

Technical Memorandum

TO: Lacey Tisler P.E., NDOT **DATE:** August 18, 2021

FROM: Jim Ceragioli, CA Group

SUBJECT: Henderson Interchange Project: Traffic Safety Analysis Report

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1. INTRODUCTION

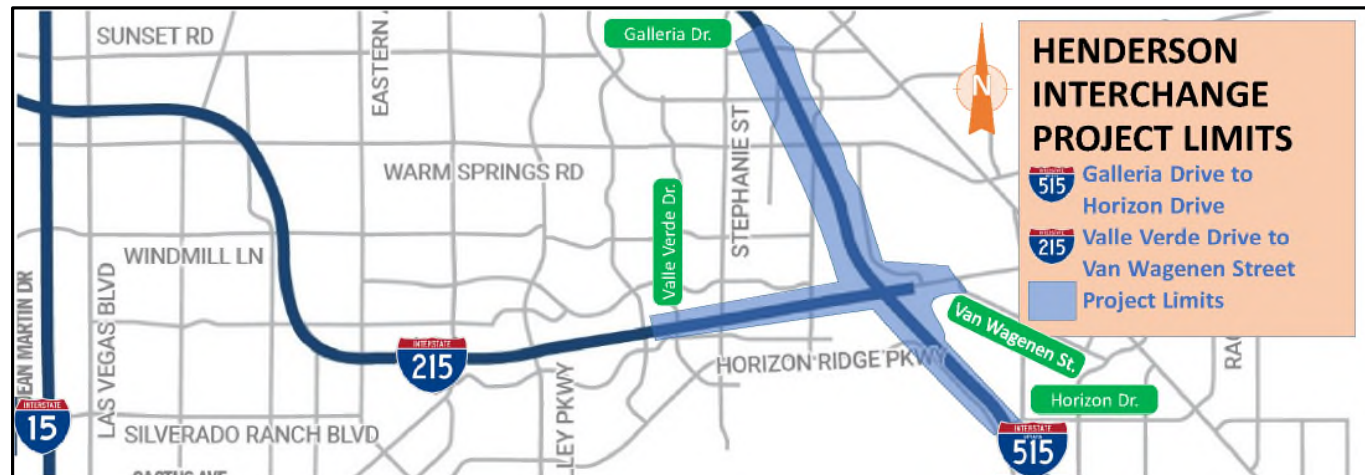
The Henderson Interchange Project is needed to address roadway deficiencies that could contribute to crashes and travel delays, restore connectivity, and accommodate regional and local plans. Traffic safety will further degrade as higher crash rates are experienced in and around the Henderson Interchange. The Purpose of the project is to:

- Resolve existing roadway deficiencies in the Henderson Interchange and surrounding roadways
- Provide transportation improvements to serve existing and future growth areas
- Enhance safety and improve congestion
- Restore local traffic connectivity
- Accommodate regional and local plans

The Henderson Interchange Project is currently in the National Environmental Policy Act (NEPA) phase for the Project limits and shown in **Figure 1**:

- Interstate 11 (I-11), Interstate 215 (I-215), and Interstate 515 (I-515) at system-to-system Interchange Reconstruction
- Direct Access Ramps to/from I-11, I-215, and I-515
- Lake Mead Parkway (LMP) from system-to-system interchange to Van Wagenen Street

Figure 1: Henderson Interchange Project Limits



This document, along with the crash analysis report presents the results of the existing and design year safety evaluation to estimate the difference in crash frequency between the No-build and the selected Build alternative.

During the crash data analysis time period of January 1, 2015, through January 1, 2020, the I-515/I-215 Re-Stripe Project (constructed between September 2018 and August 2019) was completed. The crash data was analyzed, and the estimated number of crashes that occurred on the freeway while under construction during this study period was approximately 22% of the total number of crashes. Although it was not clear in the crash data if the crashes that occurred were due to the construction or due to regular congestion, it was determined to have no significant impact to the Traffic Safety Analysis.

The purpose of this analysis is to quantify the safety impacts of the proposed improvements within the Henderson Interchange study area by evaluating the existing crash data and estimating the future number of crashes for the No-build and the Build options. **Table 1** shows the freeway corridors, Interchanges, and Arterial that are being evaluated in the safety analysis. Only the ramps listed below were evaluated with this safety analysis, the ramp terminals were not included as part of this project.

Table 1: Henderson Interchange Project Safety Analysis Limits

Freeway	NDOT Roadway Classification	Study Limits
I-11	Principal Arterial Interstate	Horizon Drive to I-215/I-515/LMP
I-215	Principal Arterial Interstate	Valle Verde Drive to I-11/I-515/LMP
I-515	Principal Arterial Interstate	I-11/I-215/LMP to Galleria Drive
Interchange	NDOT Roadway Classification	Study Limits (Ramps Only)
Henderson System-to-System Interchange	Principal Arterial Interstate	NB to EB/WB, NB to WB, NB to Eb, SB to WB, SB to EB, EB to NB, EB to SB, WB to NB, WB to SB
I-11-Horizon Interchange	Principal Arterial Interstate	NB on, SB off
I-215-Stephanie Interchange	Principal Arterial Interstate	WB on, WB off, EB on, EB off
I-215-Gibson Interchange	Principal Arterial Interstate	WB on, WB off, EB on, EB off
I-515-Auto Show Interchange	Principal Arterial Interstate	NB on, NB off, SB on, SB off
I-515-Sunset Interchange	Principal Arterial Interstate	NB on, NB off, SB on, SB off
Arterial	NDOT Roadway Classification	Study Limits
Lake Mead Parkway	Urban Principal Arterial-Other	I-11/I-215/I-515 to Van Wagenen Street

2. PROJECT ALTERNATIVES

The environmental study is evaluating the No-Build and the Build Alternative. The No-build would take no-action to address the existing deficiencies and safety concerns within the project limits. The Build Alternative is a crossover style interchange with the east-west highway crossing each other at special grade separated structures east and west of the system-to-system interchange.

2.1 No-build Alternative

The Henderson Interchange exists as a directional system interchange with eleven ramps. I-11, I-215, and I-515 are six-lane divided freeways. Lane widths are twelve feet, and the shoulder widths vary from one foot to ten feet within the study area. I-11 has a service interchange at Horizon Drive. I-215 has service interchanges at Valle Verde Drive, Stephanie Street, and Gibson Road. I-515 has service interchanges at Auto Show Drive, Sunset Road, and Galleria Drive. I-215 ends at I-11/I-515 and extends east as an LMP. I-515 ends at I-11/I-215 and extends in the southbound direction as I-11.

2.2 Build Alternative

The Henderson Interchange would be a crossover interchange (in the east-west direction) with nine ramps with the following improvements/modifications:

- A median-to-median connection consisting of three-lanes (in each direction) between I-215 and I-515.
- Increase the Auto Show Drive NB off-ramp to two lanes to which reduces the width of the shoulders.
- Reconfigure the LMP WB to I-11 SB ramp to pass beneath the I-515/I-11 bridge as a loop ramp that merges with I-215 EB to I-11 SB ramp, and then merges with I-11 SB on the right-hand side.
- Retain the existing I-515 SB braided off-ramp to LMP EB ramp, connecting I-515 SB to LMP EB ramp to the cross over I-215/LMP EB lanes.
- Reconfigure I-215 EB to I-11 SB ramp to exit before Gibson Drive.

All of the Interstate highway segments have twelve-foot lane widths, ten-foot shoulder widths on the inside and outside.

I-11 provides a five-lane section in the NB and SB directions. Auxiliary lanes are added between I-11 NB Horizon Drive on-ramp and the I-215 WB/LMP EB off-ramp, and between I-215 EB to I-11 SB on-ramp and the I-11 SB Horizon Drive off-ramp.

I-215 provides an additional general-purpose lane and auxiliary lane in the EB and WB direction. In the WB direction, this improvement is between Gibson Road and Stephanie Street, as well as Stephanie Street and Valle Verde Drive. In the EB direction, this improvement is between Stephanie Street and Gibson Road.

I-515 provides an additional general-purpose lane and auxiliary lane in the NB direction between Auto Show Drive and Sunset Road. An additional general-purpose lane was added in the NB direction between Sunset Road and Galleria Drive. In the SB direction, a general-purpose lane was added between Sunset Road and Auto Show Drive, and between Sunset Road and Galleria Drive.

Modification on the LMP included several improvements at the intersection of LMP at Eastgate Road/Fiesta Henderson Boulevard along with an additional lane in the EB and WB directions. The main improvement at the intersection is the modification from a dual-left to a triple-left in the NB approach.

3. SAFETY ANALYSIS METHODOLOGY

Prior to conducting the Safety Analysis, IHSDM was considered as a tool to predict the crashes within the study limits. However, a majority of the segments and ramps exceeded IHSDM's maximum criteria identified for crash prediction along freeway segments and ramps. Due to IHSDM's limitations and constraints, the methodology used in the Southern Nevada Traffic Study (SNTS) to estimate crashes and crash reductions was selected. This methodology is described in detail below.

- Results from the crash analysis for the Henderson Interchange project limits were used to perform the safety analysis.
- Each freeway segment and ramp were evaluated for crash rates and crash frequencies for all crashes; fatal crashes (K), severe injury crashes (A), injury crashes (B and C) and Property Damage Only crashes (PDO). These (KABCO) crashes were analyzed and documented in the Henderson Interchange Crash Analysis Report.
- The appropriate Crash Modification Factors (CMF) were identified for the selected alternative improvements. These CMFs are described later in this document.
- The (KABCO) crash severity type distribution percentage was calculated for the project limits.
 - This percentage is the number of crashes for each crash severity from the total crashes for the project limits.

$$X_j = \frac{\sum j}{\sum \text{Total crashes within project limits}} \times 100$$

Where:

X_j is the percentage of each crash severity type

j is the number of crashes for each crash severity for K, A, B, C, and PDO

- The present-day (KABCO) crash severity for all crashes occurring within the project limits between Jan. 01, 2017 and Jan. 01, 2019 was calculated in the following two ways:
 - Crash severity via crash data (DATA): The existing (KABCO) crash data for each freeway segment and ramp were annualized into a single year as shown below. Number of crashes divided by the number of years of crash data.

$$Y_{jData} = \frac{\sum j}{\text{No. of years}}$$

Where:

Y_{jData} is the annualized no. of crashes for each severity type

j is the number of crashes for each K, A, B, C, and PDO from the crash analysis data

No. of years of crash data used in analysis

- Crash severity via Henderson Interchange Study Limits (RATE): The estimated (KABCO) crash severity was calculated using the total crash rate for each freeway segment and ramp as well as overall percentage of each crash severity within the study limits as shown below.

$$Total\ Crashes_{Rate} = \frac{Total\ Crash\ Rate_{Segment/Ramp\ Data} \times AADT \times 365 \times Segment\ Length}{10^{^6}}$$

Where:

$Total\ Crashes_{Rate}$ is the sum of crashes estimated using a segment or ramp's total crashes

$$Y_{jRate} = Total\ Crashes_{Rate} \times Z_j$$

Where:

Y_{jRate} is the no. of crashes for each severity type

Z_j is the overall percentage of each crash severity type

j is the number of crashes for each crash severity, K, A, B, C, and PDO

- Once the present-day crashes are calculated, the 2020 and 2040 No-build estimated (KABCO) crashes are calculated using the existing crashes or the estimated crashes from whichever is higher the Data or the Rate as shown below.

- 2020 No-build: The present-day crash severity and the ratio of the 2020 AADT No-build and 2019 AADT are used to determine the 2020 No-build crash severity as shown below.

$$Y_{j2020\ No\ build} = Max[Y_{jData}, Y_{jRate}] \times \frac{AADT_{2020\ No\ build}}{AADT_{2019}}$$

Where:

$Y_{j2020\ No-Build}$ is the no. of crashes for each severity type for 2020 No-build

Y_{jData} is the annualized no. of crashes for each severity type calculated using the data approach

Y_{jRate} is the no. of crashes for each severity type calculated using the rate approach

j is the number of crashes for each crash severity, K, A, B, C, and PDO

- 2040 No-build: The present-day crash severity and the ratio of the 2040 AADT No-build and 2019 AADT are used to determine the 2040 No-build crash severity as shown below.

$$Y_{j2040\ No\ Build} = Max[Y_{jData}, Y_{jRate}] \times \frac{AADT_{2040\ No\ build}}{AADT_{2019}}$$

Where:

$Y_{j2040\ No-build}$ is the no. of crashes for each severity type for 2040 No-build

Y_{jData} is the annualized no. of crashes for each severity type calculated using the data approach

Y_{jRate} is the no. of crashes for each severity type calculated using the rate approach

j is the number of crashes for each crash severity, K, A, B, C, and PDO

- Using the present-day crash severity, the 2020 and 2040 Build estimated (KABCO) crashes are calculated as follows.

- 2020 Build: The 2020 No-build estimated crashes (for each severity) the ratio of the 2020 AADT Build and 2020 AADT No-build, and the identified crash modification factors (CMFs) are used to determine the 2020 Build crash severity as shown below.

$$Y_{j2020\ Build} = Y_{j2020\ No\ build} \times \frac{AADT_{2020\ Build}}{AADT_{2020\ No\ build}} \times (1 - CMF_i)$$

Where:

$Y_{j2020\ Build}$ is the no. of crashes for each severity type for 2020 Build

$Y_{j2020\ No-build}$ is the no. of crashes for each severity type for 2020 No-build

CMF_i is the factor for the selected Crash Modification Factor

j is the number of crashes for each crash severity, K, A, B, C, and PDO

- 2040 Build: The 2040 No-build estimated crashes (for each severity) the ratio of the 2040 AADT Build and 2040 AADT No-build, and the identified CMFs are used to determine the 2040 Build crash severity as shown below.

$$Y_{j2040\ Build} = Y_{j2040\ No\ Build} \times \frac{AADT_{2040\ Build}}{AADT_{2040\ No\ Build}} \times (1 - CMF_i)$$

Where:

$Y_{j2040\ Build}$ is the no. of crashes for each severity type for 2040 No-build

$Y_{j2040\ No-Build}$ is the no. of crashes for each severity type for 2040 Build

CMF_i is the factor for the selected Crash Modification Factor

j is the number of crashes for each crash severity, K, A, B, C, and PDO

4. CRASH MODIFICATION FACTORS

Crash Modification Factors (CMF) were used to determine the reduction in crashes for the selected counter measure implemented on a road segment or intersection. After the methodology was determined, an extensive review was conducted to identify the appropriate CMFs for the selected improvements. The review for applicable CMFs was conducted in the Nevada CMF List_V1, dated 01/29/2021, and proceeded to the searchable database of CMFs, the Crash Modification Factors Clearinghouse. The clearinghouse contains all the information available on CMFs published from 2010 and is regularly updated to include new CMFs. **Table 2** lists several of the identified CMFs selected for the Henderson Interchange project based on improvement type then on star rating.

Of the five possible CMFs identified in the review (**Table 2**) only two were applicable for this project: CMF ID 3893 - Provide an auxiliary lane between an entrance ramp and exit ramp, and CMF ID 7022 - Open grade friction course (OGFC). The three CMFs were excluded and are discussed below.

- CMF ID 8334 - Adding a lane by reducing lane and shoulder width. General purpose lanes are added throughout the project without reducing lanes and shoulder widths.
- CMF ID 10555 - Install a ramp meter. All ramps where ramp meters could be installed have existing ramp meters.
- CMF ID 2521 – Left-Lane Ramp. In the existing geometry, two major movements namely I-515 SB ramp to I-215 WB and the I-215 EB ramp to I-515 NB are considered ramp movements. In the Build alternative, these movements are considered median connectors for the interchange linking I-215 EB to I-515 NB and I-515 SB to I-215 WB.

Table 2: Henderson Interchange CMFs

CRASH MODIFICATION FACTOR ¹	FACTOR	REDUCTION	ID	STAR RATING
Adding a lane by reducing lane and shoulder width*	0.75	25%	8334	3
Provide an auxiliary lane between an entrance ramp and exit ramp	0.80	20%	3898	3
(OGFC) open grade friction course	0.95	5%	7022	4
Install a ramp meter*	0.59	41%	10555	3
Left Lane Ramp*	1.49	-49%	2521	3

*Not used in safety analysis

1 [Crash Modification Factors Clearinghouse \(cmfclearinghouse.org\)](http://cmfclearinghouse.org)

5. SAFETY ANALYSIS RESULTS – OVERALL

The results of the safety analysis are broken by freeway, interchanges (ramps only), and the arterial, and summarized by mainline segments, interchanges, arterial segments, and intersections.

There was an overall reduction of 16% in the estimated number of crashes when comparing the 2040 No-build to the 2040 Build for the Henderson Interchange Project. This reduction is further broken down by the mainline segments, interchanges and the LMP arterial segment. The mainline segments had a 23% reduction, the interchanges had 8% reduction, and the LMP arterial had 2% reduction in the estimated number of crashes. These reductions are attributed to the proposed improvements in the Build alternative.

Reviewing the individual mainline segments, including the LMP arterial segment, showed the following results:

- I-11 segment had an estimated crash reduction of 7%.
- I-215 segment had the highest estimated crash reduction of 30%.
- I-515 segment had an estimated crash reduction of 15%
- LMP segment had an estimated crash reduction of 2%.

Reviewing each interchange showed the following results:

- System-to-system interchange had an estimated crash reduction of 8%.
- Horizon Drive interchange had an estimated crash reduction of 5%.
- Stephanie Street interchange had an estimated crash reduction of 3%.
- Gibson Road interchange had the highest estimated crash reduction of 36%.
- Auto Show Drive interchange showed no significant crash reduction.
- Sunset Road interchange had an estimated crash reduction of 7%.

The results of the safety analysis for the 2040 No-build and the 2040 Build are presented in **Table 3** and **Figures 2 and 3**. Detailed results from the safety analysis are provided in Attachment A (Henderson Interchange Traffic Safety Analysis Excel Spreadsheet).

Table 3. Henderson Interchange Project Safety Analysis Results

Location	2040 No-build	2040 Build	Difference
Mainline Segments	437.11	355.57	-23%
Interchanges (Ramps Only)	177.82	164.52	-8%
Arterial Segment	65.20	63.82	-2%
Henderson Interchange Project Total	680.13	583.91	-16%

Figure 2: Mainline Crash Totals

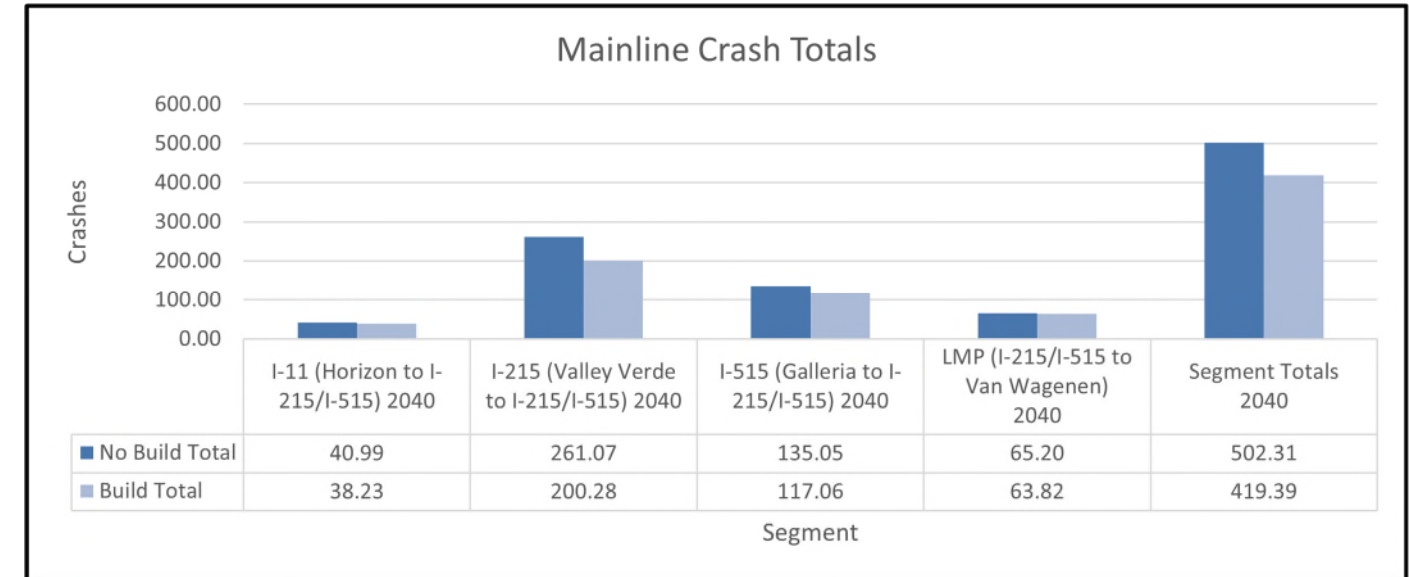
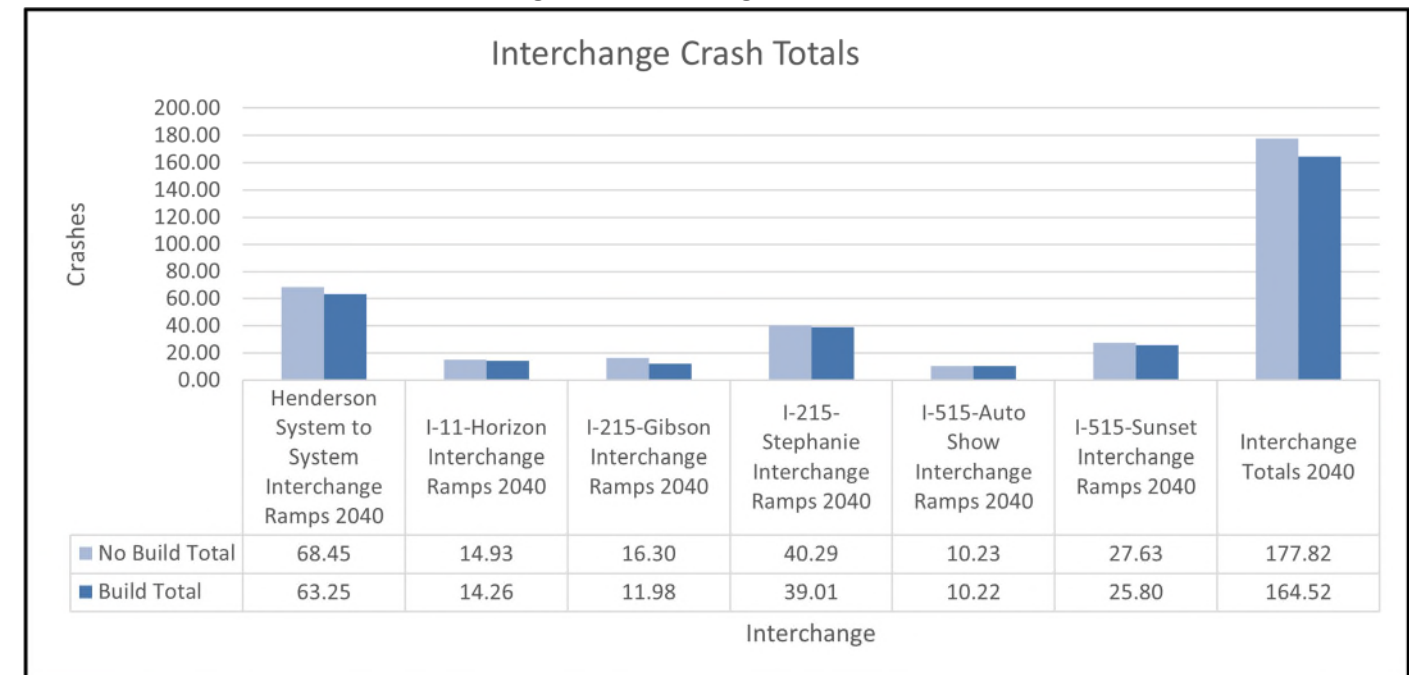


Figure 3: Interchange Crash Totals

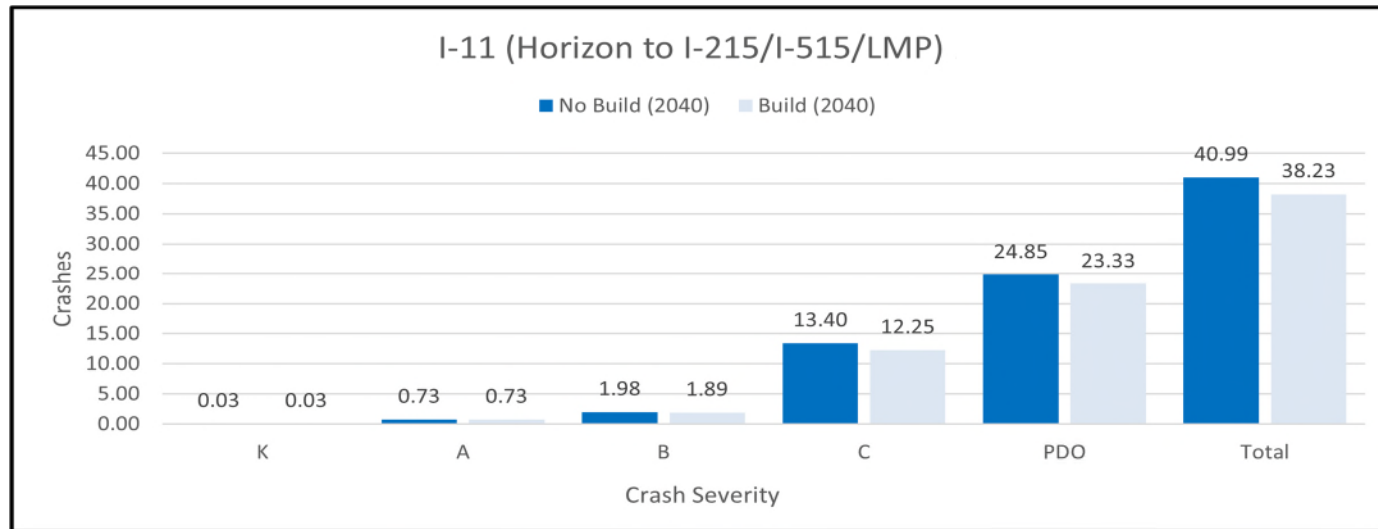


6. SAFETY ANALYSIS RESULTS – MAINLINE SEGMENTS

6.1 I-11 – Horizon Drive to I-215/I-515/LMP

The I-11 segment from Horizon Drive to I-11/I-215/I-515/LMP Interchange showed an overall reduction of approximately 7% in all crash severities with the severity level C injuries having the highest reduction of 9%. **Figure 4** shows the comparison between the 2040 No-build and 2040 Build.

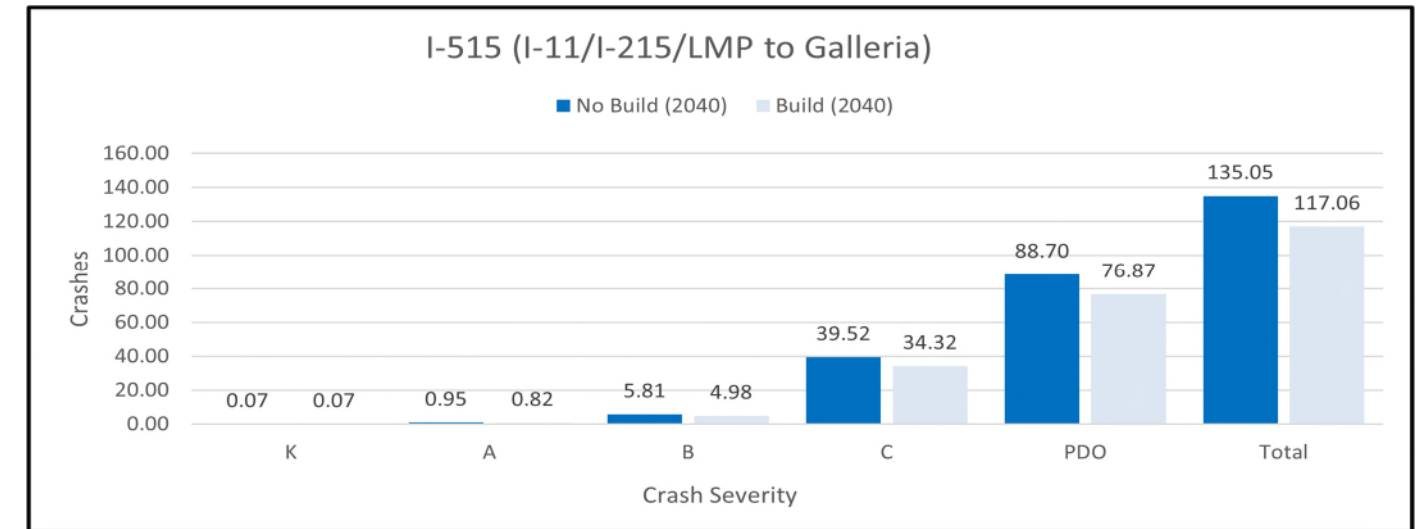
Figure 4: I-11 Mainline Segment



6.3 I-515 – I-11/I-515/LMP to Galleria Drive

The I-515 segment from I-11/I-215/I-515/LMP to Galleria Drive interchange showed a reduction of approximately 15% in all crash severities with the severity level B injuries having the highest reduction of 17%. **Figure 6** shows the comparison between the 2040 No-build and 2040 Build.

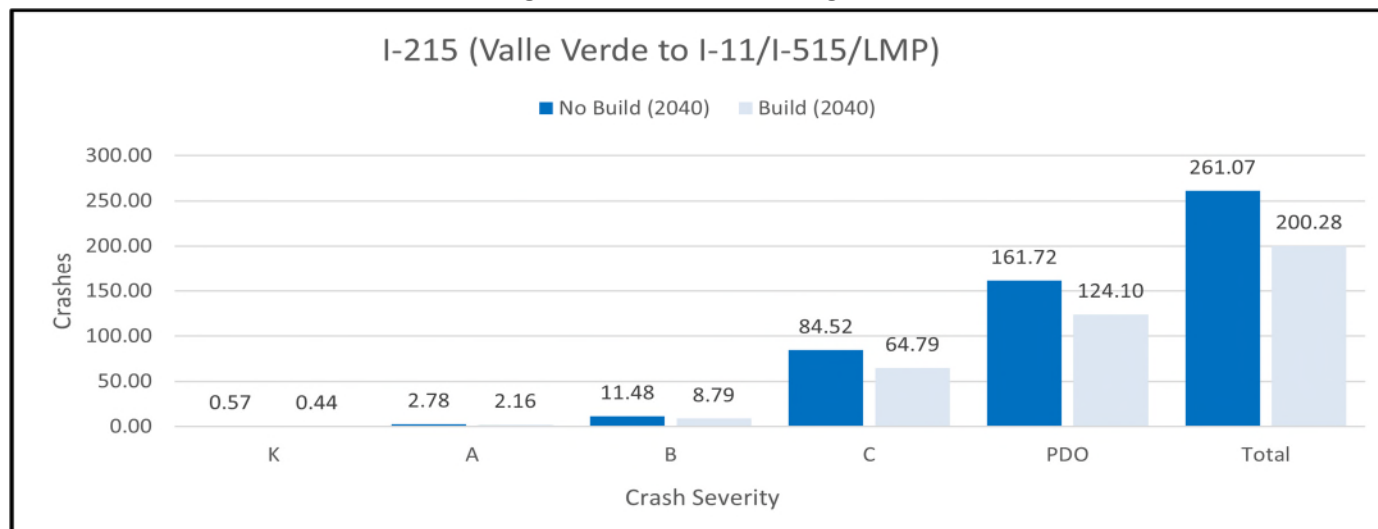
Figure 6: I-515 Mainline Segment



6.2 I-215 – Valle Verde Drive to I-11/I-515/LMP

The I-215 segment from Valley Verde Drive to I-11/I-215/I-515/LMP Interchange showed significant reduction of approximately 30% in all crash severities with the severity level B injuries having the highest reduction of 31%. **Figure 5** shows the comparison between the 2040 No-build and 2040 Build.

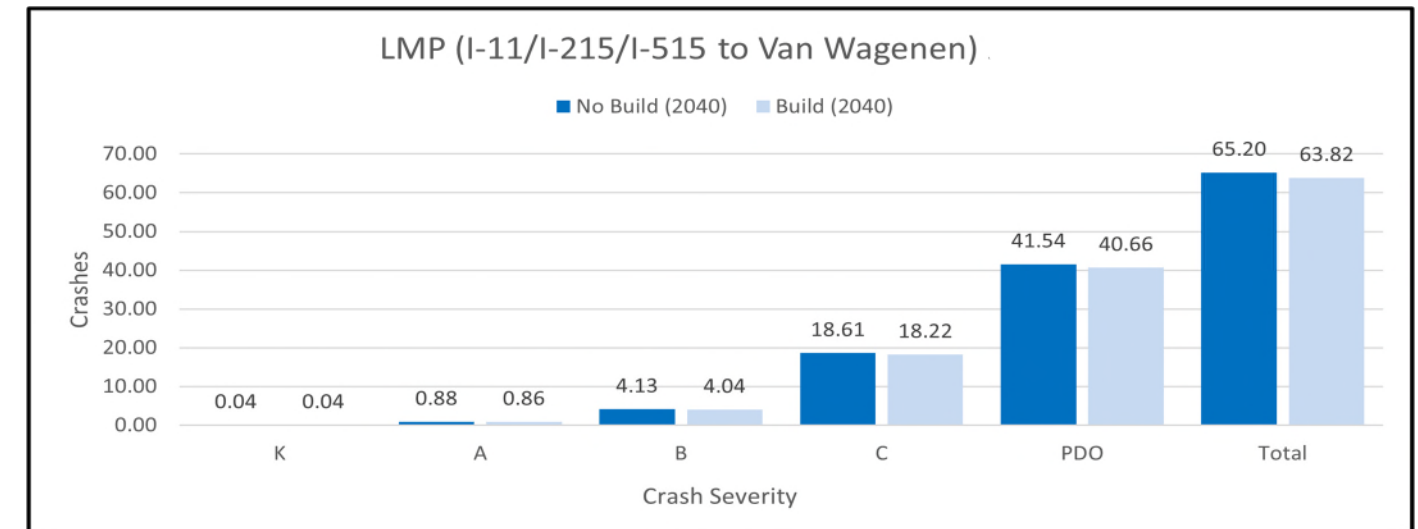
Figure 5: I-215 Mainline Segment



6.4 LMP – I-11/I-215/I-515 to Van Wagenen Street

The LMP segment from I-11/I-215/I-515 to the intersection of Van Wagenen Street (west leg), showed a slight reduction of approximately 2% in all crash severities. **Figure 7** shows the comparison between the 2040 No-build and 2040 Build.

Figure 7: LMP Arterial Segment

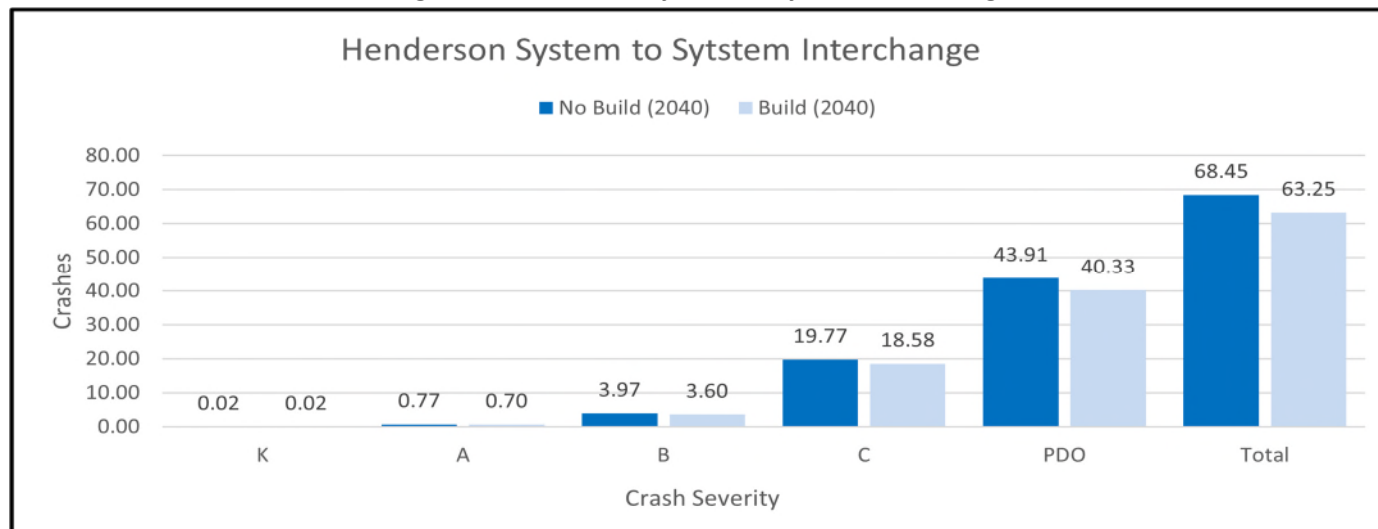


7. SAFETY ANALYSIS RESULTS – INTERCHANGES

7.1 I-11/I-215/I-515/LMP SYSTEM-TO-SYSTEM INTERCHANGE RAMPS

The I-11/I-215/I-515/LMP System-to-System Interchange ramps analysis showed a reduction of approximately 8% in all crash severities with the severity level A and B injuries having the highest reduction of 10%. The analysis included the following ramps: NB off ramp to WB on/EB on, NB off ramp to WB on, NB off ramp to EB on, WB off ramp to SB on, EB off ramp to SB on/NB on, EB off ramp to SB on, EB off ramp to NB on, WB off ramp to NB on, off ramp to WB on/LMP EB on, SB off ramp to WB on, SB off ramp to LMP EB on. **Figure 8** shows the comparison between the 2040 No-build and 2040 Build.

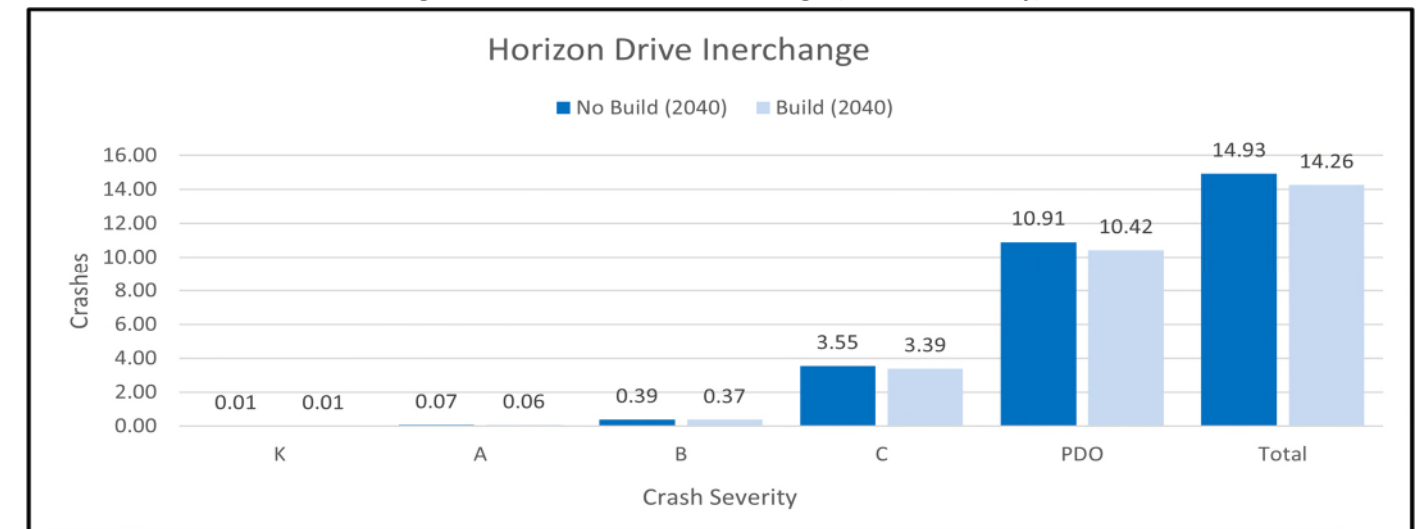
Figure 8: Henderson System to System Interchange



7.2 Horizon Drive Interchange Ramps

The Horizon Drive Interchange ramps analysis showed a reduction of approximately 5% in all crash severities. The analysis was conducted on the northern half of the interchange, which included SB off-ramp and NB on-ramp. **Figure 9** shows the comparison between the 2040 No-build and 2040 Build.

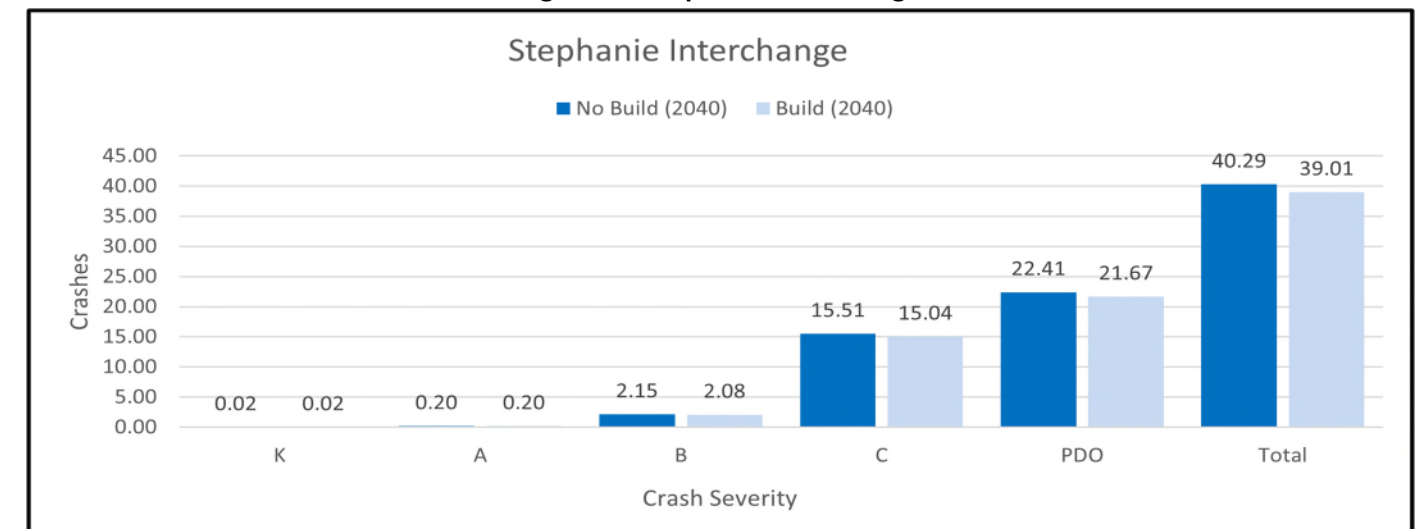
Figure 9: Horizon Drive Interchange (North Half Only)



7.3 Stephanie Street Interchange Ramps

The Stephanie Street Interchange ramps analysis showed a reduction of approximately 3% in all crash severities. The analysis included EB and WB on and off ramps. **Figure 10** shows the comparison between the 2040 No-build and 2040 Build.

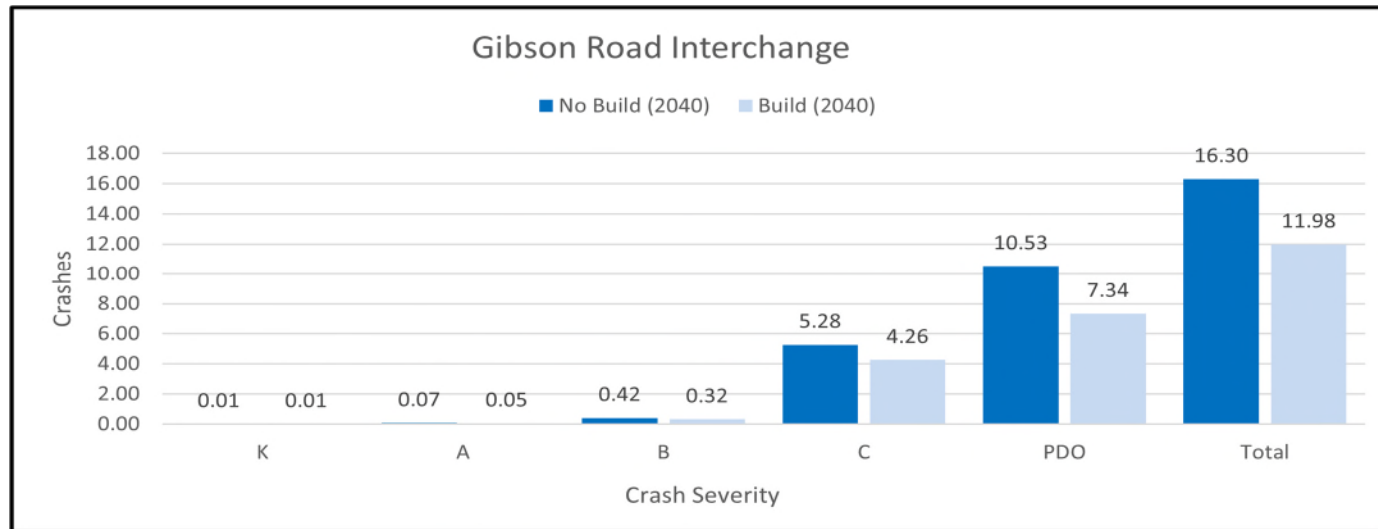
Figure 10: Stephanie Interchange



7.4 Gibson Road Interchange Ramps

The Gibson Road Interchange ramps analysis showed a reduction of approximately 36% in all crash severities with the severity level PDO having the highest reduction of 44%. The analysis included EB and WB on and off ramps. **Figure 11** shows the comparison between the 2040 No-build and 2040 Build.

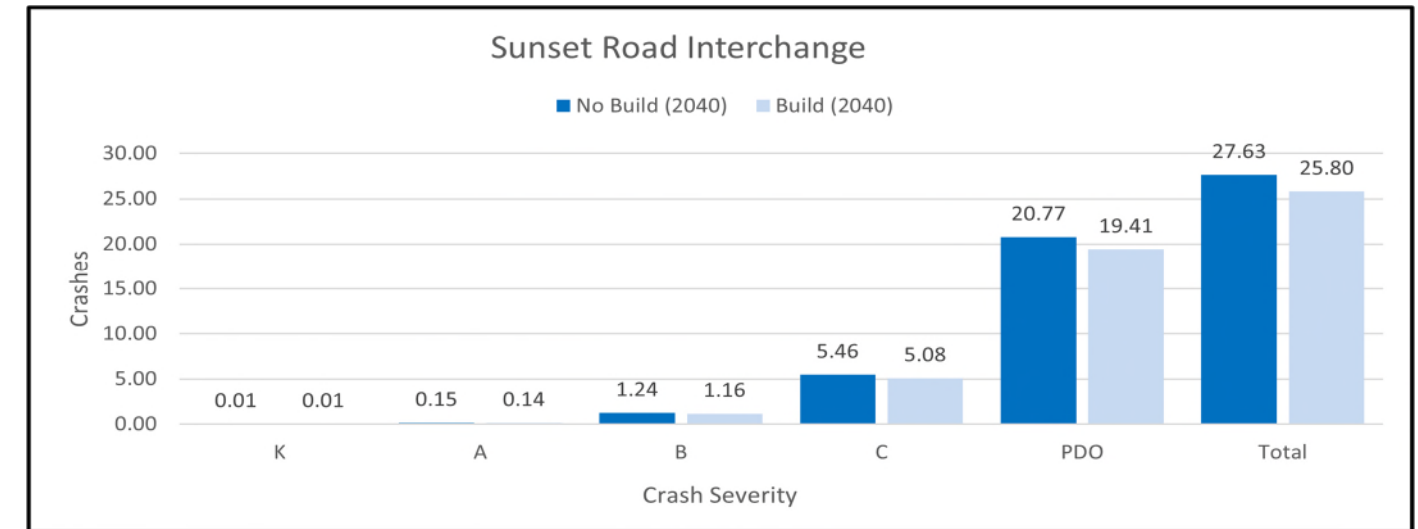
Figure 11: Gibson Road Interchange



7.6 Sunset Road Interchange Ramps

The Sunset Road Interchange ramps analysis showed a reduction of approximately 7% in all crash severities with the severity level C injuries having the highest reduction of 8%. The analysis included NB and SB on and off ramps. **Figure 13** shows the comparison between the 2040 No-build and 2040 Build.

Figure 13: Sunset Road Interchange



7.5 Auto Show Drive Interchange Ramps

The Auto Show Drive Interchange ramps analysis indicated no significant change in crashes. The analysis included NB and SB on and off ramps. **Figure 12** shows the comparison between the 2040 No-build and 2040 Build.

Figure 12: Auto Show Drive Interchange

