Transportation Systems Management and Operations Performance Report

6TH EDITION

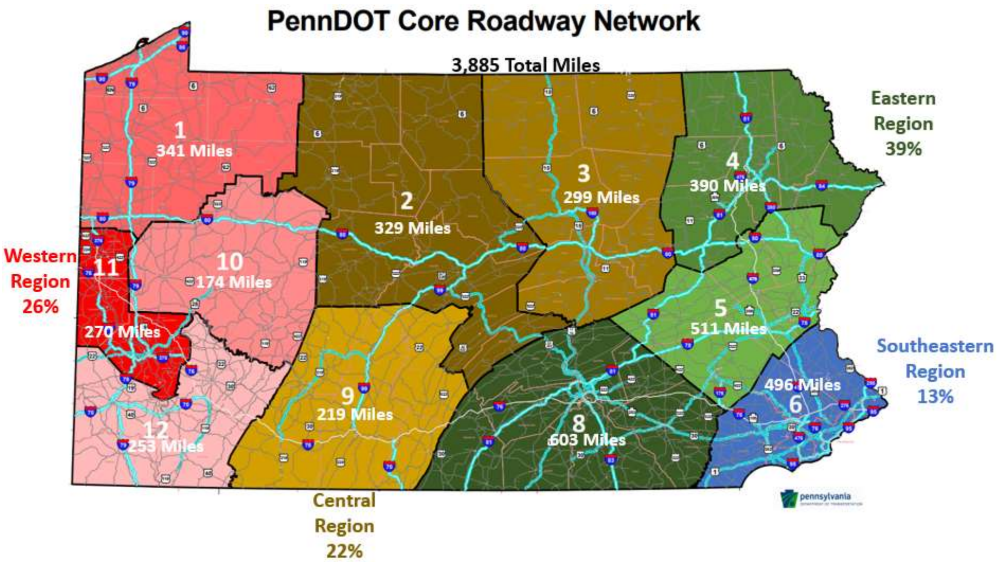
APRIL 2022

TSMO

pennsylvania
DEPARTMENT OF TRANSPORTATION

Executive Summary

The TSMO Performance Report was developed to provide information to PennDOT traffic operations staff, partner agencies, and other key stakeholders to assist in implementing appropriate strategies and to make key decisions to improve the safety and reliability of the PennDOT Core Roadway Network[1].



Under each group of evaluations conducted, a brief explanation as to how the evaluation was conducted is provided. along with a conclusions area which helps to understand the results as well as identify opportunities where this information could be beneficial. Based on the information provided within this report each District or region will review and develop how they are going to adjust their District or regional approaches with the Traffic Operations Plans (TOPs) that will be required as part of Publication 855 – TSMO Guidebook Part V – Operations.

The TSMO Performance Report (6th Edition) provides a new Hazardous Winter Weather and Incident Rate analysis. This analysis evaluates what conditions constitute whiteout conditions. It also looks at the impact of horizontal and vertical geometry on incident rates during hazardous conditions. This detailed evaluation combines roadway weather conditions Department's Road Weather Information Systems (RWIS), incident information through the Department's various sources, and roadway geometry information to determine where incident rates are increased due to roadway geometry. This evaluation can be found under the **Hazardous Winter Weather and Incident Rates** :

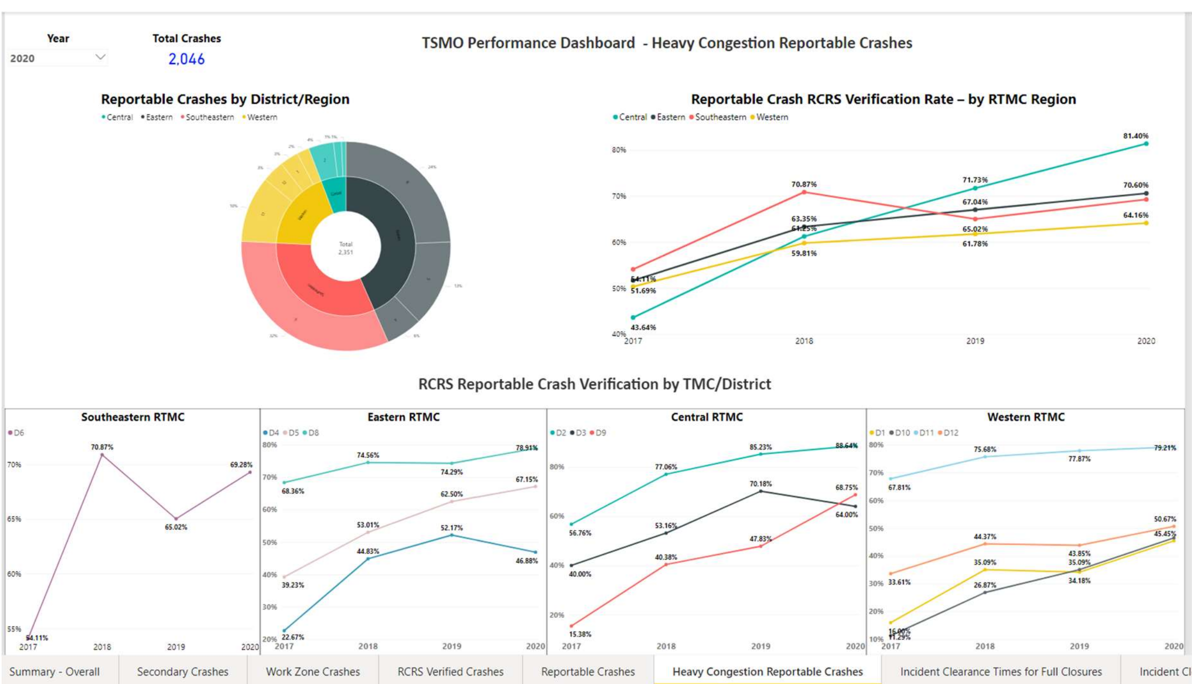
- Figure 1 – Probability of Crashes during Active Weather Conditions (Visibility)
- Figure 2 – Probability of Crashes during Active Weather Conditions (Intensity)
- Figure 3 – Roadway Curvature Crash Impact Rates During Hazardous Winter Conditions
- Figure 4 – Roadway Curvature Crash Impact Locations During Hazardous Winter Conditions (2018-2020)
- Figure 5 – Disabled Vehicle Rates by Grade During Hazardous Winter Conditions (2017 – 2021)
- Figure 6 – Disabled Vehicles In Steep Grade Locations During Hazardous Winter Conditions (2017-2021)

In addition to this new analysis, this TSMO Performance Report also provides annual updates to 6 previously provided categories which include:

[1] Pennsylvania's "Core Roadway Network" was established in 2011 for 511PA, and includes state owned interstates, limited access roads, and other major routes throughout the Commonwealth.

- **Congestion Pie Chart Updates (Figures 7 through 8)** – Incorporates the methodology provided within **Appendix 1** to provide updates to the congestion pie chart on the PennDOT Core Roadway Network and compares with changes from 2019
- **Reportable Congestion Crashes (Figures 9 through 11)** – Displays crashes by congestion type and type of crash, and provides a breakdown of injuries by severity
- **Secondary Crashes (Figures 12 and 13)** – Displays a breakdown of secondary crashes by District/region, time and distance from the primary crash.
- **Work Zone Congestion Crashes (Figures 14 through 17)** – Displays a breakdown work zone crashes by District/region and distance from the work zone and identifies the short-term and long term work zones with the highest crash rates
- **Traffic Management Center (TMC) Situational Awareness (Figures 18 through 27)** – Provides several metrics for the TMCs to evaluate and improve their performance. Also considers crowd sourced data to identify key locations with ITS situational awareness gaps in **Appendix B.**
- **Average Incident Clearance Times (Figures 28 through 33)** – Provides several breakdowns and comparisons of incident clearance times by District and county.

As the TSMO Performance Program has evolved, the team has recognized the need to provide District/TMC personnel with more specific performance data in a more timely manner. As a result, a TSMO Performance Dashboard is in development which will improve the ability to update data as it becomes available instead of waiting for the next TSMO Performance Report. This dashboard will allow the filtering of all metrics by District/TMC. As a result, an appendix with District specifics for certain metrics like crashes with existing congestion will not be provided with this report as in previous reports. Instead, this data will be available to view as needed when the TSMO Dashboard is released in the summer of 2022. A sample of that dashboard is shown below.



NEW ANALYSIS

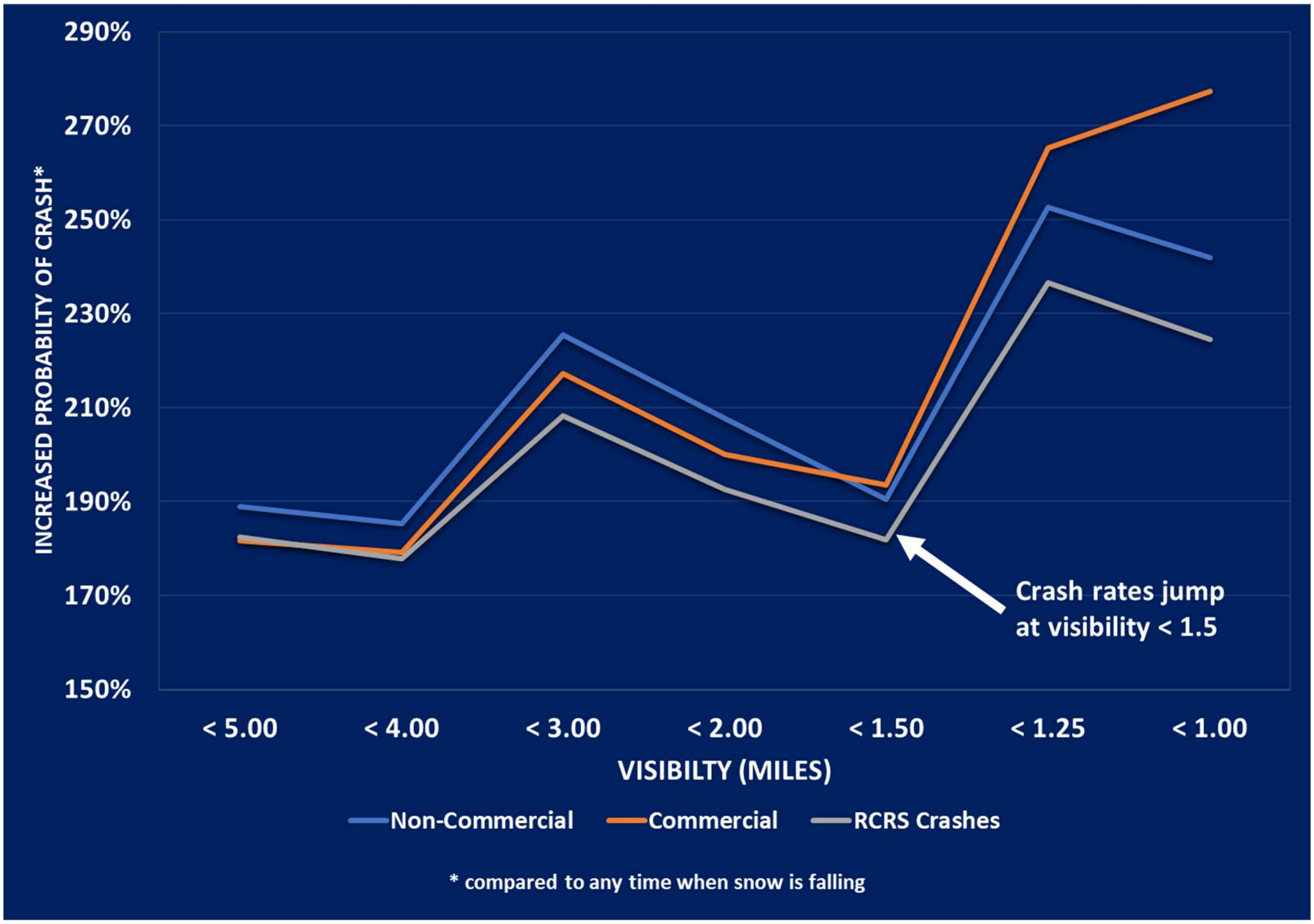
Hazardous Winter Weather and Incident Rates

Whiteout Conditions

The previous TSMO Performance Report provided analysis that determined the tipping points where crashes become more likelihood during hazardous winter weather conditions for a variety of winter conditions. This report is following up on this analysis by identifying the weather conditions which constitute whiteout conditions, an extremely dangerous condition which typically leads to a significant number of crashes.

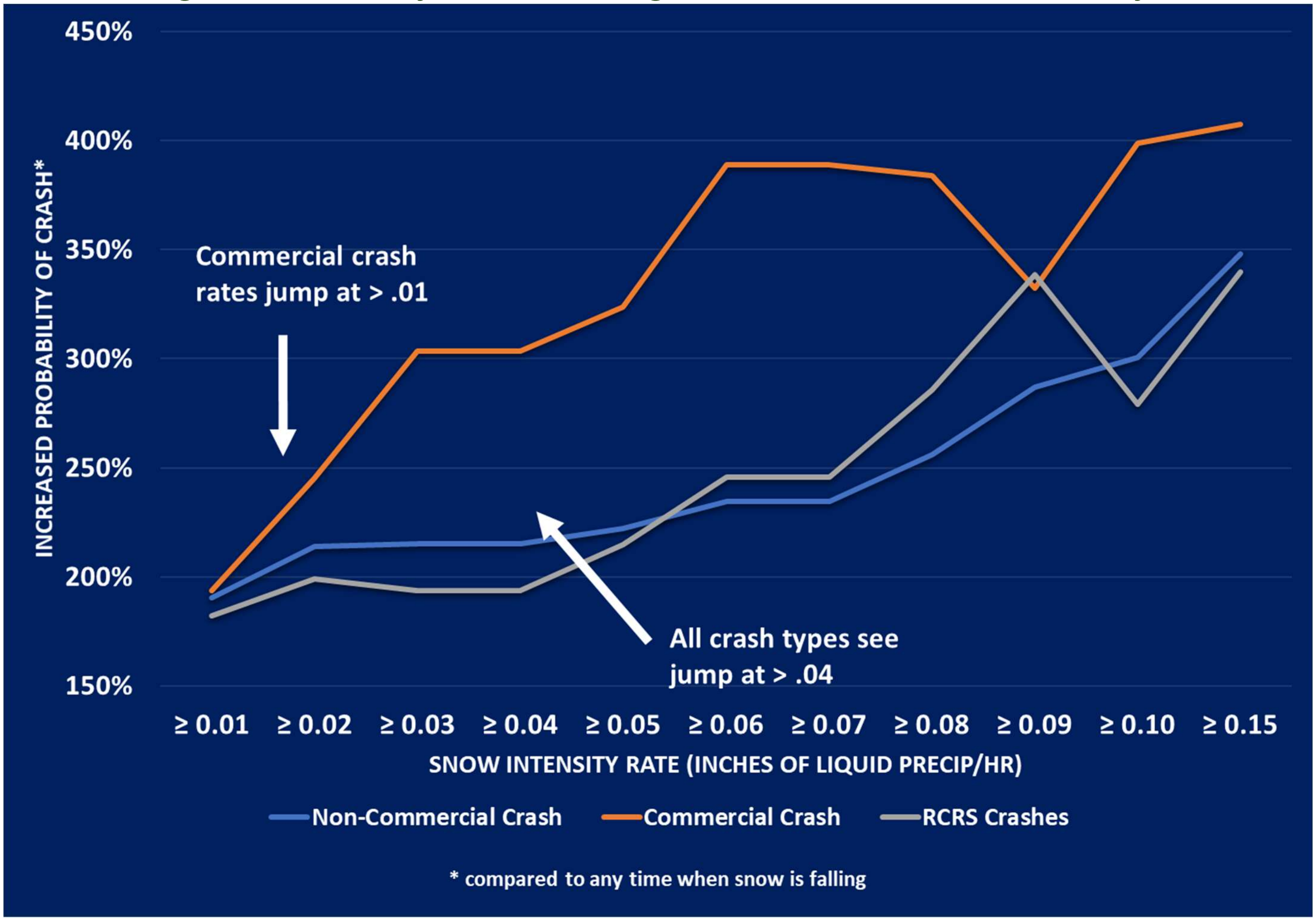
The two charts below compare crash rate vs the rates in all snow conditions, when looking specifically at visibility and snow intensity, as measured by PennDOT's Road Weather Information System (RWIS) stations.

Figure 1 – Probability of Crashes during Active Weather Conditions (Visability)



NEW ANALYSIS

Figure 2 – Probability of Crashes during Active Weather Conditions (Intensity)



Conclusions

Based on the information shown in the above two charts, **whiteout conditions have been identified to exist at a given RWIS station when visibility is less than 1.5 miles and snow intensity is at or above .04**. This information, along with the observed spike in commercial vehicle crashes when snow intensity is above .01 can be used to develop automated messaging to alert users of the dangerous conditions. Particular focus should be given on providing this information to travelers before they drive into these conditions.

Impact of Curve on Crash Rates

The curvature of the roadway has the potential to make hazardous winter road conditions even more dangerous. Analysis was done to determine the impact of curve and major curve roads on crash rates during whiteout conditions, as well as each of the 5 hazardous roadway conditions that were identified in the 5th TSMO Performance Report. The table below shows the increased likelihood of crashes when these conditions occur on curve/major curve roads, as opposed to when they occur on straight roads.

Figure 3 – Roadway Curvature Crash Impact Rates During Hazardous Winter Weather

Weather Condition	Horizontal Curvature	Greater Likelihood of Crash / Incident than on Straight Segment			
		Reportable Crashes		RCRS Crash[2]	RCRS Other[3]
		Commercial Vehicle	No Commercial Vehicle		
Overall	Curve[4]	1.0 x	1.3 x	1.1 x	1.2 x
	Major Curve[5]	1.8 x	1.6 x	1.8 x	1.6 x
White Out[6]	Curve[5]	1.0 x	1.8 x	0.7 x	1.1 x
	Major Curve[6]	1.0 x	1.6 x	1.1 x	0.9 x
High Wind[7]	Curve[5]	0.4 x	1.2 x	0.8 x	1.4 x
	Major Curve[6]	0.6 x	4.5 x	1.8 x	1.3 x
Freezing Surfaces[8]	Curve[5]	1.2 x	1.6 x	1.3 x	1.6 x
	Major Curve[6]	2.1 x	2.3 x	2.2 x	2.0 x
Freezing Rain[9]	Curve[5]	2.5 x	1.3 x	1.0 x	1.6 x
	Major Curve[6]	4.8 x	1.5 x	1.8 x	2.3 x
Slippery Surfaces[10]	Curve[5]	1.0 x	1.4 x	1.0 x	1.2 x
	Major Curve[6]	2.1 x	2.1 x	1.8 x	1.9 x

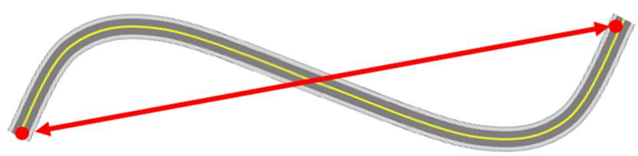
* - Straight segments have a sinuosity value of approximately 1.

[2] Any crash reported in RCRS, reportable or non-reportable
[3] RCRS event with cause of Disabled Vehicle, Winter Weather, or Other, and without a reference to crash in the description
[4] Curve segments are based on a sinuosity value of 1.004 or greater.
[5] Major curve segments are based on a sinuosity value of 1.02 or greater.
[6] Visibility of 1 mile or less, with snow, and a rain intensity 0.04 or greater.
[7] Wind speeds 25 MPH or greater.
[8] Non-dry road surfaces with a surface temperature of 32° or less.
[9] Non-snow precipitation with an air temperature of 33° or less.
[10] RWIS grip level 65 or less, with an air temperature under 40°, and some precipitation in the past three hours.

Defining Sinuosity

For this report, sinuosity is defined as the ratio of the length of a route segment to the straight-line distance between the beginning and end point of the segment. For instance, if a route segment is 1.2 miles long, but the beginning and ending points are only 1 mile apart as the crow flies, that route would have a sinuosity of 1.2.

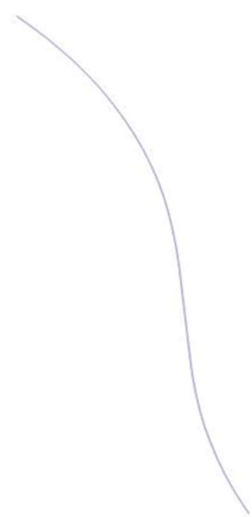
$$\text{Sinuosity} = \frac{\text{Actual Segment Length}}{\text{Straight-Line Distance Between Beginning and End Points}}$$



Curve = Sinuosity value of 1.004 or greater.
Major Curve = Sinuosity value of 1.02 or greater

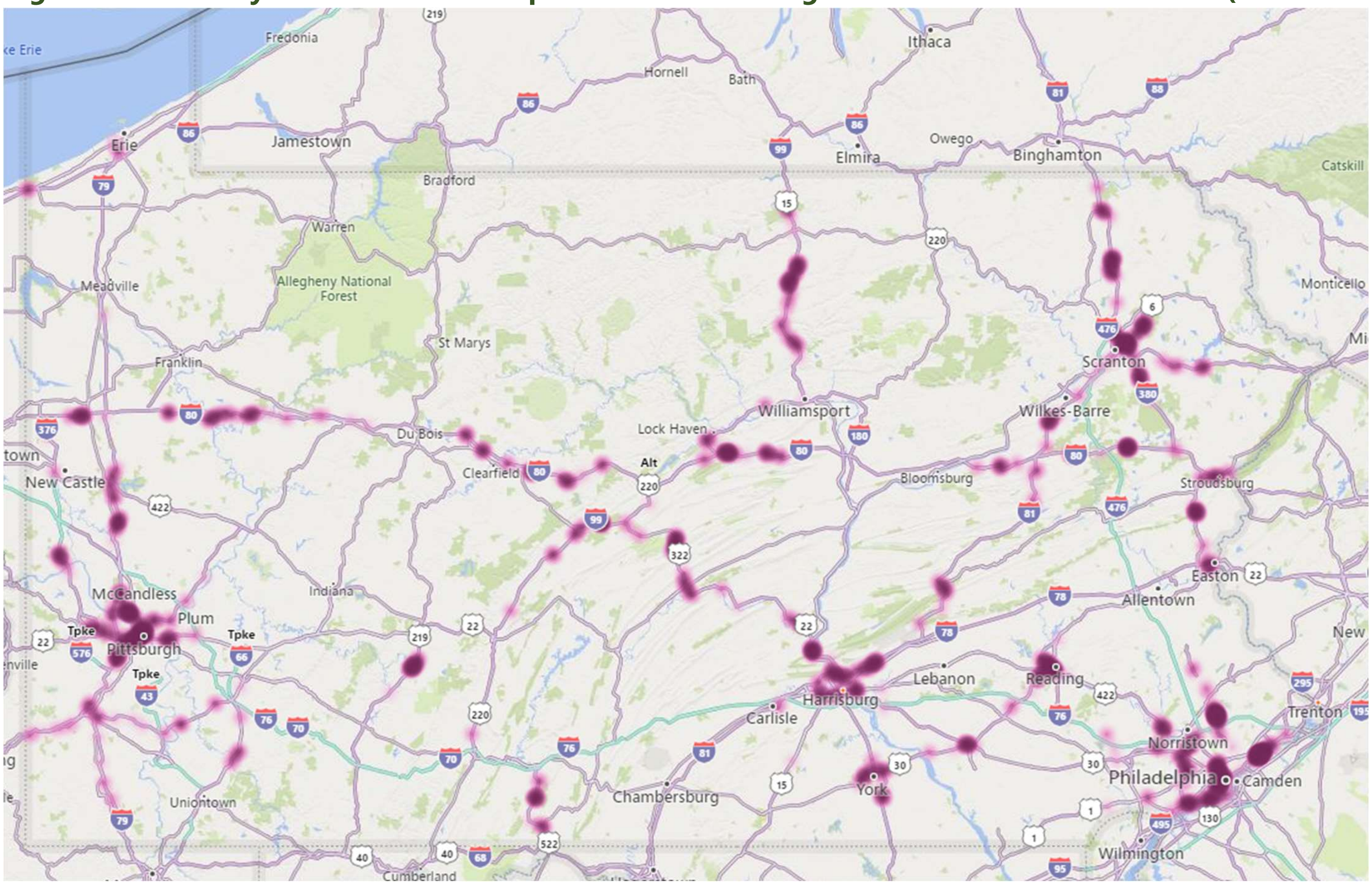
Curve

Major Curve



The map below shows areas with high rates of crashes that have occurred under hazardous winter road conditions on road segments that are designated as major curve. The data is provided from 2018 through 2020. These are areas that could merit special awareness, monitoring, and messaging during winter weather events.

Figure 4 – Roadway Curvature Crash Impact Locations During Hazardous Winter Conditions (2018-2020)



Impact of Grade on Crash Rates

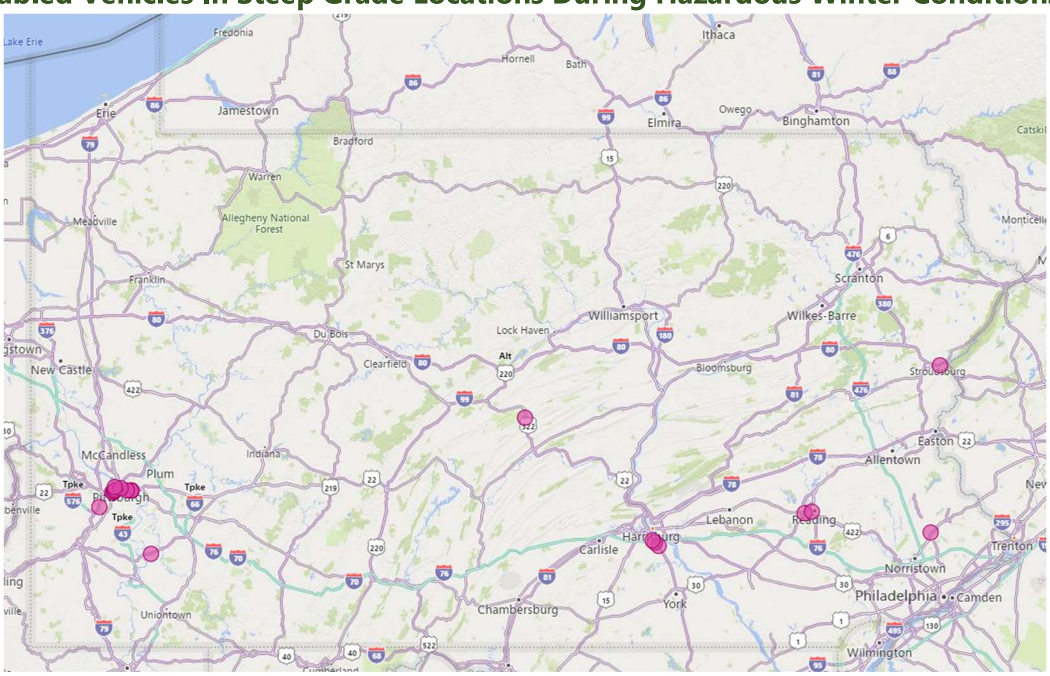
In addition to curvature, the impact of roadway grade on crash rates in hazardous conditions was investigated. Grade was not found to have a significant impact on crash rates during hazardous conditions. However, for freezing and slippery surfaces, there was a significant impact found on the likelihood of disabled vehicles or other non-crash RCRS events. These impacts are outlined in the table below.

Figure 5 – Disabled Vehicle Rates by Grade During Hazardous Winter Conditions (2017 – 2021)

Weather Condition	Terrain	Increased Likelihood of Disabled Vehicle or Other non-crash RCRS Event
Overall	Rolling[11]	0.7 x
	Steep[12]	0.9 x
Freezing Surfaces[13]	Rolling	1.5 x
	Steep	1.8 x
Slippery Surfaces[14]	Rolling	1.3 x
	Steep	8.4 x

The map below shows areas where disable vehicles and other non-crash RCRS events have occurred under hazardous winter road conditions on road segments that are designated as steep. The data is provided from 2017 through 2020. These are areas that could merit special awareness, monitoring, and messaging during winter weather events.

Figure 6 – Disabled Vehicles In Steep Grade Locations During Hazardous Winter Conditions (2017-2021)



[11] Grade between 3% and 6%
[12] Grade greater than 6%
[13] Non-dry road surfaces with a surface temperature of 32° or less.
[14] RWIS grip level 65 or less, with an air temperature under 40°, and some precipitation in the past three hours.

Pennsylvania's Congestion Pie Chart - 2020

Background

In early 2020, the TSMO Performance Program released a Pennsylvania-specific congestion pie chart using real data for 2018. This effort turned out to be one of the first in the nation to place comprehensive data behind the measure allowing for the congestion profile to be dynamically scaled to different geography's of interest.

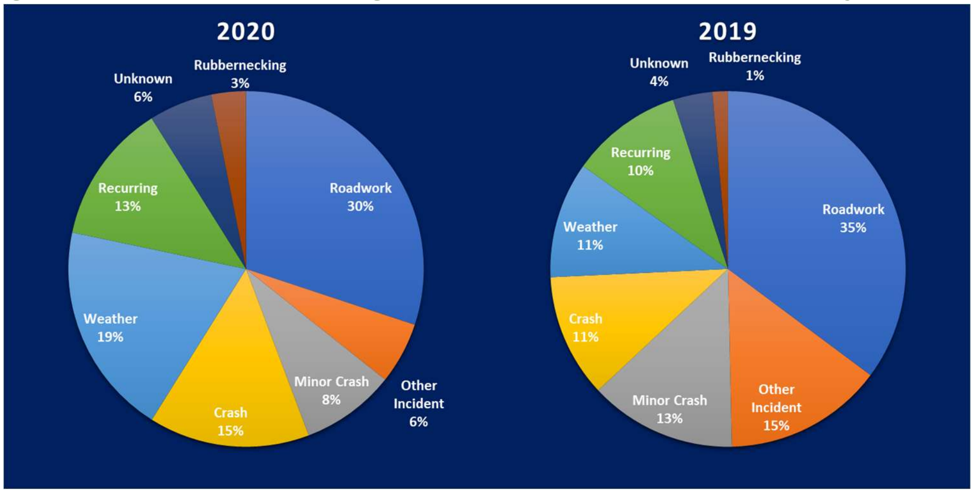
Below are updated charts for 2020 for the entire core roadway network. For District-specific pie charts for 2020, see Appendix 4 - 2020 District Specific Congestion Pie Charts

In 2020, the tool was updated to allow for pie charts at the municipality level. The 2020 congestion pie chart is available via the Traffic Operations Analytics (TOA) portal for anyone with a Commonwealth of Pennsylvania account, via this link.

For further information about the methodology used to develop the congestion pie chart, see Appendix 1 – Congestion Pie Chart Methodology.

2020 Congestion Pie Chart vs 2019 – Statewide (Core Roadway Network)

Figure 7 – 2020 vs 2019 Congestion Pie Chart for Core Roadway Network



Cause	Change from 2019 to 2020	Source/Definition
Roadwork	-5%	RCRS Roadwork, Maintenance Database, or Waze Roadwork event
Other Incident	-9%	Non-crash traffic hazard from Waze (i.e. disabled/car stopped on shoulder, hazard on roadway)
Minor Crash	-5%	Non-reportable crash from RCRS or Waze
Crash	+4%	Reportable crash from the Crash Record System (CRS)
Weather	+8%	Inclement weather[15] conditions from RWIS or Waze weather event
Recurring	+3%	Congestion where speed drop is no more than 10% greater than the historical average speed
Unknown	+2%	Cause could not be identified with current data sources
Rubbernecking	+2%	Any previously identified congestion pie chart incident cause is linked to one side of the road, and no incident is correlated to the other side of the road in the same area, but still experiences a speed drop above historical norm

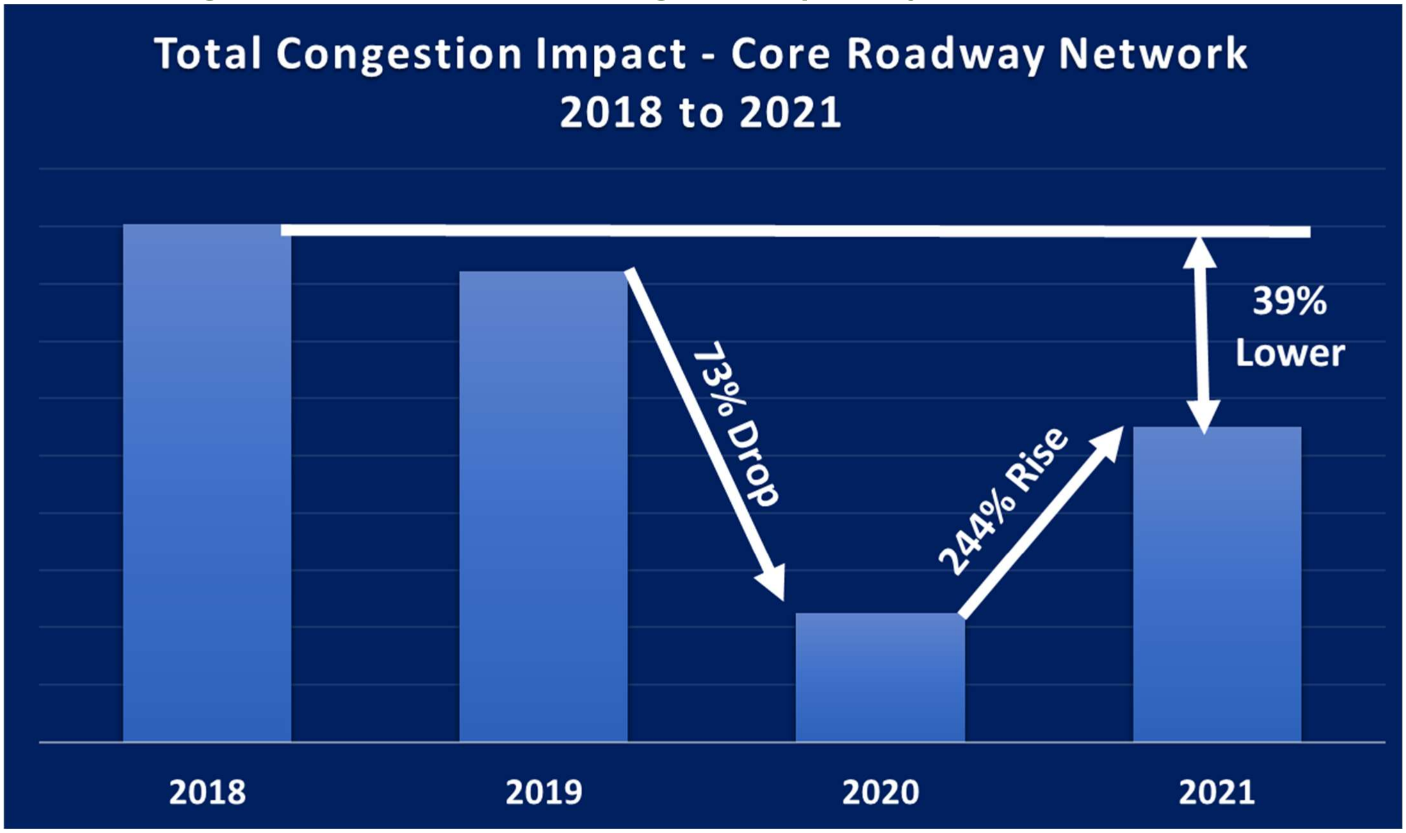
[15] Heavy rain, any kind of snow, and/or snow covered, icy, or wet (with temperature below freezing) roads

Conclusions

Although 2020 was a dramatically different year in terms of the total amount of congestion due to the beginning of the COVID-19 pandemic (see following section), the distribution of congestion causes did not necessarily change significantly. The noteworthy exception was the significant drop in the percentage of congestion assigned to minor crashes and other incidents. The likely explanation of this would that Waze is the primary source for this type of events, and there were fewer Waze users on the road in 2020 due to decreased traffic volumes in general. There was also a slight increase in the percentage of congestion that could not be assigned a cause, which may also be due to the decrease in Waze users on the road.

Impact of COVID-19 Pandemic on Core Network Congestion

Figure 8 – Total Core Network Congestion Impact[16] by Year - 2018 to 2021[17]



Conclusions

The impact of the COVID-19 pandemic on the total amount of congestion on the core roadway network was dramatic, and while congestion did make a comeback in 2021 as traffic volumes rose to 95%+ of 2019 levels, it still fell well below pre-pandemic levels. 2022 will be telling in determining whether we have reached a "new normal" or if congestion will continue to a return to 2018-2019 levels.

[16] Congestion impact = Duration x length of queue x speed drop

[17] 2021 data is preliminary and may change slightly when all data sources have been processed

Congestion Related Crashes on the Core Network

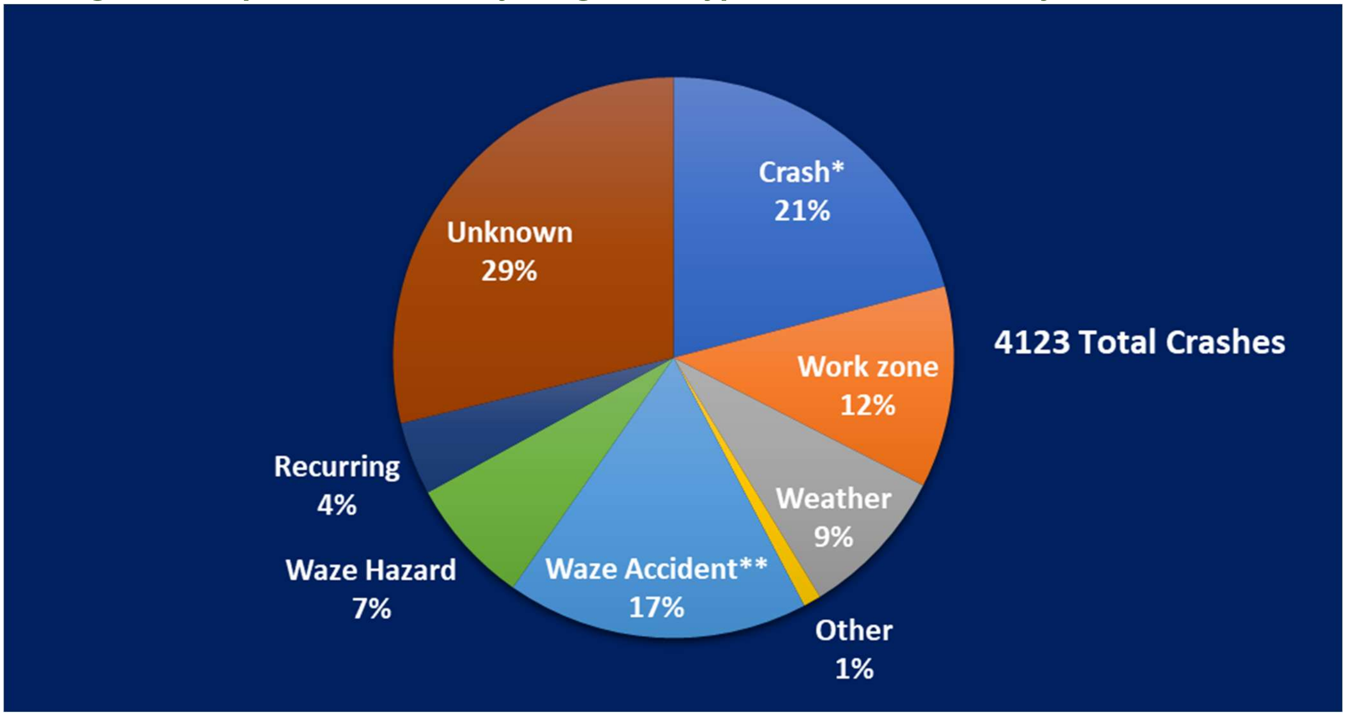
The TSMO Performance Report began presenting data on crashes that occurred in existing congestion on the core network with the 3rd report in 2017. The following information presents that data for 2020. For reference, the numbers under the “Work zone” column represent all crashes that occurred in the congestion behind a verified roadwork event (contractor or PennDOT).

For this update, the “Weather” cause was updated to include congestion caused by inclement weather being reported by an RWIS station within 15 miles of the congestion. Previously, this category only included congestion caused by RCRS weather-related events. This led to a significant increase in the number of weather congestion related crashes.

Note: As in previous analysis, Special Events and Waze Weather were also analyzed as potential causes of congestion. However, there were no congestion-related crashes found in 2020 where either of these were determined to be the primary cause of the congestion.

The chart below shows the breakdown of 2020 congestion related crashes by congestion type.

Figure 9 - Reportable Crashes by Congestion Type on the Core Roadway Network - 2020

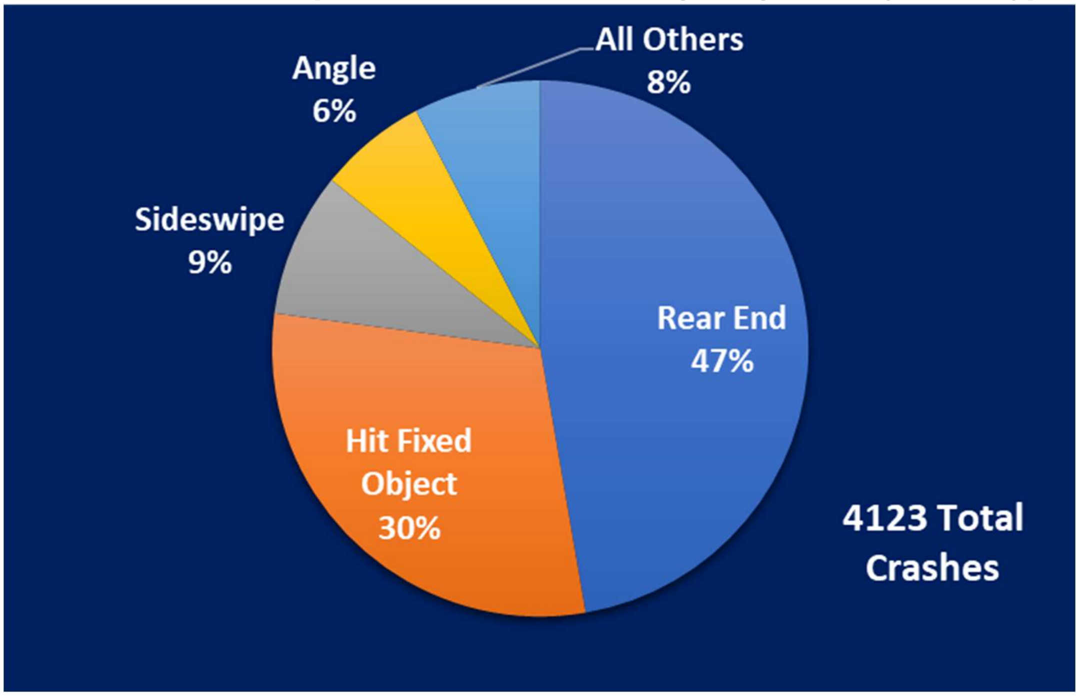


*** - Reportable crash or non-reportable crash that was verified in RCRS**

**** - Crash that was reported by Waze but not verified by a Department source**

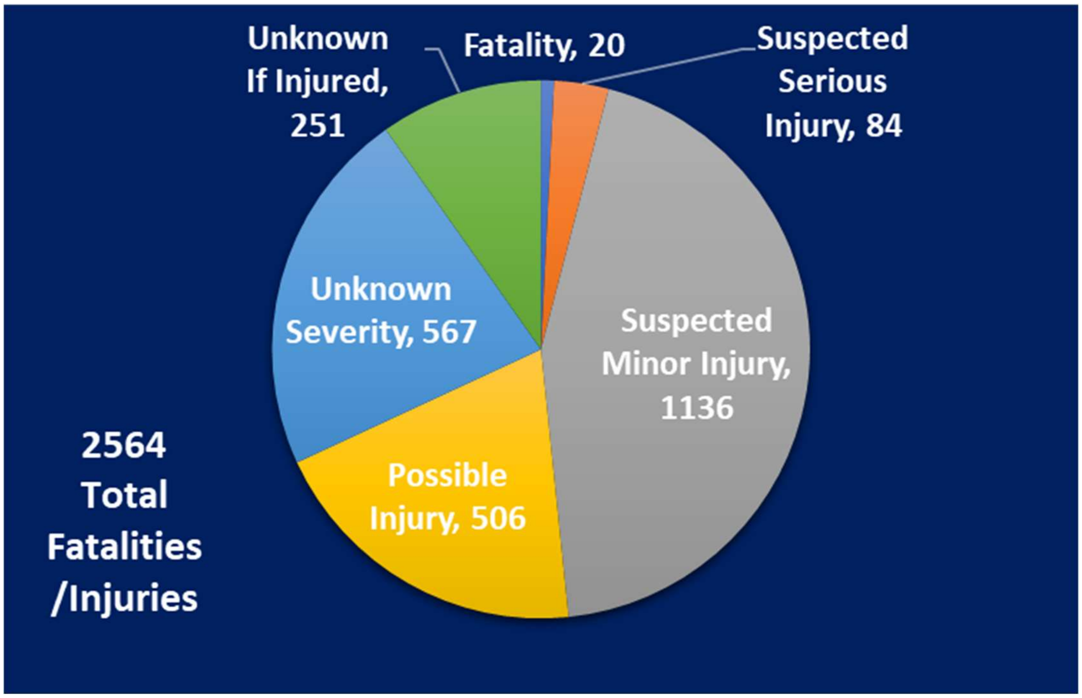
As seen in the chart below, 47% of these congestion related crashes were rear end crashes, and an additional 30% were hit fixed object, which is consistent with drivers either running into the back of a queue or swerving off the road to avoid running into the back of a queue.

Figure 10 - Core Network Reportable Crashes in Existing Congestion By Crash Type - 2020



Below is a breakdown of the injuries that occurred in core network crashes in existing congestion, by severity.

Figure 11 – Injuries in Core Network Reportable Crashes in Existing Congestion by Severity – 2020



Secondary Crashes

For the purposes of this report, a secondary crash is when a subsequent crash occurs in the backlog or queue of a prior crash.

The charts below provide a breakdown of secondary crashes by District/Region for 2020, and then provide a breakdown of these crashes by their distance from the work zone, from 2017 to 2020.

Figure 12 - 2020 Secondary Crashes by District and Region

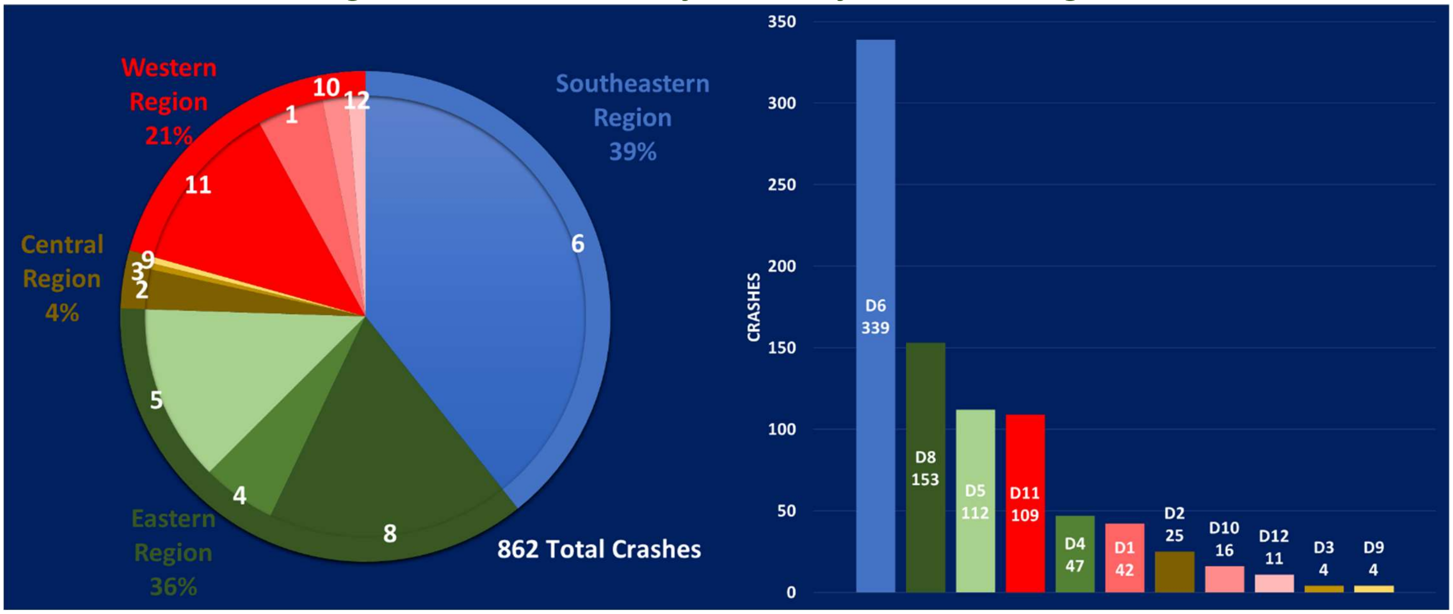
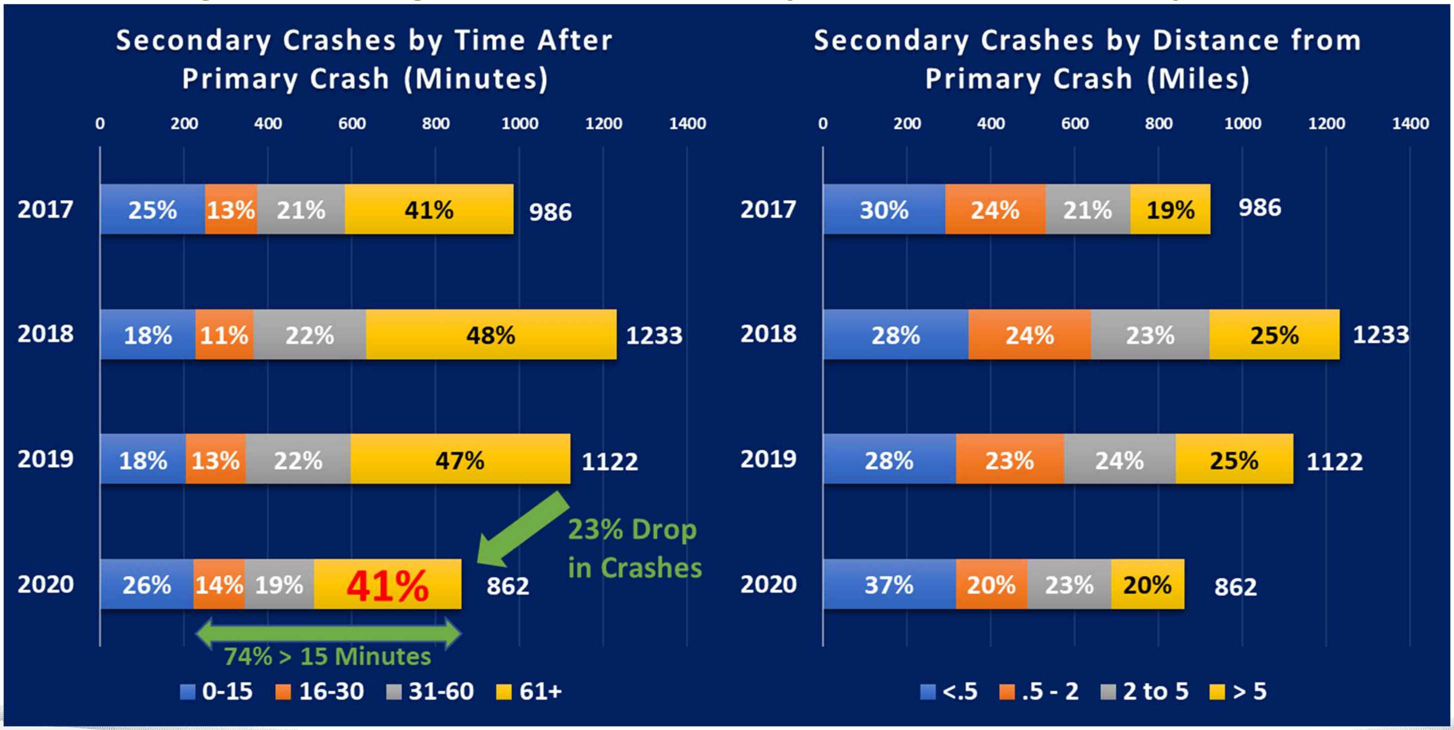


Figure 13 - Timing and Distance of Secondary Crashes Relative to Primary Crash



Conclusions

The drop in secondary crashes from 2019 to 2020 is not surprising due to the drop in traffic volumes and overall congestion in 2020 due to the COVID-19 pandemic, and so cannot necessarily be tied to any operational improvements in preventing these crashes.

The high percentage of crashes that continue to occur more than 15 minutes, and even over an hour, from the primary crash demonstrate that these timeframes are where focus should be placed by TMC's to target better operational response times and highlight the importance of promoting the efforts in FHWA's "Best Practice in TIM" DMS guidance for continuing effective messaging throughout the duration of incident's timeline, congestion, and queue adjustments.

The more motorists that can be deterred from driving towards a queue may in-turn positively impact the safety of our congestion-related crashes. The distance information above provides better supporting information for the use of upstream congestion messaging, and can be shared with TIM teams to help mitigating the congestion points more effectively. Regardless of time and distance from the primary crash, analysis has shown is a CMS close enough to alert approaching motorists of the congestion in over 85% of secondary crashes. Future analysis will focus the effectiveness of CMS messaging in preventing secondary crashes.

Work Zone Congestion-Related Crashes

Congestion from work zones is another significant factor of crashes. In 2020, there were 479 reportable crashes on the Core Roadway Network in congestion originating from a work zone[18].

The charts below provide a breakdown of work zone congestion-related crashes by District/Region for 2020, and then provide a breakdown of these crashes by their distance from the work zone, from 2017 to 2020.

Figure 14 - 2020 Work Zone Congestion-Related Crashes by District/Region

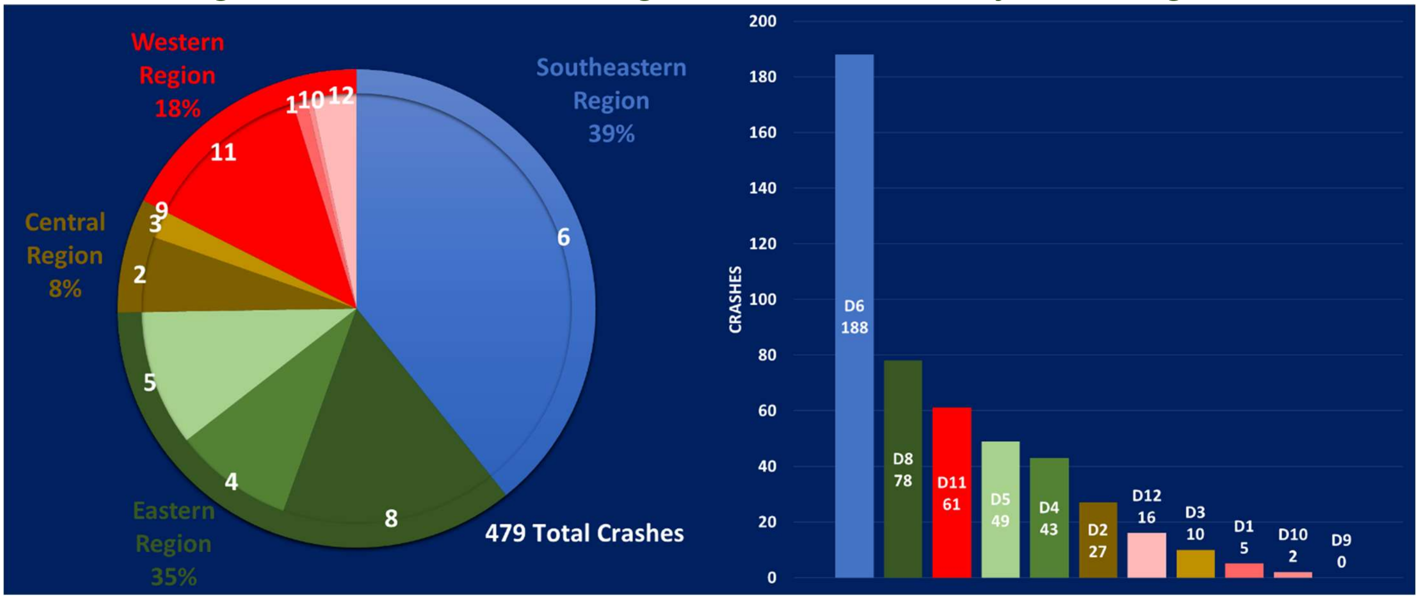
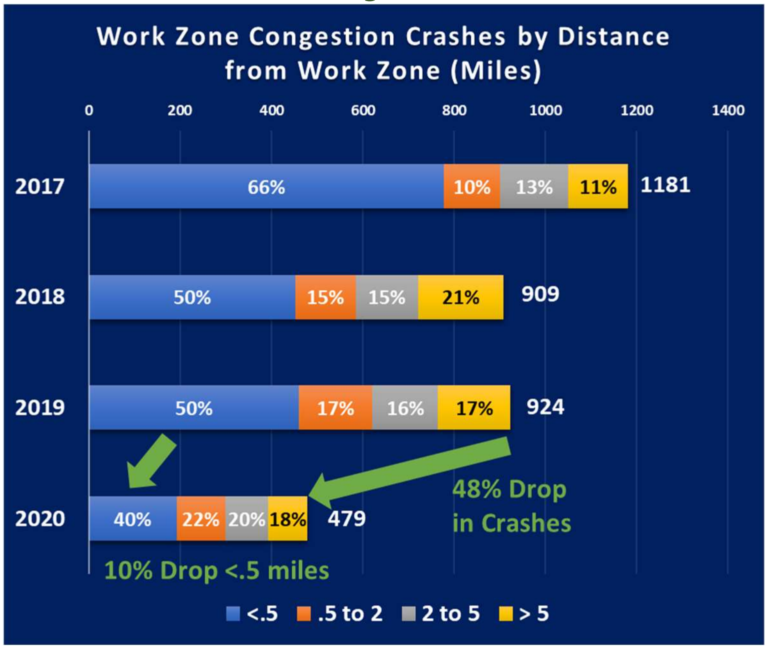


Figure 15 - Distance of All Work Zone Congestion-Related Crashes from the Work Zone



[18] Due to data processing limitations, congestion was linked to a work zone up to a maximum of 8 miles behind the work zone. Crashes that occurred in congestion further from the work zone would not be flagged as being caused by the work zone.

Conclusions

The significant drop in work zone congestion related crashes from 2019 to 2020 is not surprising giving the overall drop in traffic volumes and congestion during 2020 due to the COVID-19 pandemic, and the fact that there was a statewide pause on roadwork early in the pandemic. This drop by itself is therefore not indicative of operational improvements in managing work zone.

The drop in the percentage of crashes that occur within a half mile of a work zone does continue a trend of decline in this area. This suggests that improvements are being made in managing safety in the immediate proximity of the work zone. However, that 40% of crashes still occur in this area highlights the fact that that areas approaching a work zone are at higher risk for crashes, as well as the importance of having situational awareness on work zones, and having an operational response in place for when congestion begins to build in the work zone.

2020 Work Zones with Highest Congestion Related Crashes

The below tables highlight the 2019 work zones with the highest rates of reportable crashes that occurred in congestion related to the work zone. Tables are provided for both short term work zones (up to one week in duration) and long-term work zones (longer than one week) with RCRS IDs. Work zones must have more than one related crash to be included. For purposes of this analysis, a crash is linked to a work zone only if it occurred in congestion that was being caused by the work zone[19] – crashes that occur in/near the work zone under non-congested conditions are not considered. Long term work zones are ranked by crashes per day, short term is ranked by crashes per hour. Where possible, these work zones should be investigated to determine any lessons learned/safety improvements that could be made in the future.

Figure 16 - 2020 Work Zones With Highest Congestion Related Crash Rates (Less than 1 week)

District	RCRS ID	Route	Location	Crashes	Duration (Hours)	Crashes Per Hour
11	561505	I-376 E	MM 62 to MM 64	2	4.1	0.49
11	559029	I-376 W	MM 73 to MM 71	2	5.4	0.37
6	562924	I-95 N	Bridge Street to Cottman Ave	2	6.4	0.31
6	529344	I-95 S	Betsy Ross Ave	2	6.9	0.29
6	530369	I-95 S	Betsy Ross Ave to Allegheny Ave	2	8.0	0.25
11	559098	I-279	MM 7 to MM .9	2	9.0	0.22
6	551059	I-76 W	South Street to I-676	2	9.5	0.21
6	563748	I-95 S	US 322 to Delaware Line	2	9.8	0.20
8	536958	I-81	MM 88 and MM 81	2	12.7	0.16
6	530935	I-95 S	Chichester Ave to Delaware	2	13.4	0.15

Figure 17 - 2020 Work Zones With Highest Congestion Related Crash Rates (Longer than 1 week)

District	RCRS ID	Route	Location	Crashes	Duration (Days)	Crashes Per Day
6	542255	I-76 W	University Ave to I-676	16	27.7	0.58
6	543769	I-95 S	PA 413 to PA 132	15	27.9	0.54
6	568947	I-95 N	PA 611 to I-76	8	15.4	0.52
6	560756	I-76 W	South Street	32	66.7	0.48
11	537299	I-376 E	US 22	8	18.7	0.43
6	525425	I-95 N	Chestnut Street	27	75.1	0.36
5	527986	US 22 W	PA 248 to PA 191	9	31.2	0.29
11	547885	I-376 W	Montour Run Road	8	32.2	0.25
6	561254	US 1	Rockhill Drive to US 1 Business	15	64.2	0.23
8	523742	I-83 N	Eisenhower Blvd to Union Deposit	11	47.4	0.23

[19] Due to data processing limitations, congestion was linked to a work zone up to a maximum of 8 miles behind the work zone. Crashes that occurred in congestion further from the work zone would not be flagged as being caused by the work zone.

TMC Situational Awareness

RCRS Verified Crashes – 2017 to 2020

The following charts present a breakdown of the number of crashes (reportable and non-reportable) that were captured in RCRS in 2020 by District/Region, as well as the numbers of crashes captured in RCRS by region for 2017 through 2020 as an examination of progress that is being made in improving situational awareness.

Figure 18 – 2020 RCRS Verified Crashes by District/Region

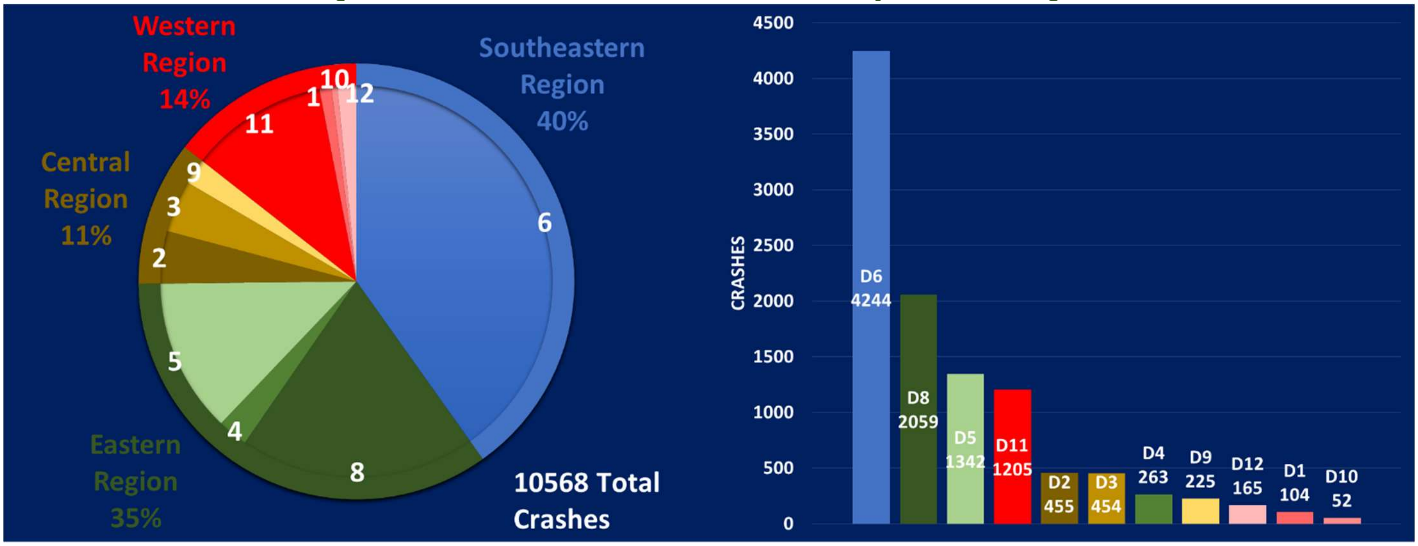
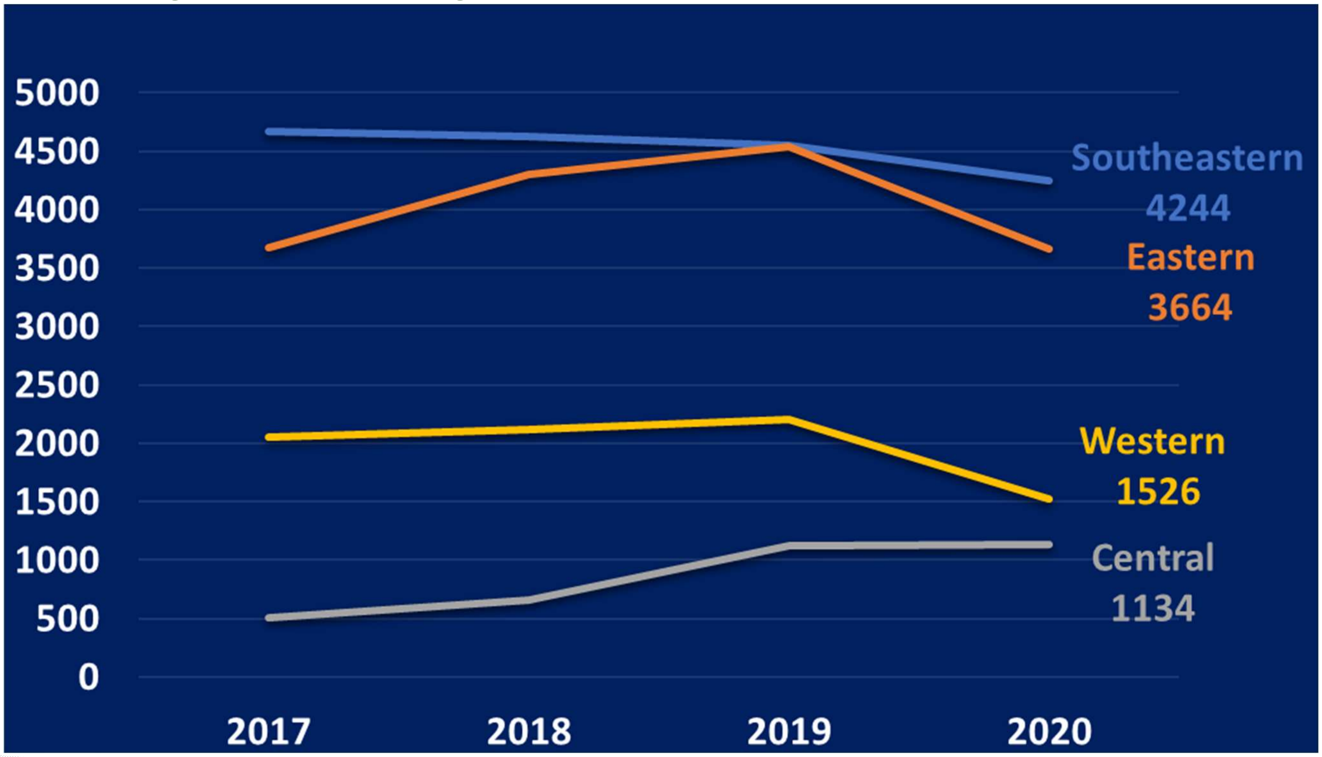


Figure 19 - 2017 through 2020 Total RCRS Verified Crashes – Core Network



The first two TSMO Performance reports issued in 2018 focused on the percentage of core network reportable crashes that were verified by TMC personnel. The chart below shows the breakdown of reportable crashes on the core network in 2020 by District/Region. It is followed by charts that show the trends in RCRS verification rates of all reportable crashes from 2017 to 2020, by RTMC Region, and then by TMC/District. These numbers are provided as insight into how TMCs are progressing in their efforts to improve overall situational awareness.

Figure 20 – 2020 Core Network Reportable Crashes by District/Region

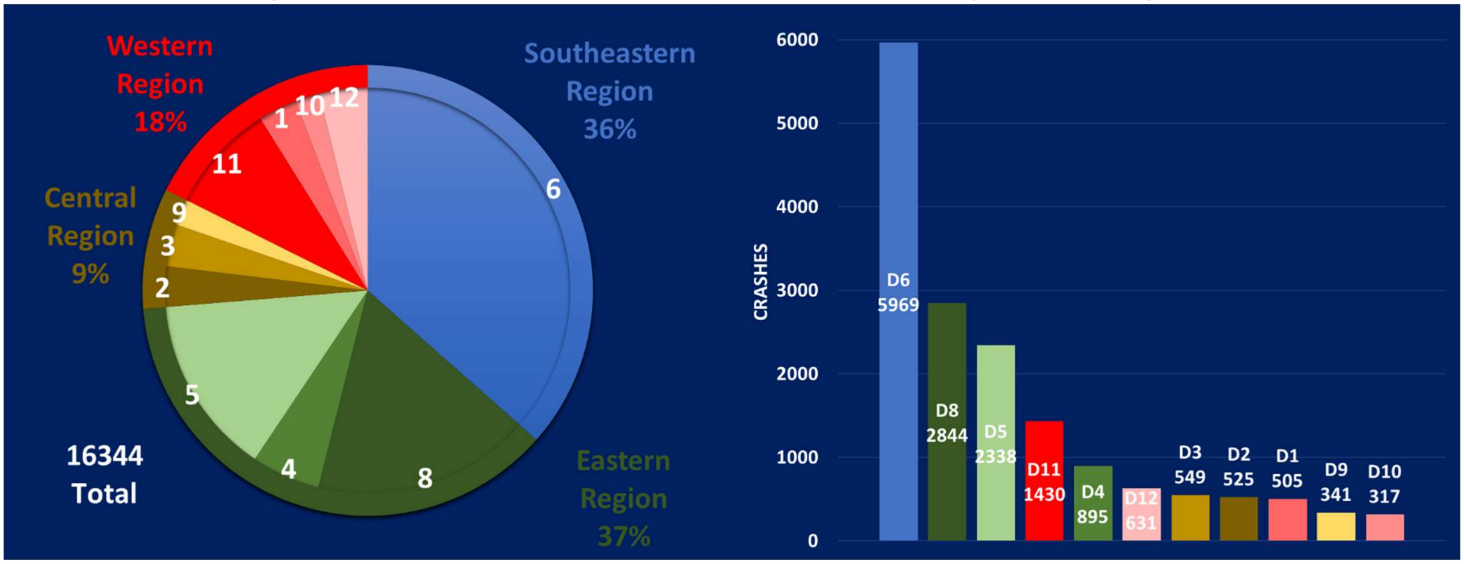


Figure 21 – Core Network Reportable Crash RCRS Verification Rate – by RTMC Region

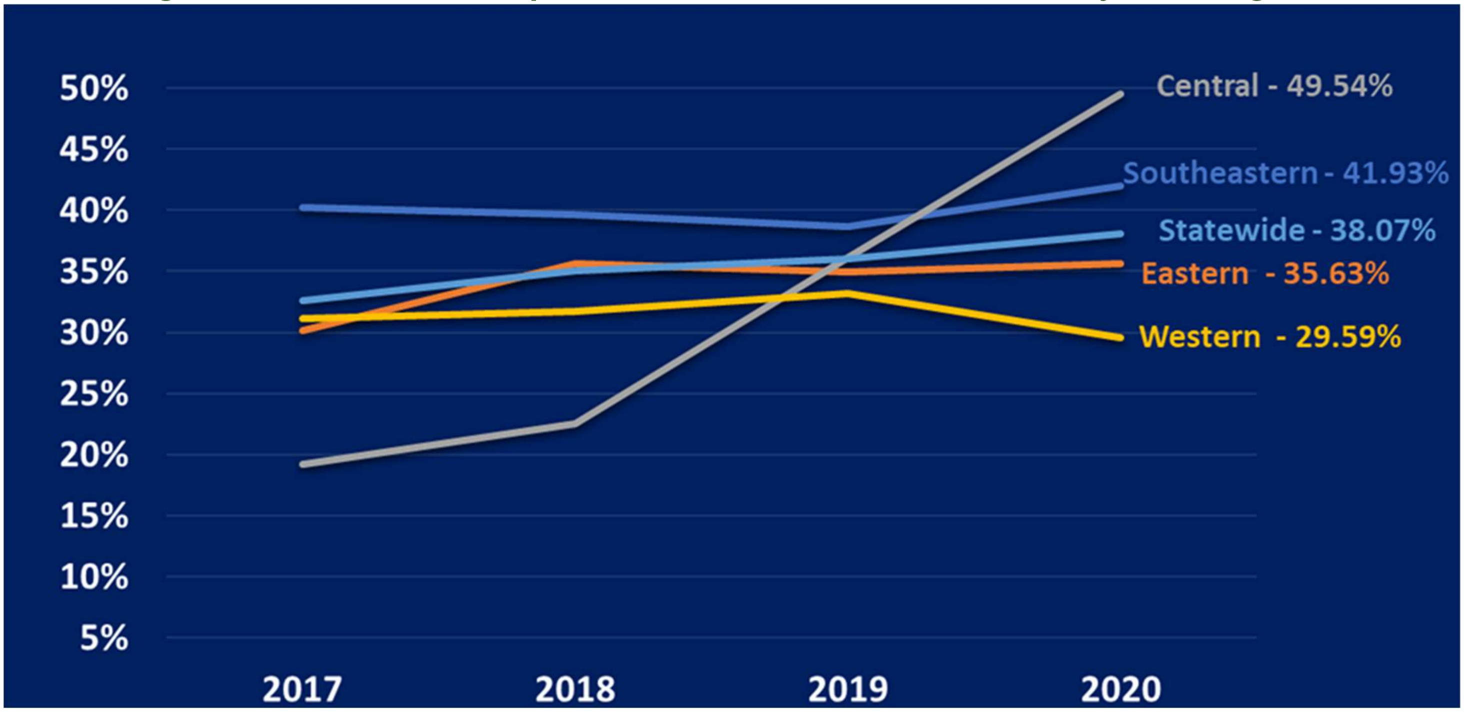
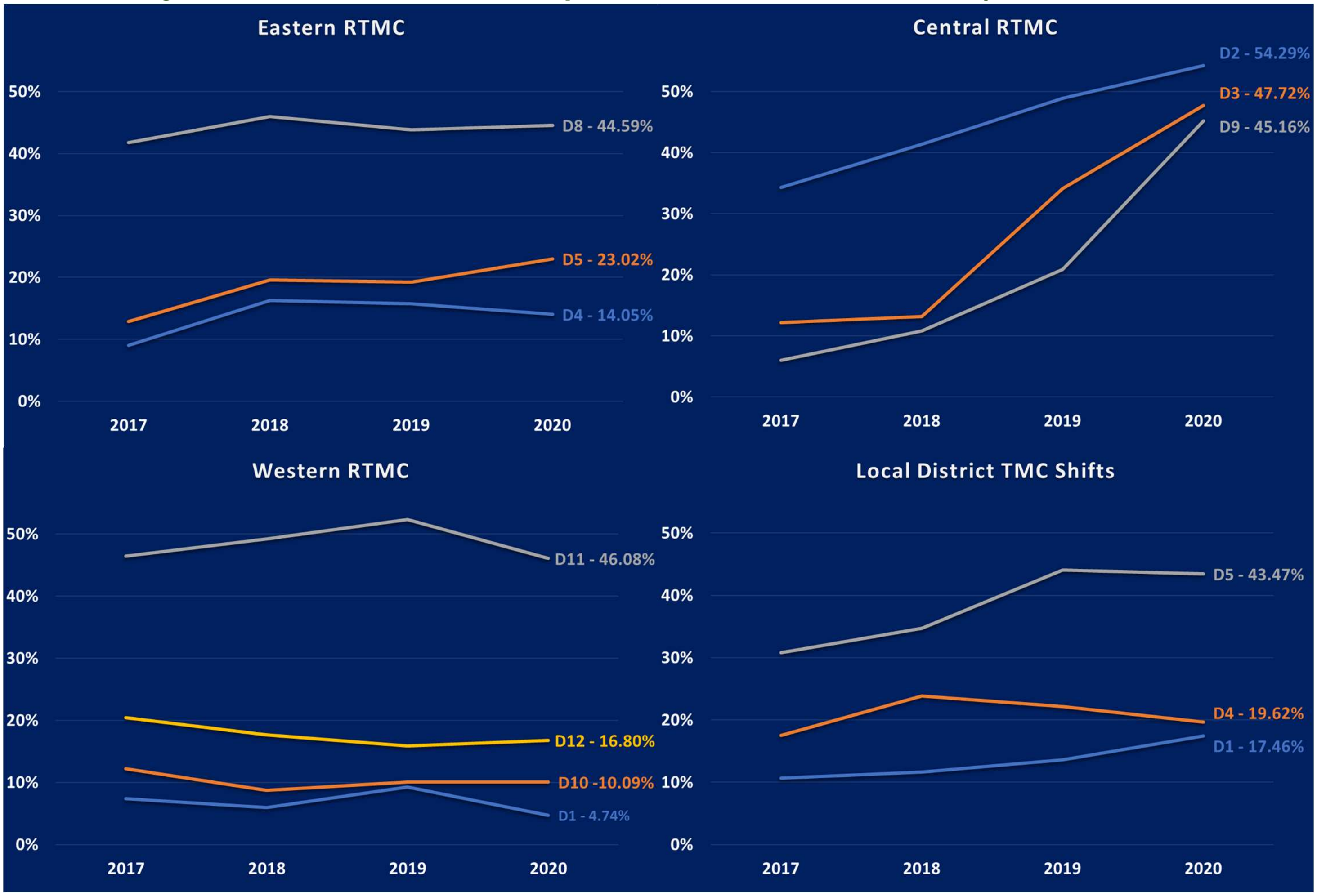


Figure 22 - Core Network RCRS Reportable Crash Verification Rate by TMC/District



Major crashes on core network roads can gridlock entire metropolitan areas. These are the instances when effective traffic management strategies are paramount, and most importantly need to be clearly communicated to first responders, and the traveling public to allow for actionable decisions. PennDOT TMCs should aim to have 80% of heavy congestion crashes verified by an RCRS entry for all core roadway network roads. RCRS feeds incident information directly to social media and third-party mapping providers. The chart below shows the breakdown of heavy congestion[20] reportable crashes on the core network in 2020 by District/Region. It is followed by charts that show the trends in RCRS verification rates of heavy congestion reportable crashes from 2017 to 2020, by RTMC Region, and then by TMC/District.

Figure 23 – 2020 Core Network Heavy Congestion Reportable Crashes by District/Region

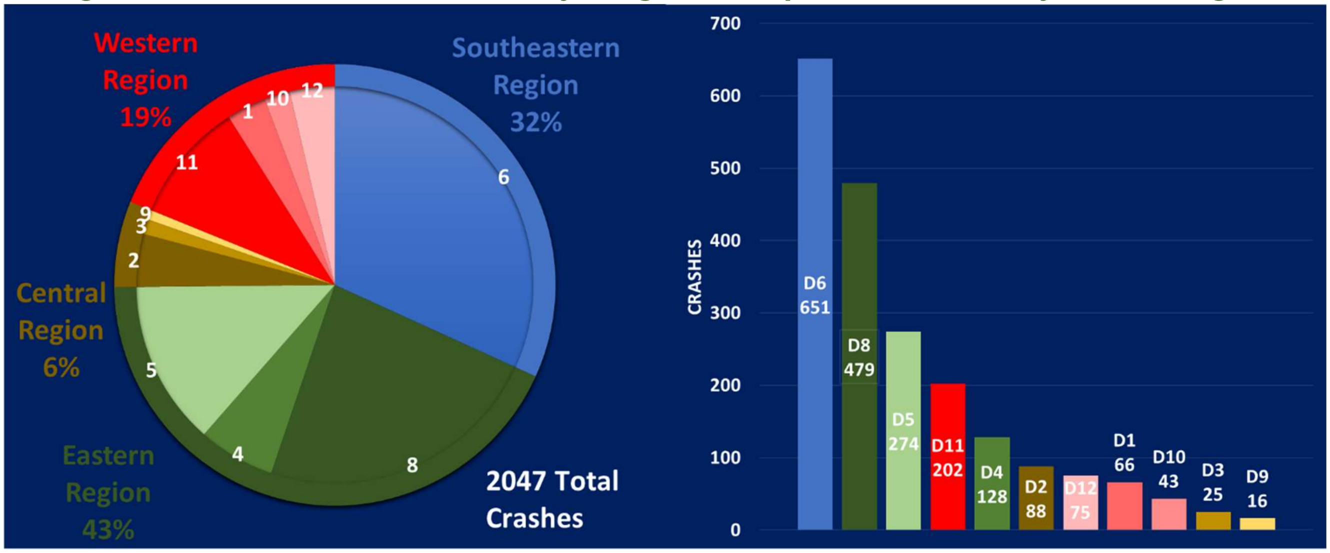
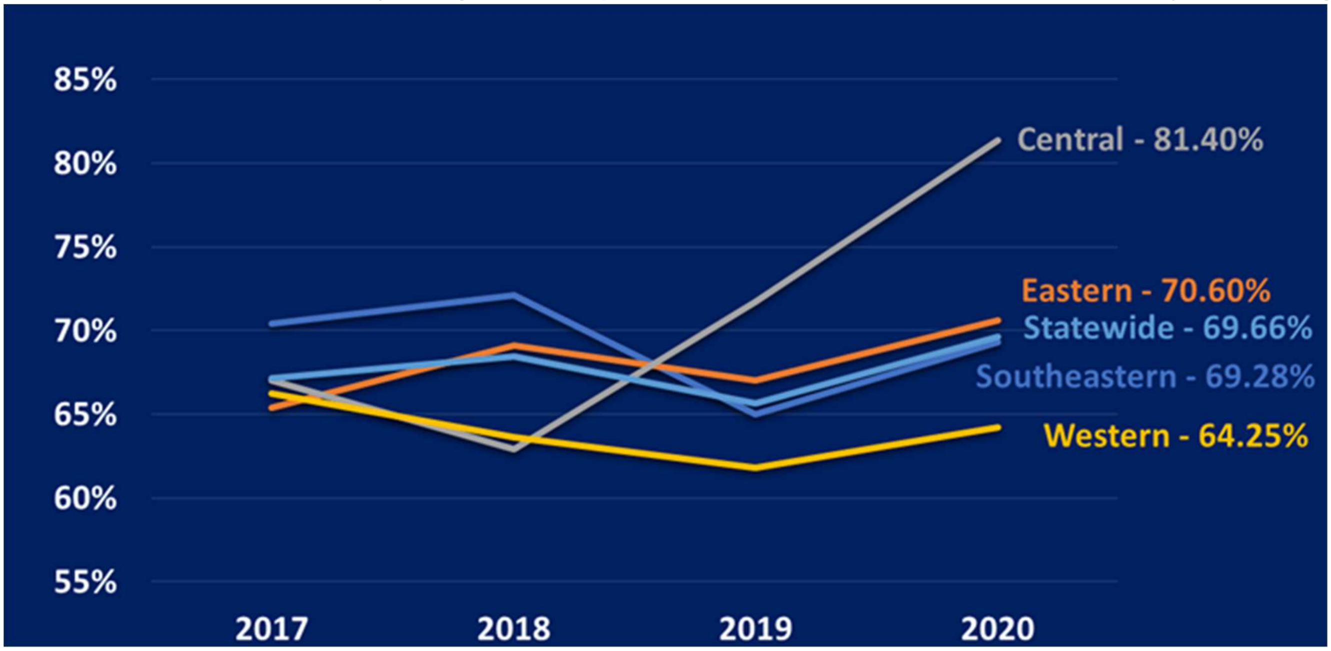
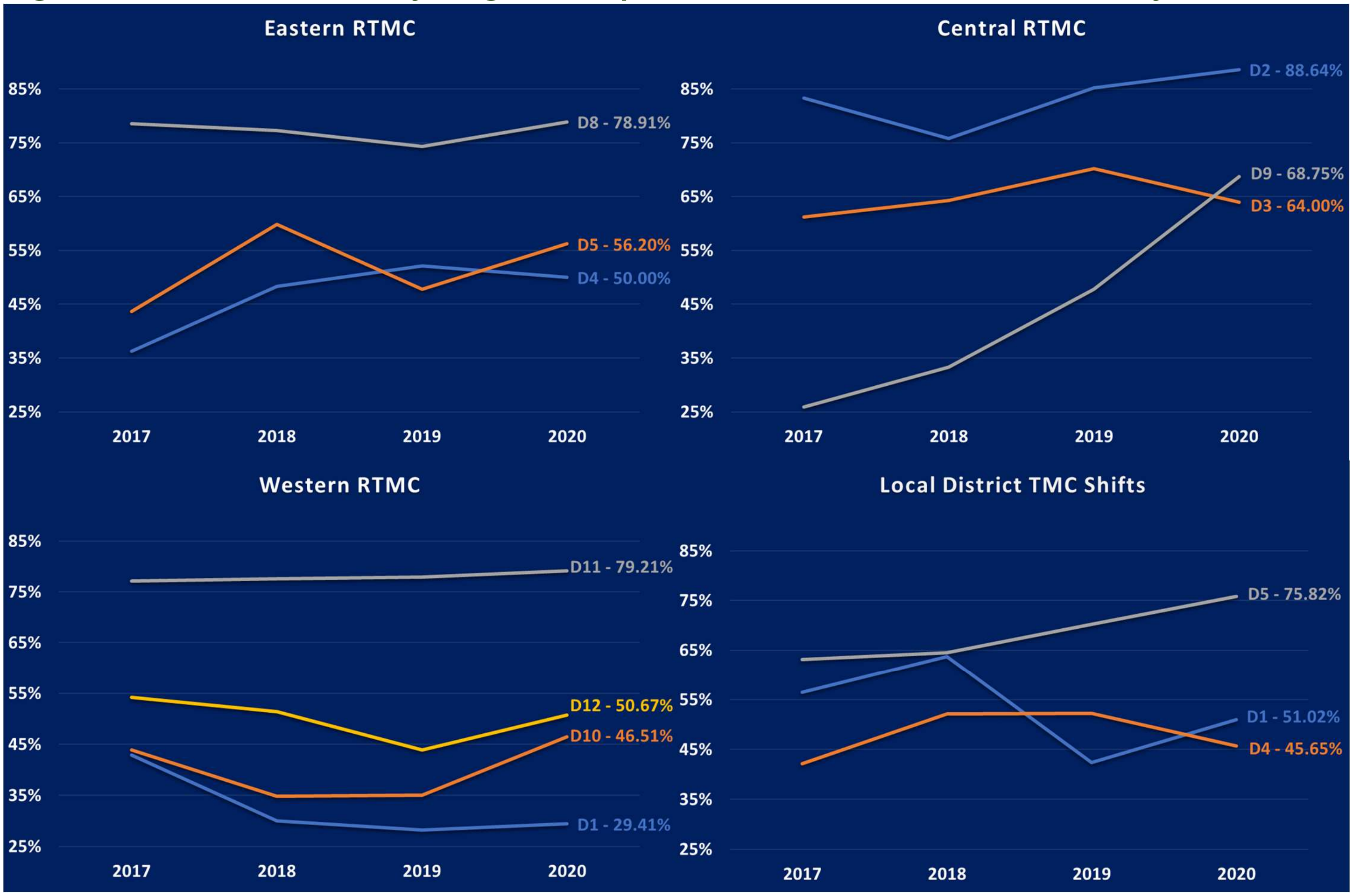


Figure 24 – Core Network Heavy Congestion Reportable Crash RCRS Verification Rate – by RTMC Region



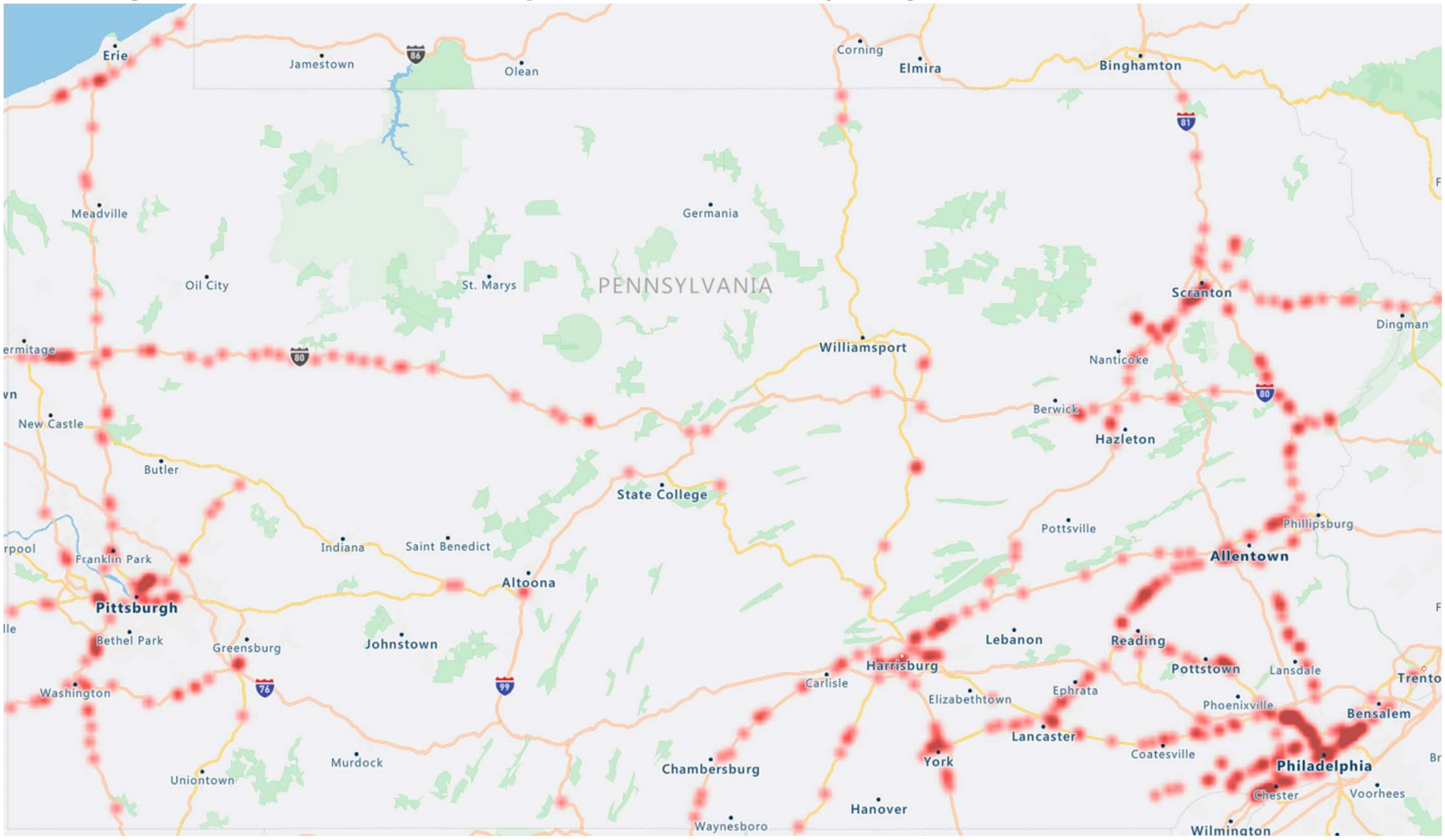
[20] A heavy congestion event has the scores: (1-Critical >= 10000, 2-Severe 3000 – 9999). Severity score methodology = (Duration of Incident) * (Historical Avg. Speed – Avg. Speed during Incident)

Figure 25 – Core Network Heavy Congestion Reportable Crash RCRS Verification Rate – By TMC/District



A statewide map of un-verified heavy congestion crashes is provided below. For District specific maps, please see [Appendix 2 – District Specific Heavy Congestion Crash Maps](#).

Figure 26 – Statewide Heat Map of Un-Verified Heavy Congestion Crashes – Core Network



Conclusions

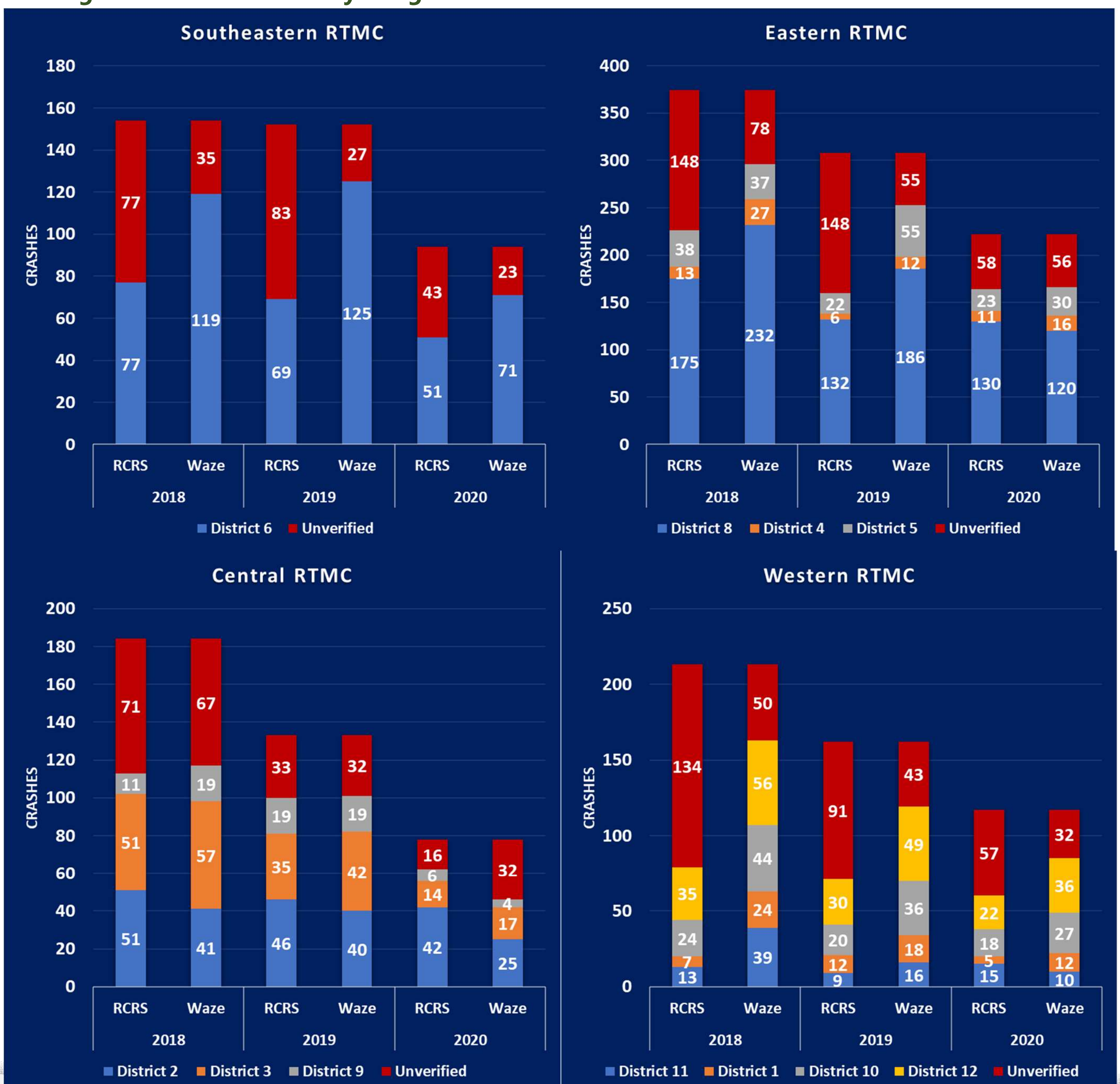
Due to reduced traffic volumes and congestion in 2020 as a result of the COVID-19 pandemic, the overall number of crashes in general, and heavy congestion crashes in particular, were down from 2019 to 2020. As such, the drop in overall RCRS crash verification should not be seen as a decline in situational awareness. RCRS verification rates for reportable crashes (all and heavy congestion) stayed steady or even improved as a general rule across the state, indicating a general effective of TMCs at situational awareness while they were operating remotely through most of the year.

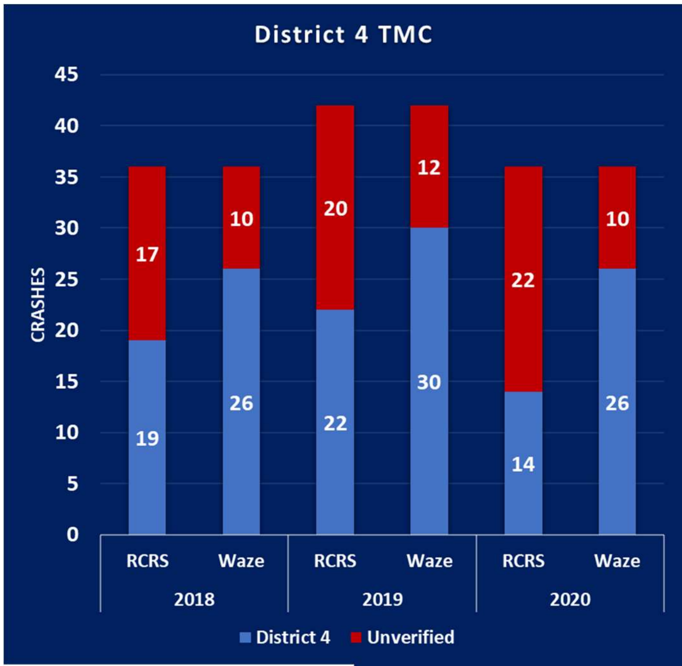
It is also worth noting that the Districts and regions that have seen and continue to see the most growth are those that are utilizing PennDOT's Traffic Alerts system. Further, the significant growth seen across all areas in the Central Region highlights the effectiveness of their efforts to bring County 911 Computer Aided Dispatch (CAD) information directly into the TMC.

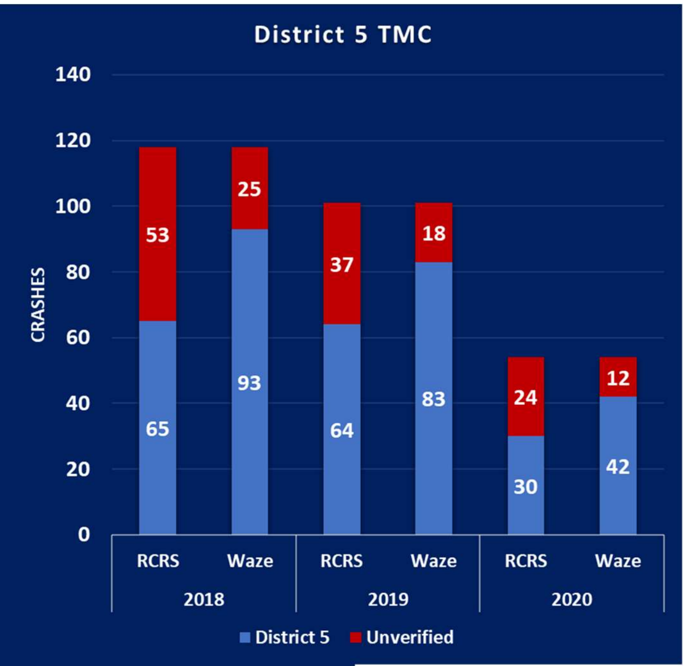
Impact of Traffic Cameras on Situational Awareness

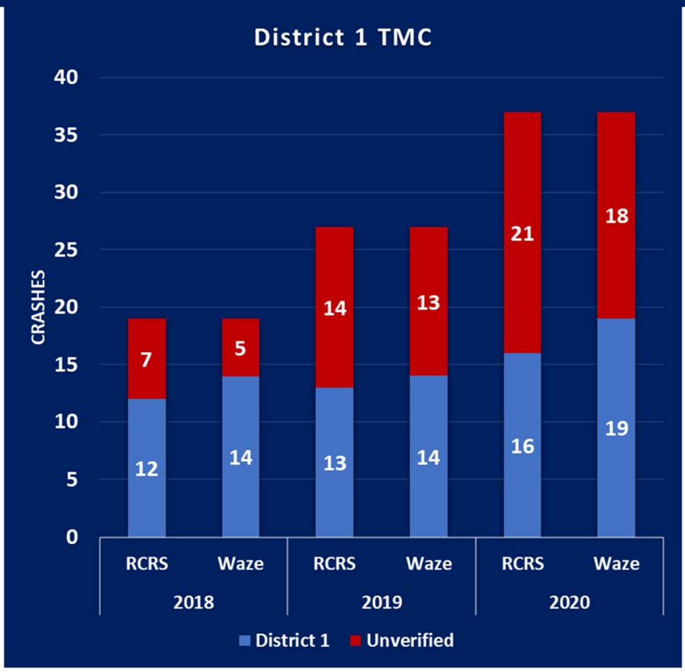
Traffic cameras are one of the most heavily utilized tools for situational awareness and verification. As a result, a preliminary analysis was done to determine the effective radius of cameras of heavy congestion crashes. 2 miles was determined to be a representative breaking point for verified heavy congestion crashes. The charts below show trends in the RCRS and Waze verification of such crashes from 2018 and 2020. The percentages of these events that were reported by Waze is also charted for reference and to demonstrate the ability of Waze to provide situational awareness in areas where traditional methods such as cameras do not reach. The below charts show verified vs unverified crashes for both RCRS and Waze from 2018 to 2020.

Figure 27 – Verified Heavy Congestion Crashes in RCRS and Waze > 2 miles from Camera









Conclusions

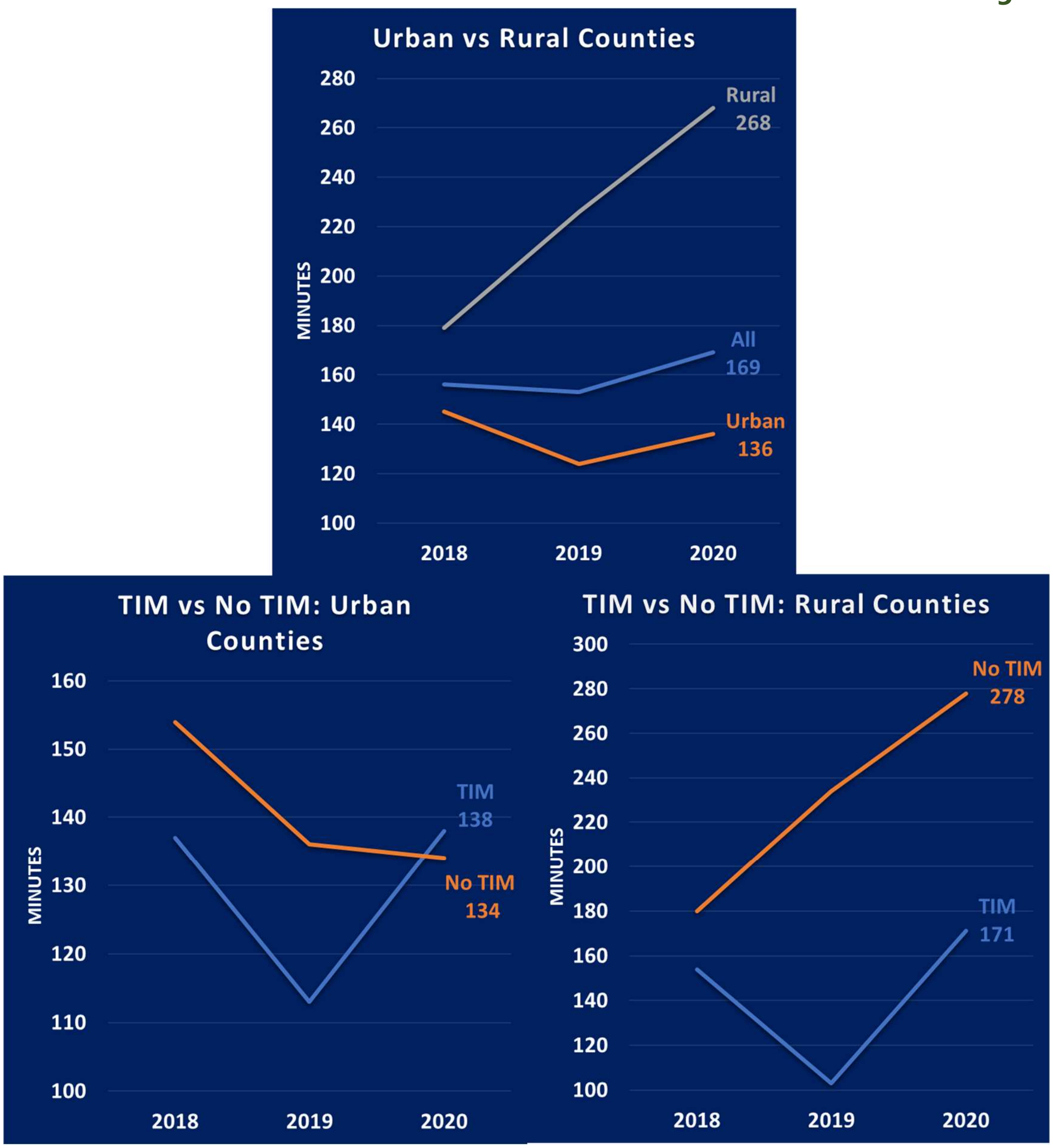
All RTMC regions saw improvement in their RCRS verification rates for heavy congestion crashes > 2 miles from a camera from 2019 to 2020. This improvement was also almost uniformly present on a District by District level for the RTMCs themselves. Interestingly, this improvement came as the Waze verification rates for these crashes fell from 2019 to 2020. There are now a number of Districts that are verifying a higher percentage of these crashes than Waze is. This is an extremely positive development, and efforts should be made to continue to improve TMC situational awareness in areas where there is no camera coverage. For District maps of these crashes see Appendix 3 – District Heavy Congestion No Camera Crash Maps.

Average Incident Clearance Times – 2018 through 2020

The first TSMO Performance Report issued in February 2018 presented a breakdown of average incident clearance times by District and County for all routes on the Core Roadway Network. This data has been updated annually since that initial report. The charts and tables that follow update this data for 2020.

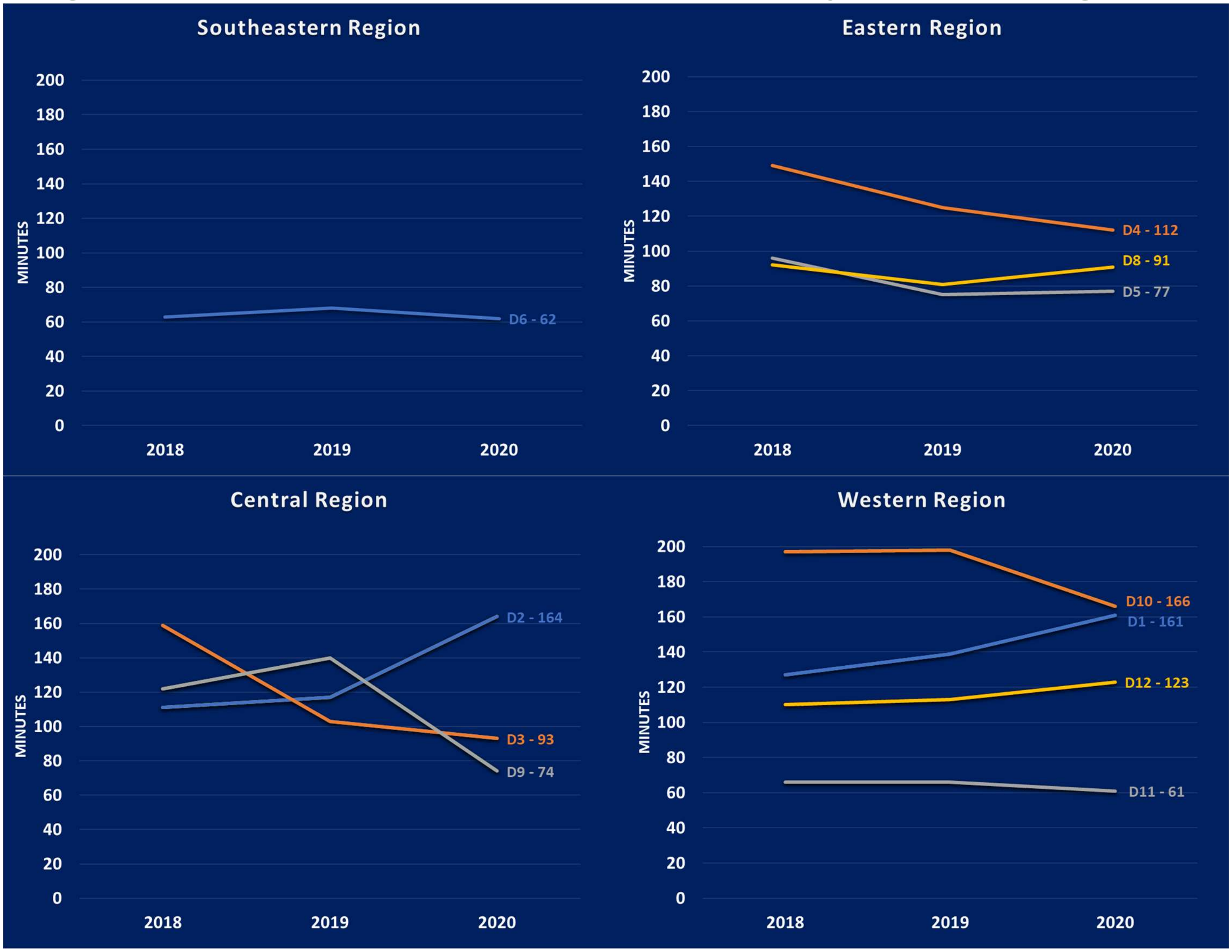
The chart below shows a breakdown of core network incident clearance times for full closures on the core network for rural vs urban counties for 2018 through 2020. It further breaks down the urban and rural counties into those which have a traffic incident management (TIM) team and those who don't.

Figure 28 - Core Network Incident Clearance Times for Full Closures – 2018 through 2020



The chart below shows the trends in core network incident clearance times by district for 2018 through 2020, grouped within their respective RTMC regions.

Figure 29 - Core Network Incident Clearance Times (All Incidents) by District– 2018 through 2020



The maps below illustrate core network clearance times and number of core network incidents by county for 2020.

Figure 30 - Core Network Incident Clearance Times (Minutes) by County – 2020

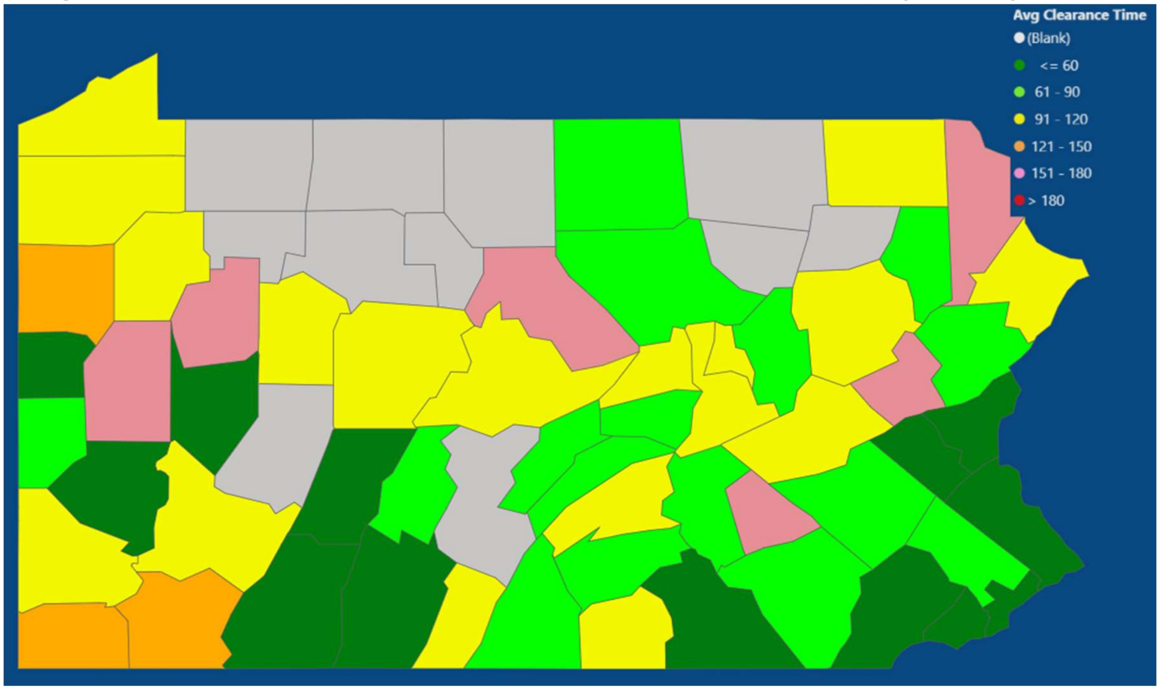
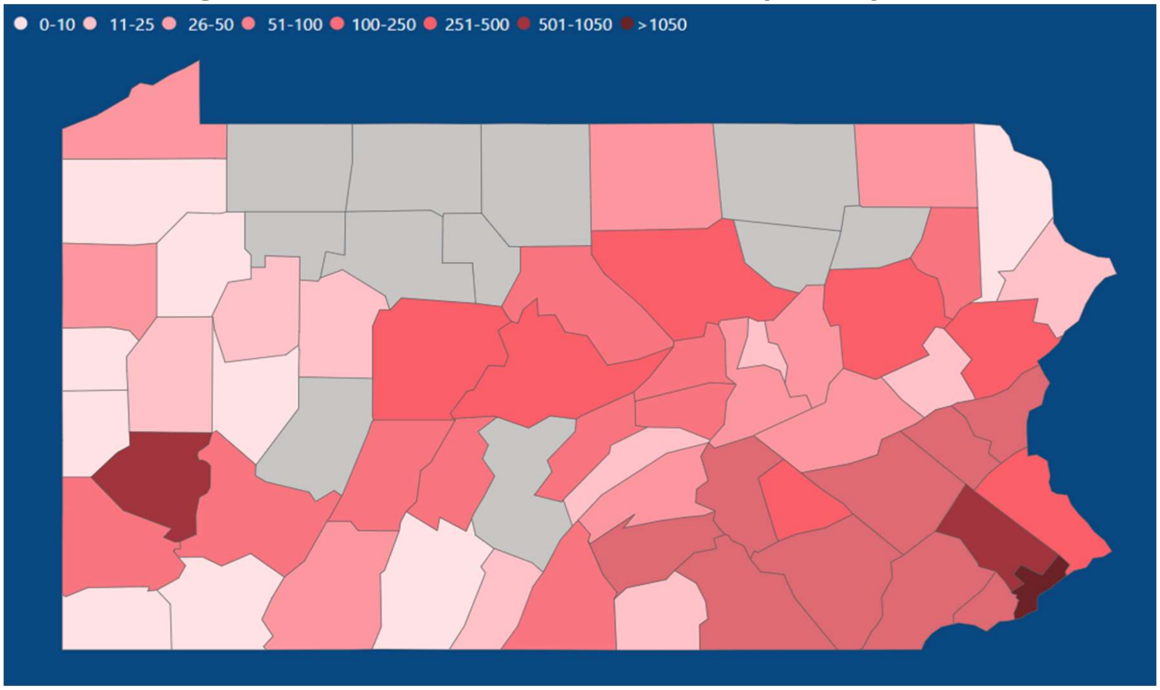


Figure 31 – Core Network Incident Count by County – 2020



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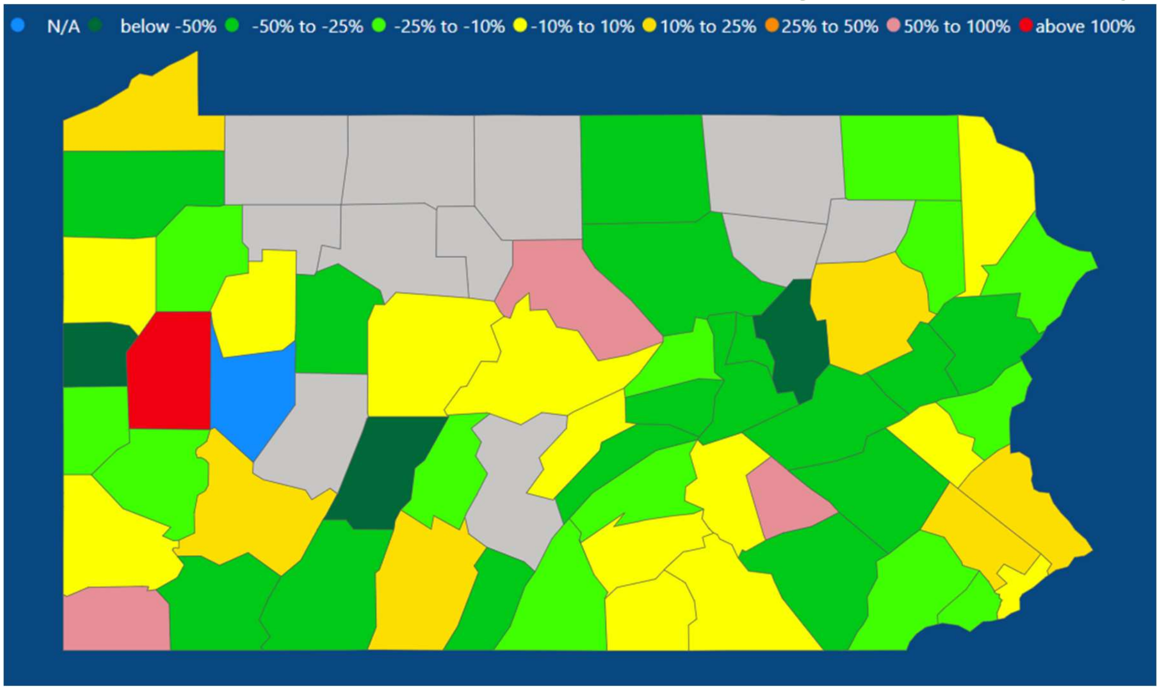
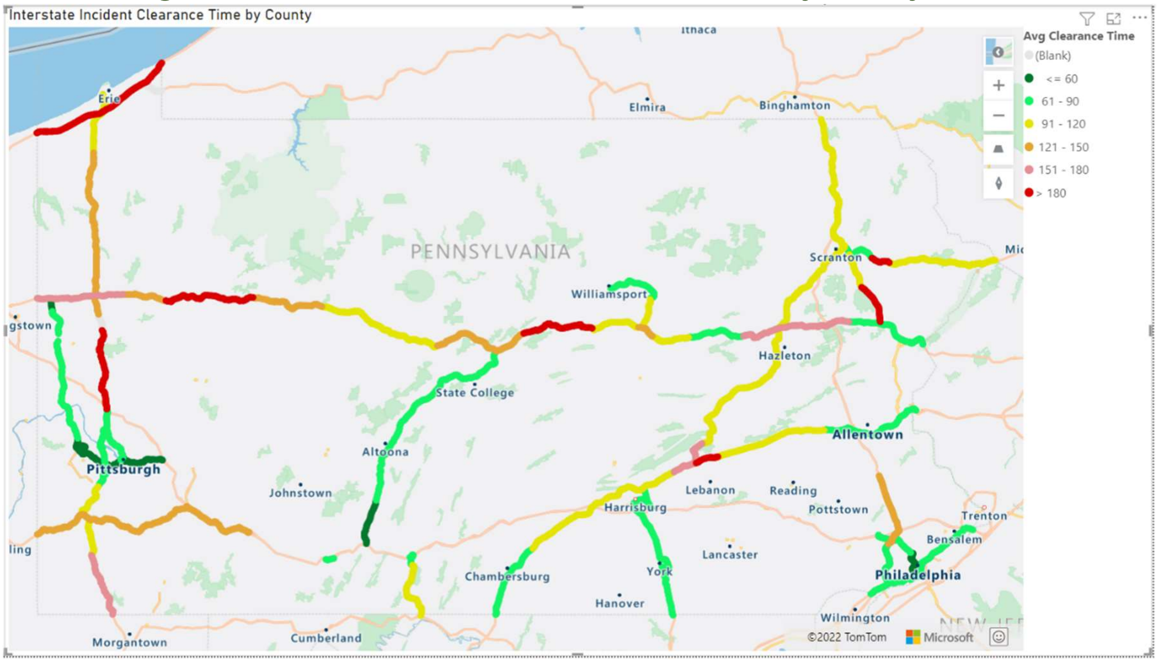
The map below shows the change in core network incident clearance times from 2018 to 2020, by county.

Figure 32 – Core Network Incident Clearance Time Percent Change from 2018 to 2020 by County



The map below shows incident clearance times on the interstates, broken down by county, for 2020.

Figure 33 - Interstate Incident Clearance Times by County – 2020



Detailed charts showing incident clearance times by District/County will be available when the [TSMO Dashboard]() is released.

Conclusions/Recommendations

The above charts and map are presented to provide insight into areas and locations where incident response and management can be improved. The initial chart comparing urban vs rural clearance times as well as clearance times where TIM teams are in placed compared to where they are not highlights the importance of these teams. According to FHWA, the chance of a secondary crash increases 2.8% for every minute that a primary crash remains a hazard. This emphasizes the importance of reducing incident timelines, and the value even the 15-20 minute reductions seen in urban counties with TIM teams. TIM Team involvement needs to be consistently increased on a statewide level.

The Traffic Operations Analytics tool provides an Incident Timeline module which can be used to analyze and better understand incident clearance times at the region, district, route, county, and even municipality level. This is a tool that can be utilized to aid TIM teams in better understanding the timeliness and effectiveness of their incident responses. In addition to incident clearance times, the module calculates the incident influence time, which is defined as the time between when the incident occurs and when traffic returns to normal. This metric provides a better picture of the overall impact of an incident on a route.

Appendix 1 – Congestion Pie Chart Methodology

Methodology

PennDOT's congestion pie chart was developed by utilizing traffic speed data provided by INRIX's flow incident API. While INRIX's exact methodology for conditions that produce a flow incident is proprietary, the general guidelines they issue are traffic speeds that drop below 65% of reference (freeflow) speed for at least 2 minutes, and that a flow incident ends when speeds have returned to greater than 70% of reference speed.

PennDOT's congestion pie chart tool was developed starting with 2018 data and it is limited to routes on PennDOT's Core Roadway Network. All INRIX flow incidents on the Core Roadway Network were brought into the database and correlated to a variety of Department data sources to uncover DOT known "causes":

Data Source	Data Type
Road Condition Reporting System (RCRS)	Traffic Incidents, Roadwork
Maintenance Database	Roadwork
Crash Reporting System (CRS)	Reportable Crashes[21]
Roadway Weather Information System (RWIS)	Inclement Weather

The table below provides the distance and time buffers that were utilized to correlate the causes from various data sources to flow incidents.

Data Type	Distance	Time
Crashes (RCRS + CRS)	2 miles	30 minutes
Weather (RWIS)	15 miles	15 minutes
Work Zone (RCRS)	3 miles	Within start/end time of work zone
Work Zone (Maintenance Database)	3 miles	30 minutes
All Waze Alerts	1 mile	30 minutes

In some cases, multiple potential causes were identified for a single congestion incident. At this time, no special analysis was done to determine a primary cause, or to assign percentages of congestion across the multiple causes. For purposes of this analysis, congestion that correlated to multiple causes, DOT data or crowd-sourced, were classified using the following priority:

1. Crash
2. Roadwork
3. Weather

To generate the pie chart, all congestion events were assigned an impact score[22]. The congestion pie charts as presented represent a breakdown of the total impact score by cause.

[21] A reportable crash is one in which an injury or a fatality occurs, or if at least one of the vehicles involved required towing from the scene.

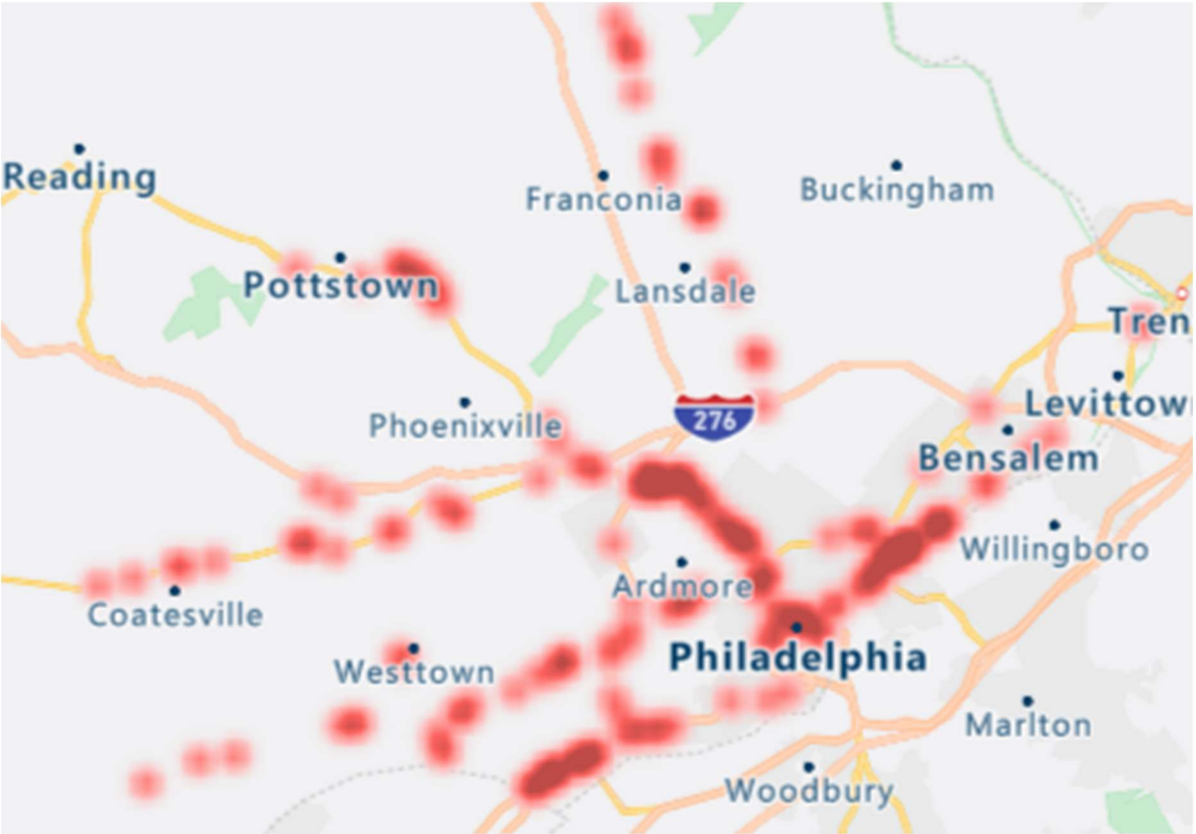
[22] The impact score of a congestion event = (event duration) x (length of queue) x (speed drop).

Appendix 2 – District Specific Heavy Congestion Crash Maps

The heat maps provided below are District-specific versions of the statewide map provided in the main body of the report. They illustrate heavy congestion crashes that were not verified in RCRS.

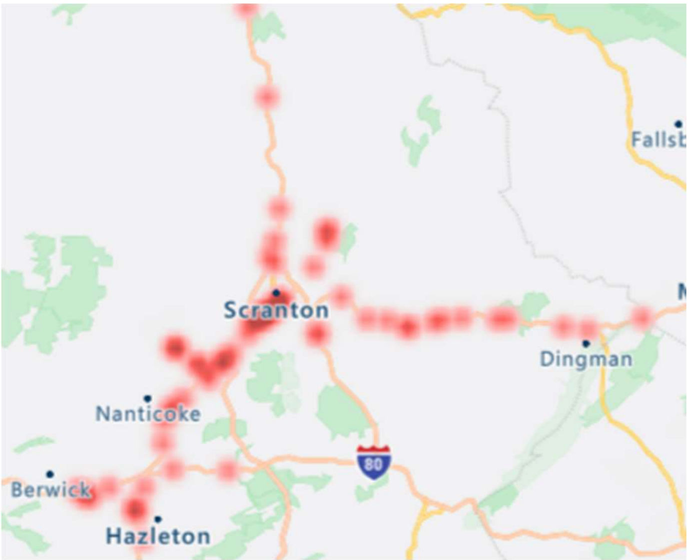
Southeastern Region

District 6

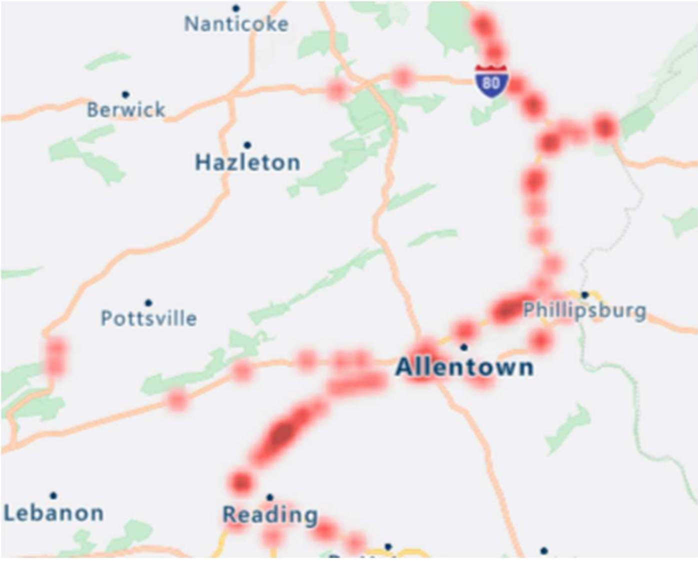


Eastern Region

District 4



District 5



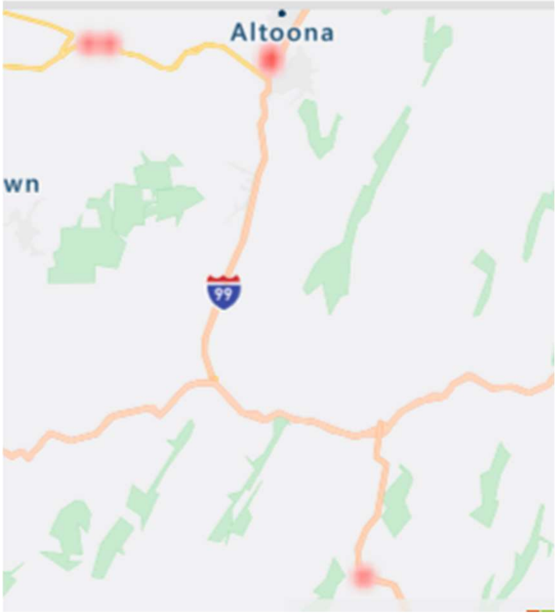
District 8

Central Region

District 2

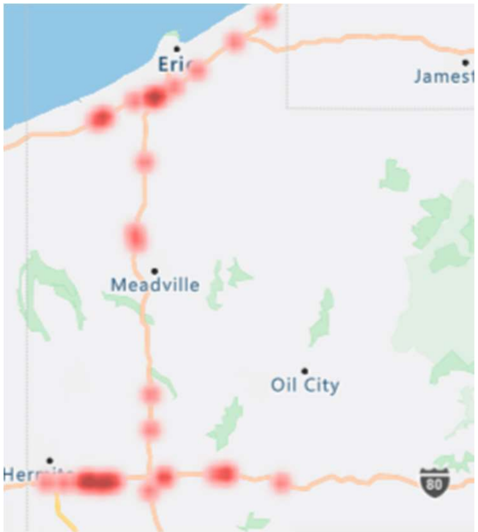
District 3

District 9

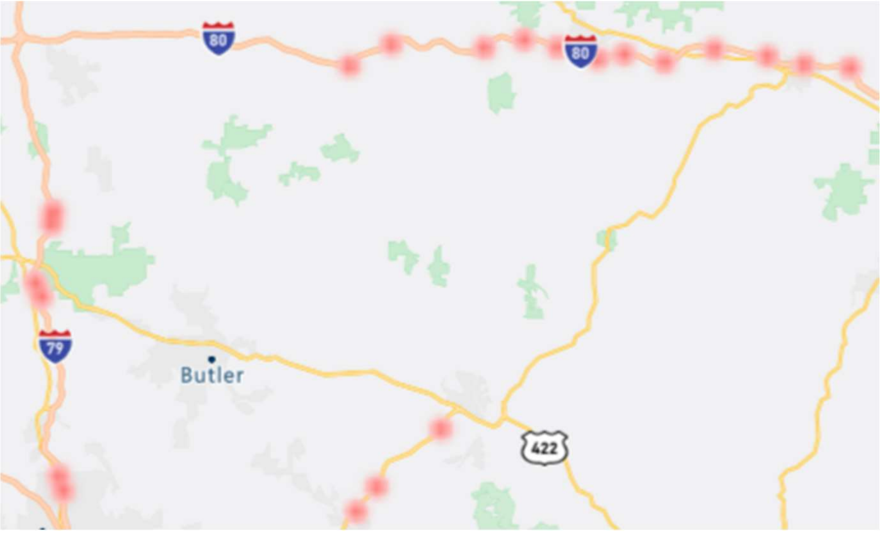


Western Region

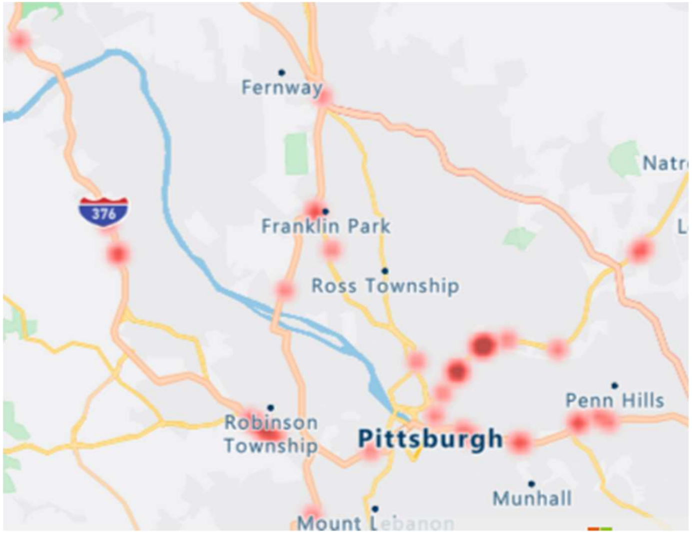
District 1



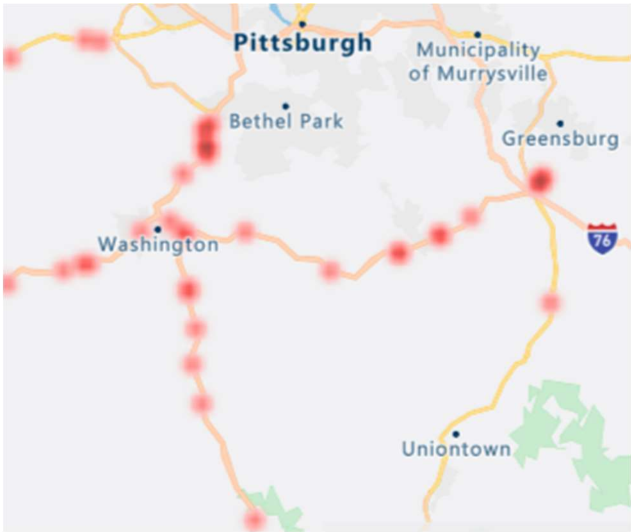
District 10



District 11



District 12



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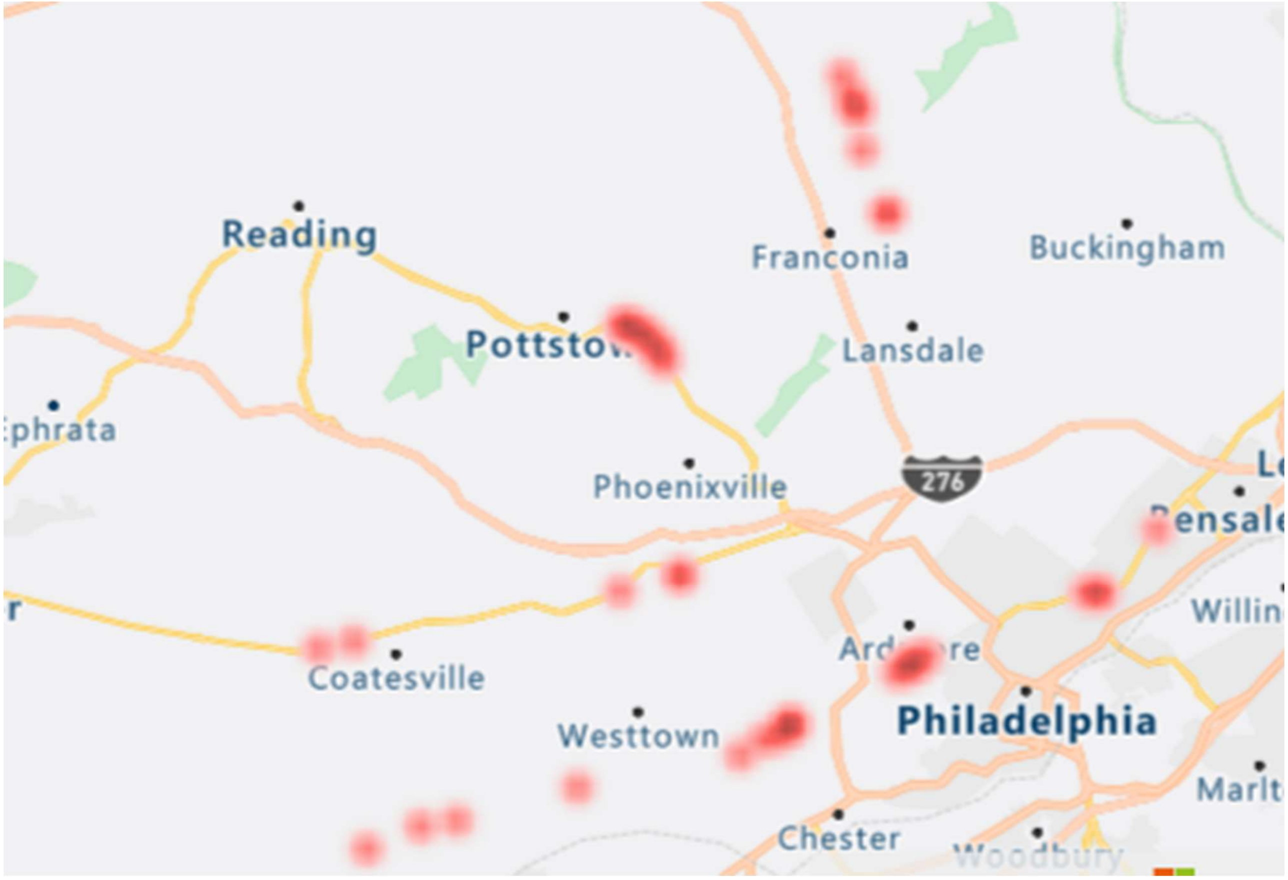
Appendix 3 – District Heavy Congestion No Camera Crash Maps

The heat maps provided illustrate heavy congestion crashes that were not verified in RCRS and were 2 miles or more from a camera, by District.

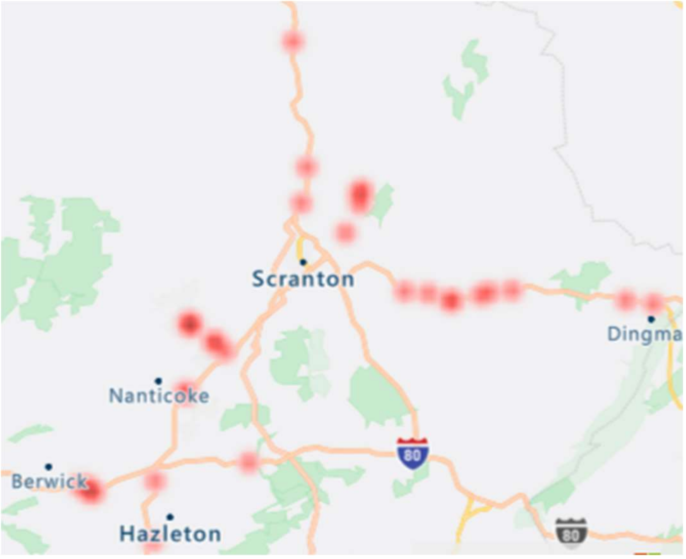
Southeastern Region

District 6

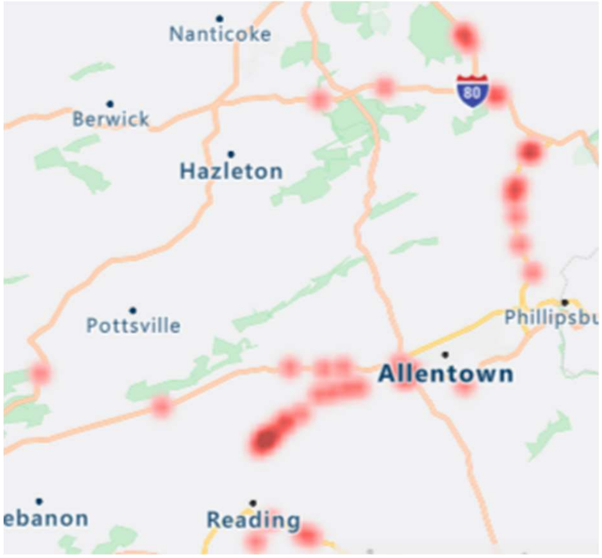


Eastern Region

District 4



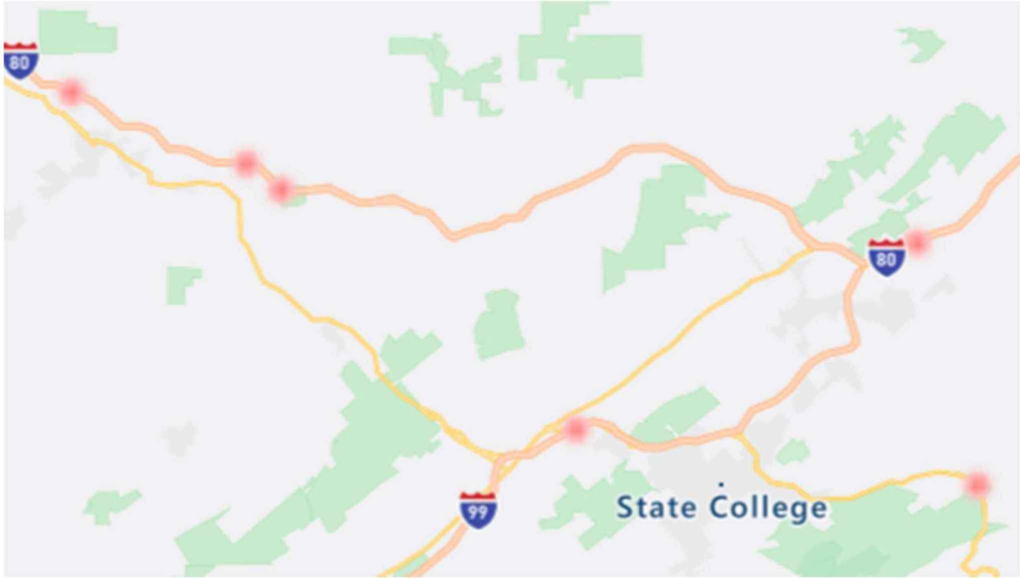
District 5



District 8

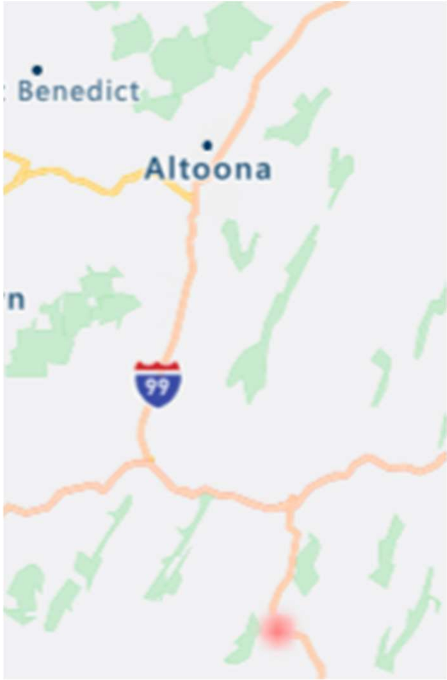
Central Region

District 2



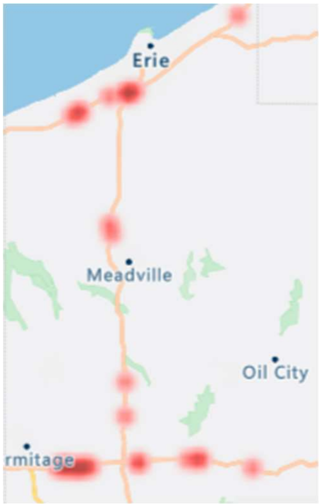
District 3

District 9

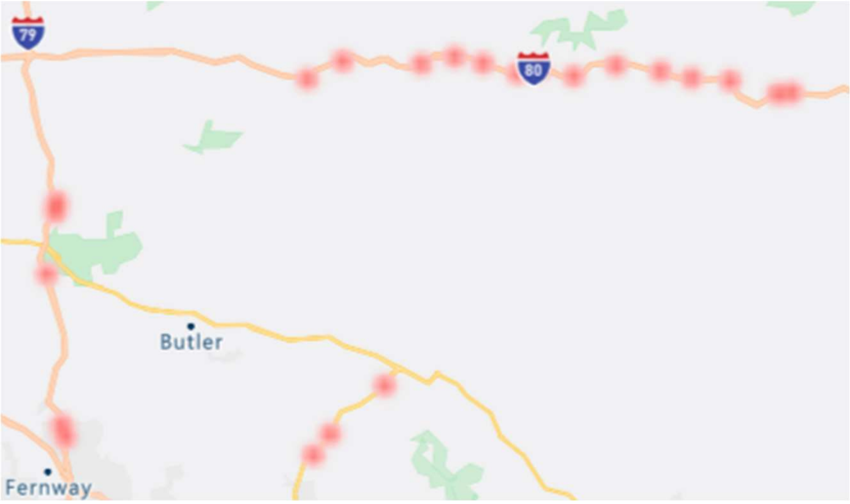


Western Region

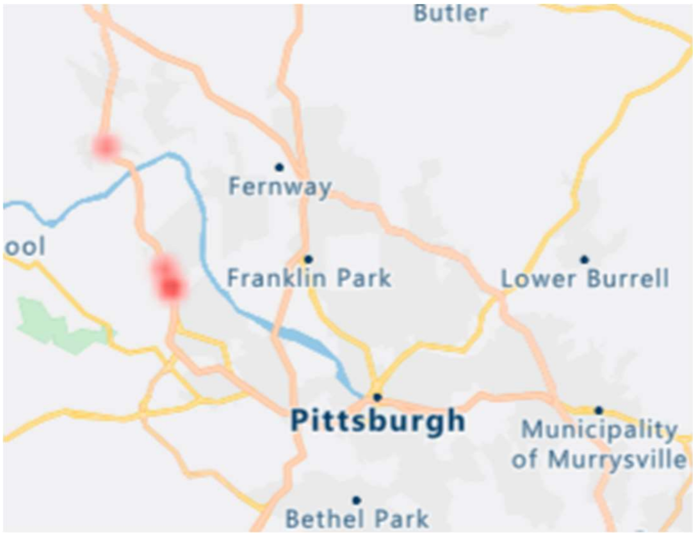
District 1



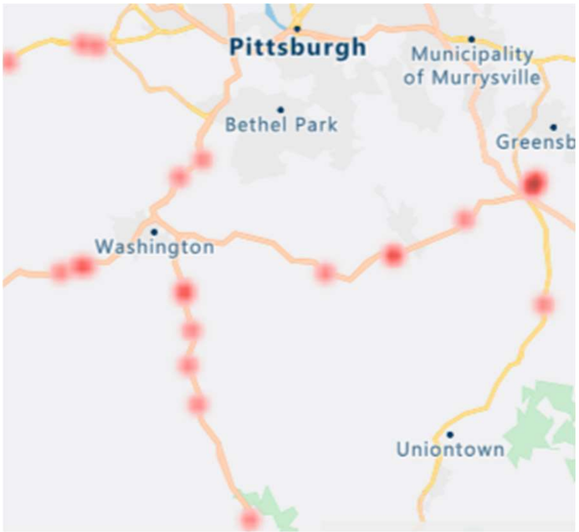
District 10



District 11

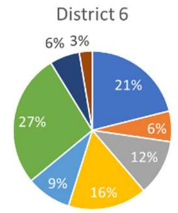


District 12

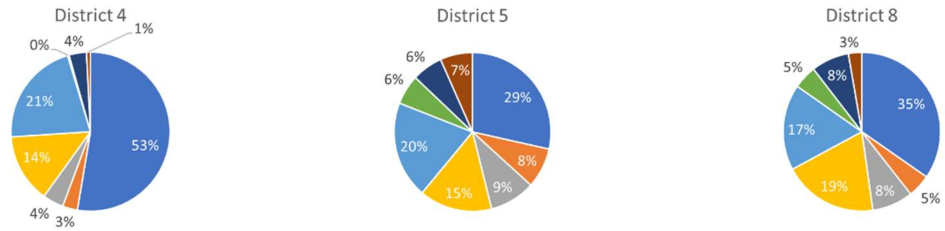


Appendix 4 - 2020 District Specific Congestion Pie Charts

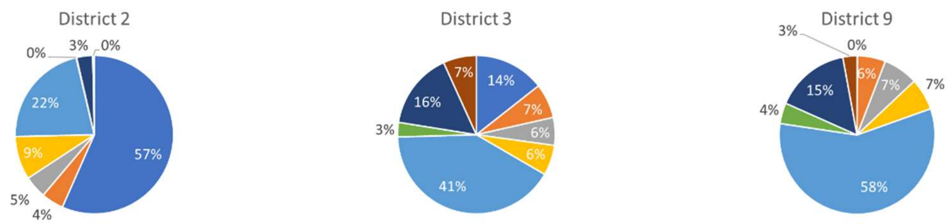
Southeastern Region



Eastern Region



Central Region



Western Region