



Memorandum

To: Tony Brindisi, P.E.
From: Josh Sender, P.E.
Date: January 21, 2020
Re: I-25 North Metro Managed Lanes RSA Report – January 2020 Update

INTRODUCTION

The Road Safety Audit (RSA) report for the I-25 North Metro Managed Lanes was completed in December of 2017. This report included a crash data review for the I-25 mainline from milepost (MP) 217.04 (US 36 / I-270) to MP 222.18 (Community Center Dr) using crash data from January 1, 2012 through December 31, 2016. A memo dated June 13, 2019 provided an update to the report with an analysis of crash data from January 1, 2017 to June 30, 2018. A second memo dated November 6, 2019 provided an additional update to the report with an analysis of crash data from July 1, 2018 to December 31, 2018. This memo intends to conduct a similar crash data review on the same project limits; however, this memo will also utilize crash data from January 1, 2019 through June 30, 2019.

This memo frequently references the following documents:

- *I-25 North Metro Managed Lanes Road Safety Audit (RSA) Report, December 2017*
- *I-25 North Metro Managed Lanes RSA Report – 2019 Update Memo, June 13, 2019*
- *I-25 North Metro Managed Lanes RSA Report – November 2019 Update Memo, November 6, 2019*

This memo contains the following sections and supporting attachments:

- Safety Enhancements
- Crash Data Review
- Next Steps

SAFETY ENHANCEMENTS

Since the completion and distribution of the RSA report, CDOT has continued to implement many of the safety enhancements mentioned in the report. These safety enhancements have included educational outreach efforts (Table 1), enhanced law enforcement visibility, and several roadway maintenance and engineering enhancements (Table 2).

Table 1 - Educational Outreach Efforts

Educational Outreach Efforts
• Traditional Media Press release with resulting TV, radio, and print coverage
• Variable Message Signs Safety messages on permanent and portable VMS, periodically changed
• Social Media

Educational Outreach Efforts
CDOT, State Patrol, Commuter Group, Corridor Government social media posts
<ul style="list-style-type: none"> • CDOT Public Information Office and Partners Leverage partner social media, newsletters, websites, and billboard access to spread messages
<ul style="list-style-type: none"> • E-470 / Express Toll Include information in billing statements and e-newsletters

Table 2 - Completed Safety Enhancements

Completed Safety Enhancement	Category
<ul style="list-style-type: none"> • "EXPRESS" word markings Reduce confusion approaching I-270 left exit 	Pavement Markings
<ul style="list-style-type: none"> • On-ramp striping improvements Merge traffic to one lane before entering mainline 	Pavement Markings
<ul style="list-style-type: none"> • "MOVE ACCIDENTS FROM TRAFFIC" signs Clear minor incidents from travel lanes quickly 	Signing
<ul style="list-style-type: none"> • Improve Express Lane dynamic sign messages Reduce confusion approaching I-270 left exit 	Signing
<ul style="list-style-type: none"> • Rumble Strips Improve compliance with managed lane entry point restrictions 	Roadway
<ul style="list-style-type: none"> • Evaluate and Implement Corridor Signing Improvements Improved signing for lane violation regulations, reduction of sign clutter, and improved guide signing 	Signing
<ul style="list-style-type: none"> • 88th Avenue Park-n-Ride Bus Operations Prevent unexpected bus maneuvers adjacent to freeway traffic. Communications with RTD appear to have resolved this issue. 	Operations / Incident Management
<ul style="list-style-type: none"> • Enhanced Law Enforcement Visibility Pilot program for rolling patrols during peak periods conducted Fall 2018. 	Enforcement
<ul style="list-style-type: none"> • Advanced Traffic Management Queue warning system implementation 	ITS
<ul style="list-style-type: none"> • Shoulder Widening (pull-out areas) Implemented in select locations. Intended to be used by law enforcement 	Incident Management / Enforcement
<ul style="list-style-type: none"> • Traffic Incident Management Plan Multi-agency coordinated incident response and detour planning. Completed and distributed to agencies December 2019. 	Operations / Incident Management

Furthermore, Table 3 shows the safety enhancements which are ongoing and currently underway.

Table 3 - Ongoing Safety Enhancements

Potential Safety Enhancement	Category	Schedule
<ul style="list-style-type: none"> Enhanced Law Enforcement Visibility Effort is continuing after aforementioned pilot program and is being funded by HPTE. Effort is continually evaluated for renewal every six months. 	Enforcement	In progress
<ul style="list-style-type: none"> Advanced Traffic Management Investigate variable speed limits and speed harmonization 	ITS	Late 2020
<ul style="list-style-type: none"> Managed Lane Ingress/Egress Zone Modifications Evaluate type, frequency, and delineation options (double dashed striping) of zones 	Signing and Pavement Markings	In progress
<ul style="list-style-type: none"> Reconstruct Roadway to Full Template Provide standard shoulders, improve lane balance at I-270 / US 36 	Roadway	Post 2020
<ul style="list-style-type: none"> Buffer Zone Delineation Enhancements Continue to explore various delineation strategies such as physical devices, seasonal applications, and selective location applications. 	Delineation	In progress

CRASH DATA REVIEW

The crash history for the period of January 1, 2012 through December 31, 2016 was examined in the RSA report. Additionally, the crash history for the periods of January 1, 2017 to June 30, 2018 and July 1, 2018 to December 31, 2018 were examined in the June 2019 and November 2019 RSA update memos respectively. Within this collective study period, 4,370 crashes were reported along I-25 between MP 217.04 and MP 222.18. Of these, there were 867 injury collisions and 4 fatal collisions; 1,172 injured and 4 killed overall. Table 4 summarizes the crash totals for mainline I-25 over the six-and-a-half-year study period.

Table 4 - Crash Totals from January 1, 2012 to December 31, 2018

Year	Property Damage Only (PDO) Crashes	Injury (INJ) Crashes	Injuries	Fatal (FAT) Crashes	Fatalities	Total Crashes
2012	253	67	95	0	0	320
2013	335	60	70	0	0	395
2014*	507	125	176	0	0	632
2015*	517	123	175	1	1	641
2016	592	153	203	3	3	748
2017	691	157	208	0	0	848
2018	604	182	245	0	0	786
Total	3,499	867	1,172	4	4	4,370
Average/Yr	499.9	123.9	167.4	0.6	0.6	624.3

*Primary construction period

Note: Crash totals for these time periods may not exactly match the crash totals seen in the RSA report or June 2019 RSA update memo. This is due to data refinements and post processing occurring since the documents were published. Changes in crash totals are minor and do not affect overall conclusions.

The RSA report also examined cumulative crash totals for 2016 to determine if the managed lane tolling operation affected crash frequency. Figure 1 (next page) displays the cumulative crash total plot with the tolling timeline from the RSA report. Figure 2 (next page) displays a similar cumulative crash total plot with the addition of all available crash data occurring during or after 2016.

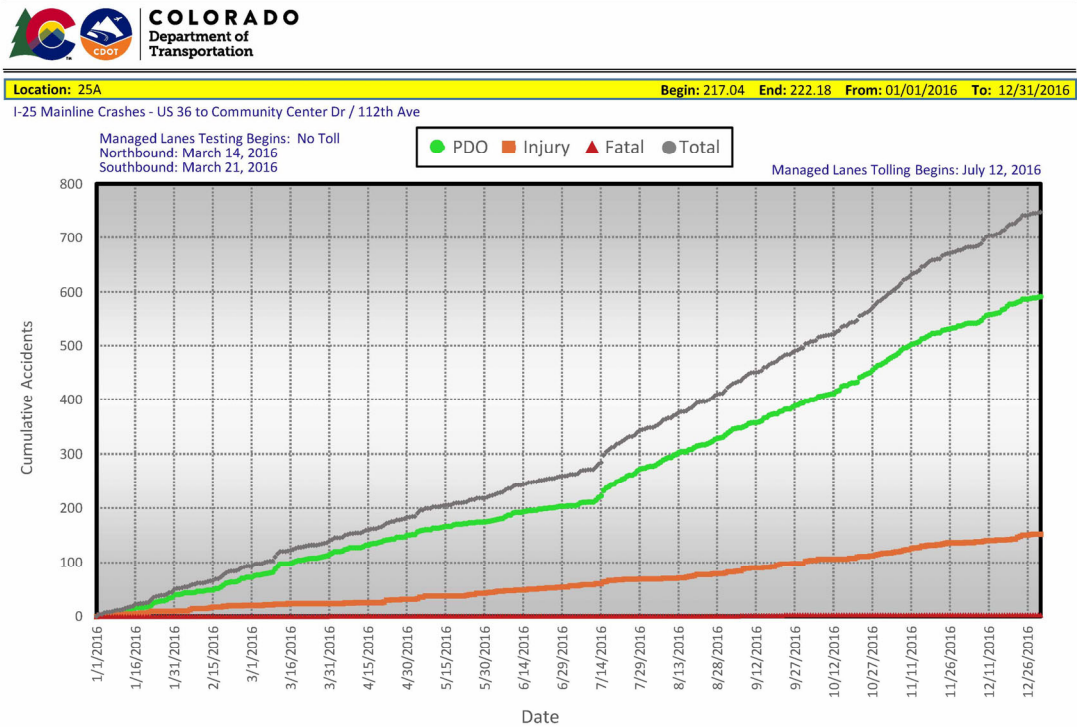


Figure 1 – January 1, 2016 to December 31, 2016 Crash Data with Tolling Timeline

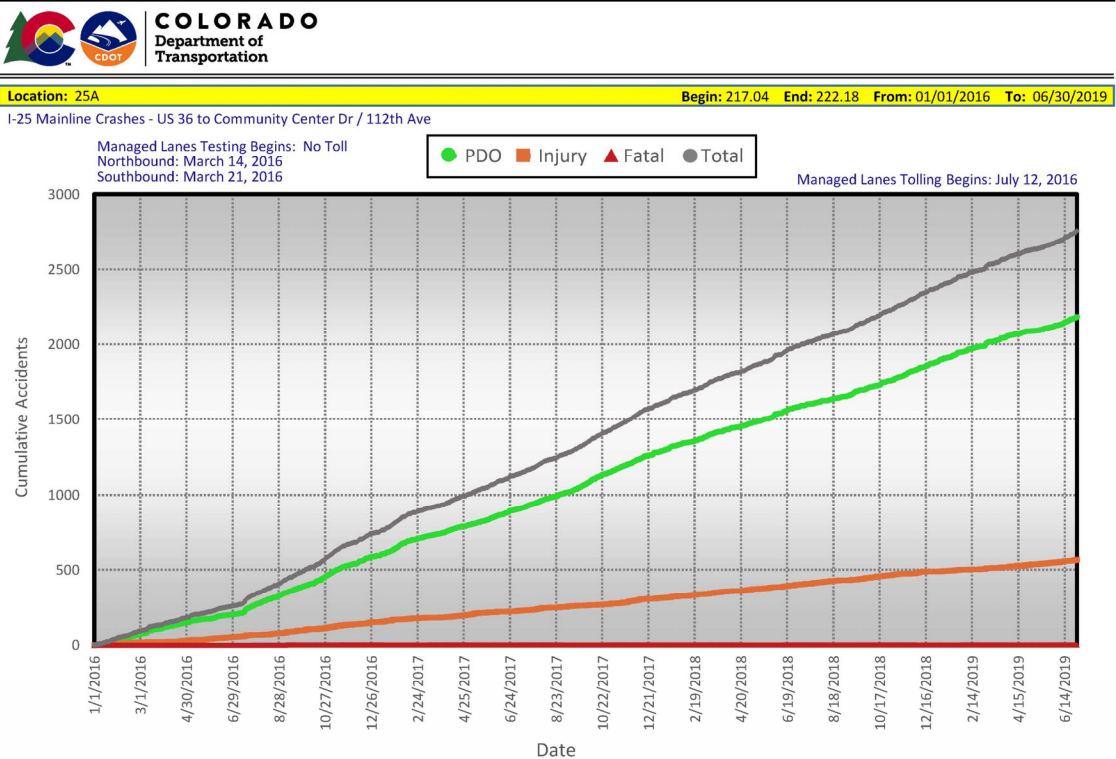


Figure 2 - January 1, 2016 to June 30, 2019 Crash Data with Tolling Timeline

Crash data from January 1, 2019 to June 30, 2019 is presented in Table 5. During this time, 377 crashes were reported in the study area. Of these, there were 76 injury collisions with 106 injured overall and 0 fatal collisions.

Table 5 - Crash Totals from January 1, 2019 to June 30, 2019

Year	Property Damage Only (PDO) Crashes	Injury (INJ) Crashes	Injuries	Fatal (FAT) Crashes	Fatalities	Total Crashes
Jan-Jun 2019	301	76	106	0	0	377
Total	301	76	106	0	0	377
Average/Yr	602.0	152.0	212.0	0.0	0.0	754.0

The original RSA as well as the subsequent update memos analyzed five-year study periods utilizing the most current crash data available at the time of publication. A similar analysis was conducted with the addition of the latest January 1, 2019 to June 30, 2019 crash data. Figure 3 indicates that the proportion of PDO crashes decreases while the proportion of INJ crashes increases with each successive five-year study period. However, PDO crashes remain the predominant crash severity in each period. Proportions in crash types remain relatively consistent, as seen in Figure 4.

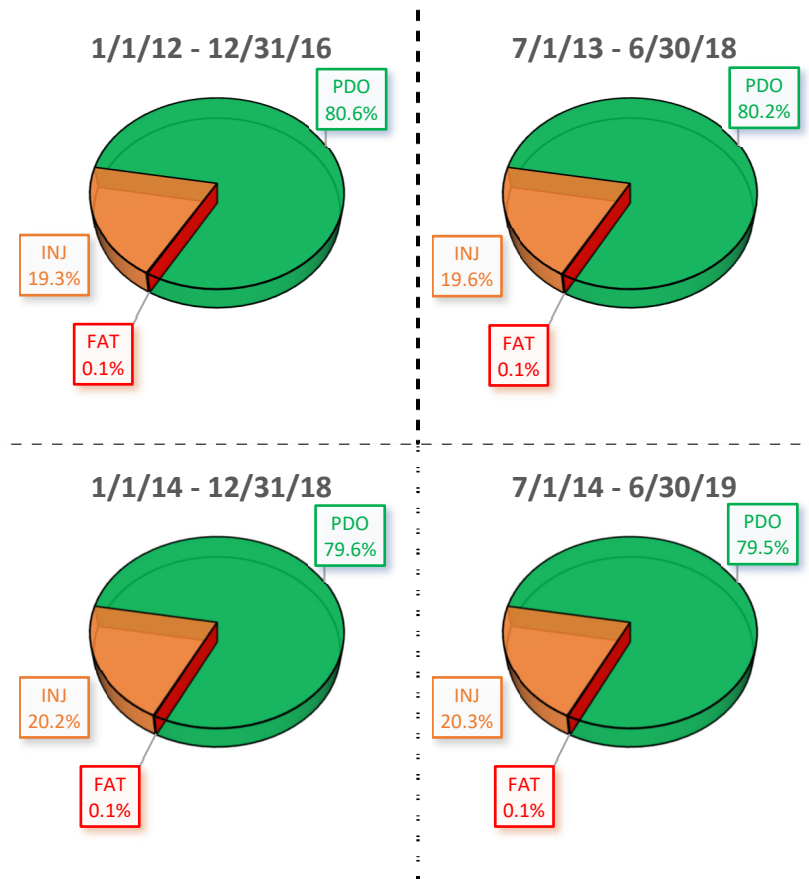


Figure 3 - Crash Distribution by Five-Year Period and Severity

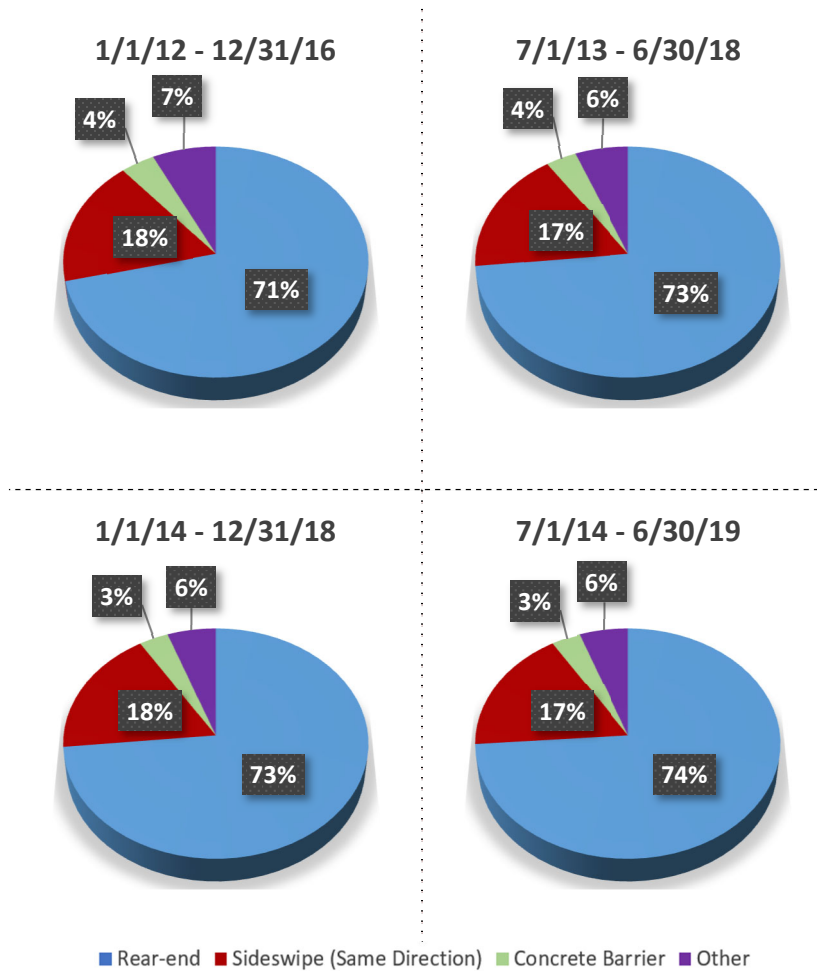


Figure 4 - Crash Distribution by Five-Year Period and Crash Type

The RSA report and subsequent update memos also analyzed crash data by specific sections of the I-25 corridor as seen in Table 6.

Table 6 - I-25 Sections

Section	Begin Mile Post	Begin Reference	End Mile Post	End Reference	Length (miles)
1	217.036	I-270 and US-36 Junction	218.463	84 th Avenue	1.451
2	218.463	84 th Avenue	219.859	Thornton Parkway	1.318
3	219.859	Thornton Parkway	221.027	104 th Avenue	1.182
4	221.027	104 th Avenue	222.177	Community Center Drive	1.135

Figure 5 shows the distribution of the at fault vehicle (Vehicle 1) direction while comparing the four five-year study periods. In each study period, a greater proportion of crashes occur in the southbound direction in Sections 2, 3, and 4 while the reverse is true in Section 1. In comparing the most recent five-year period with the previous five-year periods presented in the RSA Report and update memos, there is an increase in the proportion of southbound crashes in Section 1 and 2, while the proportions remain relatively

unchanged in Sections 3 and 4. In each case, however, the directional prevailing majority remains unchanged.

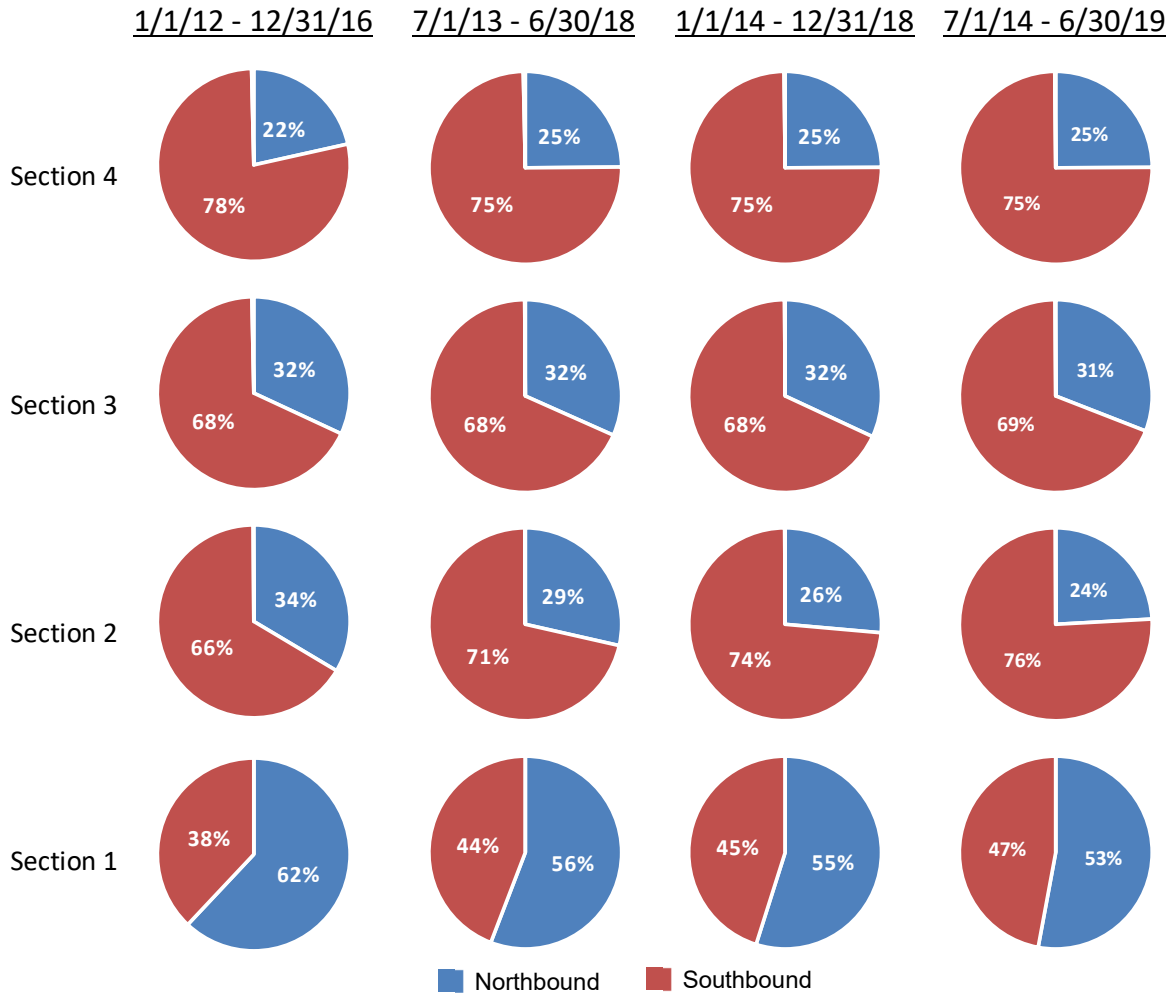
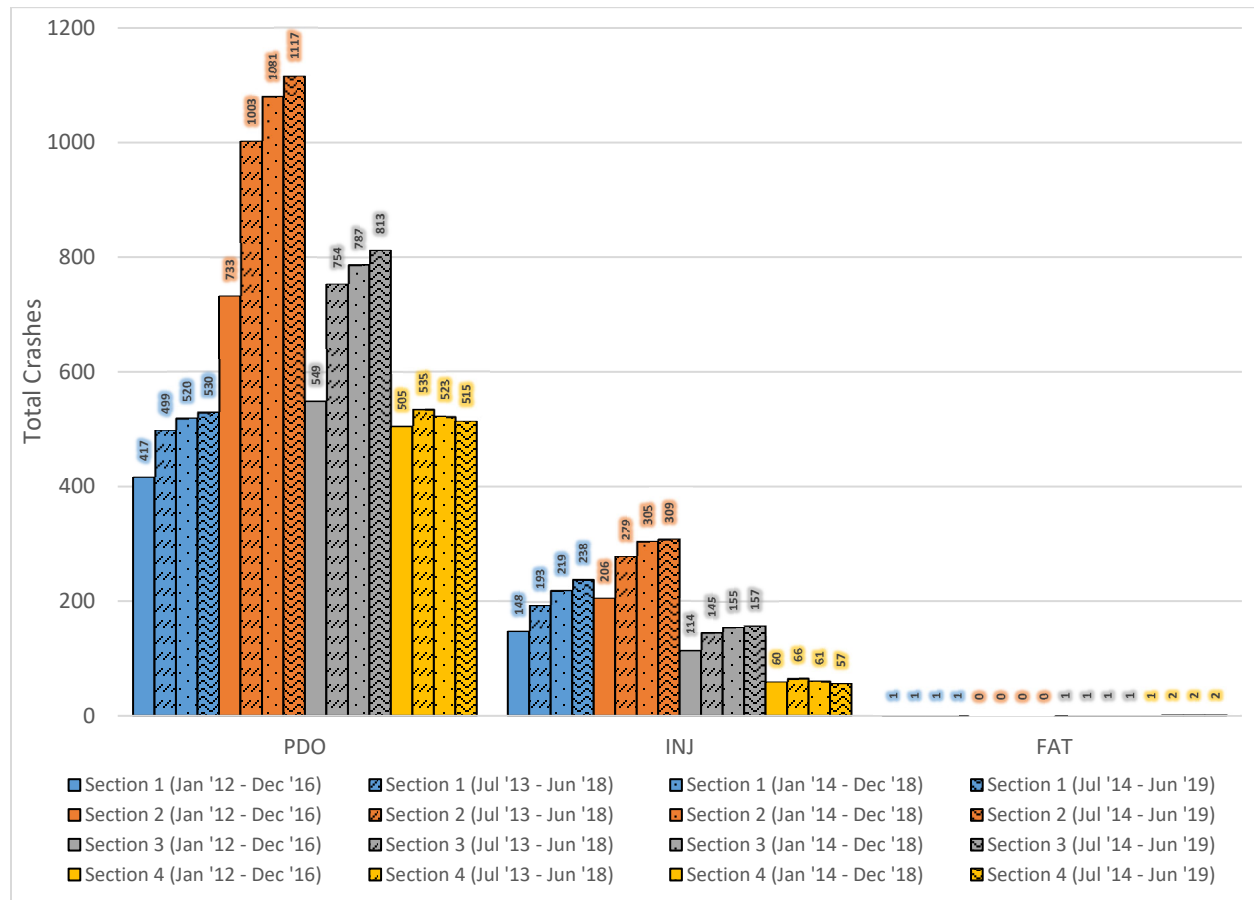


Figure 5 - Crash Distribution by Section and Direction

Figure 6 (next page) compares the crash totals in each section of I-25 using the four aforementioned five-year study periods. Consistent with the findings in the previous analyses, Section 2 still appears to stand out as the largest contributor to total crashes in this corridor of I-25. Upon comparing the most current five-year study period to previous five-year periods, Sections 1, 2, and 3 show an increase in total PDO and INJ crashes, while Section 4 shows a slight decrease in total PDO and INJ crashes. It is worthwhile to note that all four of the five-year study periods still span the transitional timeframe wherein construction and/or varying tolling activities would have occurred.



Note: Due to an error in data reporting, this figure was incorrect in the November 2019 update memo. The figure shown above has corrected this error.

Figure 6 - Total Crashes by Section and Severity

The RSA report noted that there was a distinct increase in annual crash rate from 2012 to 2016. This observation was examined by plotting the cumulative number of each crash type for each year. As mentioned in the RSA report, the plot line for each year generally trends on a linear path, indicating a consistent trend in monthly crash totals within that year. However, the RSA report notes that March to April of 2015 and June to July of 2016 both indicate a sharp increase in slope. Similarly, the June 2019 RSA update memo noted an increase in the PDO slope from 2016 to 2017, while also noting a slight decrease in INJ slope from 2016 to 2017. The November 2019 RSA update memo noted a decrease in PDO slope from 2017 to 2018, while also noting a slight increase in INJ slope from 2017 to 2018. Figure 7 displays this plot along with additional lines reflecting the new January 1, 2019 through June 30, 2019 cumulative crash totals (new lines highlighted in yellow). Figure 8 displays a similar plot, but does not disaggregate crashes by severity, rather only examines total crashes.

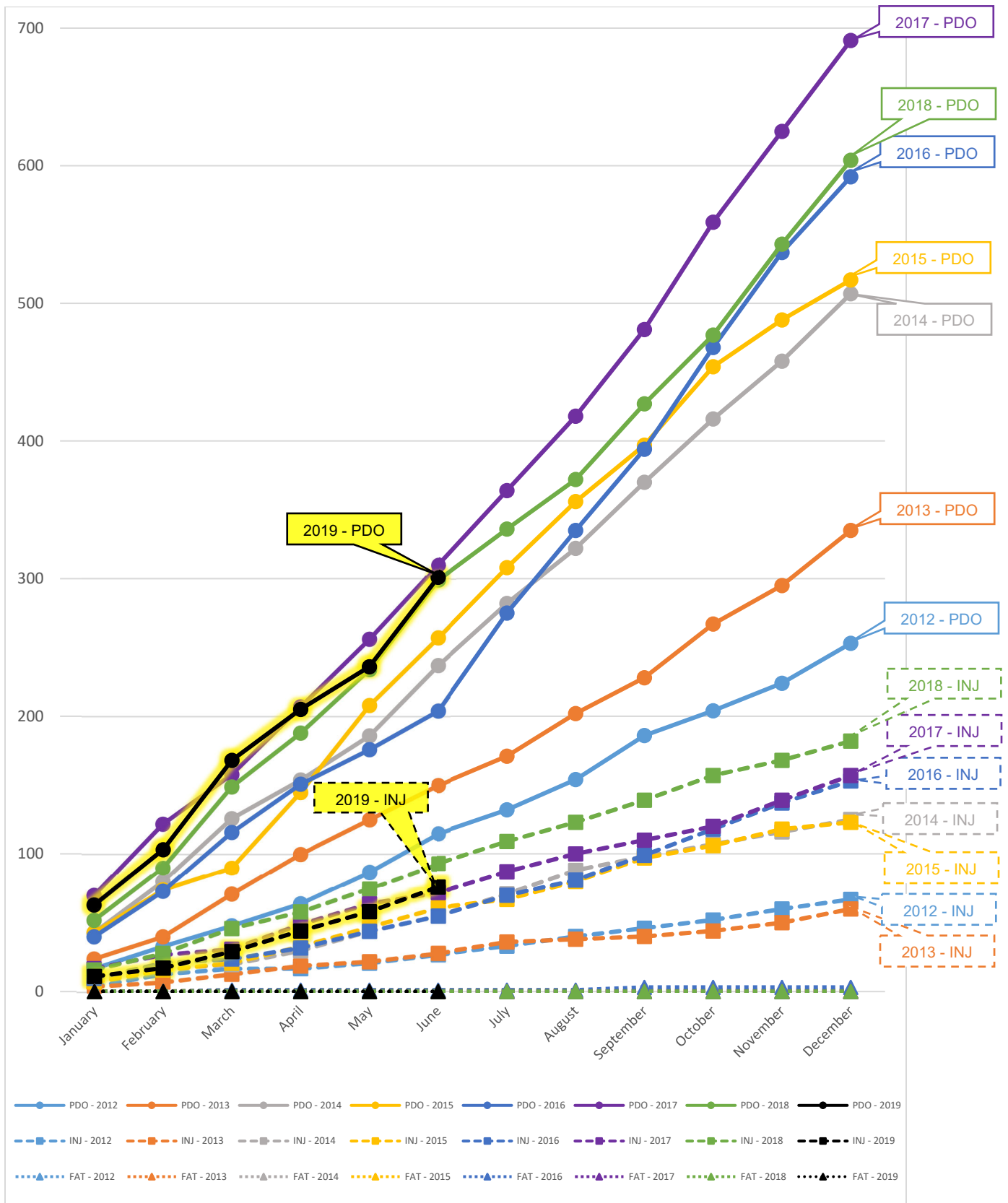


Figure 7 - Cumulative PDO, INJ, and FAT Crash Totals

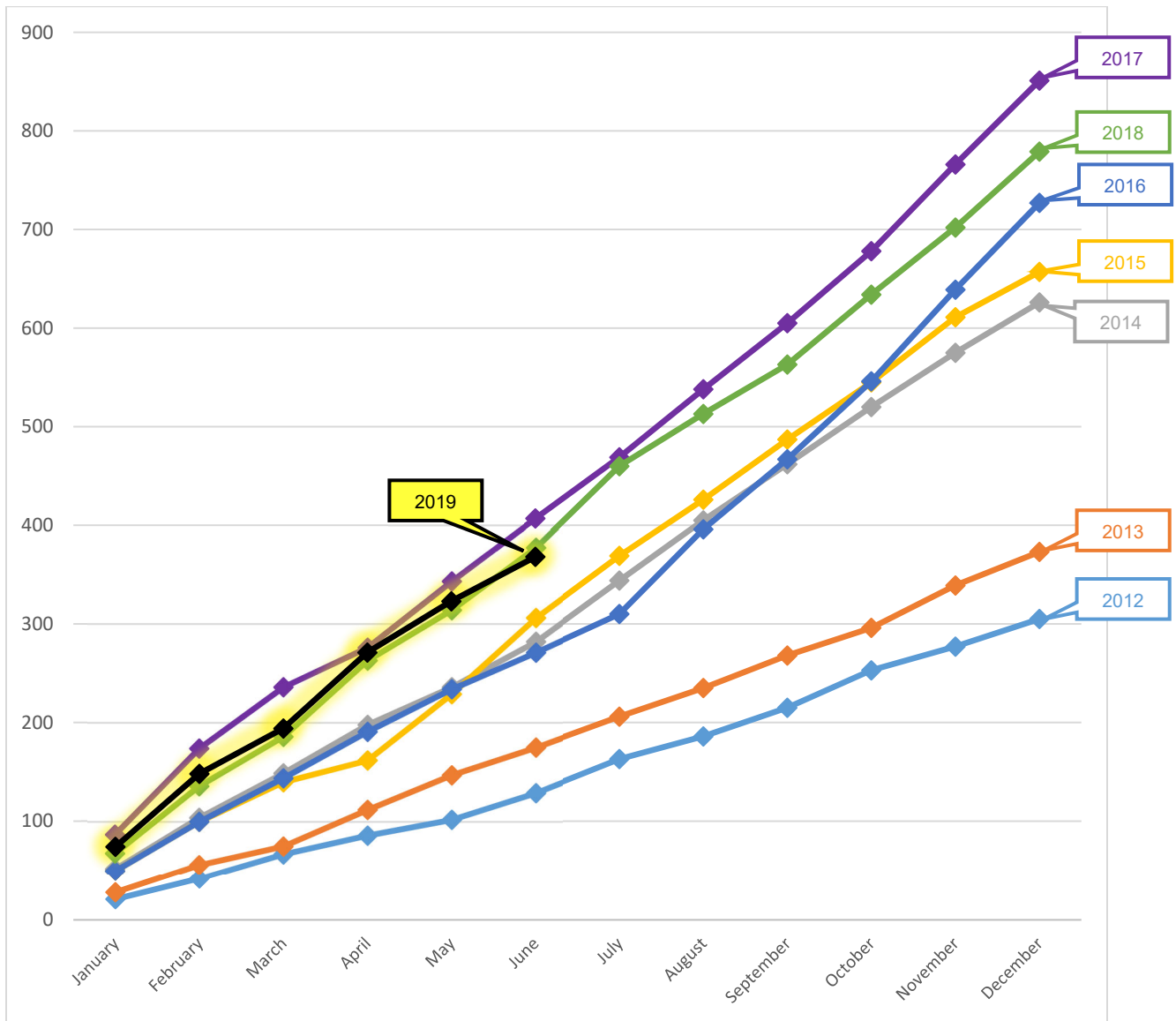


Figure 8 - Cumulative Crash Totals Including All Severities

A more detailed examination of the slope of each plot line displayed in Figure 7 and Figure 8 is shown in Table 7 below. These slopes correspond to the trend in the cumulative monthly crash totals for each crash type during each year. These data indicate that the Total, PDO, and INJ slopes in the first half of 2019 decreased by approximately 7%, 6%, and 15% respectively from the entirety of 2018.

Table 7 - Cumulative Crash Total Plot Line Slopes

	2012	2013	2014	2015	2016	2017	2018	Jan-Jun 2019
Total Slope	26.1	31.3	52.6	57.3	59.5	66.8	63.7	59.2
PDO Slope	21.8	27.9	42.2	46.3	50.6	56.2	49.3	46.5
INJ Slope	5.5	4.8	11.4	11.2	13.1	12.6	15.5	13.2
FAT Slope	0.0	0.0	0.0	0.1	0.3	0.0	0.0	0.0

The RSA report further investigated these trends by examining the total crash rate per million vehicle miles traveled (MVMT) for this I-25 corridor for each year. Figure 9 displays these crash rates and is appended with the most recent crash data, highlighted in yellow.

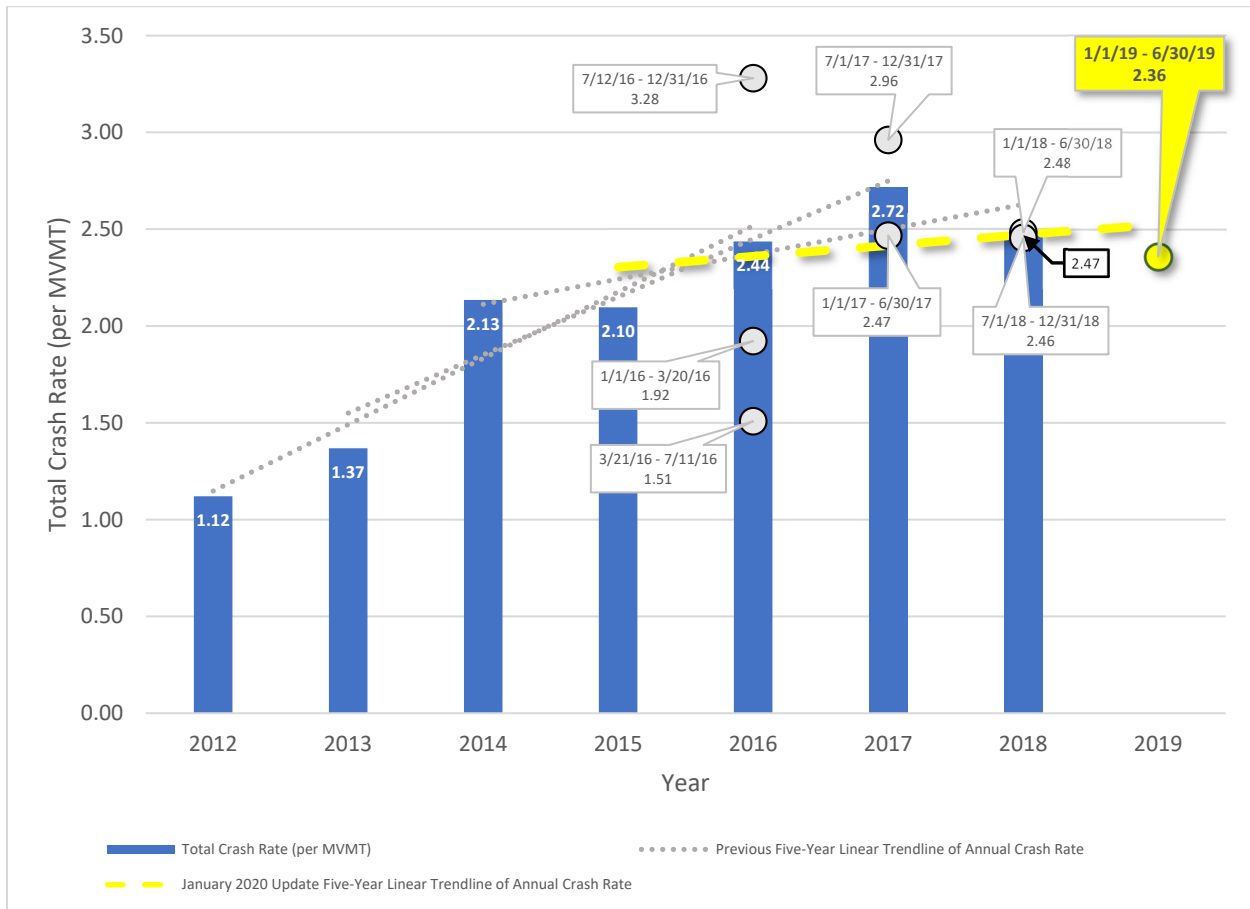


Figure 9 - Total Crash Rates by Year

The total crash rate for the first half of 2019 was 2.36 crashes per MVMT, a decrease of approximately 5% from the entirety of 2018. Figure 9 also displays four linear trendlines. The three gray dotted linear trendlines come from a five-year trend of the most current data available at the time of publication of the original RSA report, the June 2019 RSA update memo, and the November 2019 RSA update memo. The yellow dashed trendline represents the most recent five-year trend in crash data including the data from January 1, 2019 to June 30, 2019. Notably, the trendlines all have a positive slope. However, the slope of these trendline is progressively getting lower with each successive five-year update period. In practical terms, this means that on this corridor of I-25, the historical increase in total crash rate is continuing to show signs of slowing. In fact, the crash rate from the first half of 2019 is less than the crash rate from the entirety of 2016, 2017, and 2018.

The crash totals from July 1, 2018 to June 30, 2019 showed a marked decrease from July 1, 2017 to June 30, 2018, which in turn drove the latest aforementioned five-year trends downward (fewer crashes). Both of these one year long timeframes are completely outside of any construction or toll testing period. Rear-end, concrete barrier, and other crash totals decreased while sideswipe same direction crashes increased from 2017 to 2018, as seen in Figure 10 on the next page.

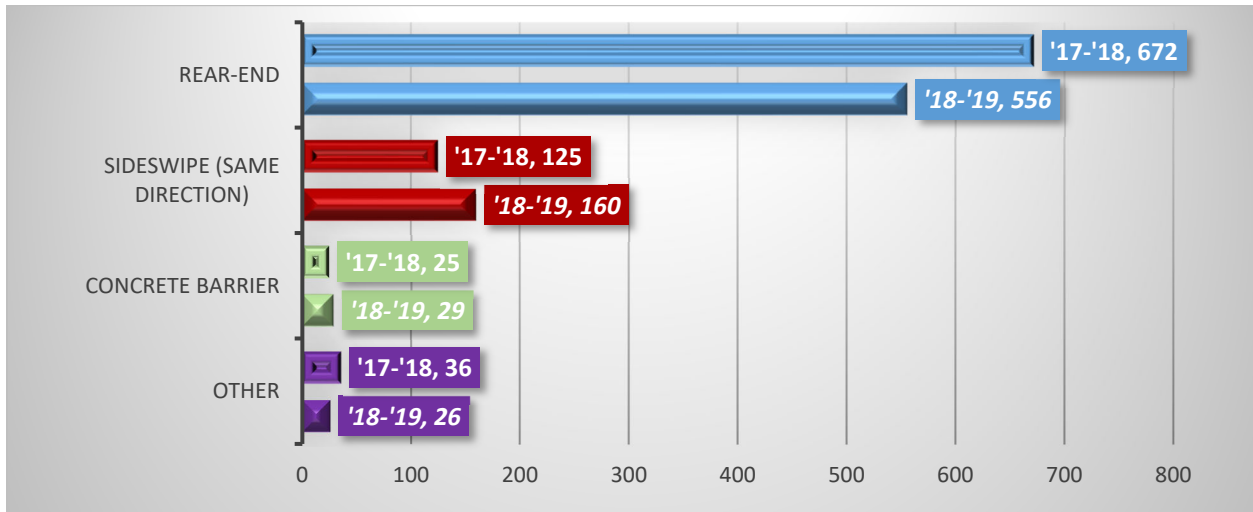


Figure 10 - Comparison of 2017 and 2018 Crash Totals by Type

More specifically, Figure 11 shows PDO and INJ crashes from July 1, 2017 to June 30, 2018 and from July 1, 2018 to June 30, 2019 each broken down by Section of I-25 (no fatal crashes occurred during these time periods). There is a decrease in PDO crash totals in Sections 1, 2, and 3 and the Sections 2, 3, and 4 INJ crash totals. Meanwhile, Section 4 PDO and Section 1 INJ crash totals increased.

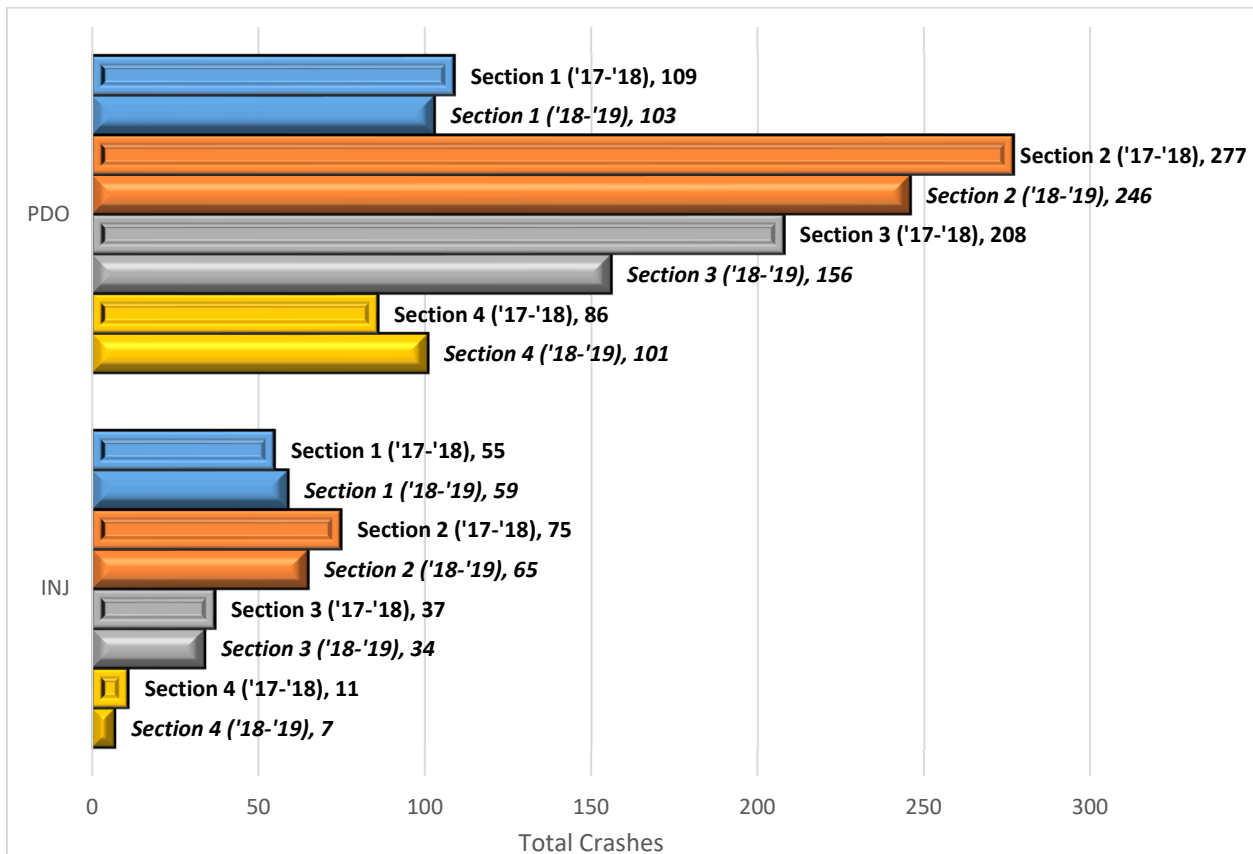


Figure 11 - Comparison of July 2017 to June 2018 and July 2018 to June 2019 Crash Totals by Severity and Section

The greatest decrease in PDO crashes between the timeframes shown in Figure 11 occurred from rear-end crashes in Sections 1, 2, and 3 with a decrease of 17, 28, and 56 total crashes respectively. Rear-end INJ crash totals also decreased in Sections 2, 3, and 4. Meanwhile, sideswipe same direction PDO crashes accounted for an increase of 14, 6, and 13 crashes in Sections 1, 3, and 4 respectively. Similarly, sideswipe same direction INJ crashes accounted for an increase of 3 and 4 crashes in Sections 1 and 2 respectively. A statistical analysis of this data indicates with approximately 75% certainty that the change in sideswipe same direction PDO crashes is statistically significant. None of the other changes in crash data were found to be statistically significant with an acceptable degree of certainty.

NEXT STEPS

The safety enhancements on this corridor of I-25 which are either completed, in progress, or planned may affect the trend in crash totals. The level of effectiveness of these safety enhancements will be seen by continuing to monitor and summarize the crash data on a regular basis.