLR concept numbered 1a and the DDI concept denoted 4a.

The predictive crash analysis presented in this memorandum is based on the principles and methods of the Highway Safety Manual (HSM) 2010 edition with 2014 supplement published by AASHTO as discussed in detail below. It presents a comparative analysis of the predicted crashes anticipated within the interchange area for the “No-Build” future condition (maintain diamond interchange) and the planned build alternatives (DLLR and DDI). The results are intended to verify the assumption that the construction of a DLLR or DDI at this location will not result in a decrease in overall safety performance in the interchange area.

Appendix A provides the concept layouts for the no-build condition and the build alternatives.

Appendix B provides the Interactive Highway Safety Design Model (IHSDM) worksheets.

Figure 1 – IHSDM Analysis Limits

Source: Google Earth, April 2018

2. Methodology

This predictive safety analysis was completed using the American Association of State Highway and Transportation Officials (AASHTO) HSM method, including the National Cooperative Highway Research Program (NCHRP) Report 17-45 method for evaluating freeways and interchanges, which is now part of the HSM as a supplemental volume published in 2014.

FHWA supports, and in many cases now requires, the use of the method for the evaluation of proposed freeway facility improvements, including new or modified Interstate access. According to the HSM preface: *"The focus of the HSM is to provide quantitative information for decision making. The HSM assembles currently available information and methodologies on measuring, estimating, and evaluating roadways in terms of crash frequency (number of crashes per year) and crash severity (level of injures due to crashes). The HSM presents tools and methodologies for consideration of 'safety' across the range of highway activities …"*

For this study, the HSM predictive method was used. *"The predictive method provides a quantitative measure of expected crash frequency under both existing conditions and conditions which have not yet occurred. This allows proposed roadway conditions to be quantitatively assessed …"* (HSM, 2010)

The HSM method crash prediction estimates are developed using safety performance functions (SPFs) for specific facility types. The SPFs take into account the daily traffic volume information, but they assume that other geometric and traffic control features match a theoretical base condition for that facility type. Therefore, crash modification factors (CMFs) are used to make adjustments to the initial SPF results, to account for differences between the actual analysis condition and the theoretical base condition. A CMF of 1 means the analysis condition and the theoretical base condition will predict the same number of crashes. Thus, if a CMF is greater than 1, that will increase the number of predicted crashes, while if it is less than 1, it will decrease the number of predicted crashes. For example, if a depressed freeway median is narrower than the assumed 60-foot base condition, then a CMF of greater than 1 is applied to adjust the SPF results for the segment.

The HSM methodology has been in development for many years and is rapidly advancing; however, there are still many limitations where the available tools do not yet offer SPFs and/or CMFs for certain conditions. Where this is the case, recent research and crash data were also considered to refine the results as described later in this section.

2.1 Facilities, Segmentation and Data Inputs:

In keeping with the site based HSM analysis approach, each type of facility was examined separately. This involved segmenting the I-229 mainline and the I-229 ramps into functional elements. The Interactive Highway Safety Design Model (IHSDM) software automatically segments highways (including freeway segments, ramps and C-D roads) following HSM guidance. The ramp terminal intersections were also considered individually. IHSDM reports provided in the **Appendix** list all freeway, ramp, and ramp terminal intersection sites that were reviewed.

The HSM method requires several geometric and operational inputs to accurately compute the SPFs and apply the correct CMFs. This includes information such as segment length, daily traffic volume, ramp locations, merge distances, and horizontal curvature. The geometric inputs were primarily obtained from the conceptual design files and aerial photography. The traffic volume data was based on data and design year volume forecasts from the 2040 Sioux Falls Travel Demand Model.

2.2 I-229 Mainline Segments

The I-229 mainline segments were evaluated using HSM methods implemented using the Interactive Highway Safety Design Model (IHSDM) version 13.1.0 software provided by FHWA.

2.3 I-229 Entrance and Exit Ramps

The I-229 entrance and exit ramps were also evaluated using HSM methods in the IHSDM software. Consistent with this method, each ramp was evaluated as one or more specific ramp segments, taking into account the ramp geometry. Some of the ramps were subdivided into multiple segments to account for changes in number of lanes or shoulder widths.

In the DLLR alternative, the I-229 Northbound exit ramp traverses a portion of two-lane ramp alignment with a tight curve radius before intersecting Benson Road. The condition is uncommon in practice and was very likely unobserved or under-sampled in the development of the HSM crash prediction models. Past research for SDDOT on this gap in the crash prediction methodology led to the “Crash Prediction Analysis Procedures for Diverging Diamond Interchange (DDI) and Two-Lane Loop Ramp” memo dated November 4th, 2015. In the memo, it is recommended to analyze the two-lane loop ramp, now called DLLR, with standard HSM procedures with greater scrutiny unless the research results of NCHRP 03-105 should develop enhanced models / guidance. The referenced research project was published in 2017 as NCHRP Web-Only Document 227: Design of Interchange Loop Ramps and Pavement/Shoulder Cross-Slope Breaks. The report includes a chapter reviewing the HSM procedure for loop ramps against directional ramps, but does not make recommendations on the specific DLLR geometry. The report’s most poignant comment on loop ramp crash prediction is that *“HSM prediction models for ramp crashes do a better job of predicting diamond ramp crashes than predicting loop ramp crashes”,* which the researchers arrived at through advanced statistical analysis of geometry and crash data.

2.4 Benson Road Ramp Terminals

For the No-Build and Build options, the ramps connect to Benson Road at signalized and non-signalized intersections. Interchange ramp terminals are evaluated using the HSM ramp terminal procedure in IHSDM. The IHSDM ramp terminal method does not, however, address DDIs. It only predicts crashes for a variety of more typical diamond and partial cloverleaf interchange ramp terminals. Therefore, it was necessary to develop an estimate for an "operationally-similar" diamond interchange design and then use CMFs from HDR's "Crash Prediction Analysis Procedures for Diverging Diamond Interchange (DDI) and Two-Lane Loop Ramp" memo dated November 4th, 2015 to modify the results to estimate the predictions for a DDI design. Based on research done in Missouri on safety evaluations of DDIs, the preliminary CMF for conversion of a traditional diamond interchange to a DDI is 0.37 for Fatal + Injury (F+I) crashes at ramp terminal intersections and 0.49 for Property Damage Only (PDO) crashes at ramp terminal intersections.

2.5 Benson Road Segments

Crash prediction for an interchange study area within a typical urban footprint can be almost entirely described by evaluating the crashes from the freeway, freeway ramps, and ramp terminal intersections due to how the HSM defines the influence area for those types of sites. For that reason, this analysis does not report urban arterial crashes outside of those estimated directly through ramp terminal analysis. Given the emerging nature of both the DLLR and DDI configurations in crash prediction practice, it is likely that the base HSM models would struggle to replicate the crash patterns for the proposed Benson Road configuration between the interchange ramp terminals.

2.6 Calibration Factors:

According to the HSM, *"the predictive models were developed from the most complete and consistent data sets available."* However, the report also recommends that the equations be calibrated for each jurisdiction because *"the general level of crash frequencies may vary substantially from one jurisdiction to another."* However, SDDOT has not yet conducted the extensive analyses required to develop a complete set of HSM related calibration factors. Therefore, using the national HSM equations is proposed as the best approach for this current analysis.

2.7 Empirical Bayes Approach: Considering Historical Crash Data:

The HSM method includes an optional step called the Empirical Bayes (EB) approach, which combines "*the estimate from a predictive model with observed crash data to obtain a more reliable estimate of the expected average crash frequency."* (HSM, 2010) Essentially, the historical crash data is used to adjust the future crash prediction. Typically, the EB method is only used when it can be applied equally to all of the alternatives under consideration. Thus the improvements being considered must be moderate, so that the historical crash data is reasonable to consider for the No-Build and Build conditions. When major alignment or traffic control changes are proposed (such as the proposed DLLR or DDI), it is not used because *"there is typically a small difference in the results obtained from the predictive method when it is used with and without the EB Method."* Therefore, *"if the EB Method is not applied consistently, such differences will likely introduce a small bias in the comparison of expected crash frequency among alternatives."* (HSM Supplement, 2014) Therefore, the results are presented without the EB method adjustment.

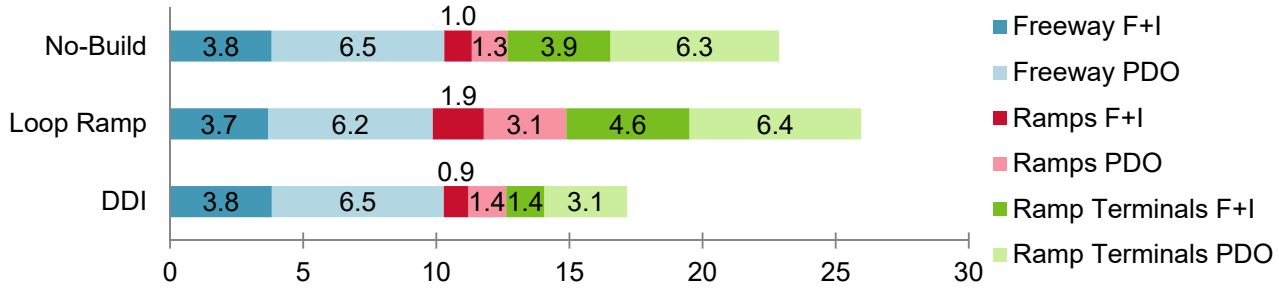
3. Analysis Results

The No-Build and Build interchange alternatives were evaluated and the predicted number of crashes was compared for the 2023 to 2045 analysis period. As mentioned previously, the required inputs were derived from design plans, aerial photography, and traffic volume data from the 2040 Sioux Falls Travel Demand Model. The following sections present the details of the analyses.

3.1 Build and No-Build Crash Frequency Comparison:

The predicted annual crash frequencies for the No-Build and Build scenarios (2023 to 2045) are presented in **Table 1** including a breakdown of Fatal + Injury (F+I) and Property Damage Only (PDO) crashes. The resulting total number of annual predicted crashes is 26.0 for the DLLR concept, 17.2 for the DDI concept, and 22.9 predicted crashes for the No-Build condition. The No-Build and Build detailed IHSDM results sheets are provided in **Appendix B**.

Table 1: 2023 to 2045 Predicted Build and No-Build Annual Crash Frequencies



As shown, the majority of predicted crashes for all scenarios occur on the freeway and at the ramp terminal intersections. The freeway crashes for the Build scenarios introduce small changes in the predicted number of crashes versus the No-Build. The ramp crashes are expected to increase due to added lanes and additional length on some of the ramps.

Focusing on the ramp terminals, the DLLR ramp terminal crashes are expected to increase by 8% and the DDI ramp terminal crashes are expected to be reduced by 56%. The reduction for the DDI is consistent with what would be expected from eliminating left-turns with the DDI concept. The DLLR findings are more surprising given that the loop ramp re-aligns a significant amount of traffic from a left turn movement to a right turn movement at the northbound ramp terminal. A more in-depth review of this site does show that the DLLR reduces total crashes from 7 crashes per year to 2.5 crashes per year, consistent with the significant amount of traffic that has moved to the loop ramp and no longer would be in conflict with cross street traffic. This means the net increase in ramp terminal crashes is projected to happen entirely at the southbound ramp terminal. The primary consideration in this increase is the traffic control device at the intersection as the No-Build assumes a continuation of the stop-controlled condition where the DLLR alternative recommends a traffic signal to improve traffic operations. Since there is not a traffic signal planned for the southbound ramp terminal, it was not considered for the No-Build scenario, even though operations would degrade to a failing level of service condition if volumes increased to the 2045 forecasted levels.

Considering predicted crash severity, the DDI concept may decrease the number of F+I crashes at the ramp terminals by 63% while the DLLR concept may increase F+I crashes by 17%. In addition, the DDI concept may decrease the number of PDO crashes at the ramp terminals by 51% while the DLLR concept may increase by 2%. This result took into account the significant reduction in F+I crashes observed at DDIs compared to standard diamond interchanges in the Missouri research (63% reduction).

4. Conclusions

Based on the preceding HSM analysis, it is concluded that the DDI interchange is likely to exhibit significantly less overall crash frequencies than the existing diamond interchange. The DLLR would likely result in an increase in crashes, but this is due to a longer northbound ramp, and the southbound terminal being signalized instead of stop-controlled. The northbound terminal, in this scenario, would be expected to have a decrease in crashes compared to the No-Build. The freeway crashes for the Build scenarios introduce small changes in the predicted number of crashes versus the No-Build. The ramp crashes are expected to increase due to added lanes and additional length on some of the ramps. The ramp terminal crashes are expected to be reduced by 56% for the DDI and increased by 8% for the DLLR. The DDI has an even better crash benefit when looking at F+I crashes. The DDI reduces F+I crashes at the ramp terminals by 63%, compared to an increase of 19% for the DLLR. The PDO crashes at the ramp terminals are reduced by 51% for the DDI and an increase of 2% for the DLLR. The DDI alternative would be expected to provide significant safety benefits compared to the No-Build, but the DLLR alternative would likely result in an increase of crashes compared to the No-Build.

APPENDIX A

Interchange Alternatives

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Figure 1A – No-Build Scenario

Source: Google Earth, April 2018

Legend

- Interchange/Ramp/Loop Construction
- Pedestrian Underpass Construction
- Raised Median Construction
- Bridge Construction
- Retaining Wall
- Existing ROW / Property Line
- ROW Acquisition
- Road Closure
- Signalized Intersection
- < 3 Number of Traffic Lanes

N

Scale in Feet
0 200 400

St Paul Avenue
Benson Road
Potsdam Avenue
52nd Street N
54th Street N
Hainje Avenue
INTERSTATE 229
300' Radius
V = 30 mph

Benson 1a Option Features:

- Dual right turn lane and free right turn movement for EB Benson Road to SB I-229 traffic.
- 30 mph 2-lane ramp loop for NB I-229 to WB Benson Road traffic.
- Pedestrian underpass for NB off-ramp / NB on-ramp loop.
- Realign I-229 NB off-ramp, EB on Benson Road yield movement.
- 3rd WB lane on Benson Road from I-229 to the west.
- 3rd EB lane on Benson Road from Lewis Avenue to I-229.
- Widen existing Benson Road bridge.
- Raised median Benson Road with left turn lanes.
- Retaining walls necessary for power poles and pedestrian underpass.

Drawn By: B.Miller
Date: 5/14/2018
Chked By: P.Sanow
Date: 5/14/2018
Revision:

Alternative Scenario 1a
2-Lane Northeast Quadrant Loop with 3-Lane SB On-Ramp.
I-229 Exit 9 (Benson Road) IMJR
Sioux Falls, SD

Figure
2A

Legend

- Interchange/Ramp/Loop Construction
- Pedestrian Underpass Construction
- Raised Median Construction
- Bridge Construction
- Retaining Wall
- Existing ROW / Property Line
- ROW Acquisition
- Road Closure
- Signalized Intersection
- < 3 Number of Traffic Lanes

N

Scale in Feet
0 200 400

St Paul Avenue
Benson Road
Potsdam Avenue
52nd Street N
54th Street N
Hainje Avenue
INTERSTATE 229

< 3 | 3 > | < 2 | 2 > | < 3 | 3 > | < 4 | 2 > | < 2 | 2 > | < 2 | 2 > | < 4 | 2 > | 3 > | 1 > | 2 > | 2 > | 2 > | < 2

Benson 4a Option Features:

- Diverging Diamond Interchange configuration.
- Widen existing Benson Road bridge.
- Realign west I-229 ramps to maximize separation distance to Potsdam Avenue.
- 2-lane free right turn movement for EB Benson Road to SB I-229 traffic.

Drawn By: B.Miller
Date: 5/14/2018
Chked By: P.Sanow
Date: 5/14/2018
Revision:

Alternative Scenario 4a
Diverging Diamond Interchange with 3-Lane SB On-Ramp. Add 2 WB Lanes to Existing Overpass.
I-229 Exit 9 (Benson Road) IMJR
Sioux Falls, SD

Figure
3A

APPENDIX B

Crash Prediction Evaluation Reports

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Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 1:23 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:17:04 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
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E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: I-229
Highway Comment: Created Wed Apr 11 10:14:11 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 13:14:11 CDT 2018

Minimum Location: 324+28.000
Maximum Location: 447+11.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Section 1 Evaluation

Section: Section 1
Evaluation Start Location: 324+28.000
Evaluation End Location: 447+11.000
Functional Class: Freeway
Type of Alignment: Divided, Multilane
Model Category: Freeway Segment
Calibration Factor: FI_EN=1.0; FI_EX=1.0; FI_MV=1.0; FI_SV=1.0; PDO_EN=1.0; PDO_EX=1.0; PDO_MV=1.0; PDO_SV=1.0;

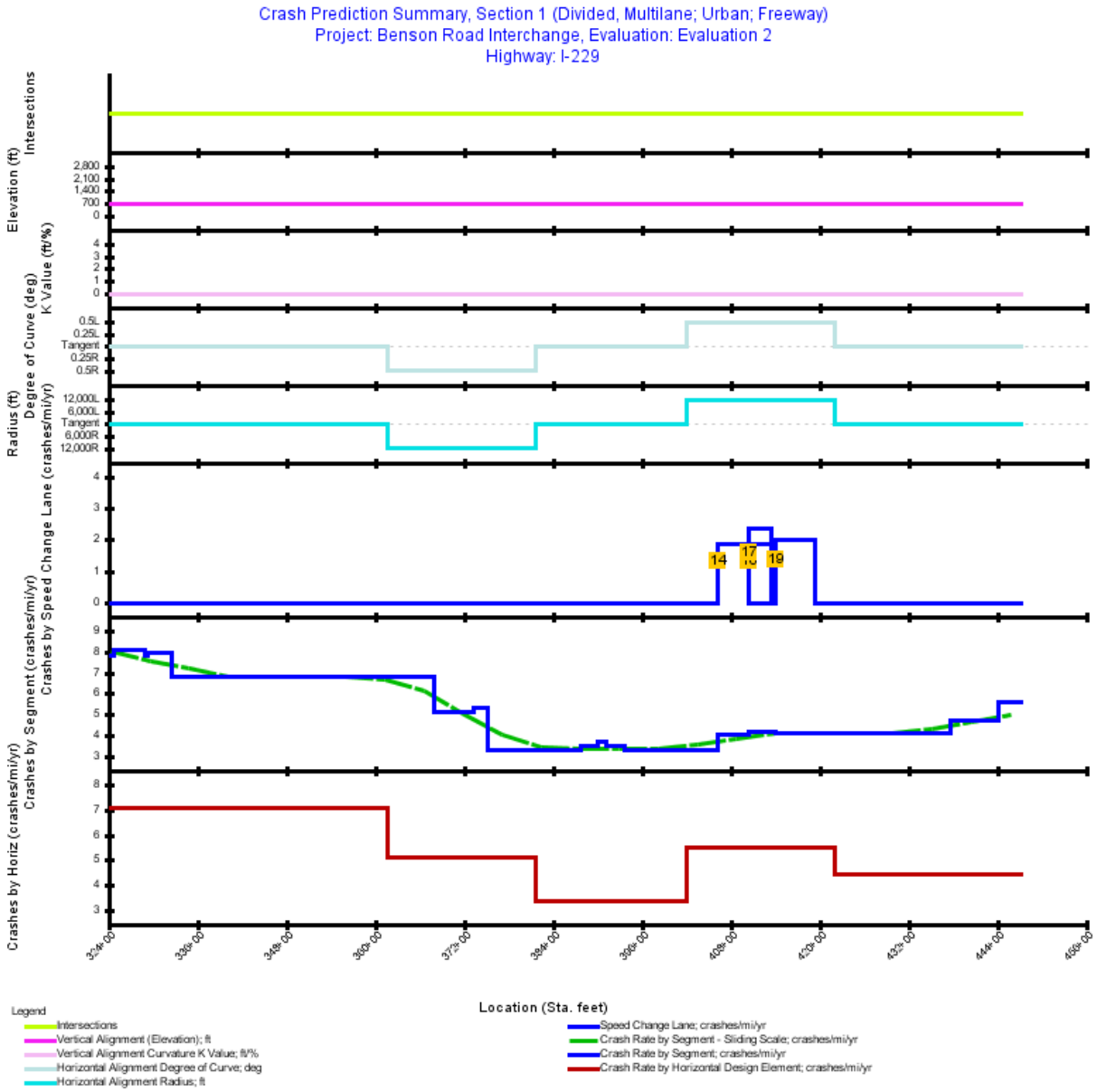

Figure 1. Crash Prediction Summary (Section 1)

Table 1. Evaluation Freeway - Homogeneous Segments (Section 1)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
1	6F	Urban	324+28.000	324+58.000	30.00	0.0057	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
2	6F	Urban	324+58.000	328+83.000	425.00	0.0805	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
3	6F	Urban	328+83.000	329+22.000	39.00	0.0074	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
4	6F	Urban	329+22.000	332+44.000	322.00	0.0610	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
5	6F	Urban	332+44.000	367+88.000	3,544.00	0.6712	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
6	6F	Urban	367+88.000	373+20.500	532.50	0.1008	2023: 26,300; 2024: 26,775; 2025: 27,250; 2026: 27,725; 2027: 28,200; 2028: 28,675; 2029: 29,150; 2030: 29,625; 2031: 30,100; 2032: 30,575; 2033: 31,050; 2034: 31,526; 2035: 32,001; 2036: 32,476; 2037: 32,951; 2038: 33,426; 2039: 33,901; 2040: 34,376; 2041: 34,851; 2042: 35,326; 2043: 35,801; 2044: 36,276; 2045: 36,752	60.00	Traversable Median	72.00
7	5F	Urban	373+20.500	375+20.000	199.50	0.0378	2023: 26,300; 2024: 26,775; 2025: 27,250; 2026: 27,725; 2027: 28,200; 2028: 28,675; 2029: 29,150; 2030: 29,625; 2031: 30,100; 2032: 30,575; 2033: 31,050; 2034: 31,526; 2035: 32,001; 2036: 32,476; 2037: 32,951; 2038: 33,426; 2039: 33,901; 2040: 34,376; 2041: 34,851; 2042: 35,326; 2043: 35,801; 2044: 36,276; 2045: 36,752	60.00	Traversable Median	72.00
8	4F	Urban	375+20.000	387+71.000	1,251.00	0.2369	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
9	4F	Urban	387+71.000	390+06.000	235.00	0.0445	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
10	4F	Urban	390+06.000	391+17.000	111.00	0.0210	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
11	4F	Urban	391+17.000	393+63.000	246.00	0.0466	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
12	4F	Urban	393+63.000	406+26.000	1,263.00	0.2392	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
13	4F	Urban	406+26.000	410+39.300	413.30	0.0783	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
15	4F	Urban	410+39.300	414+02.000	362.70	0.0687	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
18	4F	Urban	414+02.000	437+61.000	2,359.00	0.4468	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
20	4F	Urban	437+61.000	444+19.000	658.00	0.1246	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
21	4F	Urban	444+19.000	447+11.000	292.00	0.0553	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00

Table 2. Evaluation Freeway - Speed Change Lanes (Speed Change)

Seg. No.	Type	Ramp Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
14	4SC	Entrance	406+26.000	410+39.300	413.30	0.0783	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
16	4SC	Entrance	410+39.300	414+02.000	362.70	0.0687	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
17	4SC	Exit	410+39.300	413+39.300	300.00	0.0568	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
19	4SC	Entrance	414+02.000	419+26.000	524.00	0.0992	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00

Table 3. Expected Freeway Crash Rates and Frequencies (Section 1)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	2.3263
Average Future Road AADT (vpd)	30,282
Expected Crashes	
Total Crashes	257.45
Fatal and Injury Crashes	95.44
Property-Damage-Only Crashes	162.00
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	37
Percent Property-Damage-Only Crashes (%)	63
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	4.8116
Fatal and Injury Crash Rate (crashes/mi/yr)	1.7838
Property-Damage-Only Crash Rate (crashes/mi/yr)	3.0278
Expected Travel Crash Rate	
Total Travel (million veh-mi)	591.39
Travel Crash Rate (crashes/million veh-mi)	0.43
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.16
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.27

Table 4. Expected Freeway Speed Change Lane Crash Rates and Frequencies (Speed Change)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3030
Average Future Road AADT (vpd)	12,041
Expected Crashes	
Total Crashes	13.95
Fatal and Injury Crashes	4.12
Property-Damage-Only Crashes	9.83
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	30
Percent Property-Damage-Only Crashes (%)	70
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	2.0008
Fatal and Injury Crash Rate (crashes/mi/yr)	0.5909
Property-Damage-Only Crash Rate (crashes/mi/yr)	1.4099
Expected Travel Crash Rate	
Total Travel (million veh-mi)	30.63
Travel Crash Rate (crashes/million veh-mi)	0.46
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.13
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.32

Note: *Total Travel and Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 5. Expected Crash Frequencies and Rates by Freeway Segment (Section 1)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Effective Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	324+28.000	324+58.000	0.0057	1.021	7.8142	0.51
2	324+58.000	328+83.000	0.0805	14.940	8.0700	0.53
3	328+83.000	329+22.000	0.0074	1.327	7.8142	0.51
4	329+22.000	332+44.000	0.0610	11.177	7.9687	0.52
5	332+44.000	367+88.000	0.6712	105.010	6.8021	0.45
6	367+88.000	373+20.500	0.1009	11.936	5.1458	0.45
7	373+20.500	375+20.000	0.0378	4.621	5.3169	0.46
8	375+20.000	387+71.000	0.2369	18.004	3.3039	0.43
9	387+71.000	390+06.000	0.0445	3.569	3.4861	0.45
10	390+06.000	391+17.000	0.0210	1.787	3.6960	0.48
11	391+17.000	393+63.000	0.0466	3.736	3.4861	0.45
12	393+63.000	406+26.000	0.2392	18.134	3.2960	0.42
13	406+26.000	410+39.300	0.0391	3.625	4.0266	0.47
15	410+39.300	414+02.000	0.0059	0.575	4.2070	0.49
18	414+02.000	437+61.000	0.3972	37.390	4.0932	0.45
20	437+61.000	444+19.000	0.1246	13.519	4.7165	0.52
21	444+19.000	447+11.000	0.0553	7.076	5.5630	0.61

Note: *Effective Length* is the *segment length* minus the length of the *speed change lanes* if present.

Table 6. Expected Crash Frequencies and Rates by Freeway Speed Change Lane (Speed Change)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
14	406+26.000	410+39.300	0.0783	3.355	1.8635	0.43
16	410+39.300	414+02.000	0.0687	2.944	1.8635	0.43
17	410+39.300	413+39.300	0.0568	3.095	2.3687	0.55
19	414+02.000	419+26.000	0.0992	4.550	1.9935	0.44

Note: *Travel Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 7. Expected Crash Frequencies and Rates by Horizontal Design Element (Section 1)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	324+28.000	361+59.260	0.7067	114.846	7.0659	0.46
Simple Curve 1	361+59.260	381+62.890	0.3795	44.439	5.0916	0.44
Tangent	381+62.890	401+97.440	0.3853	29.824	3.3651	0.43
Simple Curve 2	401+97.440	422+00.920	0.3794	36.960	5.5274	0.82
Tangent	422+00.920	447+11.000	0.4754	45.322	4.4276	0.48

Table 8. Expected Crash Severity by Freeway Segment (Section 1)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0064	0.0165	0.1181	0.2311	0.6490
2	0.0845	0.2236	1.6266	3.3876	9.6179
3	0.0083	0.0215	0.1536	0.3004	0.8438
4	0.0704	0.1816	1.2818	2.4132	7.2302
5	0.8108	2.0437	13.6569	22.3709	66.1273
6	0.1131	0.2910	1.7560	2.4984	7.2777
7	0.0421	0.1084	0.6542	0.9307	2.8851
8	0.1567	0.3963	2.5253	3.8291	11.0968
9	0.0258	0.0652	0.4481	0.7736	2.2559
10	0.0116	0.0297	0.2080	0.3823	1.1555
11	0.0270	0.0682	0.4691	0.8098	2.3615
12	0.1540	0.3870	2.5147	3.9013	11.1764
13	0.0335	0.0863	0.5206	0.7406	2.2436
15	0.0053	0.0137	0.0830	0.1180	0.3544
18	0.3002	0.7565	4.9925	7.9945	23.3466
20	0.0879	0.2256	1.5822	2.9172	8.7059
21	0.0382	0.1010	0.7344	1.5257	4.6766
Total	1.9758	5.0160	33.3250	55.1246	162.0043

Table 9. Expected Crash Severity by Speed Change Lane (Speed Change)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
14	0.0235	0.0605	0.3648	0.5191	2.3872
16	0.0206	0.0531	0.3202	0.4555	2.0949
17	0.0240	0.0619	0.3733	0.5311	2.1051
19	0.0313	0.0808	0.4899	0.7086	3.2397
Total	0.0994	0.2562	1.5482	2.2143	9.8269

Table 10. Expected Speed Change Lane Crash Type Distribution (Section 1)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.24	0.1	2.45	1.0	2.69	1.0
Highway Segment	Collision with Fixed Object	44.15	17.1	79.70	31.0	123.85	48.1
Highway Segment	Collision with Other Object	3.12	1.2	15.47	6.0	18.59	7.2
Highway Segment	Other Single-vehicle Collision	12.72	4.9	11.91	4.6	24.63	9.6
Highway Segment	Collision with Parked Vehicle	0.92	0.4	1.78	0.7	2.70	1.0
Highway Segment	Total Single Vehicle Crashes	61.15	23.8	111.32	43.2	172.47	67.0
Highway Segment	Right-Angle Collision	1.06	0.4	0.91	0.4	1.98	0.8
Highway Segment	Head-on Collision	0.27	0.1	0.10	0.0	0.38	0.1
Highway Segment	Other Multi-vehicle Collision	1.06	0.4	1.22	0.5	2.28	0.9
Highway Segment	Rear-end Collision	25.72	10.0	34.97	13.6	60.69	23.6
Highway Segment	Sideswipe, Same Direction Collision	6.17	2.4	13.48	5.2	19.66	7.6
Highway Segment	Total Multiple Vehicle Crashes	34.29	13.3	50.69	19.7	84.98	33.0
Highway Segment	Total Highway Segment Crashes	95.44	37.1	162.00	62.9	257.45	100.0
	Total Crashes	95.44	37.1	162.00	62.9	257.45	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 11. Expected Exit Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.5	0.01	0.5
Highway Segment	Collision with Fixed Object	0.19	6.3	0.44	14.1	0.63	20.3
Highway Segment	Collision with Other Object	0.02	0.5	0.06	2.0	0.08	2.6
Highway Segment	Other Single-vehicle Collision	0.05	1.6	0.05	1.6	0.10	3.1
Highway Segment	Collision with Parked Vehicle	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Total Single Vehicle Crashes	0.26	8.3	0.56	18.2	0.82	26.5
Highway Segment	Right-Angle Collision	0.01	0.4	0.03	0.8	0.04	1.2
Highway Segment	Head-on Collision	0.01	0.2	0.00	0.1	0.01	0.3
Highway Segment	Other Multi-vehicle Collision	0.02	0.5	0.03	1.1	0.05	1.6
Highway Segment	Rear-end Collision	0.54	17.6	1.19	38.4	1.73	56.0
Highway Segment	Sideswipe, Same Direction Collision	0.16	5.1	0.29	9.4	0.45	14.4
Highway Segment	Total Multiple Vehicle Crashes	0.73	23.6	1.54	49.8	2.27	73.5
Highway Segment	Total Highway Segment Crashes	0.99	32.0	2.10	68.0	3.10	100.0
	Total Crashes	0.99	32.0	2.10	68.0	3.10	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 12. Expected Entrance Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.1	0.01	0.1
Highway Segment	Collision with Fixed Object	0.61	5.6	1.00	9.2	1.60	14.8
Highway Segment	Collision with Other Object	0.06	0.5	0.28	2.6	0.34	3.1
Highway Segment	Other Single-vehicle Collision	0.21	1.9	0.12	1.1	0.33	3.1
Highway Segment	Collision with Parked Vehicle	0.01	0.1	0.02	0.2	0.04	0.3
Highway Segment	Total Single Vehicle Crashes	0.89	8.2	1.44	13.2	2.33	21.4
Highway Segment	Right-Angle Collision	0.06	0.5	0.12	1.1	0.18	1.7
Highway Segment	Head-on Collision	0.01	0.1	0.01	0.1	0.02	0.2
Highway Segment	Other Multi-vehicle Collision	0.05	0.5	0.12	1.1	0.17	1.6
Highway Segment	Rear-end Collision	1.70	15.7	4.09	37.7	5.79	53.4
Highway Segment	Sideswipe, Same Direction Collision	0.42	3.8	1.95	17.9	2.36	21.8
Highway Segment	Total Multiple Vehicle Crashes	2.24	20.6	6.29	57.9	8.53	78.6
Highway Segment	Total Highway Segment Crashes	3.13	28.8	7.72	71.2	10.85	100.0
	Total Crashes	3.13	28.8	7.72	71.2	10.85	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 13. Evaluation Message

Start Location (Sta. ft)	End Location (Sta. ft)	Message
373+20.500	375+20.000	for segment #7 (373+20.500 to 375+20.000), Freeway Segment of type Five-lane Freeway is using unbalanced lane processing with types Four-lane Freeway and Six-lane Freeway

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 1:45 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:38:39 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: NB On Ramp
Highway Comment: Created Wed Apr 11 11:56:51 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 13:38:29 CDT 2018

Minimum Location: 5300+00.000
Maximum Location: 5315+54.070
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5300+00.000
Evaluation End Location: 5315+54.070
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

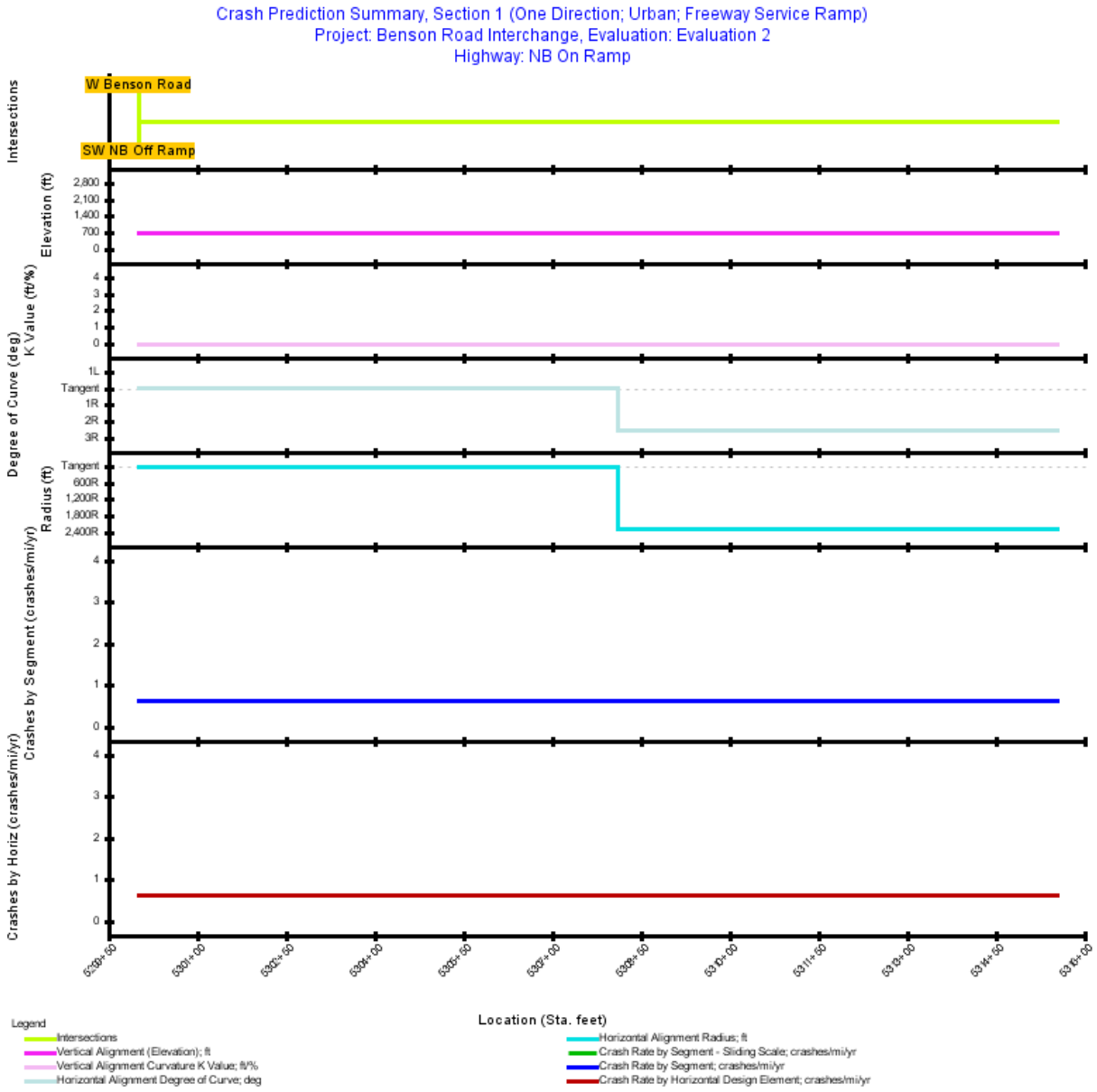

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EN	Urban	5300+00.000	5315+54.070	1,554.07	0.2943	2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2943
Average Future Road AADT (vpd)	1,664
Expected Crashes	
Total Crashes	4.29
Fatal and Injury Crashes	1.93
Property-Damage-Only Crashes	2.37
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	45
Percent Property-Damage-Only Crashes (%)	55
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	0.6340
Fatal and Injury Crash Rate (crashes/mi/yr)	0.2845
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.3495
Expected Travel Crash Rate	
Total Travel (million veh-mi)	4.11
Travel Crash Rate (crashes/million veh-mi)	1.04
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.47
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.57

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5300+00.000	5315+54.070	0.2943	4.292	0.6340	1.04

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5300+00.000	5308+09.660	0.1533	2.236	0.6340	1.04
Simple Curve 1	5308+09.660	5315+54.070	0.1410	2.056	0.6340	1.04

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0411	0.1245	0.7928	0.9674	2.3662

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.01	0.1	0.04	1.1	0.05	1.2
Highway Segment	Collision with Fixed Object	1.15	26.8	1.47	34.2	2.62	60.9
Highway Segment	Collision with Other Object	0.08	1.9	0.28	6.6	0.37	8.5
Highway Segment	Other Single-vehicle Collision	0.33	7.7	0.22	5.1	0.55	12.8
Highway Segment	Collision with Parked Vehicle	0.02	0.6	0.03	0.8	0.06	1.3
Highway Segment	Total Single Vehicle Crashes	1.59	37.1	2.05	47.8	3.64	84.8
Highway Segment	Right-Angle Collision	0.01	0.2	0.01	0.1	0.02	0.4
Highway Segment	Head-on Collision	0.00	0.1	0.00	0.0	0.00	0.1
Highway Segment	Other Multi-vehicle Collision	0.01	0.2	0.01	0.2	0.02	0.4
Highway Segment	Rear-end Collision	0.25	5.9	0.22	5.1	0.47	11.0
Highway Segment	Sideswipe, Same Direction Collision	0.06	1.4	0.08	2.0	0.14	3.4
Highway Segment	Total Multiple Vehicle Crashes	0.34	7.8	0.32	7.4	0.65	15.2
Highway Segment	Total Highway Segment Crashes	1.93	44.9	2.37	55.1	4.29	100.0
	Total Crashes	1.93	44.9	2.37	55.1	4.29	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 1:47 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:46:18 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: SB On Ramp
Highway Comment: Created Wed Apr 11 12:08:08 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 13:46:09 CDT 2018

Minimum Location: 5000+00.000
Maximum Location: 5015+45.940
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5000+00.000
Evaluation End Location: 5015+45.940
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

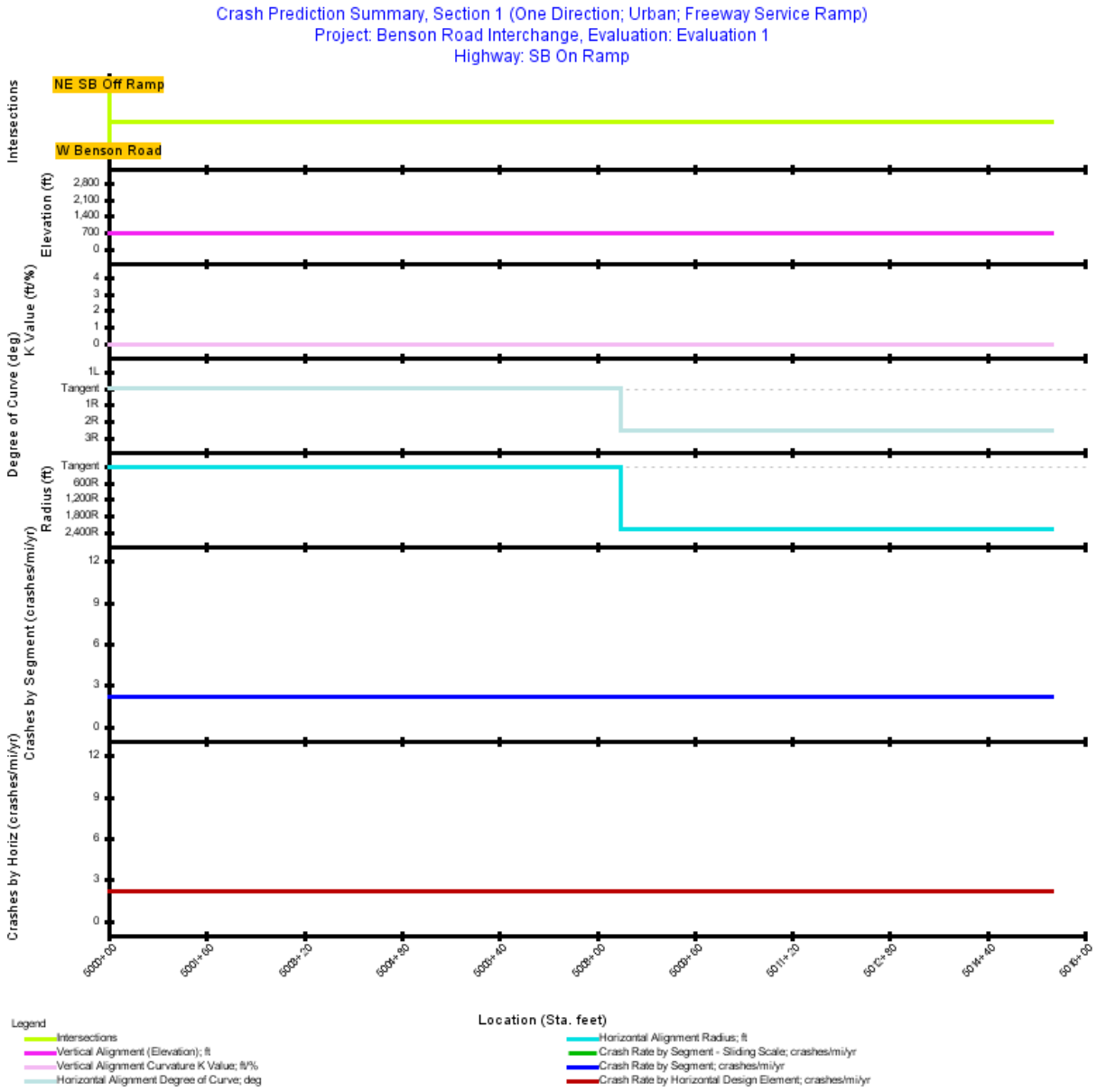

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EN	Urban	5000+00.000	5015+45.940	1,545.94	0.2928	2023: 9,000; 2024: 8,965; 2025: 8,930; 2026: 8,896; 2027: 8,861; 2028: 8,827; 2029: 8,792; 2030: 8,758; 2031: 8,723; 2032: 8,689; 2033: 8,654; 2034: 8,620; 2035: 8,585; 2036: 8,550; 2037: 8,516; 2038: 8,481; 2039: 8,447; 2040: 8,412; 2041: 8,378; 2042: 8,343; 2043: 8,309; 2044: 8,274; 2045: 8,240

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2928
Average Future Road AADT (vpd)	8,620
Expected Crashes	
Total Crashes	14.53
Fatal and Injury Crashes	5.96
Property-Damage-Only Crashes	8.57
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	41
Percent Property-Damage-Only Crashes (%)	59
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	2.1575
Fatal and Injury Crash Rate (crashes/mi/yr)	0.8843
Property-Damage-Only Crash Rate (crashes/mi/yr)	1.2733
Expected Travel Crash Rate	
Total Travel (million veh-mi)	21.19
Travel Crash Rate (crashes/million veh-mi)	0.69
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.28
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.40

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5000+00.000	5015+45.940	0.2928	14.529	2.1575	0.69

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5000+00.000	5008+38.790	0.1589	7.883	2.1575	0.69
Simple Curve 1	5008+38.790	5015+45.940	0.1339	6.646	2.1575	0.69

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.1270	0.3851	2.4515	2.9912	8.5746

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.02	0.1	0.14	0.9	0.15	1.1
Highway Segment	Collision with Fixed Object	3.44	23.7	4.41	30.3	7.85	54.0
Highway Segment	Collision with Other Object	0.24	1.7	0.86	5.9	1.10	7.6
Highway Segment	Other Single-vehicle Collision	0.99	6.8	0.66	4.5	1.65	11.4
Highway Segment	Collision with Parked Vehicle	0.07	0.5	0.10	0.7	0.17	1.2
Highway Segment	Total Single Vehicle Crashes	4.76	32.8	6.16	42.4	10.92	75.2
Highway Segment	Right-Angle Collision	0.04	0.3	0.04	0.3	0.08	0.6
Highway Segment	Head-on Collision	0.01	0.1	0.01	0.0	0.01	0.1
Highway Segment	Other Multi-vehicle Collision	0.04	0.3	0.06	0.4	0.10	0.7
Highway Segment	Rear-end Collision	0.89	6.1	1.67	11.5	2.56	17.6
Highway Segment	Sideswipe, Same Direction Collision	0.21	1.5	0.64	4.4	0.86	5.9
Highway Segment	Total Multiple Vehicle Crashes	1.19	8.2	2.42	16.6	3.61	24.8
Highway Segment	Total Highway Segment Crashes	5.96	41.0	8.57	59.0	14.53	100.0
	Total Crashes	5.96	41.0	8.57	59.0	14.53	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 1:49 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:48:42 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: NB Off Ramp
Highway Comment: Created Wed Apr 11 12:37:16 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 13:48:33 CDT 2018

Minimum Location: 5+28.500
Maximum Location: 24+28.450
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5+28.500
Evaluation End Location: 24+28.450
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

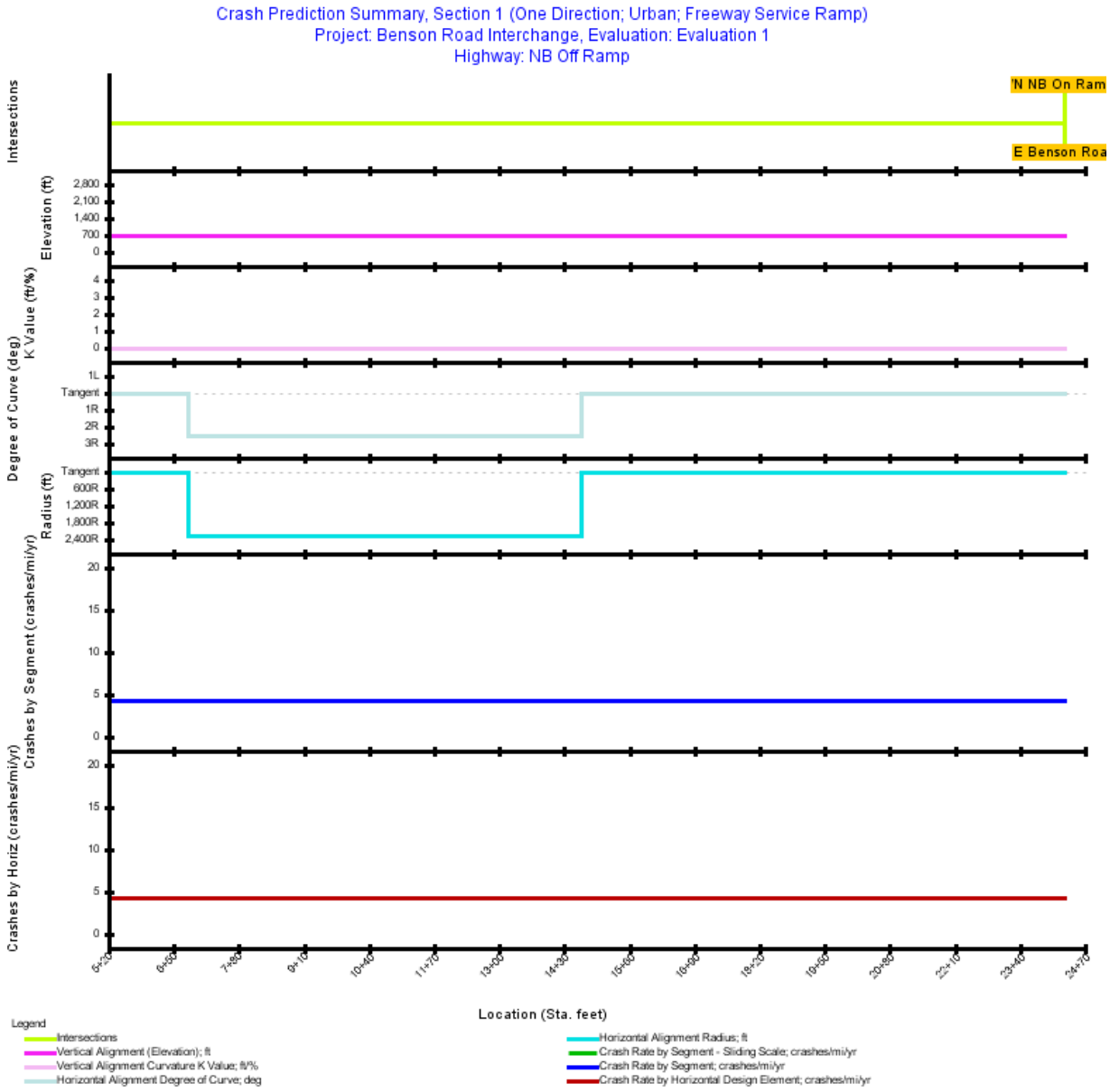

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EX	Urban	5+28.500	24+28.450	1,899.95	0.3598	2023: 8,600; 2024: 8,743; 2025: 8,886; 2026: 9,029; 2027: 9,172; 2028: 9,315; 2029: 9,458; 2030: 9,601; 2031: 9,744; 2032: 9,887; 2033: 10,030; 2034: 10,174; 2035: 10,317; 2036: 10,460; 2037: 10,603; 2038: 10,746; 2039: 10,889; 2040: 11,032; 2041: 11,175; 2042: 11,318; 2043: 11,461; 2044: 11,604; 2045: 11,748

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3598
Average Future Road AADT (vpd)	10,174
Expected Crashes	
Total Crashes	35.09
Fatal and Injury Crashes	15.50
Property-Damage-Only Crashes	19.59
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	44
Percent Property-Damage-Only Crashes (%)	56
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	4.2393
Fatal and Injury Crash Rate (crashes/mi/yr)	1.8728
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.3665
Expected Travel Crash Rate	
Total Travel (million veh-mi)	30.73
Travel Crash Rate (crashes/million veh-mi)	1.14
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.50
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.64

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5+28.500	24+28.450	0.3598	35.086	4.2393	1.14

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5+28.500	6+78.060	0.0283	2.762	4.2393	1.14
Simple Curve 1	6+78.060	14+62.820	0.1486	14.492	4.2393	1.14
Tangent	14+62.820	24+28.450	0.1829	17.832	4.2393	1.14

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.4612	1.3986	4.7278	8.9125	19.5855

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.06	0.2	0.36	1.0	0.41	1.2
Highway Segment	Collision with Fixed Object	10.40	29.6	11.57	33.0	21.97	62.6
Highway Segment	Collision with Other Object	0.73	2.1	2.25	6.4	2.98	8.5
Highway Segment	Other Single-vehicle Collision	3.00	8.5	1.73	4.9	4.72	13.5
Highway Segment	Collision with Parked Vehicle	0.22	0.6	0.26	0.7	0.47	1.4
Highway Segment	Total Single Vehicle Crashes	14.40	41.0	16.16	46.1	30.56	87.1
Highway Segment	Right-Angle Collision	0.03	0.1	0.06	0.2	0.10	0.3
Highway Segment	Head-on Collision	0.01	0.0	0.01	0.0	0.02	0.0
Highway Segment	Other Multi-vehicle Collision	0.03	0.1	0.08	0.2	0.12	0.3
Highway Segment	Rear-end Collision	0.82	2.3	2.36	6.7	3.19	9.1
Highway Segment	Sideswipe, Same Direction Collision	0.20	0.6	0.91	2.6	1.11	3.2
Highway Segment	Total Multiple Vehicle Crashes	1.10	3.1	3.42	9.8	4.52	12.9
Highway Segment	Total Highway Segment Crashes	15.50	44.2	19.59	55.8	35.09	100.0
	Total Crashes	15.50	44.2	19.59	55.8	35.09	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Evaluation Date: Wed Jun 13 13:49:48 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: SB Off Ramp
Highway Comment: Created Wed Apr 11 12:42:33 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 13:49:40 CDT 2018

Minimum Location: 3+59.600
Maximum Location: 24+86.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 3+59.600
Evaluation End Location: 24+86.000
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

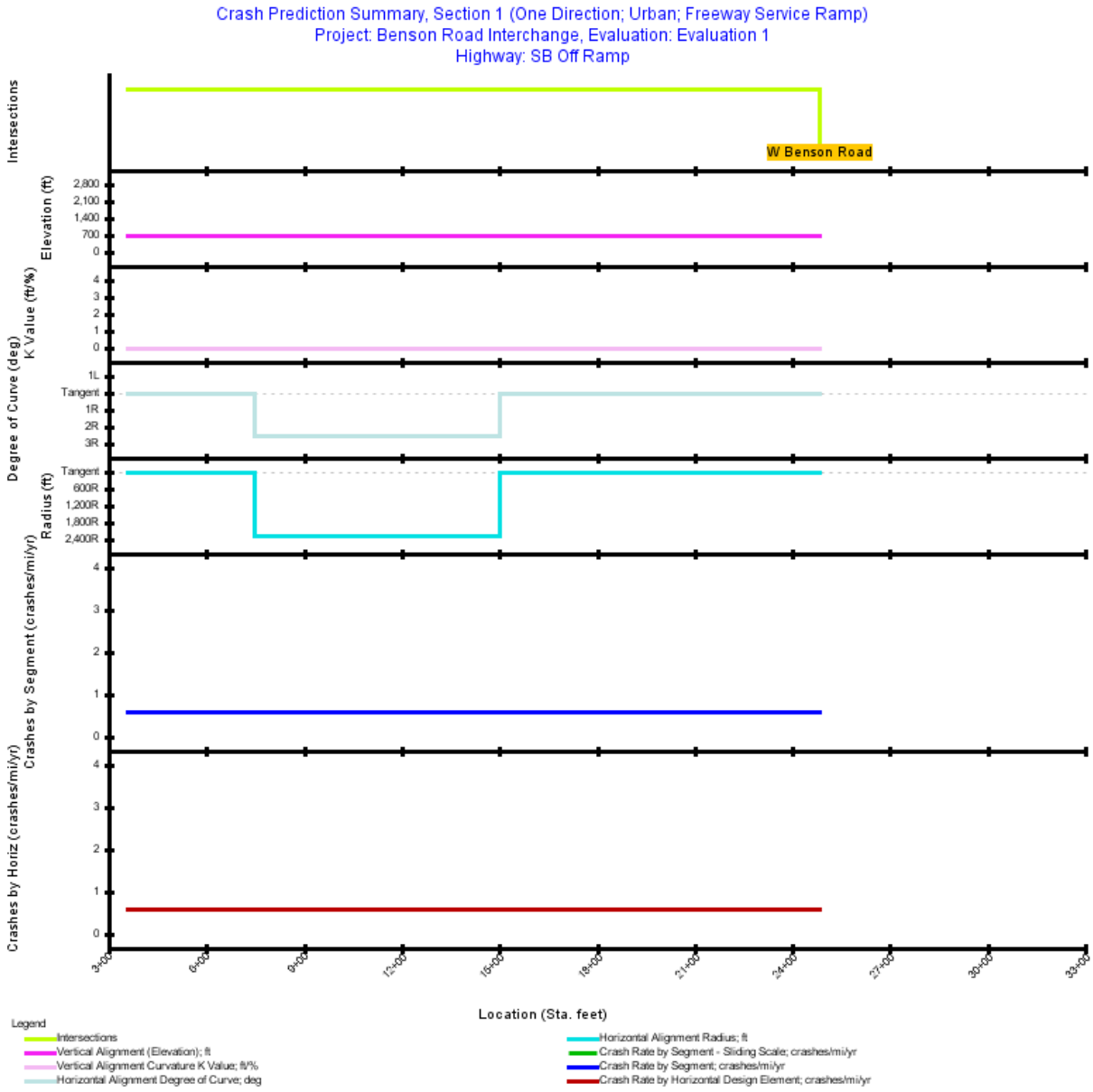

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EX	Urban	3+59.600	24+86.000	2,126.40	0.4027	2023: 1,300; 2024: 1,274; 2025: 1,248; 2026: 1,222; 2027: 1,197; 2028: 1,171; 2029: 1,145; 2030: 1,119; 2031: 1,094; 2032: 1,068; 2033: 1,042; 2034: 1,017; 2035: 991; 2036: 965; 2037: 939; 2038: 914; 2039: 888; 2040: 862; 2041: 836; 2042: 811; 2043: 785; 2044: 759; 2045: 734

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.4027
Average Future Road AADT (vpd)	1,017
Expected Crashes	
Total Crashes	5.26
Fatal and Injury Crashes	2.49
Property-Damage-Only Crashes	2.77
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	47
Percent Property-Damage-Only Crashes (%)	53
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	0.5675
Fatal and Injury Crash Rate (crashes/mi/yr)	0.2690
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.2985
Expected Travel Crash Rate	
Total Travel (million veh-mi)	3.44
Travel Crash Rate (crashes/million veh-mi)	1.53
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.72
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.80

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	3+59.600	24+86.000	0.4027	5.257	0.5675	1.53

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	3+59.600	7+48.480	0.0737	0.961	0.5675	1.53
Simple Curve 1	7+48.480	15+01.540	0.1426	1.862	0.5675	1.53
Tangent	15+01.540	24+86.000	0.1865	2.434	0.5675	1.53

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0778	0.2359	0.9810	1.1970	2.7648

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.01	0.2	0.06	1.1	0.07	1.3
Highway Segment	Collision with Fixed Object	1.73	33.0	1.91	36.4	3.65	69.4
Highway Segment	Collision with Other Object	0.12	2.3	0.37	7.1	0.49	9.4
Highway Segment	Other Single-vehicle Collision	0.50	9.5	0.29	5.4	0.79	14.9
Highway Segment	Collision with Parked Vehicle	0.04	0.7	0.04	0.8	0.08	1.5
Highway Segment	Total Single Vehicle Crashes	2.40	45.7	2.67	50.8	5.07	96.5
Highway Segment	Right-Angle Collision	0.00	0.1	0.00	0.0	0.00	0.1
Highway Segment	Head-on Collision	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Other Multi-vehicle Collision	0.00	0.1	0.00	0.0	0.01	0.1
Highway Segment	Rear-end Collision	0.07	1.3	0.06	1.2	0.13	2.5
Highway Segment	Sideswipe, Same Direction Collision	0.02	0.3	0.03	0.5	0.04	0.8
Highway Segment	Total Multiple Vehicle Crashes	0.09	1.7	0.09	1.8	0.18	3.5
Highway Segment	Total Highway Segment Crashes	2.49	47.4	2.77	52.6	5.26	100.0
	Total Crashes	2.49	47.4	2.77	52.6	5.26	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 1:54 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:50:40 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Intersection Title: NB Terminal
Intersection Comment: Created Wed Apr 11 12:49:16 CDT 2018
Intersection Version: v1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 13:50:31 CDT 2018

Minimum Location: 10+00.000
Maximum Location: 31+00.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

NB Terminal Evaluation

Intersection: NB Terminal
Evaluation Start Location: 10+00.000
Evaluation End Location: 31+00.000
Calibration Factor: RT_SG_FI=1.0; RT_SG_PDO=1.0;

Table 1. Evaluation Ramp Terminal - Site (NB Terminal)

Inter. No.	Ramp Terminal Type	Area Type	Legs	Location (Sta. ft)	Traffic Control	AADT
1	D4-Four-Leg Ramp Terminal with Diagonal Ramps	Urban	4	25+34.430	Signalized	Inside: 2023: 9,000; 2024: 9,559; 2025: 10,119; 2026: 10,678; 2027: 11,238; 2028: 11,797; 2029: 12,357; 2030: 12,917; 2031: 13,476; 2032: 14,036; 2033: 14,595; 2034: 15,155; 2035: 15,715; 2036: 16,274; 2037: 16,834; 2038: 17,393; 2039: 17,953; 2040: 18,513; 2041: 19,072; 2042: 19,632; 2043: 20,191; 2044: 20,751; 2045: 21,311; Outside: 2023: 1,500; 2024: 2,089; 2025: 2,679; 2026: 3,269; 2027: 3,859; 2028: 4,449; 2029: 5,038; 2030: 5,628; 2031: 6,218; 2032: 6,808; 2033: 7,398; 2034: 7,988; 2035: 8,577; 2036: 9,167; 2037: 9,757; 2038: 10,347; 2039: 10,937; 2040: 11,526; 2041: 12,116; 2042: 12,706; 2043: 13,296; 2044: 13,886; 2045: 14,476 :: Entrance: 2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429; Exit: 2023: 8,600; 2024: 8,743; 2025: 8,886; 2026: 9,029; 2027: 9,172; 2028: 9,315; 2029: 9,458; 2030: 9,601; 2031: 9,744; 2032: 9,887; 2033: 10,030; 2034: 10,174; 2035: 10,317; 2036: 10,460; 2037: 10,603; 2038: 10,746; 2039: 10,889; 2040: 11,032; 2041: 11,175; 2042: 11,318; 2043: 11,461; 2044: 11,604; 2045: 11,748

Table 2. Expected Ramp Terminal Crash Rates and Frequencies (NB Terminal)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.0000
Expected Crashes	
Total Crashes	156.07
Fatal and Injury Crashes	68.01
Property-Damage-Only Crashes	88.06
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	44
Percent Property-Damage-Only Crashes (%)	56

Table 3. Expected Crash Frequencies and Rates by Ramp Terminal (NB Terminal)

Segment Number/Intersection Name/Cross Road	Location (Sta. ft)	Expected No. Crashes for Evaluation Period	Expected No. Crashes/Year (crashes/million veh)	Expected Crash Rate (crashes/yr)
NB Terminal	25+34.430	156.069	1.06	6.7856

Table 4. Expected Crash Severity by Ramp Terminal (NB Terminal)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0801	1.9996	11.9200	54.0127	88.0562

Table 5. Expected Ramp Terminal Crash Type Distribution (NB Terminal)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Ramp Terminal	Collision with Animal	0.00	0.0	0.00	0.0	0.00	0.0
Ramp Terminal	Collision with Fixed Object	2.24	1.4	4.40	2.8	6.65	4.3
Ramp Terminal	Collision with Other Object	0.07	0.0	0.18	0.1	0.24	0.2
Ramp Terminal	Other Single-vehicle Collision	1.22	0.8	0.62	0.4	1.84	1.2
Ramp Terminal	Collision with Parked Vehicle	0.07	0.0	0.18	0.1	0.24	0.2
Ramp Terminal	Total Single Vehicle Crashes	3.60	2.3	5.37	3.4	8.98	5.8
Ramp Terminal	Right-Angle Collision	17.68	11.3	19.37	12.4	37.06	23.7
Ramp Terminal	Head-on Collision	0.75	0.5	0.62	0.4	1.36	0.9
Ramp Terminal	Other Multi-vehicle Collision	0.61	0.4	1.76	1.1	2.37	1.5
Ramp Terminal	Rear-end Collision	42.51	27.2	47.81	30.6	90.32	57.9
Ramp Terminal	Sideswipe, Same Direction Collision	2.86	1.8	13.12	8.4	15.98	10.2
Ramp Terminal	Total Multiple Vehicle Crashes	64.41	41.3	82.69	53.0	147.09	94.2
Ramp Terminal	Total Ramp Terminal Crashes	68.01	43.6	88.06	56.4	156.07	100.0
	Total Crashes	68.01	43.6	88.06	56.4	156.07	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 13:55:45 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
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Phone: 402-578-9254
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Project Title: Benson Road Interchange
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Intersection Title: SB Terminal
Intersection Comment: Created Wed Apr 11 12:56:42 CDT 2018
Intersection Version: v1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 13:55:39 CDT 2018

Minimum Location: 10+00.000
Maximum Location: 31+00.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

SB Terminal Evaluation

Intersection: SB Terminal
Evaluation Start Location: 10+00.000
Evaluation End Location: 31+00.000
Calibration Factor: RT_ST_FI=1.0; RT_ST_PDO=1.0;

Table 1. Evaluation Ramp Terminal - Site (SB Terminal)

Inter. No.	Ramp Terminal Type	Area Type	Legs	Location (Sta. ft)	Traffic Control	AADT
1	D4-Four-Leg Ramp Terminal with Diagonal Ramps	Urban	4	14+66.230	Stop-Controlled	Inside: 2023: 9,000; 2024: 9,559; 2025: 10,119; 2026: 10,678; 2027: 11,238; 2028: 11,797; 2029: 12,357; 2030: 12,917; 2031: 13,476; 2032: 14,036; 2033: 14,595; 2034: 15,155; 2035: 15,715; 2036: 16,274; 2037: 16,834; 2038: 17,393; 2039: 17,953; 2040: 18,513; 2041: 19,072; 2042: 19,632; 2043: 20,191; 2044: 20,751; 2045: 21,311; Outside: 2023: 17,300; 2024: 17,748; 2025: 18,197; 2026: 18,645; 2027: 19,094; 2028: 19,542; 2029: 19,991; 2030: 20,439; 2031: 20,888; 2032: 21,336; 2033: 21,785; 2034: 22,234; 2035: 22,682; 2036: 23,131; 2037: 23,579; 2038: 24,028; 2039: 24,476; 2040: 24,925; 2041: 25,373; 2042: 25,822; 2043: 26,270; 2044: 26,719; 2045: 27,168 :: Entrance: 2023: 9,000; 2024: 8,965; 2025: 8,930; 2026: 8,896; 2027: 8,861; 2028: 8,827; 2029: 8,792; 2030: 8,758; 2031: 8,723; 2032: 8,689; 2033: 8,654; 2034: 8,620; 2035: 8,585; 2036: 8,550; 2037: 8,516; 2038: 8,481; 2039: 8,447; 2040: 8,412; 2041: 8,378; 2042: 8,343; 2043: 8,309; 2044: 8,274; 2045: 8,240; Exit: 2023: 1,300; 2024: 1,274; 2025: 1,248; 2026: 1,222; 2027: 1,197; 2028: 1,171; 2029: 1,145; 2030: 1,119; 2031: 1,094; 2032: 1,068; 2033: 1,042; 2034: 1,017; 2035: 991; 2036: 965; 2037: 939; 2038: 914; 2039: 888; 2040: 862; 2041: 836; 2042: 811; 2043: 785; 2044: 759; 2045: 734

Table 2. Expected Ramp Terminal Crash Rates and Frequencies (SB Terminal)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.0000
Expected Crashes	
Total Crashes	99.20
Fatal and Injury Crashes	29.03
Property-Damage-Only Crashes	70.17
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	29
Percent Property-Damage-Only Crashes (%)	71

Table 3. Expected Crash Frequencies and Rates by Ramp Terminal (SB Terminal)

Segment Number/Intersection Name/Cross Road	Location (Sta. ft)	Expected No. Crashes for Evaluation Period	Expected No. Crashes/Year (crashes/million veh)	Expected Crash Rate (crashes/yr)
SB Terminal	14+66.230	99.196	0.50	4.3129

Table 4. Expected Crash Severity by Ramp Terminal (SB Terminal)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.1538	0.8077	5.2214	22.8456	70.1676

Table 5. Expected Ramp Terminal Crash Type Distribution (SB Terminal)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Ramp Terminal	Collision with Animal	0.00	0.0	0.00	0.0	0.00	0.0
Ramp Terminal	Collision with Fixed Object	2.47	2.5	7.72	7.8	10.19	10.3
Ramp Terminal	Collision with Other Object	0.00	0.0	0.00	0.0	0.00	0.0
Ramp Terminal	Other Single-vehicle Collision	0.73	0.7	1.40	1.4	2.13	2.1
Ramp Terminal	Collision with Parked Vehicle	0.00	0.0	0.56	0.6	0.56	0.6
Ramp Terminal	Total Single Vehicle Crashes	3.19	3.2	9.68	9.8	12.88	13.0
Ramp Terminal	Right-Angle Collision	13.29	13.4	26.52	26.7	39.82	40.1
Ramp Terminal	Head-on Collision	0.49	0.5	0.84	0.8	1.33	1.3
Ramp Terminal	Other Multi-vehicle Collision	0.49	0.5	1.12	1.1	1.62	1.6
Ramp Terminal	Rear-end Collision	10.83	10.9	26.45	26.7	37.28	37.6
Ramp Terminal	Sideswipe, Same Direction Collision	0.73	0.7	5.54	5.6	6.27	6.3
Ramp Terminal	Total Multiple Vehicle Crashes	25.84	26.0	60.48	61.0	86.32	87.0
Ramp Terminal	Total Ramp Terminal Crashes	29.03	29.3	70.17	70.7	99.20	100.0
	Total Crashes	29.03	29.3	70.17	70.7	99.20	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 6. Evaluation Message

Start Location (Sta. ft)	End Location (Sta. ft)	Message
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (18,197 vpd) for 2025 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (18,645 vpd) for 2026 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (19,094 vpd) for 2027 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (19,542 vpd) for 2028 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (19,991 vpd) for 2029 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (20,439 vpd) for 2030 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (20,888 vpd) for 2031 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (21,336 vpd) for 2032 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (21,785 vpd) for 2033 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (22,234 vpd) for 2034 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (22,682 vpd) for 2035 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (23,131 vpd) for 2036 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (23,579 vpd) for 2037 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (24,028 vpd) for 2038 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), outside crossroad traffic volume (24,476 vpd) for 2039 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (18,513 vpd) for 2040 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (19,072 vpd) for 2041 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (19,632 vpd) for 2042 exceeds model limit (18,000 vpd) for reliable results for intersection type D4

Start Location (Sta. ft)	End Location (Sta. ft)	Message
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (20,191 vpd) for 2043 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (20,751 vpd) for 2044 exceeds model limit (18,000 vpd) for reliable results for intersection type D4
14+66.230	14+66.230	for intersection #1 (14+66.230 to 14+66.230), inside crossroad traffic volume (21,311 vpd) for 2045 exceeds model limit (18,000 vpd) for reliable results for intersection type D4

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 2:12 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 14:10:27 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
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Project Title: Benson Road Interchange DDI
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: I-229
Highway Comment: Created Wed Apr 11 10:14:11 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 14:10:15 CDT 2018

Minimum Location: 324+28.000
Maximum Location: 447+11.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Section 1 Evaluation

Section: Section 1
Evaluation Start Location: 324+28.000
Evaluation End Location: 447+11.000
Functional Class: Freeway
Type of Alignment: Divided, Multilane
Model Category: Freeway Segment
Calibration Factor: FI_EN=1.0; FI_EX=1.0; FI_MV=1.0; FI_SV=1.0; PDO_EN=1.0; PDO_EX=1.0; PDO_MV=1.0; PDO_SV=1.0;

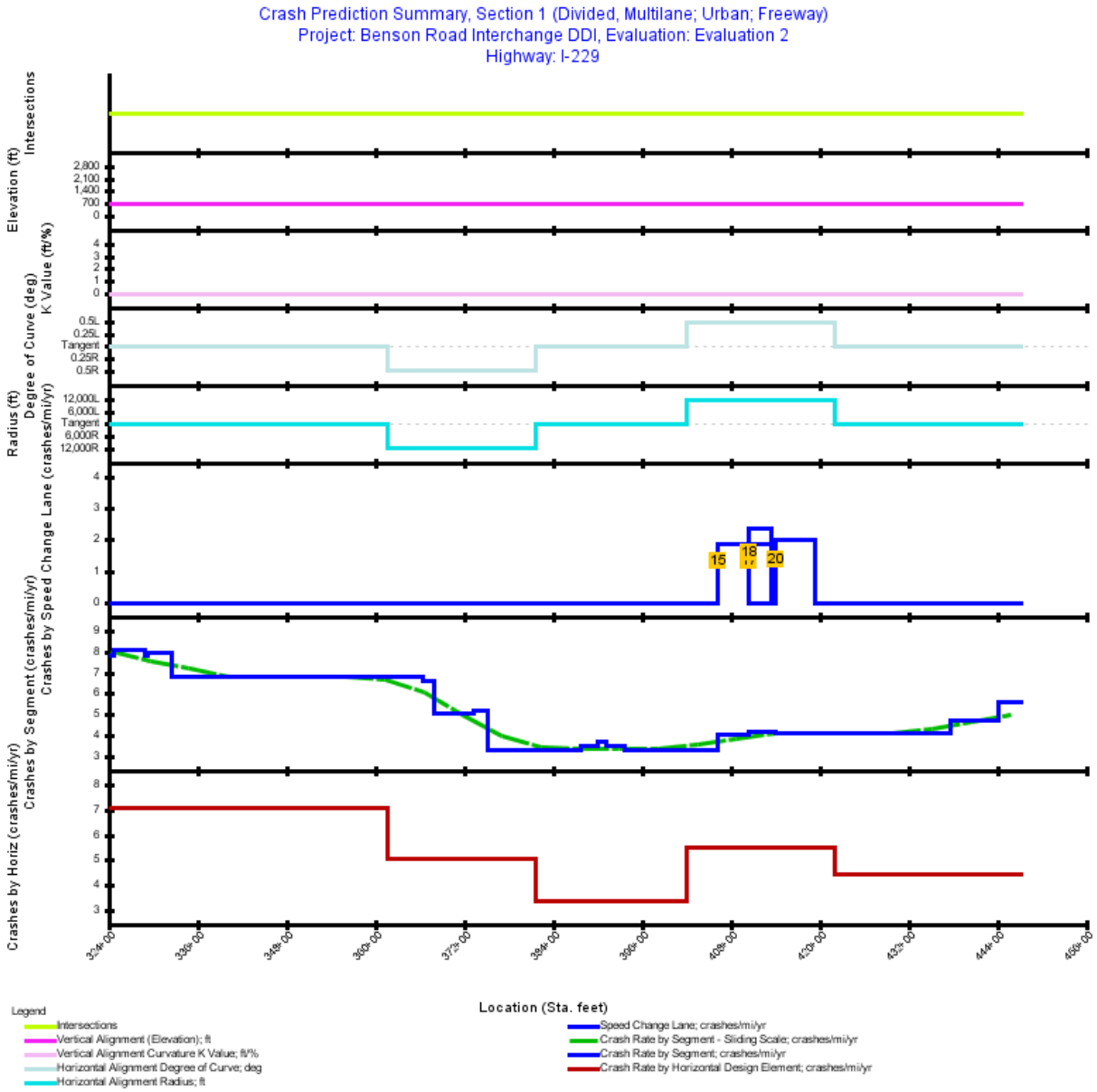

Figure 1. Crash Prediction Summary (Section 1)

Table 1. Evaluation Freeway - Homogeneous Segments (Section 1)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
1	6F	Urban	324+28.000	324+58.000	30.00	0.0057	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
2	6F	Urban	324+58.000	328+83.000	425.00	0.0805	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
3	6F	Urban	328+83.000	329+22.000	39.00	0.0074	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
4	6F	Urban	329+22.000	332+44.000	322.00	0.0610	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
5	6F	Urban	332+44.000	366+45.000	3,401.00	0.6441	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
6	7F	Urban	366+45.000	367+88.000	143.00	0.0271	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
7	7F	Urban	367+88.000	373+20.500	532.50	0.1008	2023: 26,300; 2024: 26,775; 2025: 27,250; 2026: 27,725; 2027: 28,200; 2028: 28,675; 2029: 29,150; 2030: 29,625; 2031: 30,100; 2032: 30,575; 2033: 31,050; 2034: 31,526; 2035: 32,001; 2036: 32,476; 2037: 32,951; 2038: 33,426; 2039: 33,901; 2040: 34,376; 2041: 34,851; 2042: 35,326; 2043: 35,801; 2044: 36,276; 2045: 36,752	60.00	Traversable Median	72.00
8	6F	Urban	373+20.500	375+20.000	199.50	0.0378	2023: 26,300; 2024: 26,775; 2025: 27,250; 2026: 27,725; 2027: 28,200; 2028: 28,675; 2029: 29,150; 2030: 29,625; 2031: 30,100; 2032: 30,575; 2033: 31,050; 2034: 31,526; 2035: 32,001; 2036: 32,476; 2037: 32,951; 2038: 33,426; 2039: 33,901; 2040: 34,376; 2041: 34,851; 2042: 35,326; 2043: 35,801; 2044: 36,276; 2045: 36,752	60.00	Traversable Median	72.00
9	4F	Urban	375+20.000	387+71.000	1,251.00	0.2369	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
10	4F	Urban	387+71.000	390+06.000	235.00	0.0445	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
11	4F	Urban	390+06.000	391+17.000	111.00	0.0210	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
12	4F	Urban	391+17.000	393+63.000	246.00	0.0466	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
13	4F	Urban	393+63.000	406+26.000	1,263.00	0.2392	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
14	4F	Urban	406+26.000	410+39.300	413.30	0.0783	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
16	4F	Urban	410+39.300	414+02.000	362.70	0.0687	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
19	4F	Urban	414+02.000	437+61.000	2,359.00	0.4468	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
21	4F	Urban	437+61.000	444+19.000	658.00	0.1246	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
22	4F	Urban	444+19.000	447+11.000	292.00	0.0553	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00

Table 2. Evaluation Freeway - Speed Change Lanes (Speed Change)

Seg. No.	Type	Ramp Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
15	4SC	Entrance	406+26.000	410+39.300	413.30	0.0783	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
17	4SC	Entrance	410+39.300	414+02.000	362.70	0.0687	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
18	4SC	Exit	410+39.300	413+39.300	300.00	0.0568	2023: 19,200; 2024: 19,603; 2025: 20,006; 2026: 20,409; 2027: 20,812; 2028: 21,216; 2029: 21,619; 2030: 22,022; 2031: 22,425; 2032: 22,829; 2033: 23,232; 2034: 23,635; 2035: 24,038; 2036: 24,441; 2037: 24,845; 2038: 25,248; 2039: 25,651; 2040: 26,054; 2041: 26,458; 2042: 26,861; 2043: 27,264; 2044: 27,667; 2045: 28,071	60.00	Traversable Median	72.00
20	4SC	Entrance	414+02.000	419+26.000	524.00	0.0992	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00

Table 3. Expected Freeway Crash Rates and Frequencies (Section 1)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	2.3263
Average Future Road AADT (vpd)	30,282
Expected Crashes	
Total Crashes	257.02
Fatal and Injury Crashes	95.54
Property-Damage-Only Crashes	161.47
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	37
Percent Property-Damage-Only Crashes (%)	63
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	4.8035
Fatal and Injury Crash Rate (crashes/mi/yr)	1.7857
Property-Damage-Only Crash Rate (crashes/mi/yr)	3.0179
Expected Travel Crash Rate	
Total Travel (million veh-mi)	591.39
Travel Crash Rate (crashes/million veh-mi)	0.43
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.16
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.27

Table 4. Expected Freeway Speed Change Lane Crash Rates and Frequencies (Speed Change)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3030
Average Future Road AADT (vpd)	12,041
Expected Crashes	
Total Crashes	13.95
Fatal and Injury Crashes	4.12
Property-Damage-Only Crashes	9.83
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	30
Percent Property-Damage-Only Crashes (%)	70
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	2.0008
Fatal and Injury Crash Rate (crashes/mi/yr)	0.5909
Property-Damage-Only Crash Rate (crashes/mi/yr)	1.4099
Expected Travel Crash Rate	
Total Travel (million veh-mi)	30.63
Travel Crash Rate (crashes/million veh-mi)	0.46
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.13
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.32

Note: *Total Travel and Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 5. Expected Crash Frequencies and Rates by Freeway Segment (Section 1)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Effective Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	324+28.000	324+58.000	0.0057	1.021	7.8142	0.51
2	324+58.000	328+83.000	0.0805	14.940	8.0700	0.53
3	328+83.000	329+22.000	0.0074	1.327	7.8142	0.51
4	329+22.000	332+44.000	0.0610	11.177	7.9687	0.52
5	332+44.000	366+45.000	0.6441	100.780	6.8026	0.45
6	366+45.000	367+88.000	0.0271	4.129	6.6291	0.44
7	367+88.000	373+20.500	0.1009	11.695	5.0420	0.44
8	373+20.500	375+20.000	0.0378	4.532	5.2148	0.45
9	375+20.000	387+71.000	0.2369	18.004	3.3039	0.43
10	387+71.000	390+06.000	0.0445	3.569	3.4861	0.45
11	390+06.000	391+17.000	0.0210	1.787	3.6960	0.48
12	391+17.000	393+63.000	0.0466	3.736	3.4861	0.45
13	393+63.000	406+26.000	0.2392	18.134	3.2960	0.42
14	406+26.000	410+39.300	0.0391	3.625	4.0266	0.47
16	410+39.300	414+02.000	0.0059	0.575	4.2070	0.49
19	414+02.000	437+61.000	0.3972	37.390	4.0932	0.45
21	437+61.000	444+19.000	0.1246	13.519	4.7165	0.52
22	444+19.000	447+11.000	0.0553	7.076	5.5630	0.61

Note: *Effective Length* is the *segment length* minus the length of the *speed change lanes* if present.

Table 6. Expected Crash Frequencies and Rates by Freeway Speed Change Lane (Speed Change)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
15	406+26.000	410+39.300	0.0783	3.355	1.8635	0.43
17	410+39.300	414+02.000	0.0687	2.944	1.8635	0.43
18	410+39.300	413+39.300	0.0568	3.095	2.3687	0.55
20	414+02.000	419+26.000	0.0992	4.550	1.9935	0.44

Note: *Travel Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 7. Expected Crash Frequencies and Rates by Horizontal Design Element (Section 1)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	324+28.000	361+59.260	0.7067	114.853	7.0663	0.46
Simple Curve 1	361+59.260	381+62.890	0.3795	44.003	5.0416	0.44
Tangent	381+62.890	401+97.440	0.3853	29.824	3.3651	0.43
Simple Curve 2	401+97.440	422+00.920	0.3794	36.960	5.5274	0.82
Tangent	422+00.920	447+11.000	0.4754	45.322	4.4276	0.48

Table 8. Expected Crash Severity by Freeway Segment (Section 1)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0064	0.0165	0.1181	0.2311	0.6490
2	0.0845	0.2236	1.6266	3.3876	9.6179
3	0.0083	0.0215	0.1536	0.3004	0.8438
4	0.0704	0.1816	1.2818	2.4132	7.2302
5	0.7730	1.9468	13.0650	21.5285	63.4669
6	0.0385	0.0992	0.5983	0.8512	2.5422
7	0.1146	0.2948	1.7788	2.5308	6.9765
8	0.0427	0.1099	0.6628	0.9431	2.7734
9	0.1567	0.3963	2.5253	3.8291	11.0968
10	0.0258	0.0652	0.4481	0.7736	2.2559
11	0.0116	0.0297	0.2080	0.3823	1.1555
12	0.0270	0.0682	0.4691	0.8098	2.3615
13	0.1540	0.3870	2.5147	3.9013	11.1764
14	0.0335	0.0863	0.5206	0.7406	2.2436
16	0.0053	0.0137	0.0830	0.1180	0.3544
19	0.3002	0.7565	4.9925	7.9945	23.3466
21	0.0879	0.2256	1.5822	2.9172	8.7059
22	0.0382	0.1010	0.7344	1.5257	4.6766
Total	1.9786	5.0234	33.3629	55.1782	161.4732

Table 9. Expected Crash Severity by Speed Change Lane (Speed Change)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
15	0.0235	0.0605	0.3648	0.5191	2.3872
17	0.0206	0.0531	0.3202	0.4555	2.0949
18	0.0240	0.0619	0.3733	0.5311	2.1051
20	0.0313	0.0808	0.4899	0.7086	3.2397
Total	0.0994	0.2562	1.5482	2.2143	9.8269

Table 10. Expected Speed Change Lane Crash Type Distribution (Section 1)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.24	0.1	2.45	1.0	2.69	1.0
Highway Segment	Collision with Fixed Object	44.28	17.2	79.59	31.0	123.87	48.2
Highway Segment	Collision with Other Object	3.13	1.2	15.45	6.0	18.58	7.2
Highway Segment	Other Single-vehicle Collision	12.76	5.0	11.89	4.6	24.65	9.6
Highway Segment	Collision with Parked Vehicle	0.92	0.4	1.78	0.7	2.70	1.1
Highway Segment	Total Single Vehicle Crashes	61.32	23.9	111.16	43.3	172.49	67.1
Highway Segment	Right-Angle Collision	1.06	0.4	0.91	0.4	1.97	0.8
Highway Segment	Head-on Collision	0.27	0.1	0.10	0.0	0.37	0.1
Highway Segment	Other Multi-vehicle Collision	1.06	0.4	1.21	0.5	2.27	0.9
Highway Segment	Rear-end Collision	25.66	10.0	34.71	13.5	60.38	23.5
Highway Segment	Sideswipe, Same Direction Collision	6.16	2.4	13.38	5.2	19.54	7.6
Highway Segment	Total Multiple Vehicle Crashes	34.22	13.3	50.31	19.6	84.53	32.9
Highway Segment	Total Highway Segment Crashes	95.54	37.2	161.47	62.8	257.02	100.0
	Total Crashes	95.54	37.2	161.47	62.8	257.02	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 11. Expected Exit Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.5	0.01	0.5
Highway Segment	Collision with Fixed Object	0.19	6.3	0.44	14.1	0.63	20.3
Highway Segment	Collision with Other Object	0.02	0.5	0.06	2.0	0.08	2.6
Highway Segment	Other Single-vehicle Collision	0.05	1.6	0.05	1.6	0.10	3.1
Highway Segment	Collision with Parked Vehicle	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Total Single Vehicle Crashes	0.26	8.3	0.56	18.2	0.82	26.5
Highway Segment	Right-Angle Collision	0.01	0.4	0.03	0.8	0.04	1.2
Highway Segment	Head-on Collision	0.01	0.2	0.00	0.1	0.01	0.3
Highway Segment	Other Multi-vehicle Collision	0.02	0.5	0.03	1.1	0.05	1.6
Highway Segment	Rear-end Collision	0.54	17.6	1.19	38.4	1.73	56.0
Highway Segment	Sideswipe, Same Direction Collision	0.16	5.1	0.29	9.4	0.45	14.4
Highway Segment	Total Multiple Vehicle Crashes	0.73	23.6	1.54	49.8	2.27	73.5
Highway Segment	Total Highway Segment Crashes	0.99	32.0	2.10	68.0	3.10	100.0
	Total Crashes	0.99	32.0	2.10	68.0	3.10	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 12. Expected Entrance Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.1	0.01	0.1
Highway Segment	Collision with Fixed Object	0.61	5.6	1.00	9.2	1.60	14.8
Highway Segment	Collision with Other Object	0.06	0.5	0.28	2.6	0.34	3.1
Highway Segment	Other Single-vehicle Collision	0.21	1.9	0.12	1.1	0.33	3.1
Highway Segment	Collision with Parked Vehicle	0.01	0.1	0.02	0.2	0.04	0.3
Highway Segment	Total Single Vehicle Crashes	0.89	8.2	1.44	13.2	2.33	21.4
Highway Segment	Right-Angle Collision	0.06	0.5	0.12	1.1	0.18	1.7
Highway Segment	Head-on Collision	0.01	0.1	0.01	0.1	0.02	0.2
Highway Segment	Other Multi-vehicle Collision	0.05	0.5	0.12	1.1	0.17	1.6
Highway Segment	Rear-end Collision	1.70	15.7	4.09	37.7	5.79	53.4
Highway Segment	Sideswipe, Same Direction Collision	0.42	3.8	1.95	17.9	2.36	21.8
Highway Segment	Total Multiple Vehicle Crashes	2.24	20.6	6.29	57.9	8.53	78.6
Highway Segment	Total Highway Segment Crashes	3.13	28.8	7.72	71.2	10.85	100.0
	Total Crashes	3.13	28.8	7.72	71.2	10.85	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 13. Evaluation Message

Start Location (Sta. ft)	End Location (Sta. ft)	Message
366+45.000	367+88.000	for segment #6 (366+45.000 to 367+88.000), Freeway Segment of type Seven-lane Freeway is using unbalanced lane processing with types Six-lane Freeway and Eight-lane Freeway
367+88.000	373+20.500	for segment #7 (367+88.000 to 373+20.500), Freeway Segment of type Seven-lane Freeway is using unbalanced lane processing with types Six-lane Freeway and Eight-lane Freeway
373+20.500	375+20.000	for segment #8 (373+20.500 to 375+20.000), Freeway Segment of type Six-lane Freeway is using unbalanced lane processing with types Four-lane Freeway and Eight-lane Freeway

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

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Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 14:12:35 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange DDI
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: NB On Ramp
Highway Comment: Created Wed Apr 11 11:56:51 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Wed Jun 13 14:12:25 CDT 2018

Minimum Location: 5300+00.000
Maximum Location: 5315+54.070
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5300+00.000
Evaluation End Location: 5315+54.070
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

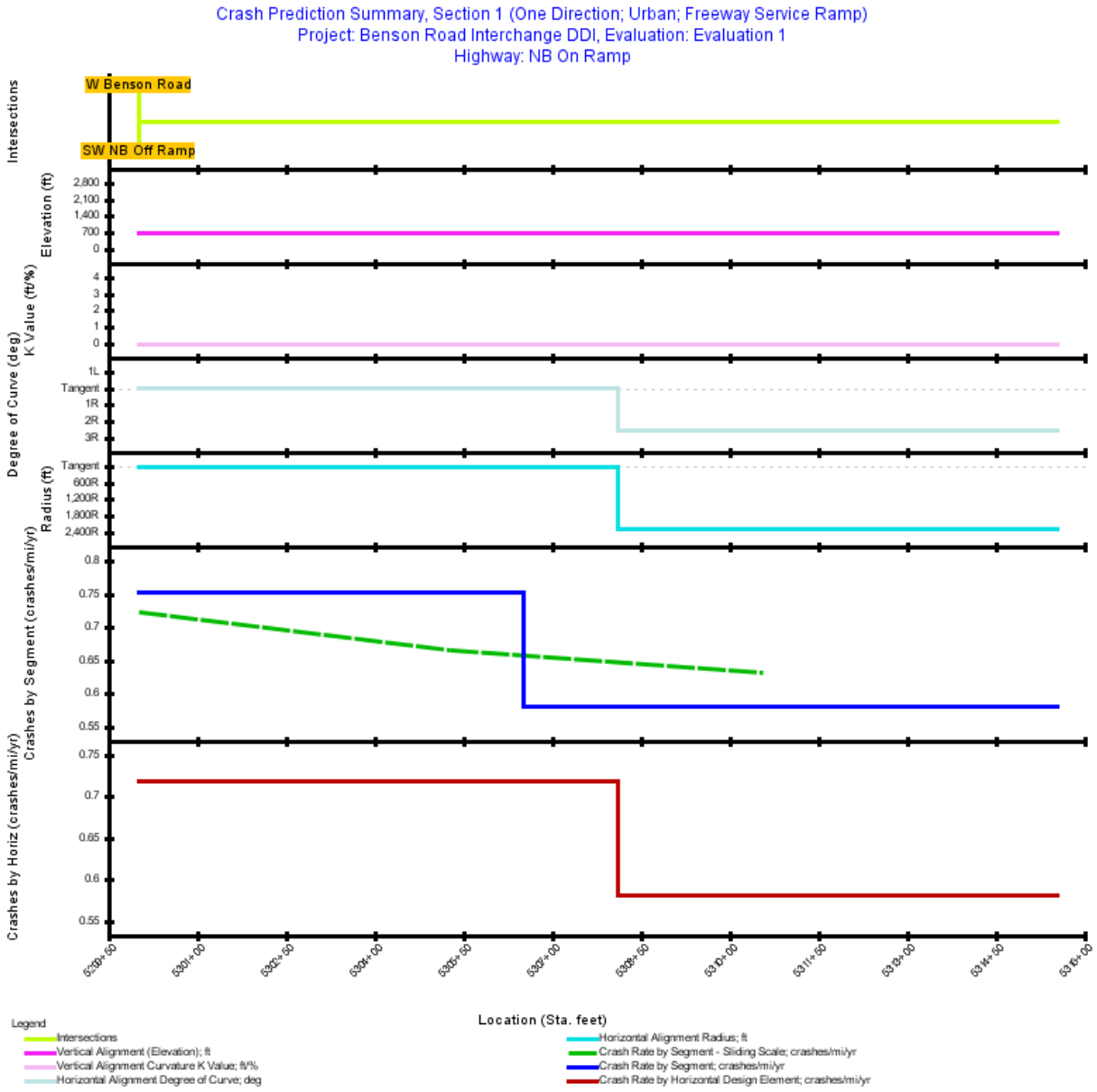

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EN	Urban	5300+00.000	5306+51.000	651.00	0.1233	2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429
2	1EN	Urban	5306+51.000	5315+54.070	903.07	0.1710	2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2943
Average Future Road AADT (vpd)	1,664
Expected Crashes	
Total Crashes	4.42
Fatal and Injury Crashes	1.73
Property-Damage-Only Crashes	2.69
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	39
Percent Property-Damage-Only Crashes (%)	61
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	0.6530
Fatal and Injury Crash Rate (crashes/mi/yr)	0.2554
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.3976
Expected Travel Crash Rate	
Total Travel (million veh-mi)	4.11
Travel Crash Rate (crashes/million veh-mi)	1.07
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.42
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.66

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5300+00.000	5306+51.000	0.1233	2.136	0.7533	1.24
2	5306+51.000	5315+54.070	0.1710	2.284	0.5807	0.96

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5300+00.000	5308+09.660	0.1533	2.538	0.7195	1.19
Simple Curve 1	5308+09.660	5315+54.070	0.1410	1.883	0.5807	0.96

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0163	0.0494	0.2559	0.4824	1.3323
2	0.0197	0.0598	0.3807	0.4645	1.3595
Total	0.0360	0.1092	0.6365	0.9468	2.6918

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.01	0.1	0.05	1.1	0.05	1.2
Highway Segment	Collision with Fixed Object	0.98	22.1	1.60	36.1	2.57	58.2
Highway Segment	Collision with Other Object	0.07	1.6	0.31	7.0	0.38	8.6
Highway Segment	Other Single-vehicle Collision	0.28	6.4	0.24	5.4	0.52	11.8
Highway Segment	Collision with Parked Vehicle	0.02	0.5	0.04	0.8	0.06	1.3
Highway Segment	Total Single Vehicle Crashes	1.35	30.7	2.23	50.4	3.58	81.1
Highway Segment	Right-Angle Collision	0.01	0.3	0.01	0.2	0.02	0.5
Highway Segment	Head-on Collision	0.00	0.1	0.00	0.0	0.00	0.1
Highway Segment	Other Multi-vehicle Collision	0.01	0.3	0.01	0.3	0.02	0.5
Highway Segment	Rear-end Collision	0.28	6.3	0.32	7.2	0.60	13.6
Highway Segment	Sideswipe, Same Direction Collision	0.07	1.5	0.12	2.8	0.19	4.3
Highway Segment	Total Multiple Vehicle Crashes	0.37	8.4	0.46	10.5	0.84	18.9
Highway Segment	Total Highway Segment Crashes	1.73	39.1	2.69	60.9	4.42	100.0
	Total Crashes	1.73	39.1	2.69	60.9	4.42	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

Report Generated: Jun 13, 2018 2:28 PM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 14:26:53 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange DDI
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: SB On Ramp
Highway Comment: Created Wed Apr 11 12:08:08 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 14:26:43 CDT 2018

Minimum Location: 5000+20.800
Maximum Location: 5015+45.940
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5000+20.800
Evaluation End Location: 5015+45.940
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

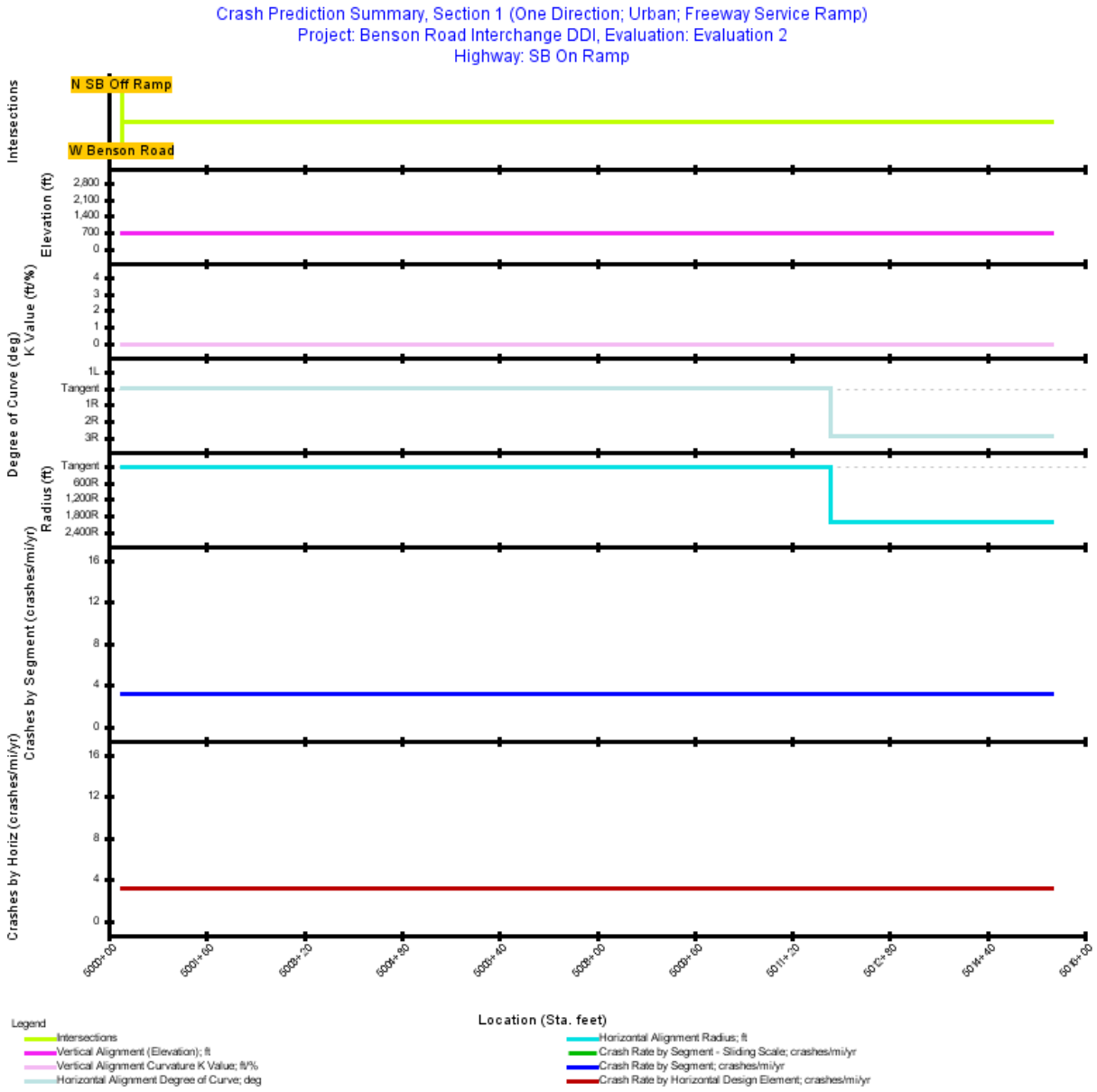

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EN	Urban	5000+20.800	5015+45.940	1,525.14	0.2888	2023: 9,000; 2024: 8,965; 2025: 8,930; 2026: 8,896; 2027: 8,861; 2028: 8,827; 2029: 8,792; 2030: 8,758; 2031: 8,723; 2032: 8,689; 2033: 8,654; 2034: 8,620; 2035: 8,585; 2036: 8,550; 2037: 8,516; 2038: 8,481; 2039: 8,447; 2040: 8,412; 2041: 8,378; 2042: 8,343; 2043: 8,309; 2044: 8,274; 2045: 8,240

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2889
Average Future Road AADT (vpd)	8,620
Expected Crashes	
Total Crashes	20.88
Fatal and Injury Crashes	7.59
Property-Damage-Only Crashes	13.29
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	36
Percent Property-Damage-Only Crashes (%)	64
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	3.1430
Fatal and Injury Crash Rate (crashes/mi/yr)	1.1422
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.0008
Expected Travel Crash Rate	
Total Travel (million veh-mi)	20.90
Travel Crash Rate (crashes/million veh-mi)	1.00
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.36
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.64

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5000+20.800	5015+45.940	0.2889	20.881	3.1430	1.00

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5000+20.800	5011+83.600	0.2202	15.920	3.1430	1.00
Simple Curve 1	5011+83.600	5015+45.940	0.0686	4.961	3.1430	1.00

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.1539	0.4666	2.4150	4.5527	13.2924

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.02	0.1	0.17	0.8	0.20	0.9
Highway Segment	Collision with Fixed Object	3.85	18.4	5.69	27.3	9.54	45.7
Highway Segment	Collision with Other Object	0.27	1.3	1.10	5.3	1.38	6.6
Highway Segment	Other Single-vehicle Collision	1.11	5.3	0.85	4.1	1.96	9.4
Highway Segment	Collision with Parked Vehicle	0.08	0.4	0.13	0.6	0.21	1.0
Highway Segment	Total Single Vehicle Crashes	5.33	25.5	7.95	38.1	13.28	63.6
Highway Segment	Right-Angle Collision	0.07	0.3	0.10	0.5	0.17	0.8
Highway Segment	Head-on Collision	0.02	0.1	0.01	0.1	0.03	0.1
Highway Segment	Other Multi-vehicle Collision	0.07	0.3	0.13	0.6	0.20	0.9
Highway Segment	Rear-end Collision	1.69	8.1	3.69	17.7	5.38	25.8
Highway Segment	Sideswipe, Same Direction Collision	0.41	1.9	1.42	6.8	1.83	8.7
Highway Segment	Total Multiple Vehicle Crashes	2.25	10.8	5.34	25.6	7.60	36.4
Highway Segment	Total Highway Segment Crashes	7.59	36.3	13.29	63.7	20.88	100.0
	Total Crashes	7.59	36.3	13.29	63.7	20.88	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 11:08 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Wed Jun 13 14:29:58 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange DDI
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: NB Off Ramp
Highway Comment: Created Wed Apr 11 12:37:16 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 14:29:49 CDT 2018

Minimum Location: 5+28.500
Maximum Location: 24+28.450
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5+28.500
Evaluation End Location: 24+28.450
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

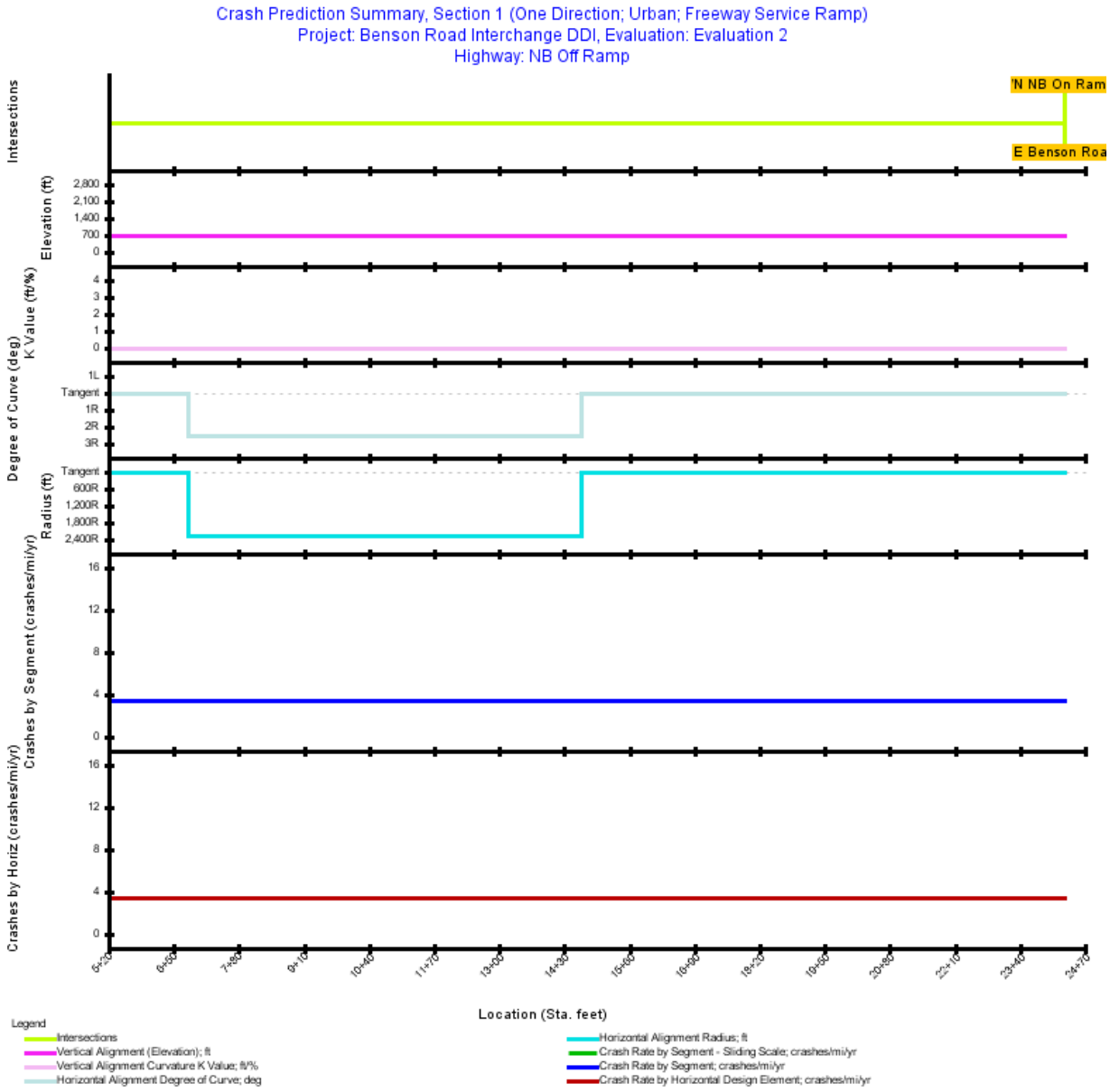

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EX	Urban	5+28.500	24+28.450	1,899.95	0.3598	2023: 8,600; 2024: 8,743; 2025: 8,886; 2026: 9,029; 2027: 9,172; 2028: 9,315; 2029: 9,458; 2030: 9,601; 2031: 9,744; 2032: 9,887; 2033: 10,030; 2034: 10,174; 2035: 10,317; 2036: 10,460; 2037: 10,603; 2038: 10,746; 2039: 10,889; 2040: 11,032; 2041: 11,175; 2042: 11,318; 2043: 11,461; 2044: 11,604; 2045: 11,748

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3598
Average Future Road AADT (vpd)	10,174
Expected Crashes	
Total Crashes	27.98
Fatal and Injury Crashes	11.22
Property-Damage-Only Crashes	16.77
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	40
Percent Property-Damage-Only Crashes (%)	60
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	3.3812
Fatal and Injury Crash Rate (crashes/mi/yr)	1.3553
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.0259
Expected Travel Crash Rate	
Total Travel (million veh-mi)	30.73
Travel Crash Rate (crashes/million veh-mi)	0.91
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.36
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.55

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5+28.500	24+28.450	0.3598	27.984	3.3812	0.91

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5+28.500	6+78.060	0.0283	2.203	3.3812	0.91
Simple Curve 1	6+78.060	14+62.820	0.1486	11.559	3.3812	0.91
Tangent	14+62.820	24+28.450	0.1829	14.223	3.3812	0.91

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.3338	1.0121	3.4214	6.4499	16.7666

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.04	0.1	0.30	1.1	0.35	1.2
Highway Segment	Collision with Fixed Object	7.53	26.9	9.91	35.4	17.43	62.3
Highway Segment	Collision with Other Object	0.53	1.9	1.92	6.9	2.46	8.8
Highway Segment	Other Single-vehicle Collision	2.17	7.7	1.48	5.3	3.65	13.0
Highway Segment	Collision with Parked Vehicle	0.16	0.6	0.22	0.8	0.38	1.4
Highway Segment	Total Single Vehicle Crashes	10.42	37.2	13.84	49.4	24.26	86.7
Highway Segment	Right-Angle Collision	0.03	0.1	0.05	0.2	0.08	0.3
Highway Segment	Head-on Collision	0.01	0.0	0.01	0.0	0.01	0.0
Highway Segment	Other Multi-vehicle Collision	0.03	0.1	0.07	0.3	0.10	0.3
Highway Segment	Rear-end Collision	0.60	2.1	2.02	7.2	2.62	9.4
Highway Segment	Sideswipe, Same Direction Collision	0.14	0.5	0.78	2.8	0.92	3.3
Highway Segment	Total Multiple Vehicle Crashes	0.79	2.8	2.93	10.5	3.73	13.3
Highway Segment	Total Highway Segment Crashes	11.22	40.1	16.77	59.9	27.98	100.0
	Total Crashes	11.22	40.1	16.77	59.9	27.98	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 13, 2018

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Report Overview

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Evaluation Date: Wed Jun 13 14:29:58 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange DDI
Project Comment: Benson Road & I-229 Interchange
Project Unit System: U.S. Customary

Highway Title: NB Off Ramp
Highway Comment: Created Wed Apr 11 12:37:16 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Wed Jun 13 14:29:49 CDT 2018

Minimum Location: 5+28.500
Maximum Location: 24+28.450
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 5+28.500
Evaluation End Location: 24+28.450
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

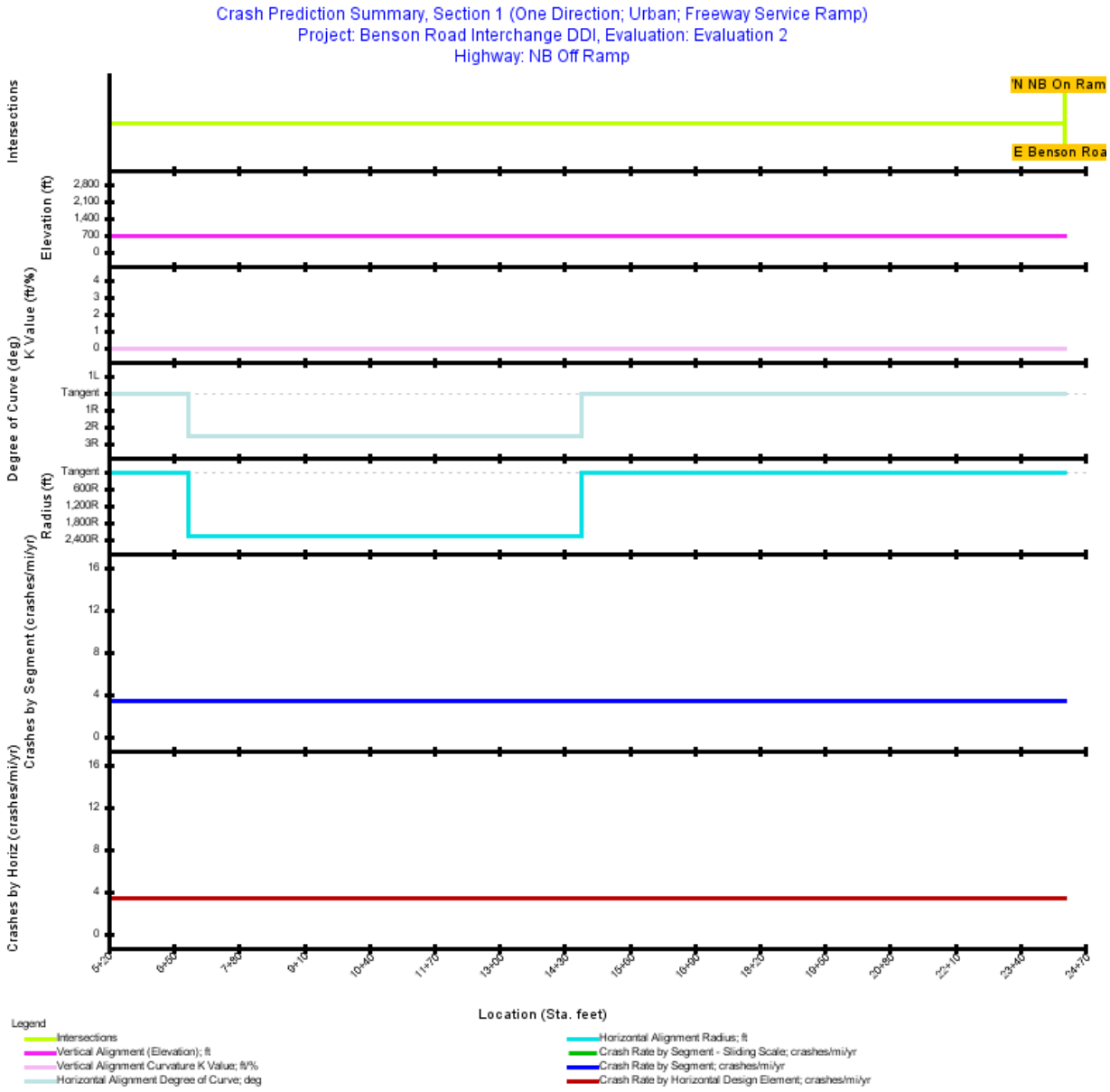

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EX	Urban	5+28.500	24+28.450	1,899.95	0.3598	2023: 8,600; 2024: 8,743; 2025: 8,886; 2026: 9,029; 2027: 9,172; 2028: 9,315; 2029: 9,458; 2030: 9,601; 2031: 9,744; 2032: 9,887; 2033: 10,030; 2034: 10,174; 2035: 10,317; 2036: 10,460; 2037: 10,603; 2038: 10,746; 2039: 10,889; 2040: 11,032; 2041: 11,175; 2042: 11,318; 2043: 11,461; 2044: 11,604; 2045: 11,748

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3598
Average Future Road AADT (vpd)	10,174
Expected Crashes	
Total Crashes	27.98
Fatal and Injury Crashes	11.22
Property-Damage-Only Crashes	16.77
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	40
Percent Property-Damage-Only Crashes (%)	60
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	3.3812
Fatal and Injury Crash Rate (crashes/mi/yr)	1.3553
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.0259
Expected Travel Crash Rate	
Total Travel (million veh-mi)	30.73
Travel Crash Rate (crashes/million veh-mi)	0.91
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.36
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.55

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	5+28.500	24+28.450	0.3598	27.984	3.3812	0.91

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	5+28.500	6+78.060	0.0283	2.203	3.3812	0.91
Simple Curve 1	6+78.060	14+62.820	0.1486	11.559	3.3812	0.91
Tangent	14+62.820	24+28.450	0.1829	14.223	3.3812	0.91

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.3338	1.0121	3.4214	6.4499	16.7666

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.04	0.1	0.30	1.1	0.35	1.2
Highway Segment	Collision with Fixed Object	7.53	26.9	9.91	35.4	17.43	62.3
Highway Segment	Collision with Other Object	0.53	1.9	1.92	6.9	2.46	8.8
Highway Segment	Other Single-vehicle Collision	2.17	7.7	1.48	5.3	3.65	13.0
Highway Segment	Collision with Parked Vehicle	0.16	0.6	0.22	0.8	0.38	1.4
Highway Segment	Total Single Vehicle Crashes	10.42	37.2	13.84	49.4	24.26	86.7
Highway Segment	Right-Angle Collision	0.03	0.1	0.05	0.2	0.08	0.3
Highway Segment	Head-on Collision	0.01	0.0	0.01	0.0	0.01	0.0
Highway Segment	Other Multi-vehicle Collision	0.03	0.1	0.07	0.3	0.10	0.3
Highway Segment	Rear-end Collision	0.60	2.1	2.02	7.2	2.62	9.4
Highway Segment	Sideswipe, Same Direction Collision	0.14	0.5	0.78	2.8	0.92	3.3
Highway Segment	Total Multiple Vehicle Crashes	0.79	2.8	2.93	10.5	3.73	13.3
Highway Segment	Total Highway Segment Crashes	11.22	40.1	16.77	59.9	27.98	100.0
	Total Crashes	11.22	40.1	16.77	59.9	27.98	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Generated: Jun 14, 2018 10:42 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:39:31 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Intersection Title: SB Ramp Terminal
Intersection Comment: Created Wed Jun 06 14:30:34 CDT 2018
Intersection Version: v1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Thu Jun 14 10:39:22 CDT 2018

Minimum Location: 10+00.000
Maximum Location: 31+00.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

SB Ramp Terminal Evaluation

Intersection: SB Ramp Terminal
Evaluation Start Location: 10+00.000
Evaluation End Location: 31+00.000
Calibration Factor: RT_SG_FI=1.0; RT_SG_PDO=1.0;

Table 1. Evaluation Ramp Terminal - Site (SB Ramp Terminal)

Inter. No.	Ramp Terminal Type	Area Type	Legs	Location (Sta. ft)	Traffic Control	AADT
1	D4-Four-Leg Ramp Terminal with Diagonal Ramps	Urban	4	14+20.000	Signalized	Inside: 2023: 17,300; 2024: 17,748; 2025: 18,197; 2026: 18,645; 2027: 19,094; 2028: 19,542; 2029: 19,991; 2030: 20,439; 2031: 20,888; 2032: 21,336; 2033: 21,785; 2034: 22,234; 2035: 22,682; 2036: 23,131; 2037: 23,579; 2038: 24,028; 2039: 24,476; 2040: 24,925; 2041: 25,373; 2042: 25,822; 2043: 26,270; 2044: 26,719; 2045: 27,168; Outside: 2023: 17,300; 2024: 17,748; 2025: 18,197; 2026: 18,645; 2027: 19,094; 2028: 19,542; 2029: 19,991; 2030: 20,439; 2031: 20,888; 2032: 21,336; 2033: 21,785; 2034: 22,234; 2035: 22,682; 2036: 23,131; 2037: 23,579; 2038: 24,028; 2039: 24,476; 2040: 24,925; 2041: 25,373; 2042: 25,822; 2043: 26,270; 2044: 26,719; 2045: 27,168 :: Entrance: 2023: 9,000; 2024: 8,965; 2025: 8,930; 2026: 8,896; 2027: 8,861; 2028: 8,827; 2029: 8,792; 2030: 8,758; 2031: 8,723; 2032: 8,689; 2033: 8,654; 2034: 8,620; 2035: 8,585; 2036: 8,550; 2037: 8,516; 2038: 8,481; 2039: 8,447; 2040: 8,412; 2041: 8,378; 2042: 8,343; 2043: 8,309; 2044: 8,274; 2045: 8,240; Exit: 2023: 1,300; 2024: 1,274; 2025: 1,248; 2026: 1,222; 2027: 1,197; 2028: 1,171; 2029: 1,145; 2030: 1,119; 2031: 1,094; 2032: 1,068; 2033: 1,042; 2034: 1,017; 2035: 991; 2036: 965; 2037: 939; 2038: 914; 2039: 888; 2040: 862; 2041: 836; 2042: 811; 2043: 785; 2044: 759; 2045: 734

Table 2. Expected Ramp Terminal Crash Rates and Frequencies (SB Ramp Terminal)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.0000
Expected Crashes	
Total Crashes	221.16
Fatal and Injury Crashes	92.32
Property-Damage-Only Crashes	128.84
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	42
Percent Property-Damage-Only Crashes (%)	58

Table 3. Expected Crash Frequencies and Rates by Ramp Terminal (SB Ramp Terminal)

Segment Number/Intersection Name/Cross Road	Location (Sta. ft)	Expected No. Crashes for Evaluation Period	Expected No. Crashes/Year (crashes/million veh)	Expected Crash Rate (crashes/yr)
SB Ramp Terminal	14+20.000	221.164	0.97	9.6158

Table 4. Expected Crash Severity by Ramp Terminal (SB Ramp Terminal)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0847	2.1165	13.8738	76.2488	128.8401

Table 5. Expected Ramp Terminal Crash Type Distribution (SB Ramp Terminal)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Ramp Terminal	Collision with Animal	0.00	0.0	0.00	0.0	0.00	0.0
Ramp Terminal	Collision with Fixed Object	3.05	1.4	6.44	2.9	9.49	4.3
Ramp Terminal	Collision with Other Object	0.09	0.0	0.26	0.1	0.35	0.2
Ramp Terminal	Other Single-vehicle Collision	1.66	0.8	0.90	0.4	2.56	1.2
Ramp Terminal	Collision with Parked Vehicle	0.09	0.0	0.26	0.1	0.35	0.2
Ramp Terminal	Total Single Vehicle Crashes	4.89	2.2	7.86	3.6	12.75	5.8
Ramp Terminal	Right-Angle Collision	24.00	10.9	28.34	12.8	52.35	23.7
Ramp Terminal	Head-on Collision	1.02	0.5	0.90	0.4	1.92	0.9
Ramp Terminal	Other Multi-vehicle Collision	0.83	0.4	2.58	1.2	3.41	1.5
Ramp Terminal	Rear-end Collision	57.70	26.1	69.96	31.6	127.66	57.7
Ramp Terminal	Sideswipe, Same Direction Collision	3.88	1.8	19.20	8.7	23.07	10.4
Ramp Terminal	Total Multiple Vehicle Crashes	87.43	39.5	120.98	54.7	208.41	94.2
Ramp Terminal	Total Ramp Terminal Crashes	92.32	41.7	128.84	58.3	221.16	100.0
	Total Crashes	92.32	41.7	128.84	58.3	221.16	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 10:29 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:28:09 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
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Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: I-229
Highway Comment: Created Fri Jun 01 07:44:25 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Thu Jun 14 10:27:57 CDT 2018

Minimum Location: 324+28.000
Maximum Location: 447+11.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Section 1 Evaluation

Section: Section 1
Evaluation Start Location: 324+28.000
Evaluation End Location: 447+11.000
Functional Class: Freeway
Type of Alignment: Divided, Multilane
Model Category: Freeway Segment
Calibration Factor: FI_EN=1.0; FI_EX=1.0; FI_MV=1.0; FI_SV=1.0; PDO_EN=1.0; PDO_EX=1.0; PDO_MV=1.0; PDO_SV=1.0;

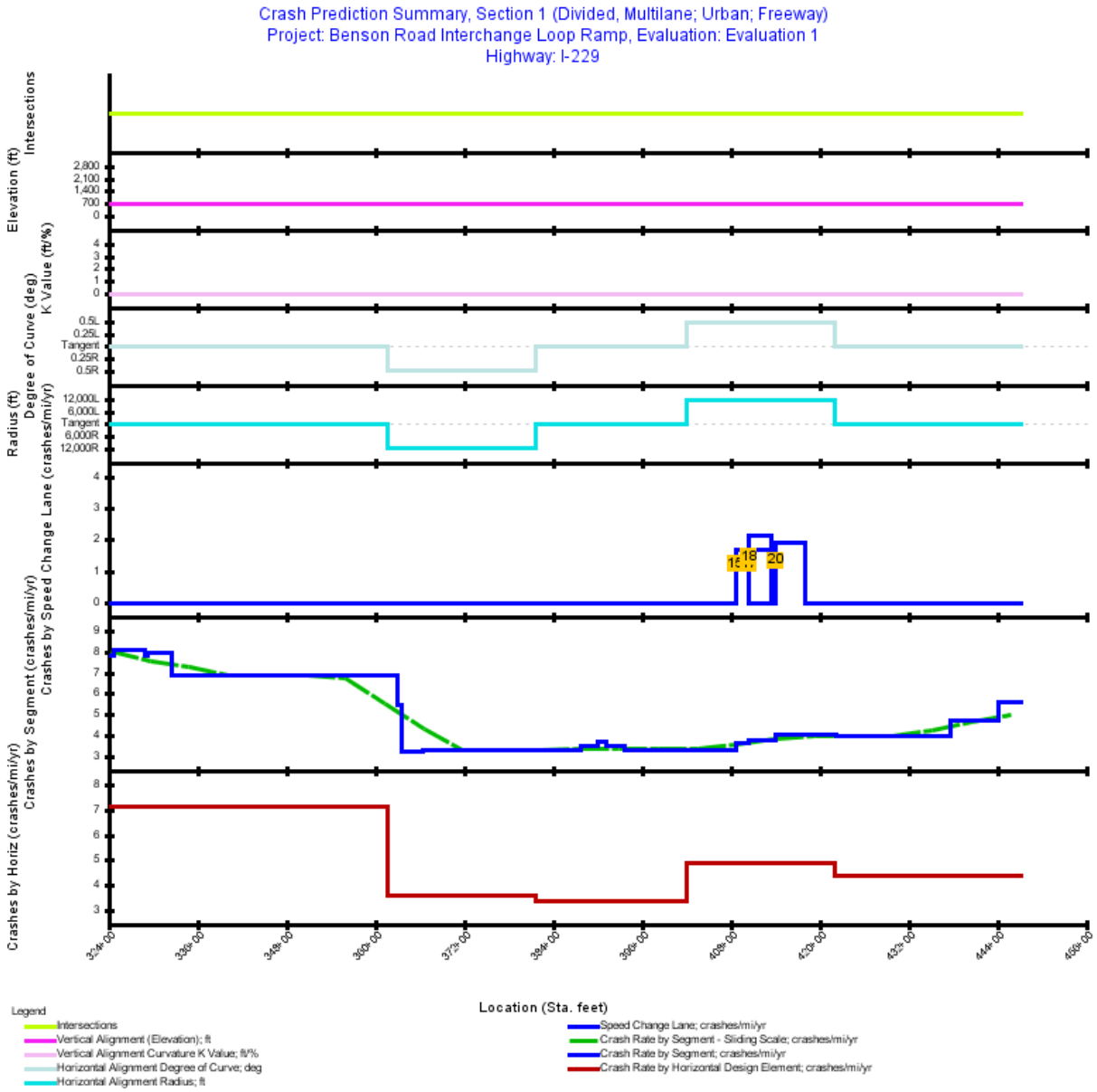

Figure 1. Crash Prediction Summary (Section 1)

Table 1. Evaluation Freeway - Homogeneous Segments (Section 1)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
1	6F	Urban	324+28.000	324+58.000	30.00	0.0057	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
2	6F	Urban	324+58.000	328+83.000	425.00	0.0805	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
3	6F	Urban	328+83.000	329+22.000	39.00	0.0074	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
4	6F	Urban	329+22.000	332+44.000	322.00	0.0610	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
5	6F	Urban	332+44.000	362+91.900	3,047.90	0.5773	2023: 34,900; 2024: 35,518; 2025: 36,136; 2026: 36,754; 2027: 37,372; 2028: 37,990; 2029: 38,609; 2030: 39,227; 2031: 39,845; 2032: 40,463; 2033: 41,081; 2034: 41,700; 2035: 42,318; 2036: 42,936; 2037: 43,554; 2038: 44,172; 2039: 44,790; 2040: 45,409; 2041: 46,027; 2042: 46,645; 2043: 47,263; 2044: 47,881; 2045: 48,500	60.00	Traversable Median	72.00
6	6F	Urban	362+91.900	363+44.800	52.90	0.0100	2023: 25,900; 2024: 26,552; 2025: 27,205; 2026: 27,858; 2027: 28,510; 2028: 29,163; 2029: 29,816; 2030: 30,469; 2031: 31,121; 2032: 31,774; 2033: 32,427; 2034: 33,080; 2035: 33,732; 2036: 34,385; 2037: 35,038; 2038: 35,690; 2039: 36,343; 2040: 36,996; 2041: 37,649; 2042: 38,301; 2043: 38,954; 2044: 39,607; 2045: 40,260	60.00	Traversable Median	72.00
7	5F	Urban	363+44.800	366+45.000	300.20	0.0569	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
8	6F	Urban	366+45.000	375+18.100	873.10	0.1654	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
9	4F	Urban	375+18.100	387+71.000	1,252.90	0.2373	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
10	4F	Urban	387+71.000	390+06.000	235.00	0.0445	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
11	4F	Urban	390+06.000	391+17.000	111.00	0.0210	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
12	4F	Urban	391+17.000	393+63.000	246.00	0.0466	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
13	4F	Urban	393+63.000	408+57.300	1,494.30	0.2830	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
14	4F	Urban	408+57.300	410+39.300	182.00	0.0345	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
16	4F	Urban	410+39.300	414+02.000	362.70	0.0687	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
19	4F	Urban	414+02.000	422+22.000	820.00	0.1553	2023: 18,600; 2024: 19,030; 2025: 19,461; 2026: 19,891; 2027: 20,322; 2028: 20,752; 2029: 21,183; 2030: 21,613; 2031: 22,044; 2032: 22,474; 2033: 22,905; 2034: 23,335; 2035: 23,766; 2036: 24,196; 2037: 24,627; 2038: 25,057; 2039: 25,488; 2040: 25,918; 2041: 26,349; 2042: 26,779; 2043: 27,210; 2044: 27,640; 2045: 28,071	60.00	Traversable Median	72.00
21	4F	Urban	422+22.000	437+61.000	1,539.00	0.2915	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
22	4F	Urban	437+61.000	444+19.000	658.00	0.1246	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00
23	4F	Urban	444+19.000	447+11.000	292.00	0.0553	2023: 20,500; 2024: 20,909; 2025: 21,318; 2026: 21,727; 2027: 22,136; 2028: 22,545; 2029: 22,954; 2030: 23,363; 2031: 23,772; 2032: 24,181; 2033: 24,590; 2034: 25,000; 2035: 25,409; 2036: 25,818; 2037: 26,227; 2038: 26,636; 2039: 27,045; 2040: 27,454; 2041: 27,863; 2042: 28,272; 2043: 28,681; 2044: 29,090; 2045: 29,500	60.00	Traversable Median	72.00

Table 2. Evaluation Freeway - Speed Change Lanes (Speed Change)

Seg. No.	Type	Ramp Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT	Median Width (ft)	Type	Effective Median Width (ft)
15	4SC	Entrance	408+57.300	410+39.300	182.00	0.0345	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
17	4SC	Entrance	410+39.300	414+02.000	362.70	0.0687	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
18	4SC	Exit	410+39.300	413+39.300	300.00	0.0568	2023: 17,300; 2024: 17,659; 2025: 18,018; 2026: 18,377; 2027: 18,736; 2028: 19,095; 2029: 19,454; 2030: 19,813; 2031: 20,172; 2032: 20,531; 2033: 20,890; 2034: 21,250; 2035: 21,609; 2036: 21,968; 2037: 22,327; 2038: 22,686; 2039: 23,045; 2040: 23,404; 2041: 23,763; 2042: 24,122; 2043: 24,481; 2044: 24,840; 2045: 25,200	60.00	Traversable Median	72.00
20	4SC	Entrance	414+02.000	418+07.300	405.30	0.0768	2023: 18,600; 2024: 19,030; 2025: 19,461; 2026: 19,891; 2027: 20,322; 2028: 20,752; 2029: 21,183; 2030: 21,613; 2031: 22,044; 2032: 22,474; 2033: 22,905; 2034: 23,335; 2035: 23,766; 2036: 24,196; 2037: 24,627; 2038: 25,057; 2039: 25,488; 2040: 25,918; 2041: 26,349; 2042: 26,779; 2043: 27,210; 2044: 27,640; 2045: 28,071	60.00	Traversable Median	72.00

Table 3. Expected Freeway Crash Rates and Frequencies (Section 1)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	2.3263
Average Future Road AADT (vpd)	28,633
Expected Crashes	
Total Crashes	246.71
Fatal and Injury Crashes	91.96
Property-Damage-Only Crashes	154.75
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	37
Percent Property-Damage-Only Crashes (%)	63
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	4.6109
Fatal and Injury Crash Rate (crashes/mi/yr)	1.7186
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.8922
Expected Travel Crash Rate	
Total Travel (million veh-mi)	559.18
Travel Crash Rate (crashes/million veh-mi)	0.44
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.16
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.28

Table 4. Expected Freeway Speed Change Lane Crash Rates and Frequencies (Speed Change)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2367
Average Future Road AADT (vpd)	10,963
Expected Crashes	
Total Crashes	10.23
Fatal and Injury Crashes	3.06
Property-Damage-Only Crashes	7.17
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	30
Percent Property-Damage-Only Crashes (%)	70
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	1.8792
Fatal and Injury Crash Rate (crashes/mi/yr)	0.5622
Property-Damage-Only Crash Rate (crashes/mi/yr)	1.3170
Expected Travel Crash Rate	
Total Travel (million veh-mi)	21.79
Travel Crash Rate (crashes/million veh-mi)	0.47
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.14
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.33

Note: *Total Travel and Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 5. Expected Crash Frequencies and Rates by Freeway Segment (Section 1)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Effective Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	324+28.000	324+58.000	0.0057	1.021	7.8142	0.51
2	324+58.000	328+83.000	0.0805	14.940	8.0700	0.53
3	328+83.000	329+22.000	0.0074	1.327	7.8142	0.51
4	329+22.000	332+44.000	0.0610	11.177	7.9687	0.52
5	332+44.000	362+91.900	0.5773	91.383	6.8829	0.45
6	362+91.900	363+44.800	0.0100	1.262	5.4770	0.45
7	363+44.800	366+45.000	0.0569	4.271	3.2661	0.42
8	366+45.000	375+18.100	0.1654	12.555	3.3010	0.43
9	375+18.100	387+71.000	0.2373	18.032	3.3039	0.43
10	387+71.000	390+06.000	0.0445	3.569	3.4861	0.45
11	390+06.000	391+17.000	0.0210	1.787	3.6960	0.48
12	391+17.000	393+63.000	0.0466	3.736	3.4861	0.45
13	393+63.000	408+57.300	0.2830	21.485	3.3006	0.43
14	408+57.300	410+39.300	0.0172	1.446	3.6477	0.47
16	410+39.300	414+02.000	0.0059	0.519	3.7992	0.49
19	414+02.000	422+22.000	0.1169	10.927	4.0634	0.48
21	422+22.000	437+61.000	0.2915	26.674	3.9789	0.44
22	437+61.000	444+19.000	0.1246	13.519	4.7165	0.52
23	444+19.000	447+11.000	0.0553	7.076	5.5630	0.61

Note: *Effective Length* is the *segment length* minus the length of the *speed change lanes* if present.

Table 6. Expected Crash Frequencies and Rates by Freeway Speed Change Lane (Speed Change)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
15	408+57.300	410+39.300	0.0345	1.354	1.7075	0.44
17	410+39.300	414+02.000	0.0687	2.698	1.7075	0.44
18	410+39.300	413+39.300	0.0568	2.806	2.1472	0.55
20	414+02.000	418+07.300	0.0768	3.375	1.9115	0.45

Note: *Travel Crash Rates/Million Vehicle Miles* for *Speed Change Lanes* reflect AADTs that are **half of the Freeway Segment AADTs** based on the assumption of 50/50 directional distribution.

Table 7. Expected Crash Frequencies and Rates by Horizontal Design Element (Section 1)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	324+28.000	361+59.260	0.7067	115.873	7.1290	0.47
Simple Curve 1	361+59.260	381+62.890	0.3795	31.345	3.5913	0.43
Tangent	381+62.890	401+97.440	0.3853	29.840	3.3670	0.43
Simple Curve 2	401+97.440	422+00.920	0.3794	32.331	4.8990	0.76
Tangent	422+00.920	447+11.000	0.4754	47.550	4.3572	0.48

Table 8. Expected Crash Severity by Freeway Segment (Section 1)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0064	0.0165	0.1181	0.2311	0.6490
2	0.0845	0.2236	1.6266	3.3876	9.6179
3	0.0083	0.0215	0.1536	0.3004	0.8438
4	0.0704	0.1816	1.2818	2.4132	7.2302
5	0.6885	1.7299	11.7534	19.6994	57.5120
6	0.0118	0.0305	0.1839	0.2617	0.7741
7	0.0412	0.1059	0.6389	0.9090	2.5762
8	0.1252	0.3221	1.9434	2.7650	7.3989
9	0.1569	0.3970	2.5293	3.8348	11.1137
10	0.0258	0.0652	0.4481	0.7736	2.2559
11	0.0116	0.0297	0.2080	0.3823	1.1555
12	0.0270	0.0682	0.4691	0.8098	2.3615
13	0.1851	0.4669	2.9994	4.5913	13.2418
14	0.0136	0.0350	0.2114	0.3008	0.8850
16	0.0049	0.0126	0.0763	0.1086	0.3163
19	0.0961	0.2498	1.5332	2.2896	6.7587
21	0.2083	0.5188	3.5125	5.7579	16.6769
22	0.0879	0.2256	1.5822	2.9172	8.7059
23	0.0382	0.1010	0.7344	1.5257	4.6766
Total	1.8918	4.8015	32.0036	53.2591	154.7501

Table 9. Expected Crash Severity by Speed Change Lane (Speed Change)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
15	0.0096	0.0246	0.1487	0.2116	0.9592
17	0.0191	0.0491	0.2964	0.4217	1.9115
18	0.0218	0.0562	0.3391	0.4825	1.9064
20	0.0237	0.0611	0.3691	0.5267	2.3942
Total	0.0742	0.1911	1.1533	1.6424	7.1713

Table 10. Expected Speed Change Lane Crash Type Distribution (Section 1)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.24	0.1	2.37	1.0	2.61	1.1
Highway Segment	Collision with Fixed Object	43.13	17.5	77.16	31.3	120.29	48.8
Highway Segment	Collision with Other Object	3.05	1.2	14.98	6.1	18.03	7.3
Highway Segment	Other Single-vehicle Collision	12.42	5.0	11.53	4.7	23.95	9.7
Highway Segment	Collision with Parked Vehicle	0.90	0.4	1.72	0.7	2.62	1.1
Highway Segment	Total Single Vehicle Crashes	59.73	24.2	107.77	43.7	167.50	67.9
Highway Segment	Right-Angle Collision	1.00	0.4	0.85	0.3	1.84	0.7
Highway Segment	Head-on Collision	0.26	0.1	0.09	0.0	0.35	0.1
Highway Segment	Other Multi-vehicle Collision	1.00	0.4	1.13	0.5	2.13	0.9
Highway Segment	Rear-end Collision	24.17	9.8	32.42	13.1	56.59	22.9
Highway Segment	Sideswipe, Same Direction Collision	5.80	2.4	12.50	5.1	18.30	7.4
Highway Segment	Total Multiple Vehicle Crashes	32.22	13.1	46.98	19.0	79.21	32.1
Highway Segment	Total Highway Segment Crashes	91.96	37.3	154.75	62.7	246.71	100.0
	Total Crashes	91.96	37.3	154.75	62.7	246.71	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 11. Expected Exit Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.5	0.01	0.5
Highway Segment	Collision with Fixed Object	0.18	6.3	0.40	14.1	0.57	20.3
Highway Segment	Collision with Other Object	0.01	0.5	0.06	2.0	0.07	2.6
Highway Segment	Other Single-vehicle Collision	0.04	1.6	0.04	1.6	0.09	3.1
Highway Segment	Collision with Parked Vehicle	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Total Single Vehicle Crashes	0.23	8.4	0.51	18.1	0.74	26.5
Highway Segment	Right-Angle Collision	0.01	0.4	0.02	0.8	0.03	1.2
Highway Segment	Head-on Collision	0.00	0.2	0.00	0.1	0.01	0.3
Highway Segment	Other Multi-vehicle Collision	0.01	0.5	0.03	1.1	0.04	1.6
Highway Segment	Rear-end Collision	0.49	17.6	1.08	38.4	1.57	56.0
Highway Segment	Sideswipe, Same Direction Collision	0.14	5.1	0.26	9.4	0.41	14.4
Highway Segment	Total Multiple Vehicle Crashes	0.67	23.7	1.40	49.8	2.06	73.5
Highway Segment	Total Highway Segment Crashes	0.90	32.1	1.91	67.9	2.81	100.0
	Total Crashes	0.90	32.1	1.91	67.9	2.81	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 12. Expected Entrance Speed Change Lane Crash Type Distribution (Speed Change)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.00	0.0	0.01	0.1	0.01	0.1
Highway Segment	Collision with Fixed Object	0.42	5.6	0.68	9.1	1.10	14.8
Highway Segment	Collision with Other Object	0.04	0.6	0.19	2.6	0.23	3.1
Highway Segment	Other Single-vehicle Collision	0.14	1.9	0.08	1.1	0.23	3.1
Highway Segment	Collision with Parked Vehicle	0.01	0.1	0.02	0.2	0.02	0.3
Highway Segment	Total Single Vehicle Crashes	0.61	8.3	0.98	13.2	1.59	21.5
Highway Segment	Right-Angle Collision	0.04	0.6	0.08	1.1	0.12	1.7
Highway Segment	Head-on Collision	0.01	0.1	0.01	0.1	0.01	0.2
Highway Segment	Other Multi-vehicle Collision	0.04	0.5	0.08	1.1	0.12	1.6
Highway Segment	Rear-end Collision	1.17	15.8	2.79	37.6	3.96	53.4
Highway Segment	Sideswipe, Same Direction Collision	0.29	3.9	1.33	17.9	1.61	21.7
Highway Segment	Total Multiple Vehicle Crashes	1.55	20.8	4.29	57.7	5.83	78.5
Highway Segment	Total Highway Segment Crashes	2.16	29.1	5.26	70.9	7.43	100.0
	Total Crashes	2.16	29.1	5.26	70.9	7.43	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Table 13. Evaluation Message

Start Location (Sta. ft)	End Location (Sta. ft)	Message
363+44.800	366+45.000	for segment #7 (363+44.800 to 366+45.000), Freeway Segment of type Five-lane Freeway is using unbalanced lane processing with types Four-lane Freeway and Six-lane Freeway
366+45.000	375+18.100	for segment #8 (366+45.000 to 375+18.100), Freeway Segment of type Six-lane Freeway is using unbalanced lane processing with types Four-lane Freeway and Eight-lane Freeway

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 10:32 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:31:57 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: NB On Ramp
Highway Comment: Created Mon Jun 04 10:02:27 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Thu Jun 14 10:31:48 CDT 2018

Minimum Location: 0.000
Maximum Location: 18+47.400
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 0.000
Evaluation End Location: 18+47.400
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

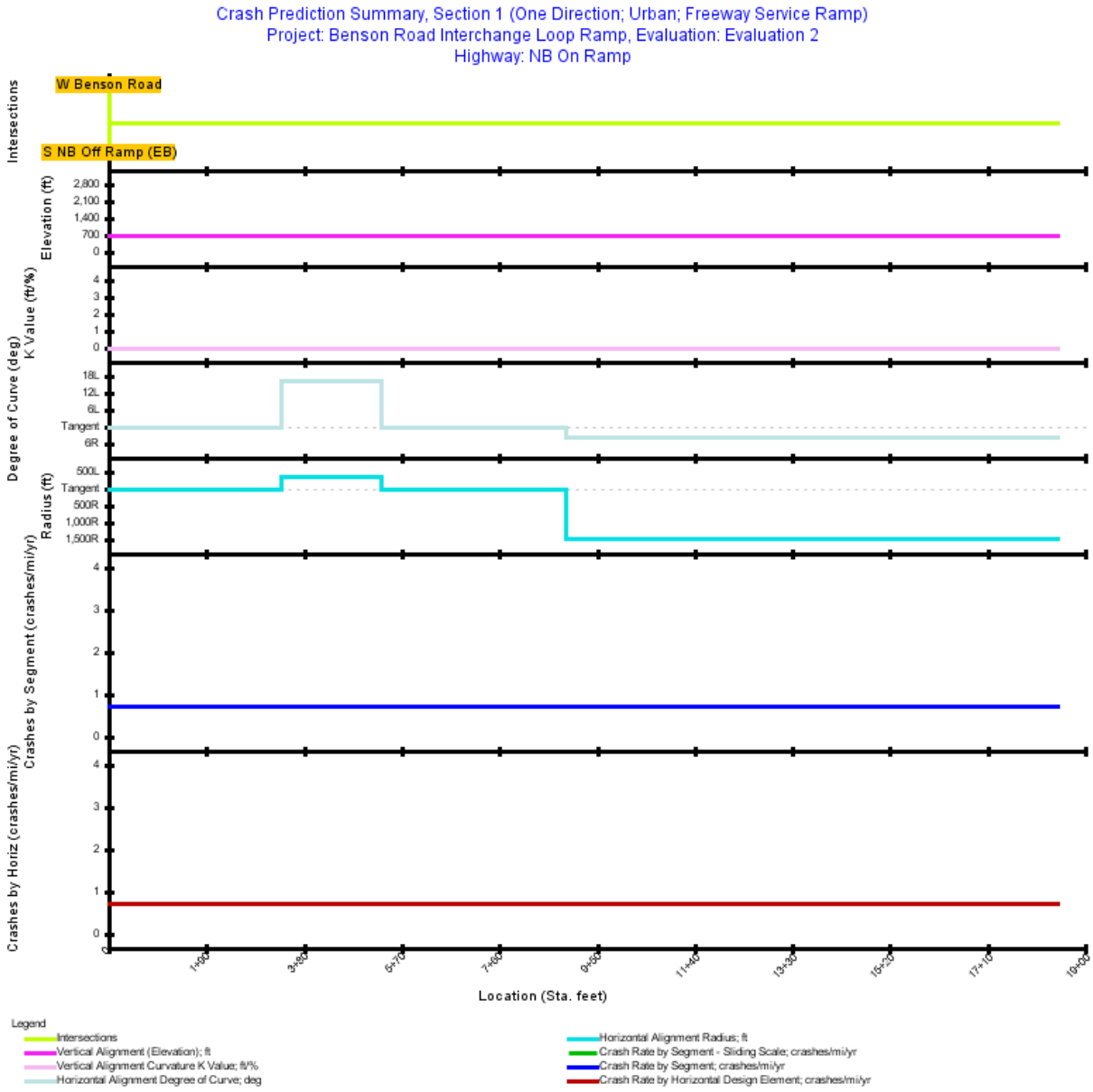

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EN	Urban	0.000	18+47.400	1,847.40	0.3499	2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.3499
Average Future Road AADT (vpd)	1,664
Expected Crashes	
Total Crashes	5.87
Fatal and Injury Crashes	2.59
Property-Damage-Only Crashes	3.28
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	44
Percent Property-Damage-Only Crashes (%)	56
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	0.7289
Fatal and Injury Crash Rate (crashes/mi/yr)	0.3216
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.4073
Expected Travel Crash Rate	
Total Travel (million veh-mi)	4.89
Travel Crash Rate (crashes/million veh-mi)	1.20
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.53
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.67

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	0.000	18+47.400	0.3499	5.866	0.7289	1.20

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	0.000	3+34.900	0.0634	1.063	0.7289	1.20
Simple Curve 1	3+34.900	5+30.600	0.0371	0.621	0.7289	1.20
Tangent	5+30.600	8+89.300	0.0679	1.139	0.7289	1.20
Simple Curve 2	8+89.300	18+47.400	0.1815	3.042	0.7289	1.20

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0552	0.1674	1.0655	1.3001	3.2775

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.01	0.1	0.06	1.1	0.07	1.2
Highway Segment	Collision with Fixed Object	1.57	26.8	2.08	35.4	3.65	62.3
Highway Segment	Collision with Other Object	0.11	1.9	0.40	6.9	0.52	8.8
Highway Segment	Other Single-vehicle Collision	0.45	7.7	0.31	5.3	0.76	13.0
Highway Segment	Collision with Parked Vehicle	0.03	0.6	0.05	0.8	0.08	1.3
Highway Segment	Total Single Vehicle Crashes	2.18	37.1	2.90	49.5	5.08	86.6
Highway Segment	Right-Angle Collision	0.01	0.2	0.01	0.1	0.02	0.3
Highway Segment	Head-on Collision	0.00	0.1	0.00	0.0	0.00	0.1
Highway Segment	Other Multi-vehicle Collision	0.01	0.2	0.01	0.2	0.02	0.4
Highway Segment	Rear-end Collision	0.31	5.2	0.26	4.4	0.56	9.6
Highway Segment	Sideswipe, Same Direction Collision	0.07	1.3	0.10	1.7	0.17	3.0
Highway Segment	Total Multiple Vehicle Crashes	0.41	7.0	0.37	6.4	0.78	13.4
Highway Segment	Total Highway Segment Crashes	2.59	44.1	3.28	55.9	5.87	100.0
	Total Crashes	2.59	44.1	3.28	55.9	5.87	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 10:31 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:31:08 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
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Phone: 402-578-9254
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Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: SB On Ramp
Highway Comment: Created Mon Jun 04 08:18:56 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Thu Jun 14 10:31:01 CDT 2018

Minimum Location: 0.000
Maximum Location: 15+45.940
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 0.000
Evaluation End Location: 15+45.940
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: ENT_RAMP_MV_FI=1.0; ENT_RAMP_MV_PDO=1.0; ENT_RAMP_SV_FI=1.0; ENT_RAMP_SV_PDO=1.0;

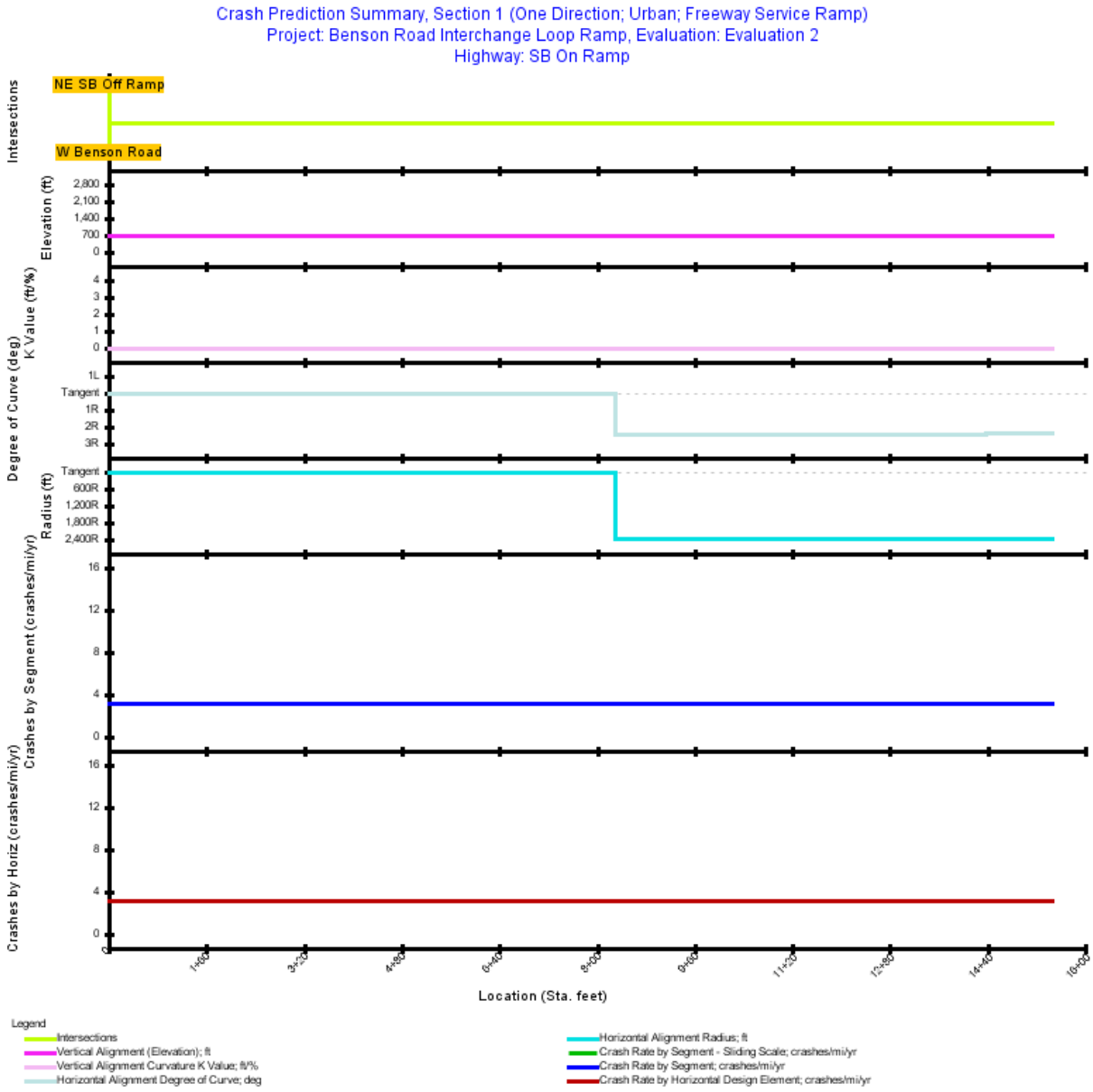

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EN	Urban	0.000	15+45.940	1,545.94	0.2928	2023: 9,000; 2024: 8,965; 2025: 8,930; 2026: 8,896; 2027: 8,861; 2028: 8,827; 2029: 8,792; 2030: 8,758; 2031: 8,723; 2032: 8,689; 2033: 8,654; 2034: 8,620; 2035: 8,585; 2036: 8,550; 2037: 8,516; 2038: 8,481; 2039: 8,447; 2040: 8,412; 2041: 8,378; 2042: 8,343; 2043: 8,309; 2044: 8,274; 2045: 8,240

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2928
Average Future Road AADT (vpd)	8,620
Expected Crashes	
Total Crashes	21.40
Fatal and Injury Crashes	7.77
Property-Damage-Only Crashes	13.63
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	36
Percent Property-Damage-Only Crashes (%)	64
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	3.1775
Fatal and Injury Crash Rate (crashes/mi/yr)	1.1541
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.0234
Expected Travel Crash Rate	
Total Travel (million veh-mi)	21.19
Travel Crash Rate (crashes/million veh-mi)	1.01
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.37
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.64

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	0.000	15+45.940	0.2928	21.398	3.1775	1.01

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	0.000	8+29.200	0.1570	11.477	3.1775	1.01
Simple Curve 1	8+29.200	14+37.400	0.1152	8.418	3.1775	1.01
Simple Curve 2	14+37.400	15+45.940	0.0206	1.502	3.1775	1.01

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.1576	0.4779	2.4736	4.6631	13.6259

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.02	0.1	0.18	0.8	0.20	0.9
Highway Segment	Collision with Fixed Object	3.96	18.5	5.87	27.4	9.82	45.9
Highway Segment	Collision with Other Object	0.28	1.3	1.14	5.3	1.42	6.6
Highway Segment	Other Single-vehicle Collision	1.14	5.3	0.88	4.1	2.02	9.4
Highway Segment	Collision with Parked Vehicle	0.08	0.4	0.13	0.6	0.21	1.0
Highway Segment	Total Single Vehicle Crashes	5.48	25.6	8.19	38.3	13.67	63.9
Highway Segment	Right-Angle Collision	0.07	0.3	0.10	0.5	0.17	0.8
Highway Segment	Head-on Collision	0.02	0.1	0.01	0.1	0.03	0.1
Highway Segment	Other Multi-vehicle Collision	0.07	0.3	0.13	0.6	0.20	0.9
Highway Segment	Rear-end Collision	1.72	8.0	3.75	17.5	5.47	25.6
Highway Segment	Sideswipe, Same Direction Collision	0.41	1.9	1.45	6.8	1.86	8.7
Highway Segment	Total Multiple Vehicle Crashes	2.29	10.7	5.43	25.4	7.73	36.1
Highway Segment	Total Highway Segment Crashes	7.77	36.3	13.63	63.7	21.40	100.0
	Total Crashes	7.77	36.3	13.63	63.7	21.40	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

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Evaluation Date: Thu Jun 14 10:36:38 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: NB Off Ramp (WB)
Highway Comment: Created Mon Jun 04 11:02:45 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Thu Jun 14 10:36:27 CDT 2018

Minimum Location: 3+20.200
Maximum Location: 48+03.900
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 3+20.200
Evaluation End Location: 48+03.900
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

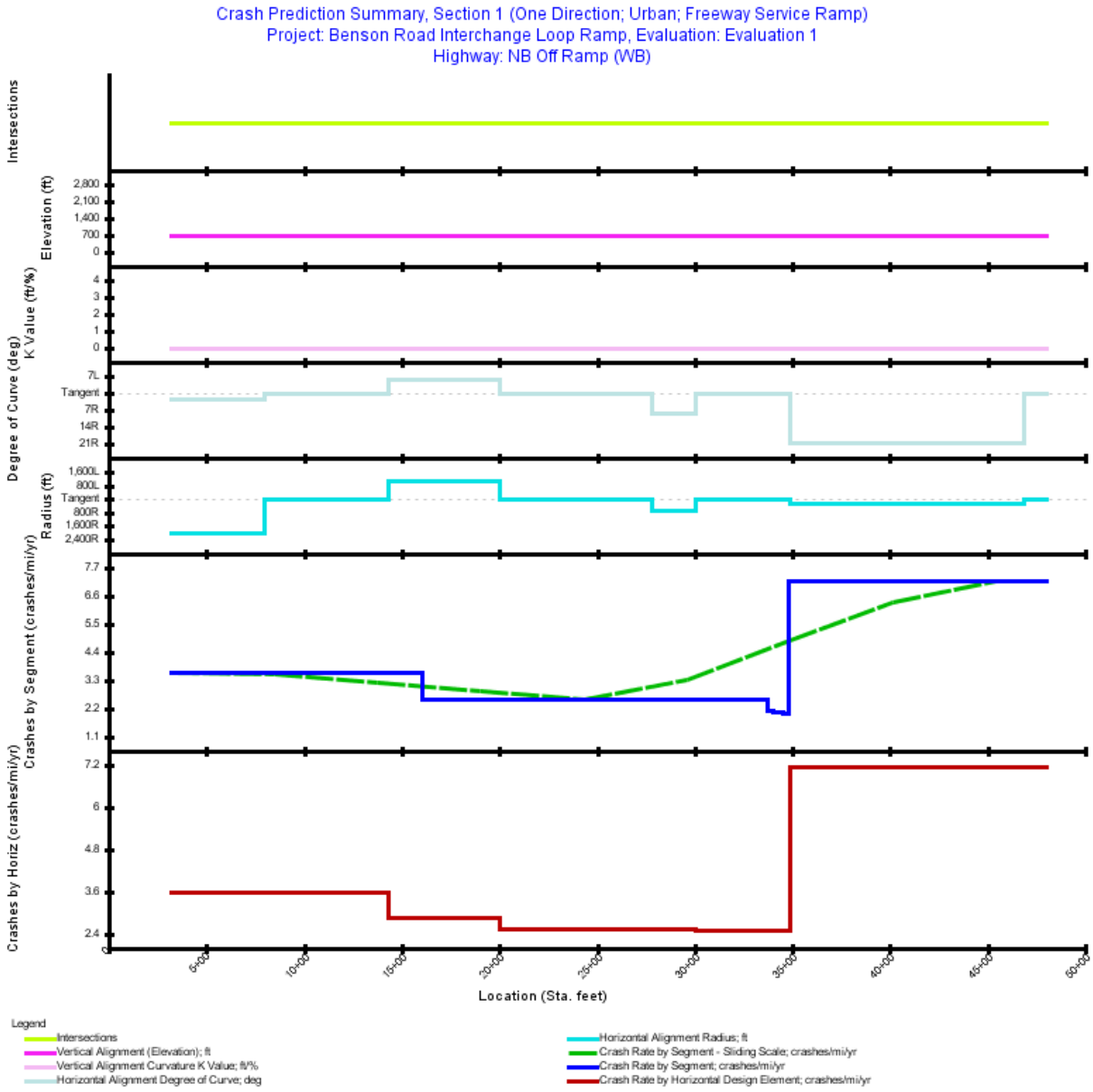

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	2EX	Urban	3+20.200	16+03.600	1,283.40	0.2431	2023: 8,600; 2024: 8,743; 2025: 8,886; 2026: 9,029; 2027: 9,172; 2028: 9,315; 2029: 9,458; 2030: 9,601; 2031: 9,744; 2032: 9,887; 2033: 10,030; 2034: 10,174; 2035: 10,317; 2036: 10,460; 2037: 10,603; 2038: 10,746; 2039: 10,889; 2040: 11,032; 2041: 11,175; 2042: 11,318; 2043: 11,461; 2044: 11,604; 2045: 11,748
2	2EX	Urban	16+03.600	33+74.200	1,770.60	0.3353	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
3	2EX	Urban	33+74.200	33+89.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
4	2EX	Urban	33+89.200	34+04.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
5	2EX	Urban	34+04.200	34+19.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
6	2EX	Urban	34+19.200	34+34.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
7	2EX	Urban	34+34.200	34+49.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
8	2EX	Urban	34+49.200	34+64.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
9	2EX	Urban	34+64.200	34+79.200	15.00	0.0028	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051
10	2EX	Urban	34+79.200	48+03.900	1,324.70	0.2509	2023: 7,930; 2024: 7,753; 2025: 7,577; 2026: 7,401; 2027: 7,224; 2028: 7,048; 2029: 6,872; 2030: 6,695; 2031: 6,519; 2032: 6,343; 2033: 6,166; 2034: 5,990; 2035: 5,814; 2036: 5,637; 2037: 5,461; 2038: 5,285; 2039: 5,108; 2040: 4,932; 2041: 4,756; 2042: 4,579; 2043: 4,403; 2044: 4,227; 2045: 4,051

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.8492
Average Future Road AADT (vpd)	7,188
Expected Crashes	
Total Crashes	82.01
Fatal and Injury Crashes	30.09
Property-Damage-Only Crashes	51.92
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	37
Percent Property-Damage-Only Crashes (%)	63
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	4.1990
Fatal and Injury Crash Rate (crashes/mi/yr)	1.5406
Property-Damage-Only Crash Rate (crashes/mi/yr)	2.6584
Expected Travel Crash Rate	
Total Travel (million veh-mi)	51.24
Travel Crash Rate (crashes/million veh-mi)	1.60
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.59
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	1.01

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	3+20.200	16+03.600	0.2431	20.076	3.5910	0.97
2	16+03.600	33+74.200	0.3353	19.714	2.5560	1.17
3	33+74.200	33+89.200	0.0028	0.139	2.1275	0.97
4	33+89.200	34+04.200	0.0028	0.138	2.1081	0.96
5	34+04.200	34+19.200	0.0028	0.137	2.0892	0.96
6	34+19.200	34+34.200	0.0028	0.135	2.0707	0.95
7	34+34.200	34+49.200	0.0028	0.134	2.0527	0.94
8	34+49.200	34+64.200	0.0028	0.133	2.0350	0.93
9	34+64.200	34+79.200	0.0028	0.132	2.0177	0.92
10	34+79.200	48+03.900	0.2509	41.275	7.1527	3.27

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Simple Curve 1	3+20.200	8+00.700	0.0910	7.516	3.5910	0.97
Tangent	8+00.700	14+29.000	0.1190	9.828	3.5910	0.97
Simple Curve 2	14+29.000	20+01.300	0.1084	7.159	2.8717	1.11
Tangent	20+01.300	27+82.900	0.1480	8.702	2.5560	1.17
Simple Curve 3	27+82.900	30+07.500	0.0425	2.501	2.5560	1.17
Tangent	30+07.500	34+86.300	0.0907	5.252	2.5179	1.15
Simple Curve 4	34+86.300	46+89.600	0.2279	37.492	7.1527	3.27
Tangent	46+89.600	48+03.900	0.0216	3.561	7.1527	3.27

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.2388	0.7240	2.4475	4.6138	12.0518
2	0.2351	0.7130	2.4102	4.5436	11.8118
3	0.0017	0.0050	0.0170	0.0321	0.0832
4	0.0016	0.0049	0.0166	0.0314	0.0832
5	0.0016	0.0048	0.0163	0.0307	0.0832
6	0.0016	0.0047	0.0159	0.0300	0.0832
7	0.0015	0.0046	0.0155	0.0293	0.0832
8	0.0015	0.0045	0.0152	0.0286	0.0832
9	0.0014	0.0044	0.0148	0.0280	0.0832
10	0.4106	1.2450	4.2086	7.9338	27.4767
Total	0.8953	2.7149	9.1777	17.3011	51.9226

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.11	0.1	1.03	1.3	1.14	1.4
Highway Segment	Collision with Fixed Object	20.64	25.2	33.49	40.8	54.12	66.0
Highway Segment	Collision with Other Object	1.46	1.8	6.50	7.9	7.96	9.7
Highway Segment	Other Single-vehicle Collision	5.95	7.2	5.00	6.1	10.95	13.4
Highway Segment	Collision with Parked Vehicle	0.43	0.5	0.75	0.9	1.18	1.4
Highway Segment	Total Single Vehicle Crashes	28.58	34.9	46.77	57.0	75.36	91.9
Highway Segment	Right-Angle Collision	0.05	0.1	0.09	0.1	0.14	0.2
Highway Segment	Head-on Collision	0.01	0.0	0.01	0.0	0.02	0.0
Highway Segment	Other Multi-vehicle Collision	0.05	0.1	0.12	0.2	0.17	0.2
Highway Segment	Rear-end Collision	1.13	1.4	3.56	4.3	4.68	5.7
Highway Segment	Sideswipe, Same Direction Collision	0.27	0.3	1.37	1.7	1.64	2.0
Highway Segment	Total Multiple Vehicle Crashes	1.50	1.8	5.15	6.3	6.66	8.1
Highway Segment	Total Highway Segment Crashes	30.09	36.7	51.92	63.3	82.01	100.0
	Total Crashes	30.09	36.7	51.92	63.3	82.01	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Evaluation Date: Thu Jun 14 10:37:47 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: NB Off Ramp (EB)
Highway Comment: Created Mon Jun 04 11:09:58 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Thu Jun 14 10:37:38 CDT 2018

Minimum Location: 1+74.600
Maximum Location: 16+68.300
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 1+74.600
Evaluation End Location: 16+68.300
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

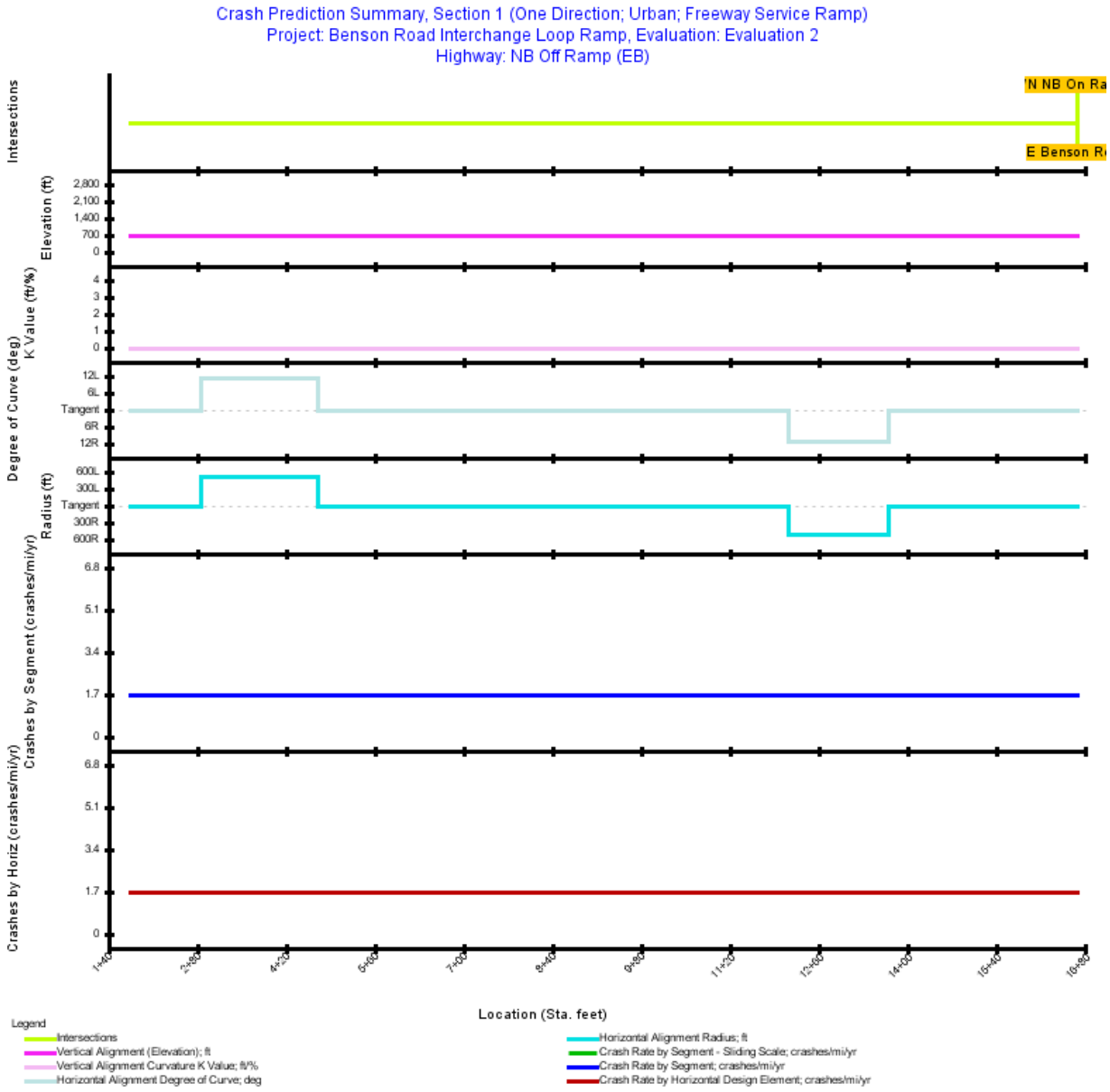

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EX	Urban	1+74.600	16+68.300	1,493.70	0.2829	2023: 670; 2024: 989; 2025: 1,308; 2026: 1,628; 2027: 1,947; 2028: 2,267; 2029: 2,586; 2030: 2,905; 2031: 3,225; 2032: 3,544; 2033: 3,864; 2034: 4,183; 2035: 4,502; 2036: 4,822; 2037: 5,141; 2038: 5,461; 2039: 5,780; 2040: 6,099; 2041: 6,419; 2042: 6,738; 2043: 7,058; 2044: 7,377; 2045: 7,697

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.2829
Average Future Road AADT (vpd)	4,183
Expected Crashes	
Total Crashes	10.92
Fatal and Injury Crashes	4.95
Property-Damage-Only Crashes	5.97
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	45
Percent Property-Damage-Only Crashes (%)	55
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	1.6783
Fatal and Injury Crash Rate (crashes/mi/yr)	0.7611
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.9172
Expected Travel Crash Rate	
Total Travel (million veh-mi)	9.93
Travel Crash Rate (crashes/million veh-mi)	1.10
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.50
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.60

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	1+74.600	16+68.300	0.2829	10.920	1.6783	1.10

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	1+74.600	2+85.000	0.0209	0.807	1.6783	1.10
Simple Curve 1	2+85.000	4+69.900	0.0350	1.352	1.6783	1.10
Tangent	4+69.900	12+11.600	0.1405	5.422	1.6783	1.10
Simple Curve 2	12+11.600	13+69.900	0.0300	1.157	1.6783	1.10
Tangent	13+69.900	16+68.300	0.0565	2.182	1.6783	1.10

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.1546	0.4689	1.9497	2.3790	5.9677

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.02	0.2	0.12	1.1	0.14	1.3
Highway Segment	Collision with Fixed Object	3.46	31.7	4.01	36.8	7.48	68.5
Highway Segment	Collision with Other Object	0.24	2.2	0.78	7.1	1.02	9.4
Highway Segment	Other Single-vehicle Collision	1.00	9.1	0.60	5.5	1.60	14.6
Highway Segment	Collision with Parked Vehicle	0.07	0.7	0.09	0.8	0.16	1.5
Highway Segment	Total Single Vehicle Crashes	4.80	44.0	5.61	51.3	10.40	95.3
Highway Segment	Right-Angle Collision	0.01	0.0	0.01	0.1	0.01	0.1
Highway Segment	Head-on Collision	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Other Multi-vehicle Collision	0.01	0.0	0.01	0.1	0.01	0.1
Highway Segment	Rear-end Collision	0.11	1.0	0.25	2.3	0.36	3.3
Highway Segment	Sideswipe, Same Direction Collision	0.03	0.3	0.10	0.9	0.12	1.1
Highway Segment	Total Multiple Vehicle Crashes	0.15	1.4	0.36	3.3	0.52	4.7
Highway Segment	Total Highway Segment Crashes	4.95	45.4	5.97	54.6	10.92	100.0
	Total Crashes	4.95	45.4	5.97	54.6	10.92	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 10:30 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:29:50 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
Organization Name: HDR Engineering
Phone: 402-578-9254
E-Mail: garret.menard@hdrinc.com

Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Highway Title: SB Off Ramp
Highway Comment: Created Fri Jun 01 10:04:18 CDT 2018
Highway Version: 1

Evaluation Title: Evaluation 2
Evaluation Comment: Created Thu Jun 14 10:29:41 CDT 2018

Minimum Location: 3+59.600
Maximum Location: 24+86.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

Freeway Ramp Evaluation

Section: Section 1
Evaluation Start Location: 3+59.600
Evaluation End Location: 24+86.000
Functional Class: Freeway Service Ramp
Type of Alignment: One Direction
Model Category: Freeway Service Ramp
Calibration Factor: EX_RAMP_MV_FI=1.0; EX_RAMP_MV_PDO=1.0; EX_RAMP_SV_FI=1.0; EX_RAMP_SV_PDO=1.0;

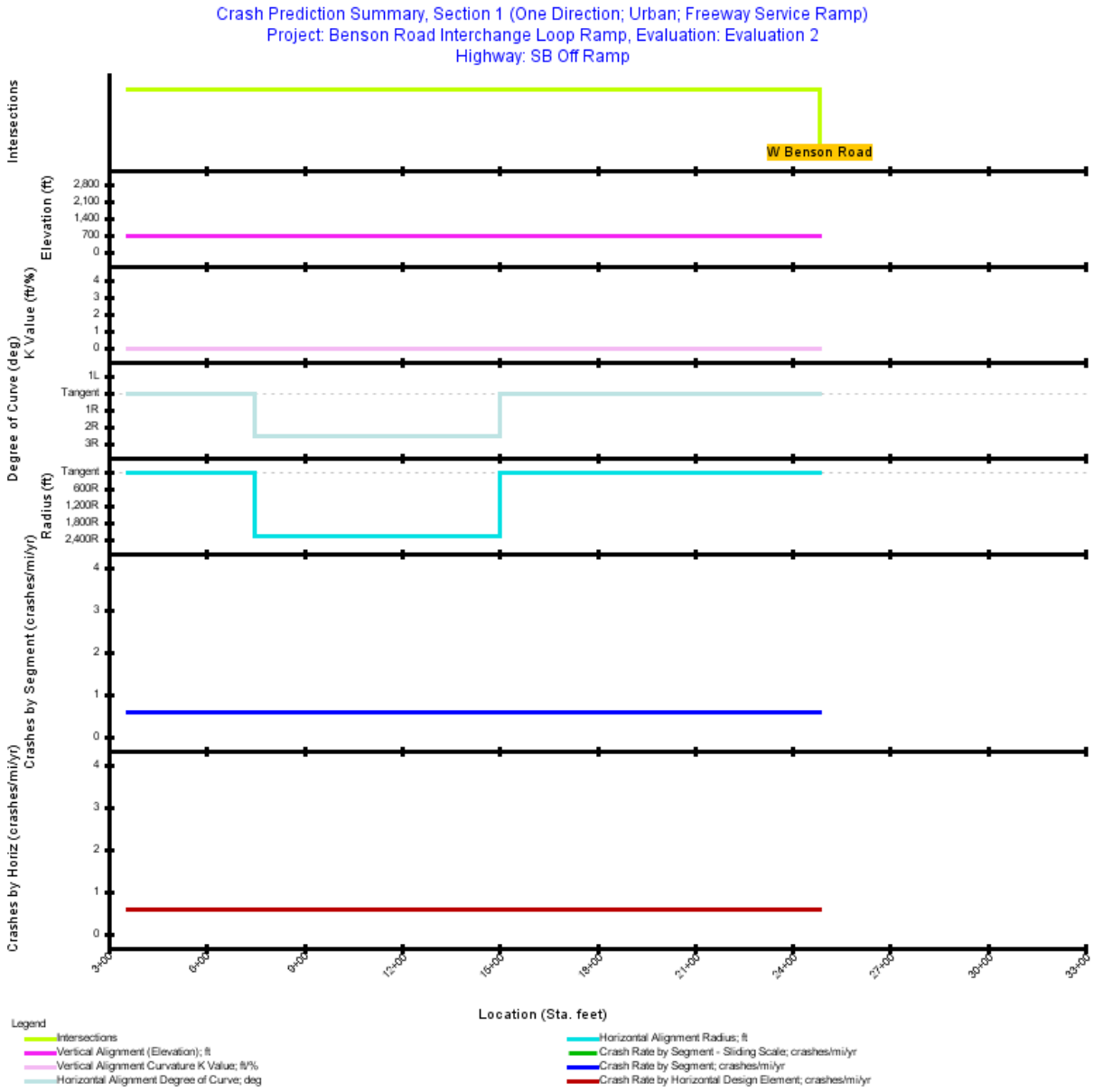

Figure 1. Crash Prediction Summary (Freeway Ramp Sections)

Table 1. Evaluation Freeway - Homogeneous Segments (Freeway Ramp Sections)

Seg. No.	Type	Area Type	Start Location (Sta. ft)	End Location (Sta. ft)	Length (ft)	Length(mi)	AADT
1	1EX	Urban	3+59.600	24+86.000	2,126.40	0.4027	2023: 1,300; 2024: 1,274; 2025: 1,248; 2026: 1,222; 2027: 1,197; 2028: 1,171; 2029: 1,145; 2030: 1,119; 2031: 1,094; 2032: 1,068; 2033: 1,042; 2034: 1,017; 2035: 991; 2036: 965; 2037: 939; 2038: 914; 2039: 888; 2040: 862; 2041: 836; 2042: 811; 2043: 785; 2044: 759; 2045: 734

Table 2. Expected Ramp Crash Rates and Frequencies (Freeway Ramp Sections)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.4027
Average Future Road AADT (vpd)	1,017
Expected Crashes	
Total Crashes	5.26
Fatal and Injury Crashes	2.49
Property-Damage-Only Crashes	2.77
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	47
Percent Property-Damage-Only Crashes (%)	53
Expected Crash Rate	
Crash Rate (crashes/mi/yr)	0.5675
Fatal and Injury Crash Rate (crashes/mi/yr)	0.2690
Property-Damage-Only Crash Rate (crashes/mi/yr)	0.2985
Expected Travel Crash Rate	
Total Travel (million veh-mi)	3.44
Travel Crash Rate (crashes/million veh-mi)	1.53
Travel Fatal and Injury Crash Rate (crashes/million veh-mi)	0.72
Travel Property-Damage-Only Crash Rate (crashes/million veh-mi)	0.80

Table 3. Expected Crash Frequencies and Rates by Ramp Segment (Freeway Ramp Sections)

Segment Number/Intersection Name/Cross Road	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
1	3+59.600	24+86.000	0.4027	5.257	0.5675	1.53

Table 4. Expected Crash Frequencies and Rates by Horizontal Design Element (Freeway Ramp Sections)

Title	Start Location (Sta. ft)	End Location (Sta. ft)	Length (mi)	Expected No. Crashes for Evaluation Period	Crash Rate (crashes/mi/yr)	Travel Crash Rate (crashes/million veh-mi)
Tangent	3+59.600	7+48.480	0.0737	0.961	0.5675	1.53
Simple Curve 1	7+48.480	15+01.540	0.1426	1.862	0.5675	1.53
Tangent	15+01.540	24+86.000	0.1865	2.434	0.5675	1.53

Table 5. Expected Crash Severity by Ramp Segment (Freeway Ramp Sections)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0778	0.2359	0.9810	1.1970	2.7648

Table 6. Expected Freeway Ramp Crash Type Distribution (Freeway Ramp Sections)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Highway Segment	Collision with Animal	0.01	0.2	0.06	1.1	0.07	1.3
Highway Segment	Collision with Fixed Object	1.73	33.0	1.91	36.4	3.65	69.4
Highway Segment	Collision with Other Object	0.12	2.3	0.37	7.1	0.49	9.4
Highway Segment	Other Single-vehicle Collision	0.50	9.5	0.29	5.4	0.79	14.9
Highway Segment	Collision with Parked Vehicle	0.04	0.7	0.04	0.8	0.08	1.5
Highway Segment	Total Single Vehicle Crashes	2.40	45.7	2.67	50.8	5.07	96.5
Highway Segment	Right-Angle Collision	0.00	0.1	0.00	0.0	0.00	0.1
Highway Segment	Head-on Collision	0.00	0.0	0.00	0.0	0.00	0.0
Highway Segment	Other Multi-vehicle Collision	0.00	0.1	0.00	0.0	0.01	0.1
Highway Segment	Rear-end Collision	0.07	1.3	0.06	1.2	0.13	2.5
Highway Segment	Sideswipe, Same Direction Collision	0.02	0.3	0.03	0.5	0.04	0.8
Highway Segment	Total Multiple Vehicle Crashes	0.09	1.7	0.09	1.8	0.18	3.5
Highway Segment	Total Highway Segment Crashes	2.49	47.4	2.77	52.6	5.26	100.0
	Total Crashes	2.49	47.4	2.77	52.6	5.26	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.

Interactive Highway Safety Design Model

Crash Prediction Evaluation Report

June 14, 2018

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Report Overview

Report Generated: Jun 14, 2018 10:43 AM
Report Template: System: Single Page [System] (mlcpm3, Jun 8, 2018 1:30 PM)

Evaluation Date: Thu Jun 14 10:42:39 CDT 2018
IHSDM Version: v13.1.0 (Mar 16, 2018)
Crash Prediction Module: v8.1.0 (Mar 16, 2018)

User Name: Garret Menard
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Project Title: Benson Road Interchange Loop Ramp
Project Comment: Created Thu May 31 14:28:00 CDT 2018
Project Unit System: U.S. Customary

Intersection Title: NB Ramp Terminal
Intersection Comment: Created Thu Jun 14 09:23:41 CDT 2018
Intersection Version: v1

Evaluation Title: Evaluation 1
Evaluation Comment: Created Thu Jun 14 10:42:31 CDT 2018

Minimum Location: 10+00.000
Maximum Location: 31+00.000
Policy for Superelevation: AASHTO 2011 U.S. Customary
Calibration: HSM Configuration
Crash Distribution: HSM Configuration
Model/CMF: HSM Configuration
Empirical-Bayes Analysis: None
First Year of Analysis: 2023
Last Year of Analysis: 2045

Section Types

NB Ramp Terminal Evaluation

Intersection: NB Ramp Terminal
Evaluation Start Location: 10+00.000
Evaluation End Location: 31+00.000
Calibration Factor: RT_SG_FI=1.0; RT_SG_PDO=1.0;

Table 1. Evaluation Ramp Terminal - Site (NB Ramp Terminal)

Inter. No.	Ramp Terminal Type	Area Type	Legs	Location (Sta. ft)	Traffic Control	AADT
1	B4-Four-Leg Ramp Terminal at Four-Quad Parclo B	Urban	4	26+50.000	Signalized	Inside: 2023: 9,000; 2024: 9,559; 2025: 10,119; 2026: 10,678; 2027: 11,238; 2028: 11,797; 2029: 12,357; 2030: 12,917; 2031: 13,476; 2032: 14,036; 2033: 14,595; 2034: 15,155; 2035: 15,715; 2036: 16,274; 2037: 16,834; 2038: 17,393; 2039: 17,953; 2040: 18,513; 2041: 19,072; 2042: 19,632; 2043: 20,191; 2044: 20,751; 2045: 21,311; Outside: 2023: 9,000; 2024: 9,559; 2025: 10,119; 2026: 10,678; 2027: 11,238; 2028: 11,797; 2029: 12,357; 2030: 12,917; 2031: 13,476; 2032: 14,036; 2033: 14,595; 2034: 15,155; 2035: 15,715; 2036: 16,274; 2037: 16,834; 2038: 17,393; 2039: 17,953; 2040: 18,513; 2041: 19,072; 2042: 19,632; 2043: 20,191; 2044: 20,751; 2045: 21,311 :: Entrance: 2023: 1,900; 2024: 1,878; 2025: 1,857; 2026: 1,835; 2027: 1,814; 2028: 1,792; 2029: 1,771; 2030: 1,750; 2031: 1,728; 2032: 1,707; 2033: 1,685; 2034: 1,664; 2035: 1,643; 2036: 1,621; 2037: 1,600; 2038: 1,578; 2039: 1,557; 2040: 1,536; 2041: 1,514; 2042: 1,493; 2043: 1,471; 2044: 1,450; 2045: 1,429; Exit: 2023: 670; 2024: 989; 2025: 1,308; 2026: 1,628; 2027: 1,947; 2028: 2,267; 2029: 2,586; 2030: 2,905; 2031: 3,225; 2032: 3,544; 2033: 3,864; 2034: 4,183; 2035: 4,502; 2036: 4,822; 2037: 5,141; 2038: 5,461; 2039: 5,780; 2040: 6,099; 2041: 6,419; 2042: 6,738; 2043: 7,058; 2044: 7,377; 2045: 7,697

Table 2. Expected Ramp Terminal Crash Rates and Frequencies (NB Ramp Terminal)

First Year of Analysis	2023
Last Year of Analysis	2045
Evaluated Length (mi)	0.0000
Expected Crashes	
Total Crashes	55.62
Fatal and Injury Crashes	23.29
Property-Damage-Only Crashes	32.33
Percent of Total Expected Crashes	
Percent Fatal and Injury Crashes (%)	42
Percent Property-Damage-Only Crashes (%)	58

Table 3. Expected Crash Frequencies and Rates by Ramp Terminal (NB Ramp Terminal)

Segment Number/Intersection Name/Cross Road	Location (Sta. ft)	Expected No. Crashes for Evaluation Period	Expected No. Crashes/Year (crashes/million veh)	Expected Crash Rate (crashes/yr)
NB Ramp Terminal	26+50.000	55.617	0.37	2.4181

Table 4. Expected Crash Severity by Ramp Terminal (NB Ramp Terminal)

Seg. No.	Fatal (K) Crashes (crashes)	Incapacitating Injury (A) Crashes (crashes)	Non-Incapacitating Injury (B) Crashes (crashes)	Possible Injury (C) Crashes (crashes)	No Injury (O) Crashes (crashes)
1	0.0214	0.5338	3.4991	19.2307	32.3323

Table 5. Expected Ramp Terminal Crash Type Distribution (NB Ramp Terminal)

Element Type	Crash Type	Fatal and Injury		Property Damage Only		Total	
		Crashes	Crashes (%)	Crashes	Crashes (%)	Crashes	Crashes (%)
Ramp Terminal	Collision with Animal	0.00	0.0	0.00	0.0	0.00	0.0
Ramp Terminal	Collision with Fixed Object	0.77	1.4	1.62	2.9	2.38	4.3
Ramp Terminal	Collision with Other Object	0.02	0.0	0.07	0.1	0.09	0.2
Ramp Terminal	Other Single-vehicle Collision	0.42	0.8	0.23	0.4	0.65	1.2
Ramp Terminal	Collision with Parked Vehicle	0.02	0.0	0.07	0.1	0.09	0.2
Ramp Terminal	Total Single Vehicle Crashes	1.23	2.2	1.97	3.5	3.21	5.8
Ramp Terminal	Right-Angle Collision	6.05	10.9	7.11	12.8	13.17	23.7
Ramp Terminal	Head-on Collision	0.26	0.5	0.23	0.4	0.48	0.9
Ramp Terminal	Other Multi-vehicle Collision	0.21	0.4	0.65	1.2	0.86	1.5
Ramp Terminal	Rear-end Collision	14.55	26.2	17.56	31.6	32.11	57.7
Ramp Terminal	Sideswipe, Same Direction Collision	0.98	1.8	4.82	8.7	5.79	10.4
Ramp Terminal	Total Multiple Vehicle Crashes	22.05	39.6	30.36	54.6	52.41	94.2
Ramp Terminal	Total Ramp Terminal Crashes	23.29	41.9	32.33	58.1	55.62	100.0
	Total Crashes	23.29	41.9	32.33	58.1	55.62	100.0

Note: *Fatal and Injury Crashes* and *Property Damage Only Crashes* do not necessarily sum up to *Total Crashes* because the distribution of these three crashes had been derived independently.