JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY

Development of Incident Management Performance Measures Database and Supporting Training Material

Myles W. Overall, Justin Mukai, Rahul Suryakant Sakhare, Jairaj Desai, Hillary Lowther, Edward Cox, James Sturdevant, and Darcy M. Bullock

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JOINT TRANSPORTATION RESEARCH PROGRAM

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16. Abstract

Secondary crashes resulting from traffic queues are a significant national safety concern. Traffic Incident Management (TIM), which involves coordinated multi-agency response to roadway incidents, is widely recognized as an effective approach to mitigating these crashes. This study aimed to develop a library of after-action case studies to support TIM training and evaluate current practices. Leveraging connected vehicle data alongside crash reports, camera footage, and dispatch audio, the research compiled 267 comprehensive after-action review reports for incidents across Indiana from June 2020 to March 2025. These reports, indexed by key attributes such as date, location, and incident type, form what is believed to be the most extensive archive of TIM case studies in the U.S. Key recommendations emphasize the value of integrating camera imagery, connected vehicle data, and dispatch audio to enhance responder training, promote peer learning, and improve situational awareness. This resource serves as both a training tool and a model for developing future TIM documentation nationwide.

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EXECUTIVE SUMMARY

Motivation

Secondary crashes, associated with queued traffic, are a national concern. Traffic Incident Management (TIM), the coordination of multiple stakeholders involved in incident response, is widely viewed as an important tool for reducing secondary crashes. The motivation of this research project was to develop a series of case studies that could be used to evaluate current TIM techniques and be incorporated into TIM training.

Study

The growth of connected vehicle data integrated with other sources of information such as crash reports and camera images has aided in building a thorough after-action review of incident management that can be incorporated into TIM training and build consensus on best practices. This study describes techniques for compiling various sources of information to prepare comprehensive after-action reports. Table 1 summarizes the types of 294 after-action report events by district compiled during this study.

Results and Impact

A total of 267 after-action review reports have been prepared for various events on Indiana highways over the period of approximately four years from June 2020 to March 2025. This library of after-action reports is archived and indexed by date, location, route, and broad class of after-action to facilitate easy retrieval. We believe this is the richest and most comprehensive set of after-action reports compiled anywhere in the United States to date. Not only will this archive provide a valuable resource for TIM training, but it is also providing a template for future after-action reports in Indiana as well as across the United States.

Recommendations

The main recommendations from this study include, but are not limited to the following:

- Including images from ITS Cameras (and in some cases dashboard cameras) provide excellent context that first responders can relate to. Time lapses of the incident response promote pride in work balanced with opportunities for peer dialog on best practices.
- Inclusion of other data sources to corroborate with crash and Roadway Event Manager (REM) reports provide additional perspective and visuals for responders. The connected vehicle data is particularly valuable for demonstrating the impact of an incident upstream (and across the road) of traffic flow, and in some cases secondary crashes.
- More recent efforts to include dispatch center audio provide additional context for first responders to relate to, and in some cases, provide feedback on best practices on scene and upstream conditions.

Supplemental Media

An open-access site of YouTube videos of more than 250 after-action reports is available at the Joint Transportation Research Program's repository of After-Action Reports for Traffic Incident Management (Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025). Illustrative examples of these are described in seven cases studies in Section 5.

TABLE 1
After-Action Report Events Summarized by District.

Type	Crawfordsville	Fort Wayne	Greenfield	La Porte	Seymour	Vincennes
Car Crash	28	6	31	19	6	0
Semi Crash	64	7	52	27	4	0
Car Fire	2	0	7	2	1	0
Semi Fire	15	2	12	4	5	0
Total	109	15	102	52	16	0

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1. INTRODUCTION

According to the National Highway Traffic Safety Administration (NHTSA), 42,514 people were killed in motor vehicle crashes just in the year 2022 (U.S. Department of Transportation [USDOT], 2024). Roadway fatalities have increased in the last decade. Nationwide police-reported motor vehicle traffic crashes totaled to 5,930,496 in 2022 (National Center for Statistics and Analysis [NCSA], 2024). Of this total, 39,221 were fatal crashes, 1,664,598 were injury-related crashes and 4,226,677 were property damage only. NHTSA estimates the economic cost of traffic crashes at $340 billion in 2019 (NCSA, 2024).

Incidents, particularly on interstates, can have a significant impact on mobility and, in many cases, result in secondary crashes occurring upstream of the incident in or at the back of the queued traffic. A three-year study of interstate crashes showed that the crash rate during congested traffic conditions on Indiana's interstates was 24 times higher than the crash rate under uncongested conditions (Mekker et al., 2020). This study prepared approximately 267 after-action reports that can serve as training material and a model for future after-action reports and to assist stakeholders in developing best practices for traffic incident management with comprehensive after-action reviews that incorporate connected vehicle data, roadside camera images, dashboard camera (dash camera) images, weather conditions, and, on occasions, public safety radio transmissions.

1.1 Summary of Crashes on Indiana Interstates

In Indiana, 949 fatalities occurred during the year 2022, a 2% increase compared to the previous year (NCSA, 2024). Approximately 47% of these were on principal arterial roadway function class including the principal arterials.

Figure 1.1 shows cumulative weekly crashes by year across the Indiana interstate system as reported by the law enforcement agencies through the Automated Reporting Information Exchange System (ARIES). As can be seen in Figure 1.1, both 2020 and 2021 have a lower rate of crashes per week in comparison to 2019 and 2022 through 2025, likely due to COVID-19 impacts. In addition, 2019 had a much higher rate of crashes to start the year and then levelled off to similar rates seen in 2022 through 2025, likely due to higher winter weather impacts in early 2019. The research team has tabulated redacted crash reports for more than 109,000 interstate crashes since 2019 from ARIES. Figure 1.2 splits all tabulated crashes into monthly crash counts over 74 months from January 2019 up through February 2025 stacked by the interstate route in Indiana. A majority of interstate crashes in Indiana are observed on I-465 and I-65. Figure 1.3 shows the same tabulated crashes split into monthly crash counts which

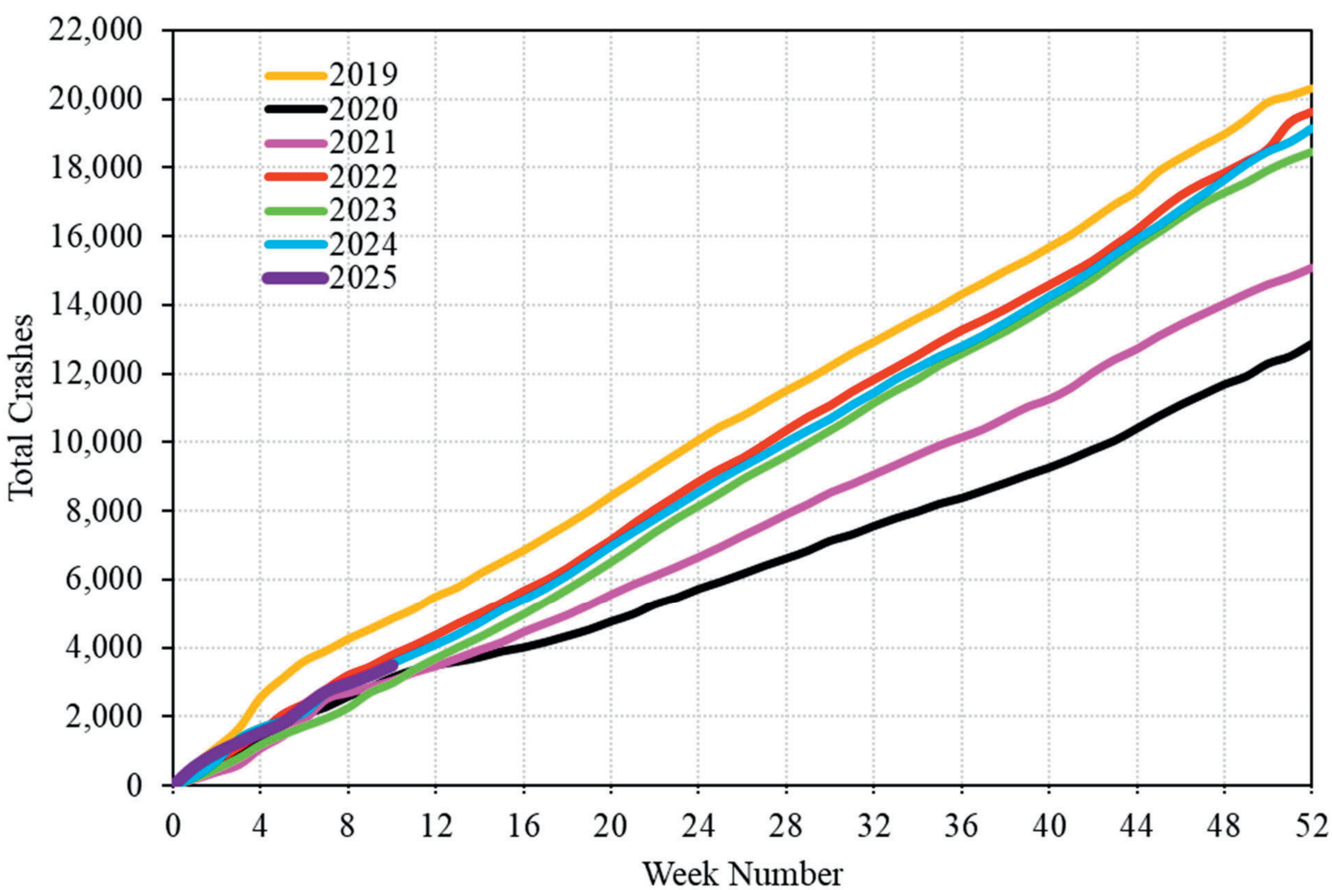


Figure 1.1 Cumulative Weekly Crashes on Indiana Interstate System by Year From 2019 to 2025.

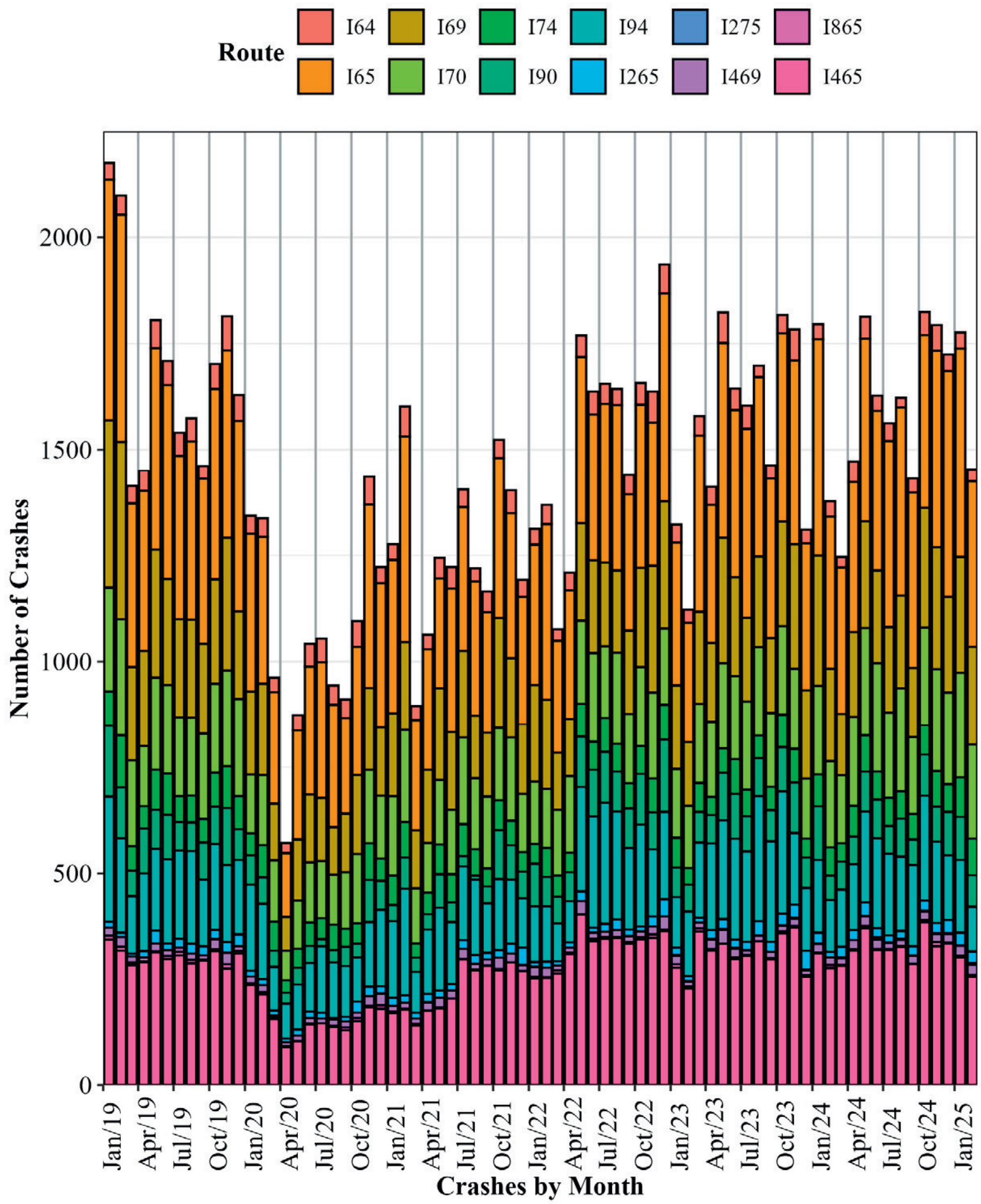


Figure 1.2 Monthly Crashes by Interstate in Indiana From January 2019 to January 2025.

are then stacked by levels of severity, that is, fatal, injury, or property damage only crash.

1.2 Related Activities

Over the past six years, the research team in collaboration with the Indiana Criminal Justice Institute has actively trained public safety officers on the use of unmanned aerial systems (UAS) for crash scene mapping and documentation to facilitate quicker scene clearance times, improve safety for first responders, and, thus, reduce the likelihood of a secondary crash occurrence. Additionally, a center to coordinate centralized processing of these crash scene images has been established (Desai, Mathew, Zhang, et al., 2022). The center has processed more than 687 crashes to date from 64 public safety agencies around the state of Indiana.

1.3 Motivation

Motorists involved in roadside incidents and first responders are exposed to significant traffic risks. There is a broad consensus that it is important to engage all partners such as public safety, transportation, towing companies, etc., to ensure safety of both the scene and queued traffic. Safety of the incident scene

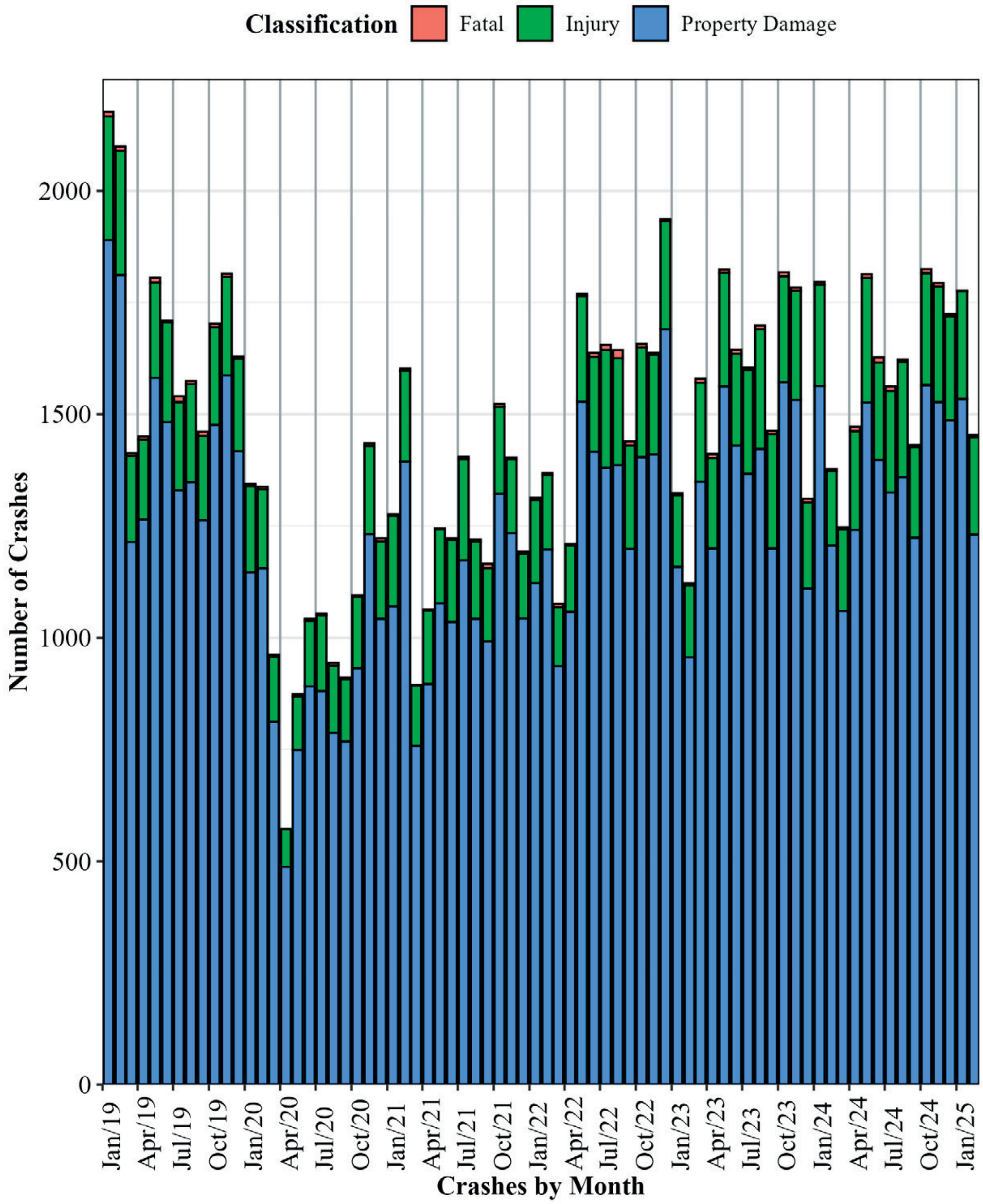


Figure 1.3 Monthly Crashes by Severity on Indiana Interstates From January 2019 to January 2025.

is important. At the same time clearing and restoring traffic as soon as safely possible is also one of the priorities. In preparation for and throughout this project, the team has engaged a variety of stakeholders in multiple forums (Figure 1.4).

1.4 Summary of After-Action Reports and Report Structure

After-action reviews are a good source for localized learning. The objective of this report is to provide a comprehensive suite of after-action reports that can be used for training as supplementary material and facilitating dialogue. Table 1.1 shows the number of after-action report events prepared per district in Indiana as a part of this study.

The report is organized in the following chapters:

- *Chapter 1—Introduction*: This chapter provides a summary of crashes on Indiana interstates and the motivation for this study.
- *Chapter 2—Connected Vehicle Data and Other Datasets*: This chapter describes the various datasets utilized and their descriptions.
- *Chapter 3—Traffic Incident Management (TIM) Event Sequence*: This chapter details the various elements of TIM event sequence, its evolution, and possible data sources for extracting these.

Figure 1.4 Hillary Lowther and Rahul Sakhare presenting on Traffic Incident Management (TIM) Training at the Purdue Road School, March 2023.

TABLE 1.1
After-Action Report Events Summarized by INDOT District.

Type	Crawfordsville	Fort Wayne	Greenfield	La Porte	Seymour	Vincennes
Car Crash	19	5	25	13	5	0
Semi Crash	46	7	42	27	4	0
Car Fire	1	0	3	1	1	0
Semi Fire	11	1	13	5	3	0
Total	77	13	83	46	13	0

- *Chapter 4—Extraction of TIM Event Sequence*: This chapter uses a case example and details each of the steps to extract TIM event sequence and TIM summary intervals.
- *Chapter 5—Case Studies*: This chapter highlights six different case studies in Indiana with details of TIM events and an after-action review of each. This chapter also shows two special case studies of impact due to solar eclipse and tornadoes in Indiana along with other case studies nationwide.
- *Chapter 6—Statistics on After-Action reports*: This chapter provides summary statistics for all the after-action reports analyzed in Indiana.
- *Chapter 7—Summary of Engagements and Dissemination*: This chapter highlights the engagement and dissemination for the project, including presentations and trainings, as well as a heat-map tool providing real-time information for traffic conditions on Indiana highways using Connected Vehicle (CV) data.
- *Chapter 8—Conclusions*: This chapter summarizes the report as well as future scope of ongoing research that may aid and enhance TIM data collection practices.
- *Appendix A*: List of Detailed After-Action Presentations
- *Appendix B*: TIM Event Summary Intervals for Analyzed After-Action Events

There is also a companion, open-access site at the Joint Transportation Research Program's (JTRP) repository of After-Action Reports for Traffic Incident Management which provides a chronological summary of more than 250 after-action reports with YouTube links for each (Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

2. CONNECTED VEHICLE DATA AND OTHER DATASETS

Previous reports have highlighted the extent of CV data and several use cases, including:

- Mathew, Desai, et al. (2021),
- Sakhare (2023),
- Sakhare, Desai, Mahlberg, et al. (2021),
- Desai, Sakhare, et al. (2021),
- Desai, Mathew, Li, et al. (2022a, 2022b),
- Sakhare, Desai, Woker, et al. (2023),
- Sakhare, Li, and Bullock (2023),
- Sakhare, Desai, Li, et al. (2022),
- Sakhare, Desai, Saldivar-Carranza, and Bullock (2024), and
- Sakhare, Desai, Mathew, McGregor, et al. (2024).

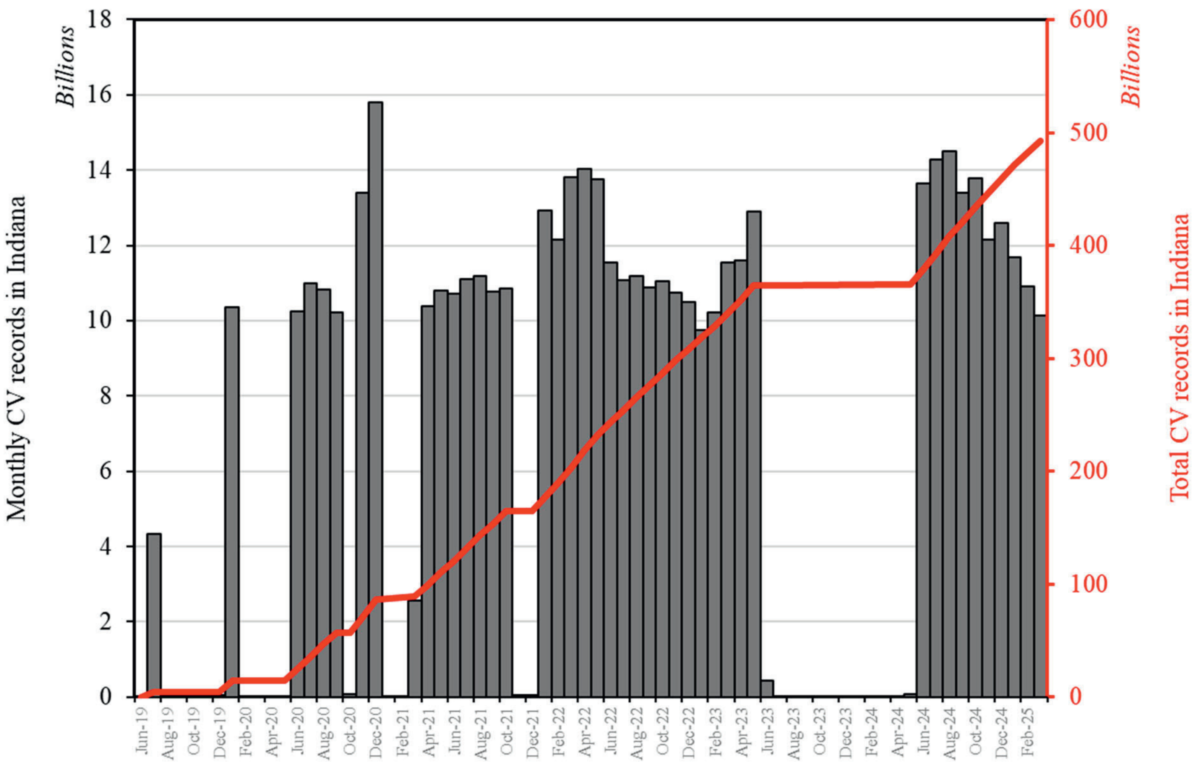


Figure 2.1 History of CV Data Records in Indiana as of March 25, 2025.

Prior to January 2022, CV data was acquired in batches as needed per use case and exploration basis. Since January 2022, the CV data has been ingested continuously in real time. Monthly CV data records and growth of total records in Indiana over the past few years, maintained by Purdue on Google's cloud platform, are highlighted in Figure 2.1. The gap between June 2023 to June 2024 is due to a change in the data provider landscape. The statewide dataset contains more than 492 billion records as of March 25, 2025. The individual records are waypoints from connected vehicles as they are travelling. Traditionally, before the availability of such data at scale, segment-based traffic speeds were derived from a combination of probe data and other records in Indiana dating back to 2014.

2.1 Connected Vehicle Data

In general, the CV data consists of anonymized individual trajectory waypoints that are collected every 1 to 2 s for connected passenger cars and 3 to 60 s for connected trucks along with an anonymized trajectory identifier, geolocation, timestamp, and heading information.

Spatiotemporal traffic speed heatmaps visually analyze the traffic conditions and assess queues, as shown by several previous studies such as USDOT (2024), Sakhare (2023), and Sakhare, Li, and Bullock (2023). CV trajectory data color coded by speed bins can be used to generate such heatmaps. In Indiana, approximately 5% of vehicles can be monitored by public agencies via anonymized data streams. Alternate interpretation of this is a data point on speed and location available for every 20 vehicles. This provides high-fidelity data on roadway conditions in near real time.

2.2 Segment Based Traffic Data

Traditionally, segment-based traffic data has been available since approximately 2008. Segment-based traffic data is aggregated for varying lengths of roadway segments and based on a combination of historic speeds and real-time data. The primary challenge with segment-based data is that the legacy model for generating this data blends historical data with real-time data, and it typically lags on identifying when an incident occurs and when a road is closed. This is in comparison to OEM-provided trajectory data that can be received from probe vehicles in less than a minute.

2.3 ITS Camera Images

More than 750 cameras along Indiana highways are operated and maintained by the Indiana Department of Transportation (INDOT). These cameras provide a good real-time view of ongoing traffic conditions on highways but have a limited radius of visibility. Purdue University logs approximately 11 million still images per month, recorded at approximately 2-min intervals from these cameras. Over the past 9 years, Purdue has recorded approximately 1 billion images. These images provide valuable contextual information but consume only modest disk storage since they are recorded at infrequent intervals. The sequence of these camera images is instrumental in helping document the

Figure 2.2 Example of Camera Image From ITS Camera Situated Along I-465 Near Mile Marker 11.7 During an Incident on December 13, 2024.

TIM event sequence, recovery efforts, and queued traffic for an incident. The overlayed timestamps on these images are critical to document events such as recovery vehicle arrival, recovery operation in progress (Figure 2.2), recovery completion, traffic back to free flow conditions, among others.

2.4 Redacted Crash Reports

Public safety agencies around the state of Indiana utilize a centralized online crash repository called ARIES. The crash reports contain detailed information on the circumstances of a crash incident along with key timeframes and geolocations recorded by the on-scene first responders aiding in recovery efforts. They provide context for likely incident cause, vehicles involved, and subsequent incident management activities such as recovery and cleanup. Any personal or identifying information is redacted from these crash reports to ensure confidentiality. In addition to detailed crash diagrams, the reports provide details, when available, on the type of crash, the route and mile marker (MM) location of the incident, and prevailing roadway and weather conditions leading up to the crash.

2.5 Auxiliary Data Items

2.5.1 Dash Camera Images

Approximately 64,000 commercial trucks have the capability to share on-vehicle dash camera images sourced from a third-party data provider. Figure 2.3 shows the locations of these trucks during a sample peak hour. Images can be retrieved in specific areas where the trucks travel more than 10 mph at approximately 1 Hz, that is, an image every second per truck. Figure 2.4 shows an example of a dash camera image retrieved from a truck. These images are also encoded with information on state, interstate, direction of travel, time of the image, and speed, as shown on the top left corner of the image. If the position information from the image does not match any interstate, latitude and longitude are shown instead of the interstate and direction of travel. Such imagery can provide agencies with an agile framework for monitoring, assessment and inspection of roadways, especially for incidents and work zones (Overall et al., 2026). These are also particularly useful to gauge on-ground situations from the motorist point of view during, before, or after the incident. In many cases, these are available from the opposite direction of travel during an active incident management.

A previous study by Sakhare, Desai, Mathew, and Bullock (2024a) has shown that the number of trucks with dash images capability ranges from 72 to 536 per week on Indiana interstates. At least one truck every day was observed during daytime for 56% of the Indiana interstate miles and during nighttime for 35% of the interstate miles. When evaluated over a week, the percentage of interstate miles covered increased to 100% and 92% during daytime and nighttime, respectively. It is possible in some cases that dash images are not available. As the applications and usability of these dash camera images increase, the number of data providers and the trucks available will continue to increase.

2.5.2 Traffic Management Center Records

INDOT generates Roadway Event Manager (REM) and Computer-Aided Dispatch (CAD) reports for most incidents in the metropolitan areas and major incidents in rural areas. These

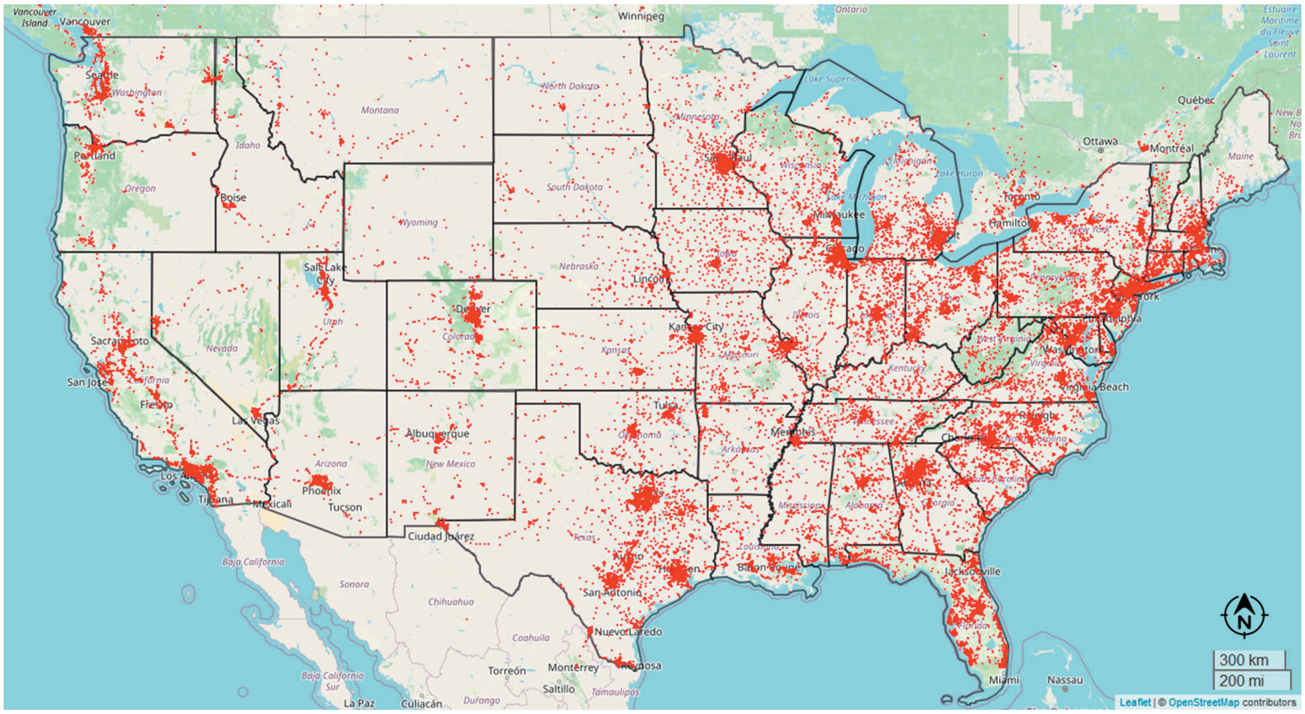


Figure 2.3 Locations of 32,667 Unique Active Trucks With Dash Cameras During a Peak Hour 12:00–1:00 p.m. ET on Thursday, April 25, 2024.

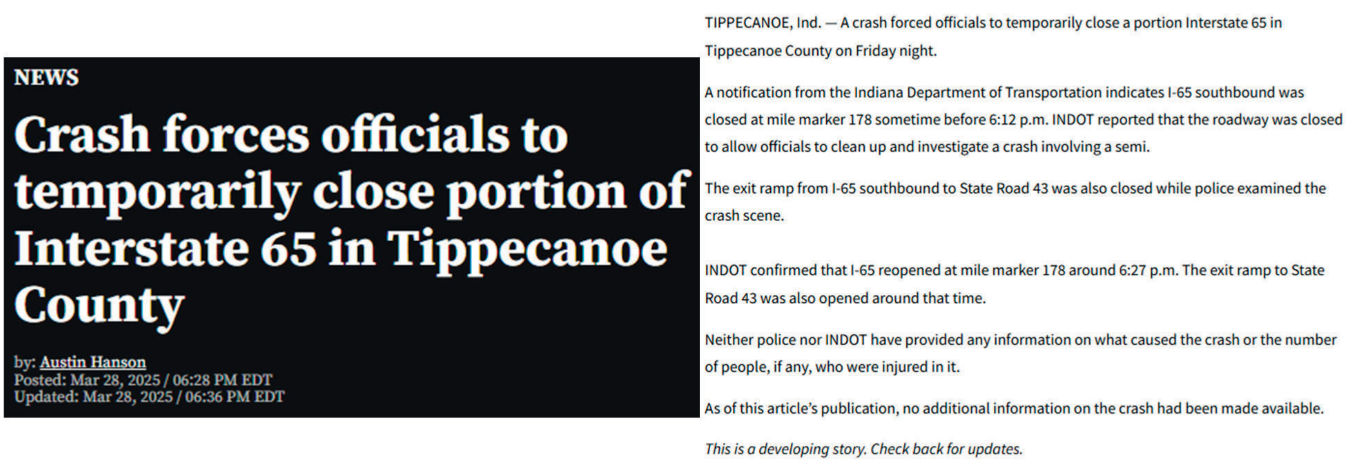
Figure 2.4 Example of Dash Camera Image From a Commercial Truck.

records provide details on when an incident happened, when an incident was reported, the dispatch resources provided, and when an incident was fully cleared.

2.5.3 CARS 511

Motorist information systems operated by state departments of transportation around the United States provide valuable information to the traveling public about roadway conditions, road or lane closures, active construction activity and designated detours, and more, often in real time. INDOT's Condition Acquisition Reporting System (CARS) collects this data and provides it to the motoring public through a website (511in.org), mobile application as well as social media channels (Figure 2.5) to increase driver awareness. These 511 notifications provide critical information and an independent source to confirm observations from other datasets about the duration of a road closure, number of lanes closed, and time at which the interstate was reopened. They can often provide near exact timestamps for certain phases in a TIM event sequence such as time of scene clearance.

Figure 2.5 Social Media Release From INDOT TrafficWise Regarding a Crash Incident (5:14 a.m.) and Subsequent Incident Clearance (7:44 a.m.) on March 24, 2025.



NEWS

Crash forces officials to temporarily close portion of Interstate 65 in Tippecanoe County

by: Austin Hanson
Posted: Mar 28, 2025 / 06:28 PM EDT
Updated: Mar 28, 2025 / 06:36 PM EDT

TIPPECANOE, Ind. — A crash forced officials to temporarily close a portion Interstate 65 in Tippecanoe County on Friday night.

A notification from the Indiana Department of Transportation indicates I-65 southbound was closed at mile marker 178 sometime before 6:12 p.m. INDOT reported that the roadway was closed to allow officials to clean up and investigate a crash involving a semi.

The exit ramp from I-65 southbound to State Road 43 was also closed while police examined the crash scene.

INDOT confirmed that I-65 reopened at mile marker 178 around 6:27 p.m. The exit ramp to State Road 43 was also opened around that time.

Neither police nor INDOT have provided any information on what caused the crash or the number of people, if any, who were injured in it.

As of this article's publication, no additional information on the crash had been made available.

This is a developing story. Check back for updates.

Figure 2.6 News Article from CBS4 Indy Regarding a Crash That Occurred on I-65 Requiring a Temporary Closure on March 28, 2025.

2.5.4 News Articles

News articles can be used to provide additional narrative in cases where crash reports have not yet been submitted or in cases like fires where a crash report may not be made. These news articles can help determine the cause of the crash as well as when the crash occurred.

3. TRAFFIC INCIDENT MANAGEMENT EVENT SEQUENCE

The Federal Highway Administration (FHWA) has established a standardized timeline to promote consistency and clarity in TIM practices across agencies. Having an understanding of this timeline is needed for evaluating incident response performance as well as improving coordination between responding agencies. Figure 3.1 details the current incident timeline.

3.1 TIM Event Sequence Definitions

The individual elements of the TIM event sequence are termed as follows:

- T_0: Time at which incident actually occurs
- T_1: Time of first recordable awareness of incident by a responsible agency
- T_2: Time at which incident is verified
- T_3: Time at which required response for the incident is identified and dispatched
- T_4: Time at which response arrives on scene
- T_5: Time of first confirmation that all lanes are available for traffic flow
- T_6: Time at which the last responder has left the scene
- T_7: Time at which traffic flow returns to normal

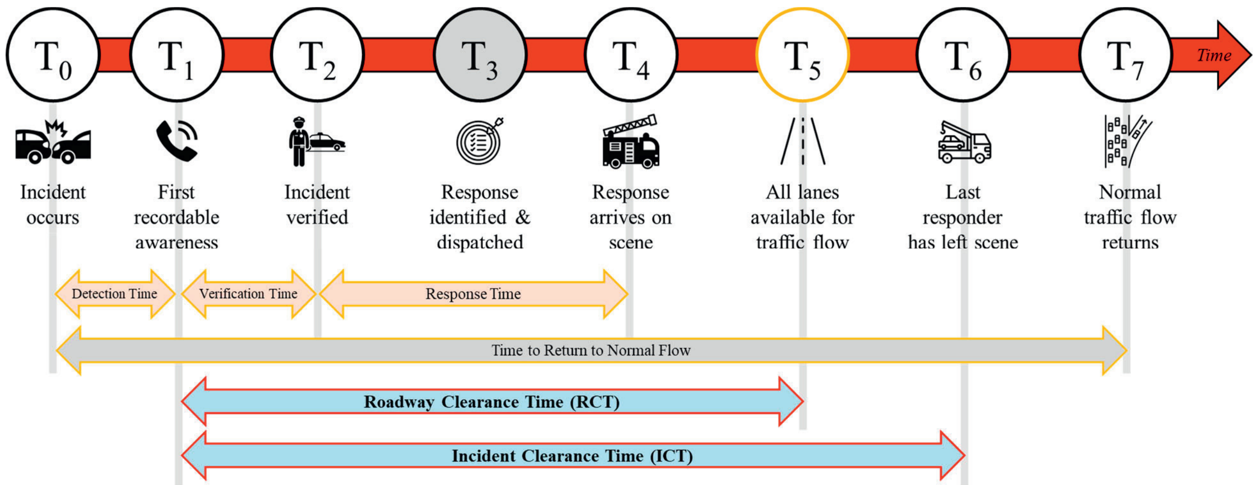


Figure 3.1 Incident Timeline, as Defined by FHWA.

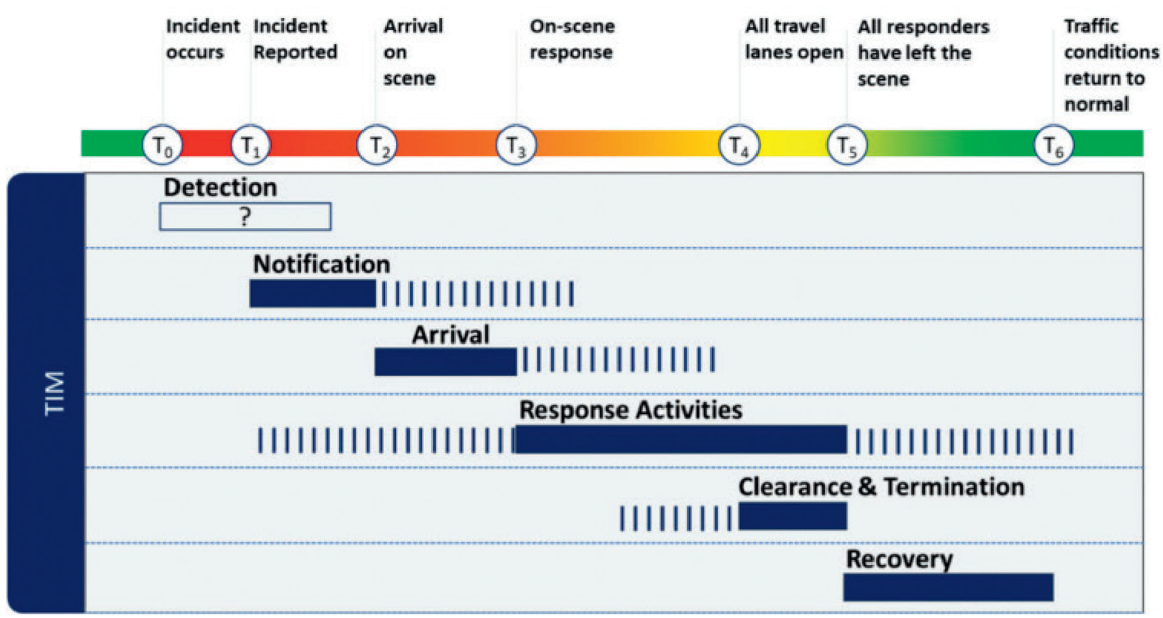


Figure 3.2 Previous Incident Timeline, as Defined by FHWA.

3.2 TIM Event Summary Interval Definitions

The individual TIM event intervals are termed as follows:

- Detection Time (DT): The time from when the incident occurs (T_0) to when it is reported (T_1).
- Verification Time (VT): The time when the incident was reported (T_1) to when it was verified (T_2).
- Response Time (RT): The time from verification (T_2) to the arrival of responders (T_4).
- Roadway Clearance Time (RCT): The time from the initial detection (T_1) to all the travel lanes reopening (T_5).
- Incident Clearance Time (ICT): The time from the initial detection (T_1) to when all responders have left the scene (T_6).
- Time to Return to Normal Flow: The time from when the incident occurs (T_0) to when traffic conditions return to normal flow (T_7).

3.3 Evolution of TIM Event Sequence

Previously, FHWA had used Figure 3.2 as the TIM timeline for agencies to evaluate performance of incidents. When the TIM timeline was updated to Figure 3.1, a new TIM event sequence was added as T_3, which is the time at which the required response for the incident is identified and dispatched. With this addition, the TIM event sequence order was updated to where T_0 through T_2 stayed the same, the previous T_3, time at which response arrives on scene, through T_6, time at which traffic flow returns to normal, was shifted to T_4 through $T_{7.}$

In general, it is very difficult to identify the exact time at which an incident occurred (T_0). $T_{0,cv}$ is defined as the time at which an incident occurred that is detected from the CV data and is often the best proxy for T_0. Trajectory data with adequate

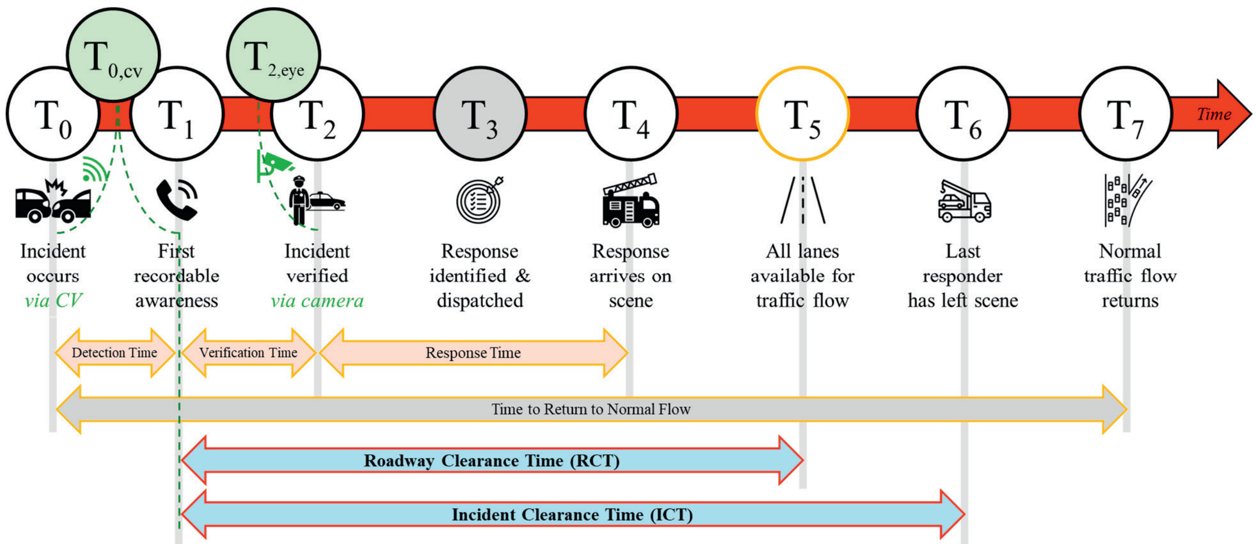


Figure 3.3 Modified Incident Timeline.

penetration provides the point of origin when vehicles start slowing down and shockwave propagates forming a queue. This can also constitute as a first recordable awareness of an incident if such CV data is continuously ingested in near real time by an agency. Hence, $T_{0,cv}$ can provide both traditional T_0 and T_1 at the same time.

Historically T_2 has been defined as the time when public safety arrives on scene and provides factual verification of location and direction of travel. More recently, ITS cameras can serve that purpose in urban areas with good camera coverage. $T_{2,eye}$ is defined as the time at which a Traffic Management Center (TMC) operator locates the event using the available ITS cameras. INDOT operates and maintains more than 750 ITS cameras across Indiana highways. With this addition, we also add a new summary interval: the TMC Verification Time, which is the time from when the incident occurs (T_0) to when an ITS camera was moved onto the event ($T_{2,eye}$). This allows for an additional performance measure that agencies can show how quickly TMC operators are verifying incidents. Furthermore, another study suggests a new performance measure to track how quickly all necessary recovery resources are arriving on scene before the recovery process can begin (Overall, Mukai, Sakhare, Desai, Lowther, & Bullock, 2025).

A modified incident timeline incorporating the aforementioned evolution is presented in Figure 3.3 and highlighted in green.

TABLE 3.1
Summary of TIM Event Sequence and Possible Sources to Extract Times.

TIM Event	Event Description	Possible Sources
T_0	Incident occurs	Approximation from Crash report; REM report
$T_{0,cv}$	Incident occurrence from CV data	CV data
T_1	First recordable awareness	Crash report; REM report
T_2	Incident verified	Crash report; REM report
$T_{2,eye}$	Incident verification from Camera Images	Camera images
T_3	Response identified & dispatched	CAD report
T_4	Response arrives on scene	Crash report; REM report; Camera images
T_5	All lanes available for traffic flow	REM report. Camera images; CV data
T_6	Last responder has left scene	REM report; Camera images
T_7	Normal traffic flow returns	CV data; Camera images

3.4 Data Sources for TIM Event Sequence

There are various ways to extract times T_0 to T_7, such as crash reports, TMC reports, or anecdotal evidence. Table 3.1 provides a summary of the ten elements and the possible sources from where to extract the times.

4. EXTRACTION OF TIM EVENT SEQUENCE

To showcase how the various data sources can be utilized to extract the TIM event sequence, a case study example from December 13, 2024, is presented. In this example, a passenger vehicle was changing lanes when it sideswiped a semitruck resulting in the semi hitting the concrete median barrier and knocking over a light pole into the other direction of travel. The semi then rolled onto its side across three lanes of travel. Figure 4.1 shows an aerial map of where the incident occurred along I-465.

Figure 4.2 shows the traffic speed heatmap of the incident along the outer loop (OL) of I-465 in Indiana using CV data.

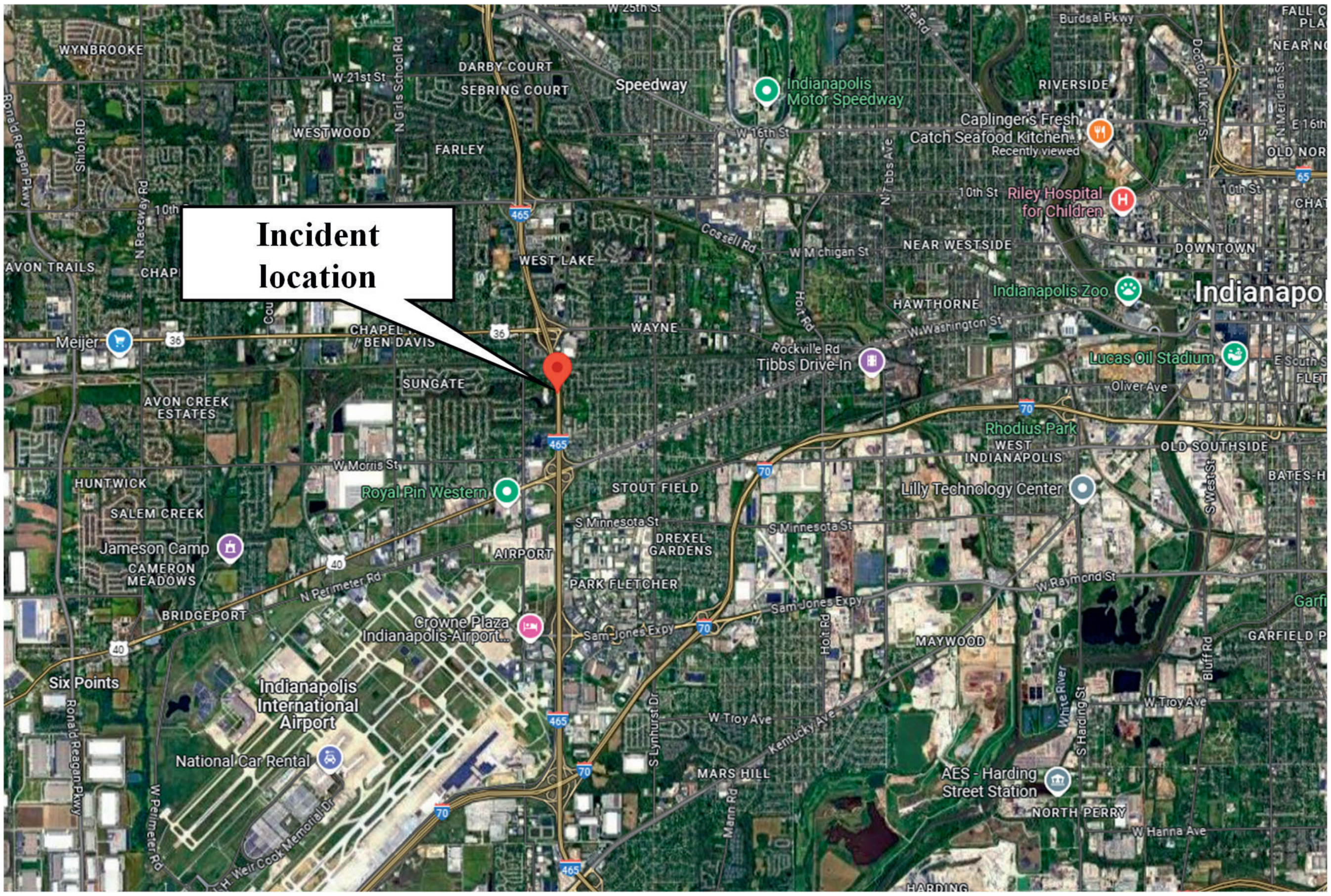


Figure 4.1 Aerial Photo of Incident Location for an Overturned Semi Crash Along I-465 Outer Loop (OL) on December 13, 2024 (Maps Data: Google ©2025).

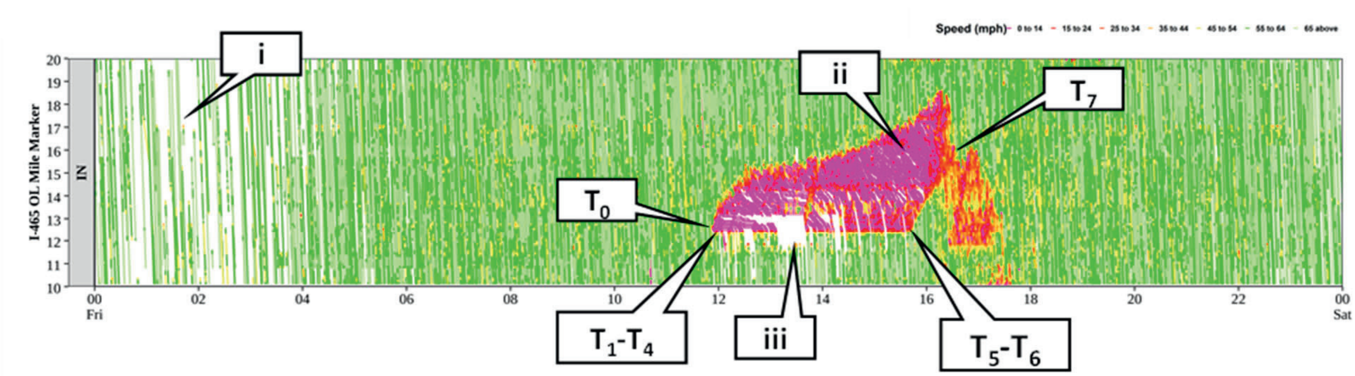
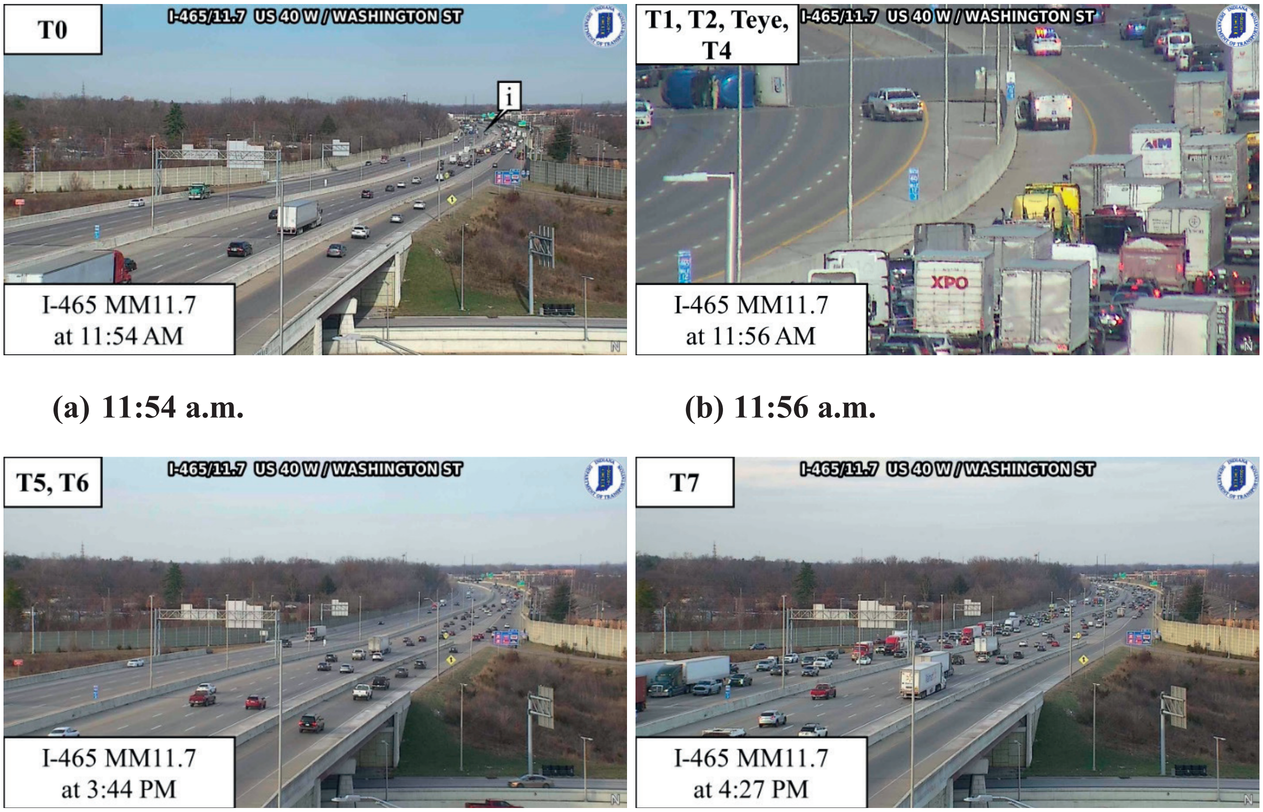


Figure 4.2 Traffic Speed Heatmap Using CV Data for an Overturned Semi Crash Along I-465 Outer Loop (OL) on December 13, 2024.

This traffic speed heatmap is a spatiotemporal plot of traffic speeds where the speeds are plotted as a color-coded line of individual trajectories. The horizontal axis is time, and the vertical axis is distance in mile markers. Lighter green lines show speeds above 65 mph, which is when traffic is not congested, and pink lines show speeds that are from 0–14 mph, which is when traffic is at a standstill. The hours between 12:00 a.m. and 04:00 a.m. have several white spaces which indicates less passenger vehicle trajectories at the time of day shown (Figure 4.2, Callout i). For the incident shown in Figure 4.2, the pink section is formed from the backwards shockwave of traffic congestion from the overturned semi blocking the travel lanes (Callout ii). The section in white shown (Callout iii) is when no data is present for the roadway, similar to the early morning hours, which is when the roadway was completely closed and no vehicles were present.

The heatmap in Figure 4.2 shows a 10-mile section of I-465 in Indiana from MM 10–20 with the TIM event sequences called out. In this example, an incident occurred in the outer loop direction at 11:54 a.m. This was verified by the camera



(a) 11:54 a.m. (b) 11:56 a.m.

(c) 3:44 p.m. (d) 4:27 p.m.

Figure 4.3 Select ITS Camera Images During an Overturned Semi Incident Along I-465 OL at Mile Marker 11.7 on December 13, 2024.

image in Figure 4.3a, Callout i. This is the TIM event of T_0. The incident generates a backwards-forming shockwave, as shown in Figure 4.2, Callout T_0. Figure 4.3b shows that crews were on scene within 2 min at 11:56 a.m. (T_2 through T_4). Figure 4.3c shows the roadway once all the lanes were open (T_5) and also when all the responders had left the scene (T_6). This is when recovery can be seen in the heatmap (Figure 4.2, Callout T_5–T_6). Finally, Figure 4.3d illustrates T_7 when the roadway returned to normal flow.

Table 4.1 lists the eight TIM events that are captured for any incident on the roadway. A majority of the TIM events for this incident were captured using the ITS cameras, as the cameras provide a ground-truth account of what occurred. T_1 was captured using the crash report, and T_7 was captured using CV data. T_3 was not available for this incident which is signified with double dashed lines.

Table 4.2 contains the seven summary intervals that are used to quantify performance measures of this specific incident. For this incident, the detection time, verification time, and response time are all within 2 min. RCT and ICT are the same due to the travel lanes reopening concurrently with when all the response vehicles had cleared the scene.

TABLE 4.1
TIM Event Sequence for an Overturned Semi Crash Along I-465 OL on December 13, 2024.

TIM event	Description	Event time	Source
T_0	Incident occurs	11:54 a.m.	Camera (Figure 4.3a)
T_1	Incident reported	11:56 a.m.	Crash report
T_2	Incident verified	11:56 a.m.	Camera (Figure 4.3b)
$T_{2,eye}$	ITS Camera On Event	11:56 a.m.	Camera (Figure 4.3b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	11:56 a.m.	Camera (Figure 4.3b)
T_5	All travel lanes open	3:44 p.m.	Camera (Figure 4.3c)
T_6	All responders have left the scene	3:44 p.m.	Camera (Figure 4.3c)
T_7	Traffic conditions return to normal	4:27 p.m.	CV data (Figure 4.3d)

TABLE 4.2
TIM Summary Intervals for an Overturned Semi Crash Along I-465 OL on December 13, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	0
Verification Time	$T_2 - T_1$	2
TMC Verification Time	$T_{2eye} - T_0$	2
Response Time	$T_4 - T_2$	0
Roadway Clearance Time (RCT)	$T_5 - T_1$	228
Incident Clearance Time (ICT)	$T_6 - T_1$	228
Time to Return to Normal Flow	$T_7 - T_0$	271

5. CASE STUDIES

Select case studies that combine the datasets and extraction methodology presented previously are discussed in this section. The case studies were selected to highlight good examples of TIM practices for several different types of incidents. The number in parenthesis for each case study is an internal event ID that can be used to quickly locate the detailed after-action video located at the JTRP repository of After-Action Reports for Traffic Incident Management (Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

5.1 Case Study I: January 11, 2025, I-65 SB MM 126.6 Passenger Vehicle Slide Off Due to Icy Bridge (202501-02)

This incident took place on the morning of January 11, 2025, at 9:08 a.m. along southbound I-65 at MM 126.6 in Marion County. The after-action review can be found in the JTRP After-Action Report Repository (202501-02; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

A single vehicle was traveling southbound in the left-most lane when a semitruck began to merge in their lane. To avoid the semi, the driver moved slightly left where they struck a piece of ice, spun out in the median, and hit the cable barrier (Figure 5.1, Callout i). Figure 5.2a shows an ITS image of when the incident occurred (T_0). Figure 5.2b shows when the incident was verified by the TMC operator (T_2 and $T_{2,eye}$) while also showing the vehicle entangled with the median barrier. Figure 5.2c shows that first responders were on scene (T_4) 28 min later at 9:40 a.m. The Hoosier Helper arrived at approximately 9:44 a.m. (Figure 5.2d) and set up cones and an arrow board in advance of the curve to provide protection for the first responders. However, the overall incident clearance time ($T_6 - T_1$) was close to 3 hr due to entanglement in the median cable barrier and needing to call in INDOT maintenance to release the tension of the median cable barrier for extraction (Figure 5.2e). At 12:12 p.m., all the travel lanes were reopened (T_5) and all the responders had cleared the scene (T_6; Figure 5.2f).

Table 5.1 and Table 5.2 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

5.2 Case Study II: December 5, 2024, I-265 EB MM 8.8 Passenger Vehicle Ran Off Road (202412-01)

This incident took place on the morning of December 5, 2024, at 7:34 a.m. along eastbound I-265 at MM 8.8 in Clark County. The after-action review can be found in the JTRP

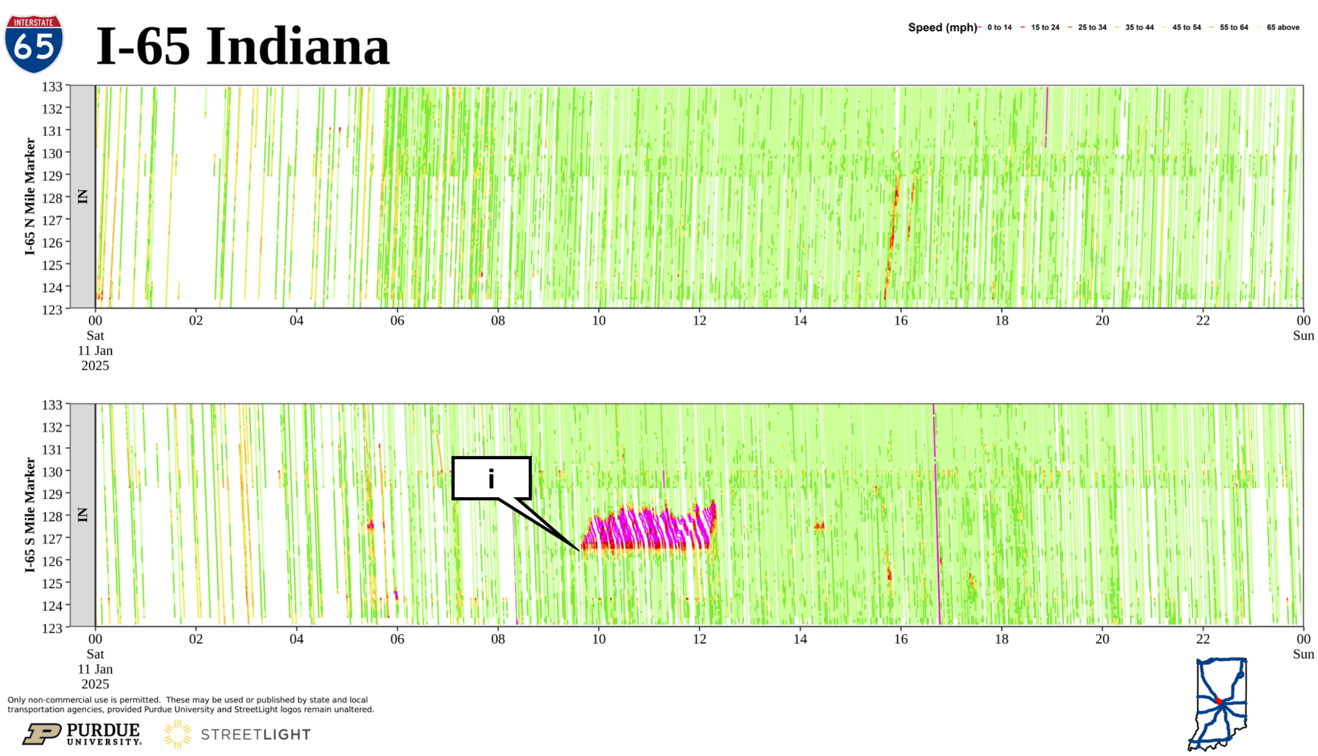
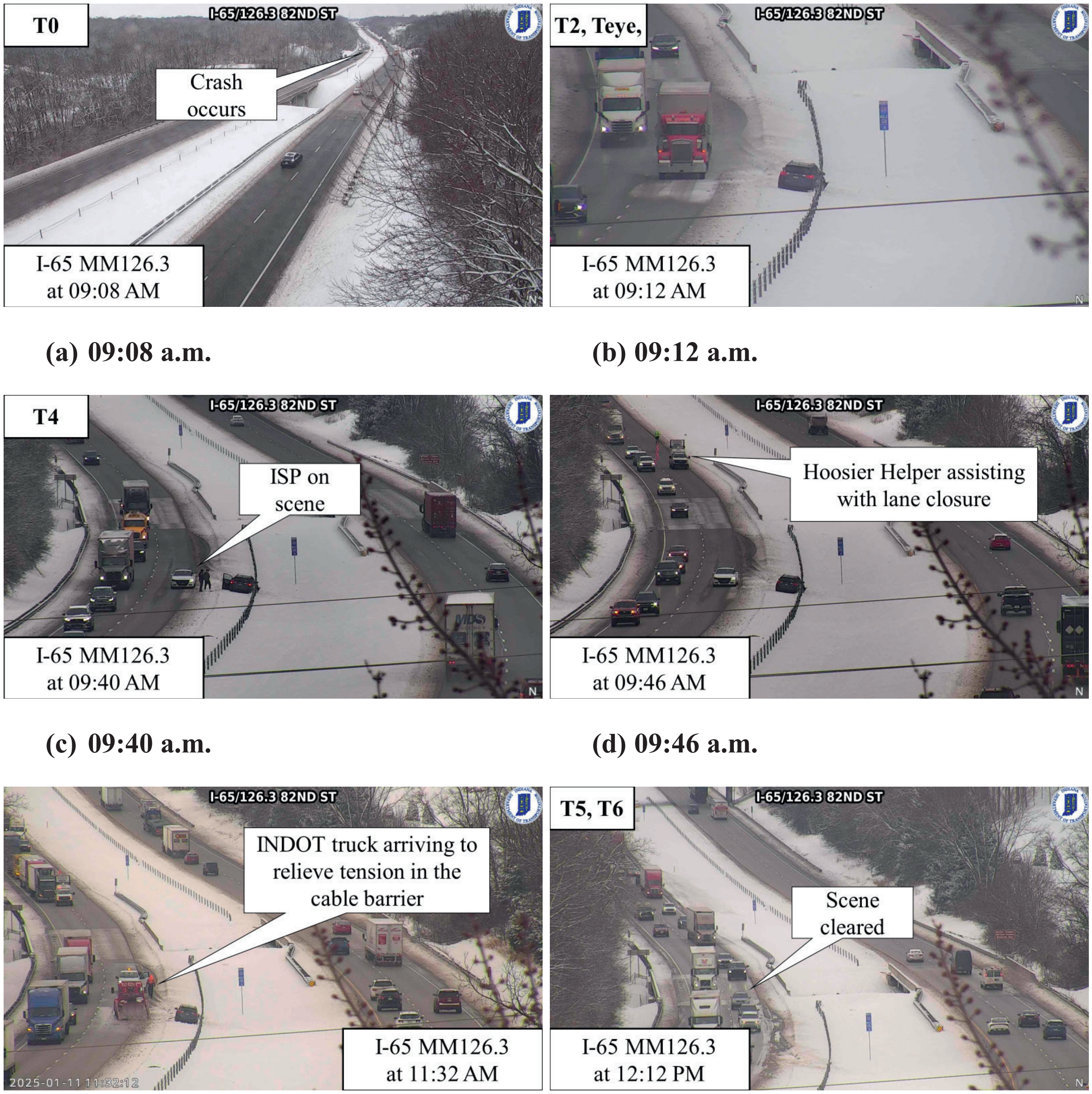


Figure 5.1 Traffic Speed Heatmap for Section of I-65 in Indiana From MM 123 to MM 133 on Saturday, January 11, 2025.



(a) 09:08 a.m. **(b) 09:12 a.m.**

(c) 09:40 a.m. **(d) 09:46 a.m.**

(e) 11:32 a.m. **(f) 12:12 p.m.**

Figure 5.2 Select ITS Camera Images During an Icy Bridge Slide Off Along I-65 SB at MM 126.3 on January 11, 2025.

TABLE 5.1
TIM Event Sequence for an Icy Bridge Slide Off Along I-65 SB on January 11, 2025.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	9:08 a.m.	Camera (Figure 5.2a)
T_1	Incident reported	9:08 a.m.	N/A
T_2	Incident verified	9:12 a.m.	Camera (Figure 5.2b)
$T_{2,eye}$	ITS Camera On Event	9:12 a.m.	Camera (Figure 5.2b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	9:40 a.m.	Camera (Figure 5.2c)
T_5	All travel lanes open	12:12 p.m.	Camera (Figure 5.2f)
T_6	All responders have left the scene	12:12 p.m.	Camera (Figure 5.2e)
T_7	Traffic conditions return to normal	12:20 p.m.	CV Data

TABLE 5.2
TIM Summary Interval for an Icy Bridge Slide Off Along I-65 SB on January 11, 2025.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	0
Verification Time	$T_2 - T_1$	4
TMC Verification Time	$T_{2eye} - T_0$	4
Response Time	$T_4 - T_2$	28
Roadway Clearance Time (RCT)	$T_5 - T_1$	184
Incident Clearance Time (ICT)	$T_6 - T_1$	184
Time to Return to Normal Flow	$T_7 - T_0$	192

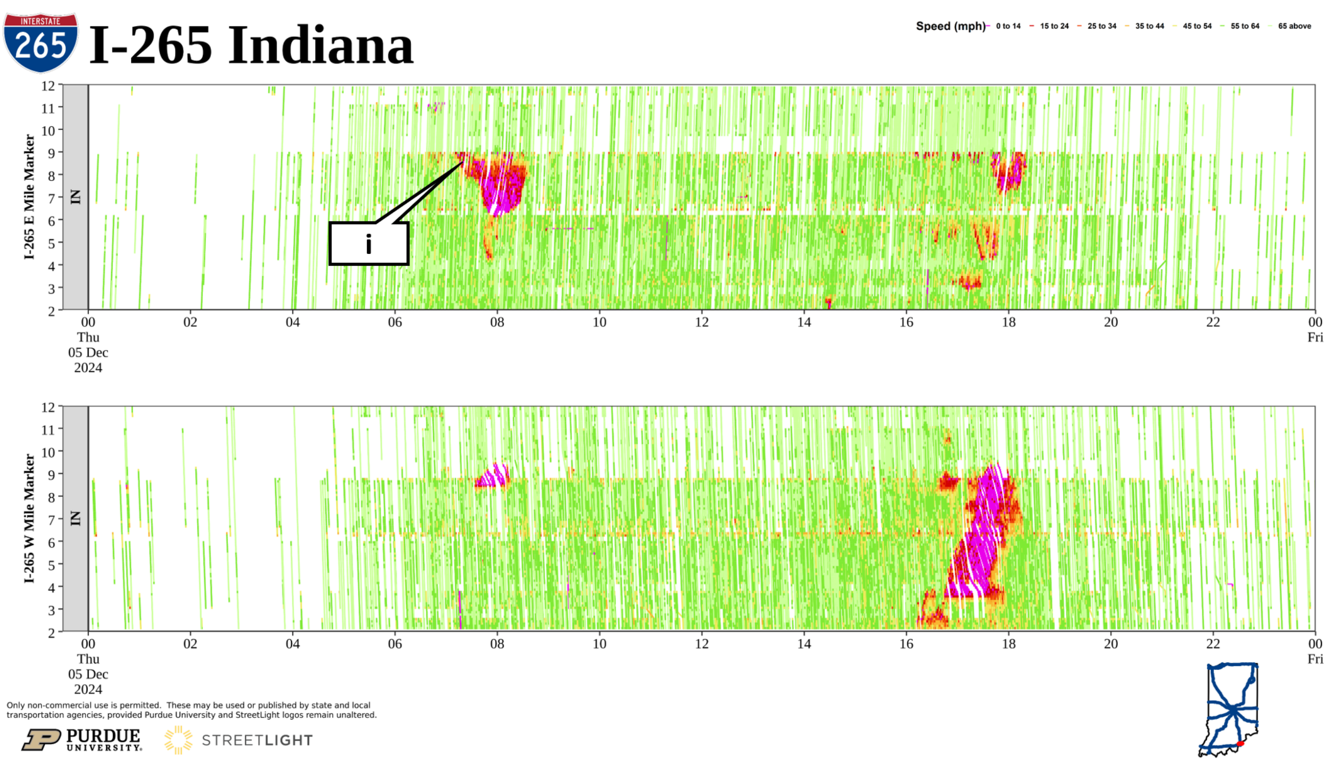


Figure 5.3 Traffic Speed Heatmap for Section of I-265 in Indiana From MM 2 to MM 12 on Thursday, December 5, 2024.

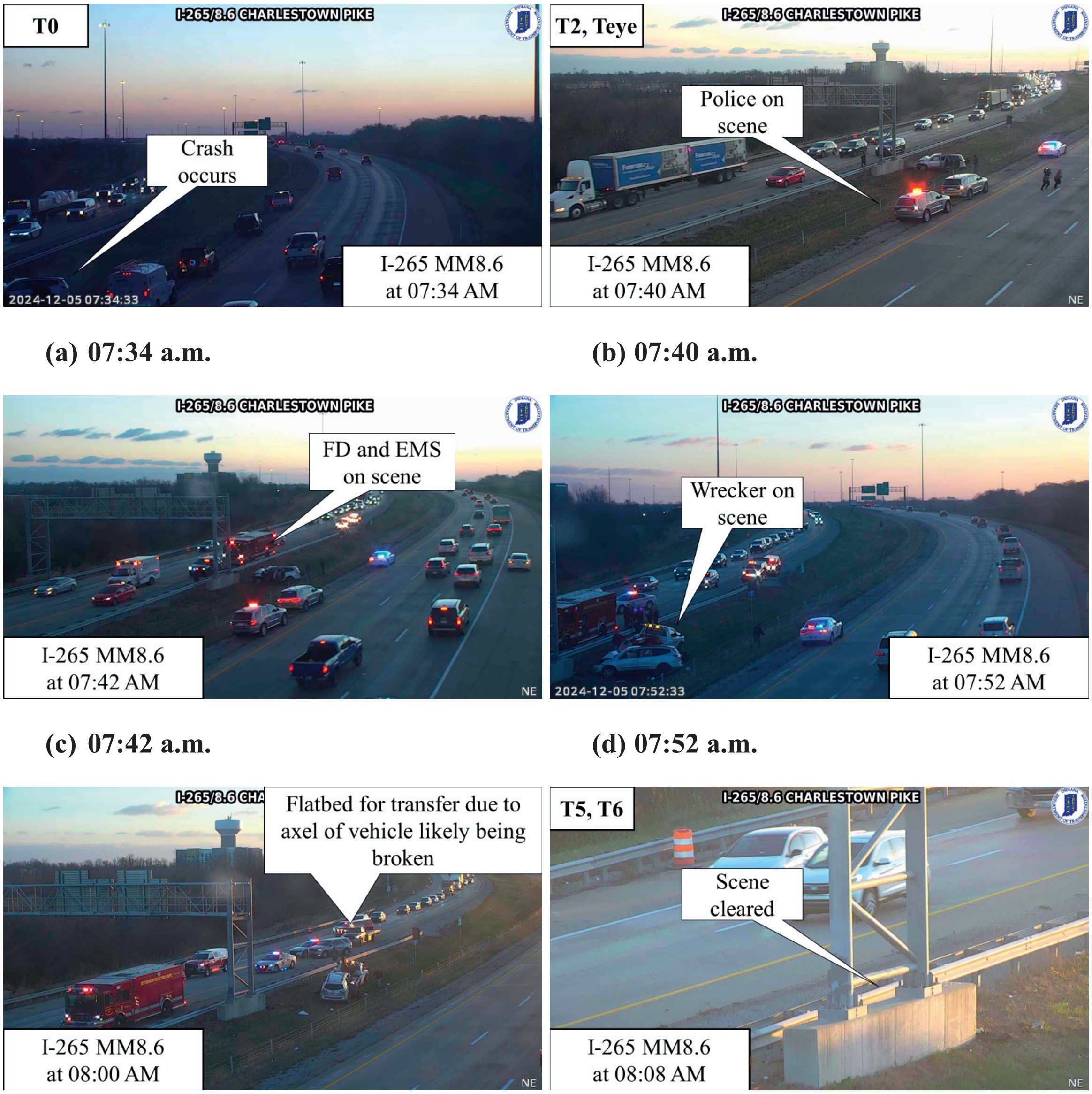
After-Action Report Repository (202412-01; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

A single vehicle was reported to be traveling at highway speed when they approached the back of the queue slower traffic. To avoid crashing into another vehicle, the driver swerved into the median and struck a concrete base for an overhead sign structure (Figure 5.3, Callout i). Figure 5.4a shows the ITS image of when the incident occurred (T_0). First responders were on scene (T_4) within 6 min (7:42 a.m.; Figure 5.4b). The vehicle was cleared from the roadway (T_5) within 32 min (8:08 a.m.) with overall congestion from this incident being 61 min (T_7–T_0). Table 5.3 and Table 5.4 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

5.3 Case Study III: April 30, 2024, I-65 NB MM 119.4 Passenger Vehicle Fire (202404-22)

This incident took place in the evening of April 30, 2024, at 6:00 p.m. along northbound I-65 at MM 119.4 in Marion County. The after-action review can be found in the JTRP After-Action Report Repository (202404-22; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

A single-passenger vehicle caught fire on the shoulder before becoming fully engulfed at 6:00 p.m. (T_0), as shown in Figure 5.5 by Callout i and in the ITS camera image shown in Figure 5.6a. Firefighters were on scene at approximately 6:08 p.m. (T_4; Figure 5.6c) and had the fire completely extinguished by 6:14 p.m. A Hoosier Helper arrived at 6:10 p.m. to assist with the closure of several lanes (Figure 5.6d). All lanes were opened by 6:26 p.m.



(a) 07:34 a.m. (b) 07:40 a.m.

(c) 07:42 a.m. (d) 07:52 a.m.

(e) 08:00 a.m. (f) 08:08 a.m.

Figure 5.4 Select ITS Camera Images During a Car Running Off the Road Along I-265 EB at MM 8.6 on December 5, 2024.

TABLE 5.3
TIM Event Sequence for a Car Running Off the Road Along I-265 EB on December 5, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	7:34 a.m.	Camera (Figure 5.4a)
T_1	Incident reported	7:36 a.m.	Crash Report
T_2	Incident verified	7:40 a.m.	Crash Report
$T_{2,eye}$	ITS Camera On Event	7:40 a.m.	Camera (Figure 5.4b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	7:40 a.m.	Crash Report
T_5	All travel lanes open	8:08 a.m.	Camera (Figure 5.4f)
T_6	All responders have left the scene	8:08 a.m.	Camera (Figure 5.4f)
T_7	Traffic conditions return to normal	8:35 a.m.	Crash Report

TABLE 5.4
TIM summary interval for a car running off the road along I-265 EB on December 5, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	1
Verification Time	$T_2 - T_1$	4
TMC Verification Time	$T_{2eye} - T_0$	5
Response Time	$T_4 - T_2$	0
Roadway Clearance Time (RCT)	$T_5 - T_1$	32
Incident Clearance Time (ICT)	$T_6 - T_1$	32
Time to Return to Normal Flow	$T_7 - T_0$	61

(T_5; Figure 5.6e), and an ISP trooper stayed on scene to wait for the wrecker to arrive to recover the vehicle. The scene was cleared by the ISP trooper and the wrecker by 7:04 p.m. (Figure 5.6f). Table 5.5 and Table 5.6 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

5.4 Case Study IV: August 28, 2024, I-70 EB MM 104.7 Work Zone Semi Crash and Median Barrier Replacement (202408-14)

This incident took place in the afternoon of August 28, 2024, at 1:30 p.m. along eastbound I-70 at MM 104.7 in Hancock County. The after-action review can be found in the JTRP

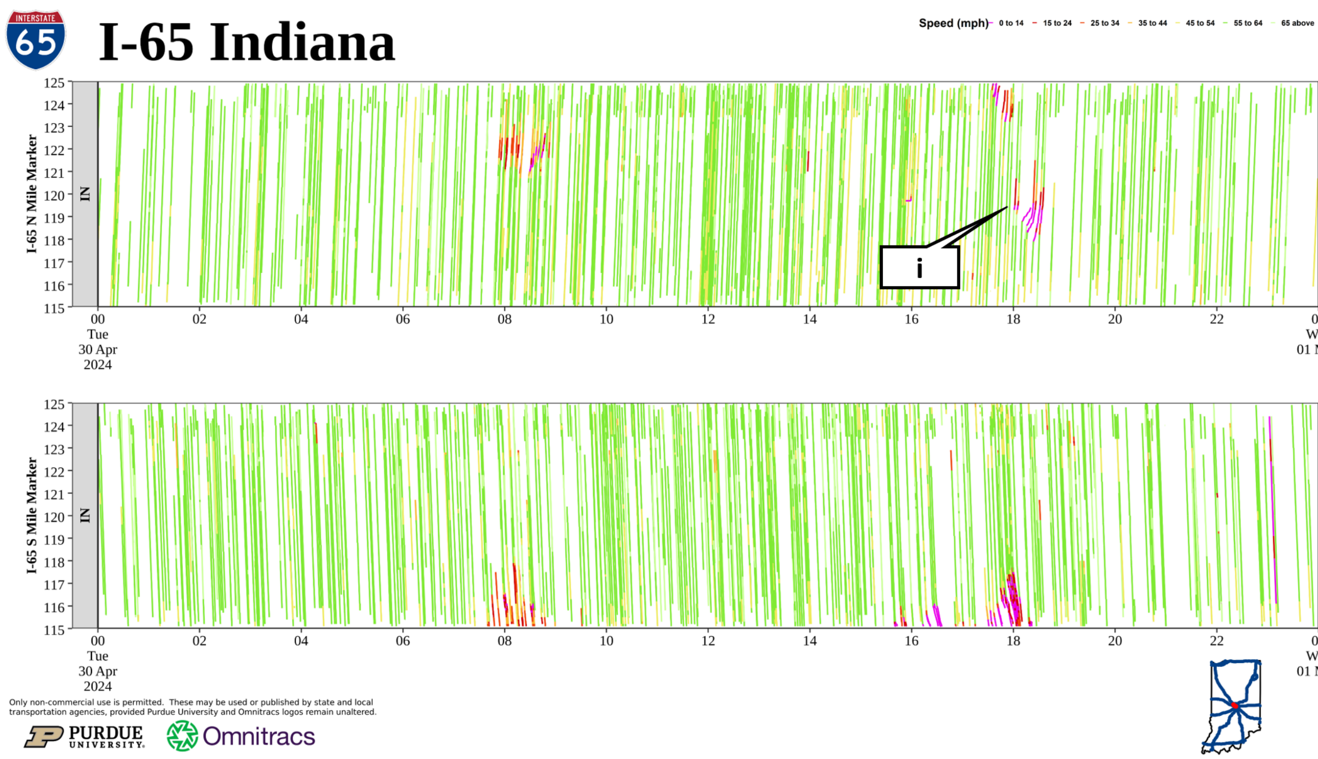
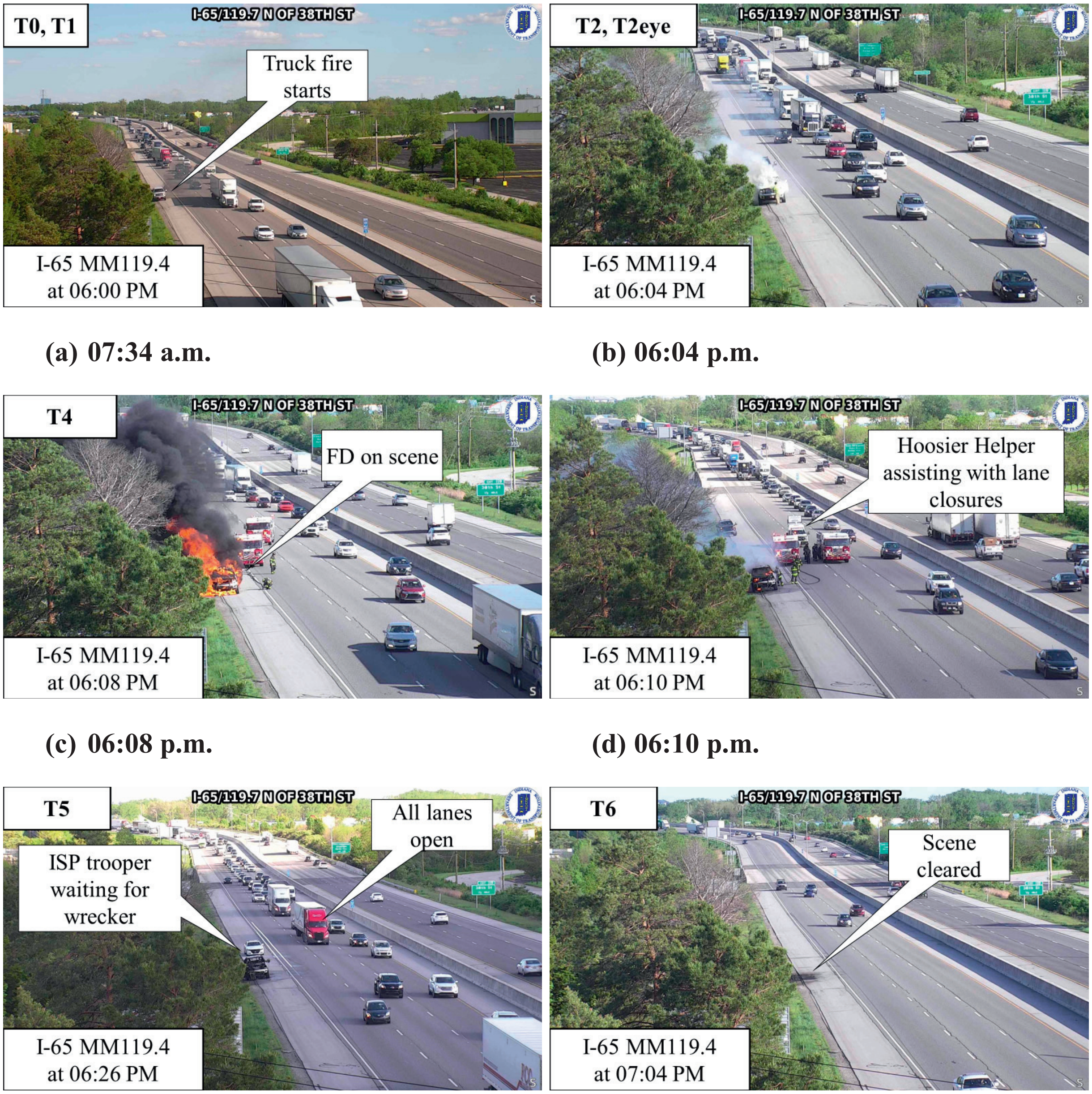


Figure 5.5 Traffic Speed Heatmap for Section of I-65 in Indiana from MM 115 to MM 125 on Tuesday, April 30, 2024.

TABLE 5.5
TIM Event Sequence for a Passenger Vehicle Fire Along I-65 NB on April 30, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	6:00 p.m.	Camera (Figure 5.6a)
T_1	Incident reported	6:00 p.m.	N/A
T_2	Incident verified	6:04 p.m.	Camera (Figure 5.6b)
$T_{2,eye}$	ITS Camera On Event	6:04 p.m.	Camera (Figure 5.6b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	6:08 p.m.	Camera (Figure 5.6c)
T_5	All travel lanes open	6:26 p.m.	Camera (Figure 5.6e)
T_6	All responders have left the scene	7:04 p.m.	Camera (Figure 5.6f)
T_7	Traffic conditions return to normal	6:46 p.m.	CV Data



(a) 07:34 a.m. **(b) 06:04 p.m.**

(c) 06:08 p.m. **(d) 06:10 p.m.**

(e) 06:26 p.m. **(f) 07:04 p.m.**

Figure 5.6 Select ITS Camera Images During a Passenger Vehicle Fire Along I-65 NB at MM 119.4 on April 30, 2024.

TABLE 5.6
TIM Summary Interval for a Passenger Vehicle Fire Along I-65 NB on April 30, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	0
Verification Time	$T_2 - T_1$	4
TMC Verification Time	$T_{2eye} - T_0$	4
Response Time	$T_4 - T_2$	4
Roadway Clearance Time (RCT)	$T_5 - T_1$	26
Incident Clearance Time (ICT)	$T_6 - T_1$	64
Time to Return to Normal Flow	$T_7 - T_0$	46

After-Action Report Repository (202408-14; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

Inside a bifurcated crossover work zone, a semitruck began to change lanes from left to right when the semi struck a passenger car and impacted the temporary median barrier in the work zone (T_0), as shown in the traffic speed heatmap by Figure 5.7, Callout i. This can also be seen on the ITS camera in Figure 5.8a. Due to the full crossover of the eastbound lanes, first responders were able to respond using the eastbound lanes that were under construction to allow for a quicker response by 1:35 p.m. (T_4). Crews were able to open the roadway in 98 min (T_5-T_1) at 3:10 p.m.

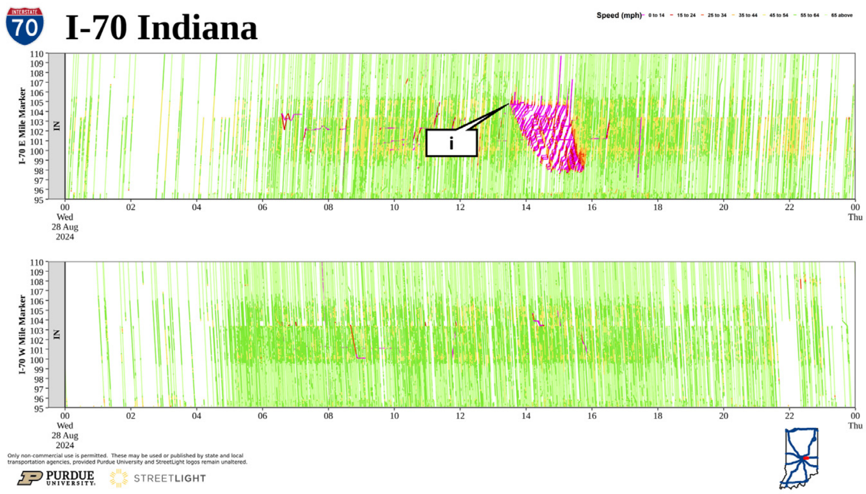


Figure 5.7 Traffic Speed Heatmap for Section of I-70 in Indiana from MM 95 to MM 110 on Wednesday, August 28, 2024.

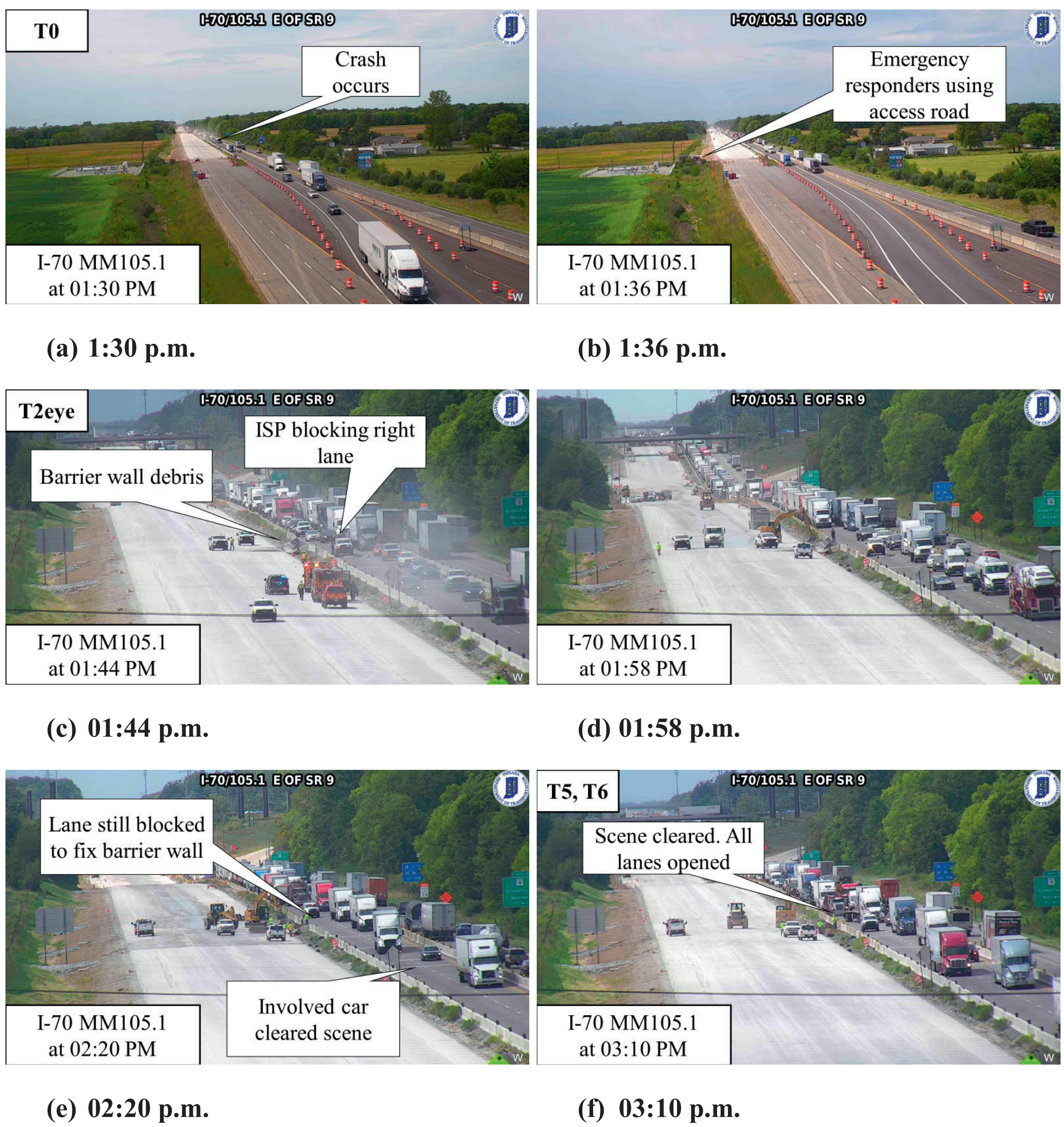


Figure 5.8 Select ITS Camera Images During a Work Zone Semi Crash Along I-70 EB at MM 105.1 on August 28, 2024.

TABLE 5.7
TIM Event Sequence for a Work Zone Semi Crash Along I-70 EB on August 28, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	1:30 p.m.	Crash Report (Figure 5.8a)
T_1	Incident reported	1:32 p.m.	Crash Report
T_2	Incident verified	1:35 p.m.	Crash Report
$T_{2,eye}$	ITS Camera On Event	1:44 p.m.	Camera (Figure 5.8c)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	1:35 p.m.	Crash Report
T_5	All travel lanes open	3:10 p.m.	Camera (Figure 5.8f)
T_6	All responders have left the scene	3:10 p.m.	Camera (Figure 5.8f)
T_7	Traffic conditions return to normal	3:47 p.m.	CV Data

TABLE 5.8
TIM Summary Interval for a Work Zone Semi Crash Along I-70 EB on August 28, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	2
Verification Time	$T_2 - T_1$	3
TMC Verification Time	$T_{2eye} - T_0$	14
Response Time	$T_4 - T_2$	0
Roadway Clearance Time (RCT)	$T_5 - T_1$	98
Incident Clearance Time (ICT)	$T_6 - T_1$	98
Time to Return to Normal Flow	$T_7 - T_0$	137

(T_5 and T_6) and repair the barrier wall in the process. Table 5.7 and Table 5.8 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

5.5 Case Study V: July 27, 2024, I-65 NB MM 126.8 Passenger Vehicle Fire (202407-06)

This incident took place on the morning of July 27, 2024, at 7:02 a.m. along northbound I-65 at MM 126.8 in Marion County. The after-action review can be found in the JTRP After-Action

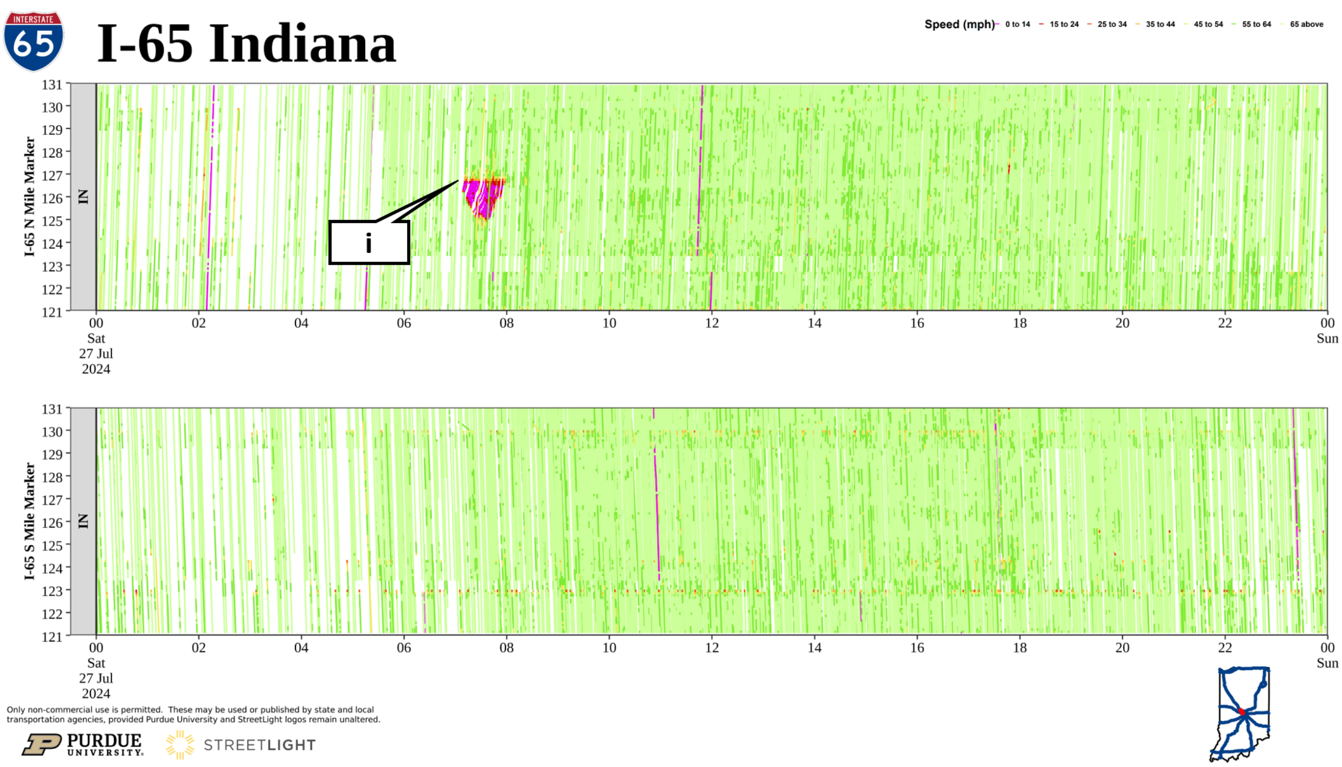


Figure 5.9 Traffic Speed Heatmap for Section of I-65 in Indiana from MM 121 to MM 131 on Saturday, July 27, 2024.

(a) 07:02 a.m. **(b) 07:08 a.m.**

(c) 07:18 a.m. **(d) 07:28 a.m.**

(e) 07:36 a.m. **(f) 08:24 a.m.**

Figure 5.10 Select ITS Camera Images During a Passenger Vehicle Fire Along I-65 NB at MM 126.3 on July 27, 2024.

TABLE 5.9
TIM Event Sequence for a Passenger Vehicle Fire Along I-65 NB on July 27, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	7:02 a.m.	Camera (Figure 5.10a)
T_1	Incident reported	7:03 a.m.	N/A
T_2	Incident verified	7:08 a.m.	Camera (Figure 5.10b)
$T_{2,eye}$	ITS Camera On Event	7:08 a.m.	Camera (Figure 5.10b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	7:18 a.m.	Camera (Figure 5.10c)
T_5	All travel lanes open	7:36 a.m.	Camera (Figure 5.10e)
T_6	All responders have left the scene	8:24 a.m.	Camera (Figure 5.10f)
T_7	Traffic conditions return to normal	8:00 a.m.	CV Data

TABLE 5.10
TIM Summary Interval for a Passenger Vehicle Fire Along I-65 NB on July 27, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	1
Verification Time	$T_2 - T_1$	5
TMC Verification Time	$T_{2eye} - T_0$	6
Response Time	$T_4 - T_2$	10
Roadway Clearance Time (RCT)	$T_5 - T_1$	33
Incident Clearance Time (ICT)	$T_6 - T_1$	81
Time to Return to Normal Flow	$T_7 - T_0$	58

Report Repository (202407-06; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

A passenger vehicle began to catch fire and, within 6 min, was fully engulfed in flames, shown in the traffic speed heatmap in Figure 5.9, Callout i. The start of the fire can also be seen in Figure 5.10a at 7:02 a.m. (T_0). Firefighters and ISP troopers were on scene at 7:18 a.m. (T_4; Figure 5.10c), and the fire was fully extinguished by 7:28 a.m. (Figure 5.10d). All travel lanes were reopened by 7:36 a.m. (T_5; Figure 5.10e), and a wrecker recovered the vehicle and cleared the scene at 8:24 a.m. (T_6; Figure 5.10f). Table 5.9 and Table 5.10 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

5.6 Case Study VI: December 13, 2024, I-465 OL MM 12.5 Overturned Semi (202412-03)

This incident took place during midday of December 13, 2024, at 11:54 a.m. along the outer loop of I-465 at MM 12.5 in Marion County. The after-action review can be found in the JTRP After-Action Report Repository (202412-03; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

In this case study, an incident occurred in the outer loop direction at 11:54 a.m. (T_0) when a passenger vehicle was changing lanes and sideswiped a semitruck. This resulted in the semi hitting the concrete median barrier, knocking over a light pole into the other direction of travel, and rolling onto its side across 3 lanes of travel, as shown in the traffic speed heatmap Figure 5.11, Callout i. This can also be seen in the ITS camera image in Figure 5.12a. Figure 5.12b shows that crews were on scene within 2 min at 11:56 a.m. (T_2–T_4). Due to the complexity of the recovery, three rotator trucks were required to recover the semi (Figure 5.12c, Figure 5.12d). Figure 5.12e shows the roadway once all lanes were reopened (T_5) and also when all the responders had left the scene (T_6). Table 5.11 and Table 5.12 show the TIM event sequence and summary interval for the incident, respectively. T_3 was not available for this incident which is signified with double dashed lines.

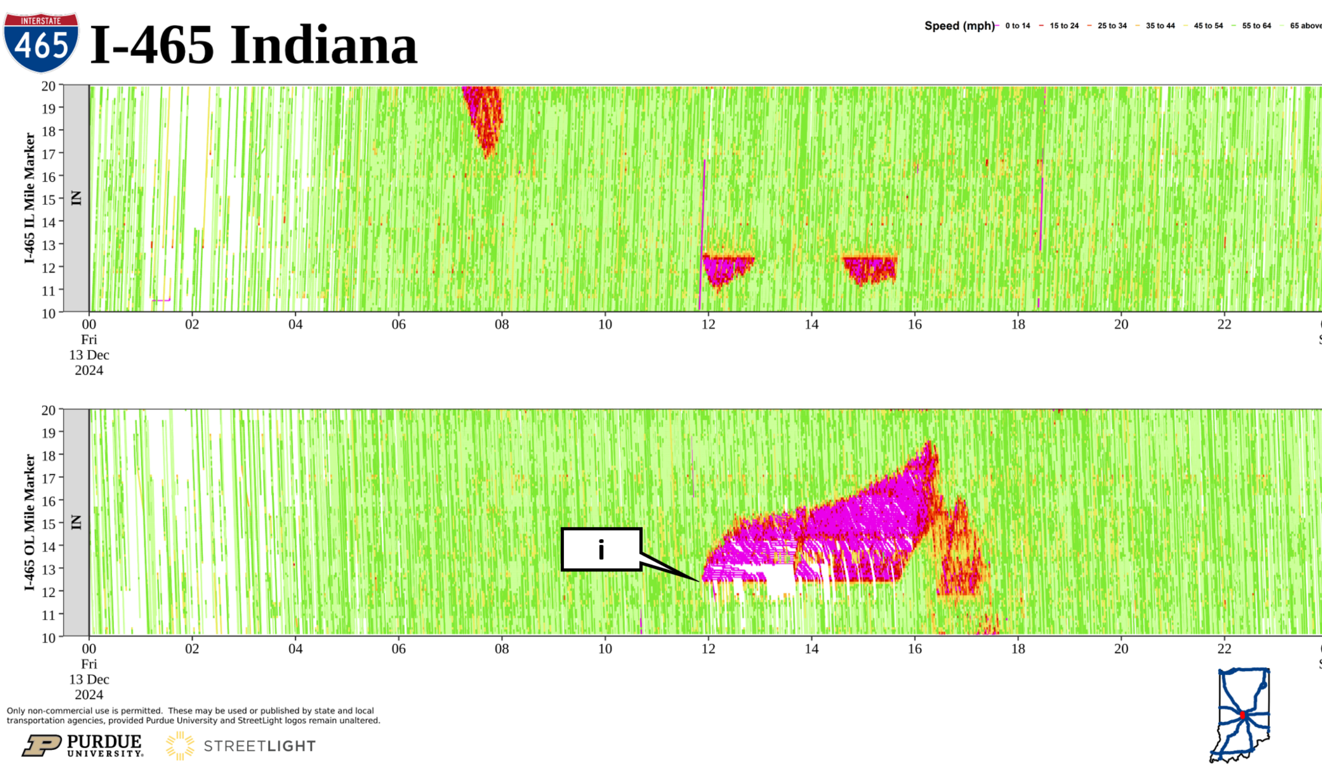
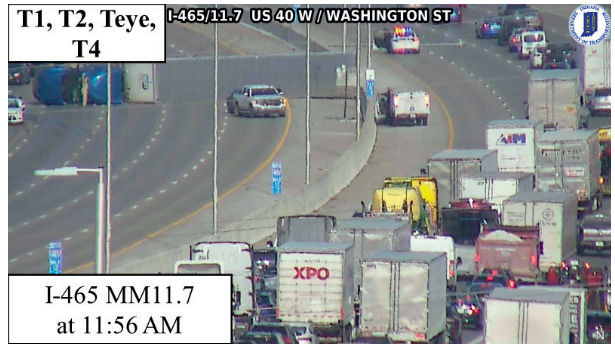


Figure 5.11 Traffic Speed Heatmap for Section of I-465 in Indiana from MM 10 to MM 20 on Friday, December 13, 2024.

(a) 11:54 a.m.

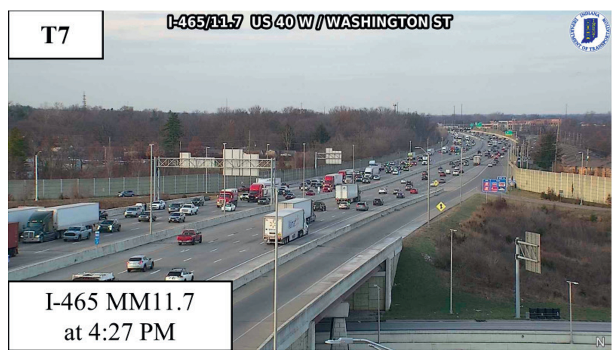


(b) 11:56 a.m.

(c) 01:00 p.m.

(d) 02:20 p.m.

(e) 03:44 p.m.



(f) 04:27 p.m.

Figure 5.12 Select ITS Camera Images During an Overturned Semi Along I-465 OL at MM 11.7 on December 13, 2024.

TABLE 5.11
TIM Event Sequence for an Overturned Semi Along I-465 OL on December 13, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	11:54 a.m.	Camera (Figure 5.12a)
T_1	Incident reported	11:56 a.m.	Crash Report
T_2	Incident verified	11:56 a.m.	Camera (Figure 5.12b)
$T_{2,eye}$	ITS Camera On Event	11:56 a.m.	Camera (Figure 5.12b)
T_3	Response identified and dispatched	--	--
T_4	Response arrives on scene	11:56 a.m.	Camera (Figure 5.12b)
T_5	All travel lanes open	3:44 p.m.	Camera (Figure 5.12e)
T_6	All responders have left the scene	3:44 p.m.	Camera (Figure 5.12e)
T_7	Traffic conditions return to normal	4:27 p.m.	CV Data

TABLE 5.12
TIM summary interval for an overturned semi along I-465 OL on December 13, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	0
Verification Time	$T_2 - T_1$	2
TMC Verification Time	$T_{2eye} - T_0$	2
Response Time	$T_4 - T_2$	0
Roadway Clearance Time (RCT)	$T_5 - T_1$	228
Incident Clearance Time (ICT)	$T_6 - T_1$	228
Time to Return to Normal Flow	$T_7 - T_0$	271

5.7 Case Study VII: August 30, 2024, I-865 EB MM 4.9 Passenger Vehicle Barrier Wall Crash, with Selected TMC Audio (202408-16)

This incident took place in the afternoon of August 30, 2024, at 12:58 p.m. along eastbound I-865 at MM 4.9 in Marion County. The after-action review can be found in the JTRP After-Action Report Repository (202408-16; Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

A single-passenger vehicle was traveling eastbound when it overcorrected to avoid an item in the roadway. It then hit the median barrier and came to rest perpendicular to the travel lanes along the

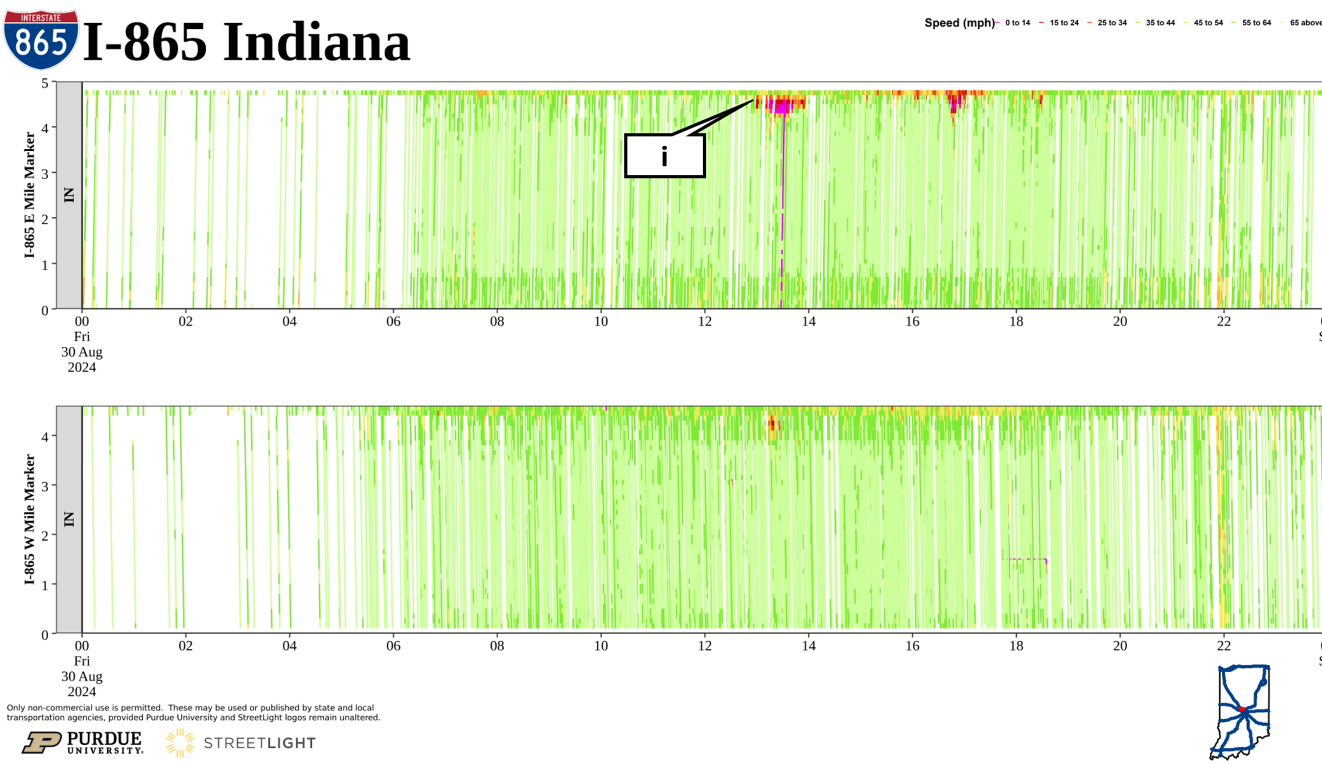


Figure 5.13 Traffic Speed Heatmap for Section of I-865 in Indiana from MM 0 to MM 5 on Friday, August 30, 2024.

TABLE 5.13
TIM Event Sequence for a Passenger Vehicle Barrier Wall Crash Along I-865 EB on August 30, 2024.

TIM Event	Description	Event Time	Source
T_0	Incident occurs	12:58 p.m.	Camera (Figure 5.14a)
T_1	Incident reported	1:02 p.m.	Audio
T_2	Incident verified	1:04 p.m.	Audio (Figure 5.14b)
$T_{2,eye}$	ITS Camera On Event	1:04 p.m.	Camera (Figure 5.14b)
T_3	Response identified and dispatched	1:04 p.m.	Audio (Figure 5.14b)
T_4	Response arrives on scene	1:12 p.m.	Camera (Figure 5.14c)
T_5	All travel lanes open	1:56 p.m.	Camera (Figure 5.14f)
T_6	All responders have left the scene	1:56 p.m.	Audio (Figure 5.14f)
T_7	Traffic conditions return to normal	1:58 p.m.	CV Data

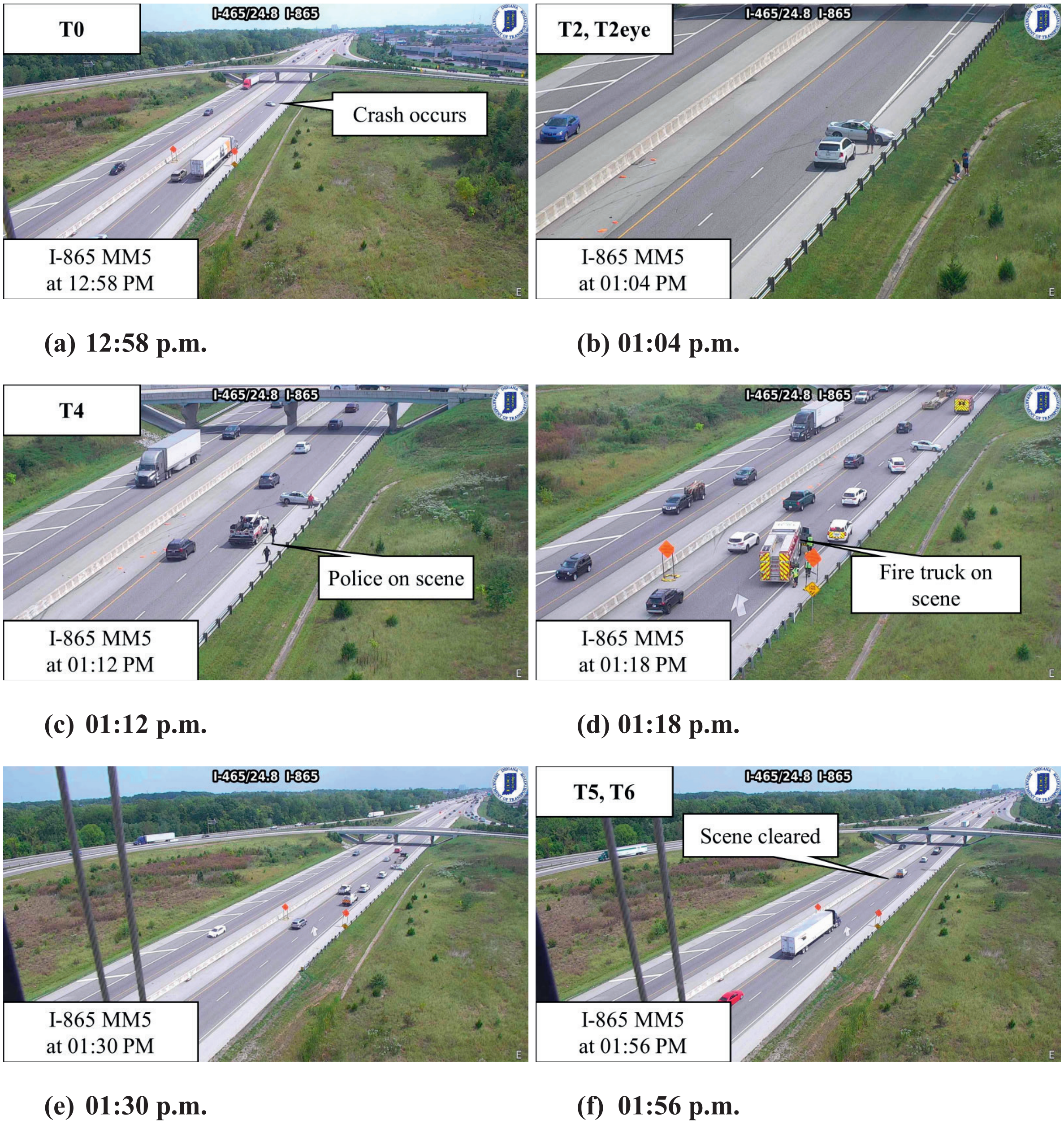


Figure 5.14 Select ITS Camera Images During a Passenger Vehicle Barrier Wall Crash Along I-865 EB at MM 5 on August 30, 2024.

TABLE 5.14
TIM Summary Interval for a Passenger Vehicle Barrier Wall Crash Along I-865 EB on August 30, 2024.

Summary Interval	Formula	Time (min)
Detection Time	$T_1 - T_0$	4
Verification Time	$T_2 - T_1$	2
TMC Verification Time	$T_{2eye} - T_0$	6
Response Time	$T_4 - T_2$	8
Roadway Clearance Time (RCT)	$T_5 - T_1$	54
Incident Clearance Time (ICT)	$T_6 - T_1$	54
Time to Return to Normal Flow	$T_7 - T_0$	60

rightmost lane at 12:58 p.m. (T_0), as shown on the traffic speed heatmap in Figure 5.13, Callout i. The time of the incident can also be seen in Figure 5.14a. TMC audio was used to determine when the incident was reported (T_1), when the incident was verified (T_2), when the correct emergency response was dispatch (T_3), and when all the responders had cleared the scene (T_6). Responders were on scene within 14 min (1:12 p.m.) with the arrival of the police (Figure 5.14c) and the arrival of the fire department (Figure 5.14d). The wrecker was able to recover the vehicle by 1:56 p.m. (Figure 5.14f). Table 5.13 and Table 5.14 show the TIM event sequence and summary interval for the incident, respectively.

5.8 Case Study on Solar Eclipse Impact

A special case of the impact of the total solar eclipse of April 8, 2024, on highway traffic as an after-action review is briefly presented in this subsection. This is unlike traditional traffic incident management after-action reports detailed in previous sections. Preparations and planning for the eclipse event were discussed during the INTime meeting led by Steven Harney, former Traffic Management Training specialist at Traffic Management Center INDOT, on Tuesday, March 19, 2024.

A detailed study on the impact of the 2024 solar eclipse on national traffic mobility estimated that congestion grew by 67% in 11 of the 13 U.S. states along the path of totality (Sakhare, Desai, Mathew, & Bullock, 2024b). Indiana had the highest increase in mile-hours (856) of congestion on the day of the eclipse compared to the two Mondays prior to the eclipse. Figure 5.15 shows traffic speed heatmaps for the entirety of I-65 in Indiana for the day before, day of, and day after the eclipse. The path of totality had passed through central Indiana around 3:00 p.m. on Monday, April 8, 2024, and lasted a few minutes. The section of I-65 that was under the path of totality is marked by the black dotted line in Figure 5.15. Callout i points to incoming traffic causing congestion and, in some cases, incidents the day before the eclipse. Callout ii points to the incoming traffic on the day of the eclipse. As soon as the totality had passed Indiana, the traffic direction flipped, and returning traffic causing congestion was evident (Callout iii). A rather less anticipated impact of this event was that congested traffic was observed the day after the eclipse as well (callout iv).

Significant mobility impacts were observed the day before, the day of, and the day after the eclipse due to several large eclipse viewing events that attracted a large number of travelers within and outside of Indiana. The logistical arrangements showed interesting traffic behavior and congestion even on the day after the eclipse that was unexpected.

Commercial vehicle dash camera images were also looked at in the area. Figure 5.16 shows one dash camera image near the I-65 SB exit 188 at 3:05 pm—the time of totality. It is worth noting that this location was just outside the path of totality. It is hypothesized that motorists that were delayed by earlier congestion in the southbound direction (Figure 5.15, Callout ii) had decided to pull off the interstate and park along the exit (Figure 5.15, Callout ii) to view the eclipse. An unsafe situation was observed with the truck and a car behind it parked inside the gore area. Callout ii also points to an open car door in the gore area as other traffic was actively moving on the interstate. Such situations can lead to higher risks and safety concerns.

In a similar fashion as the after-action review for the total solar eclipse on Indiana interstates, a national interstate mobility impact analysis was also performed. Figure 5.17 shows a national map of U.S. interstate routes (more than 97,000 miles of interstates) with every 0.1 mile of roadway colorized by the median speed of connected trucks passing through at 5:13 p.m. EDT on Monday, April 8, 2024, shortly after the total solar eclipse had passed over the United States. The path of totality is highlighted by faint grey lines passing through 13 states starting from Texas on the southwest to Maine in the northeast. For large-scale events, such as the total solar eclipse, that

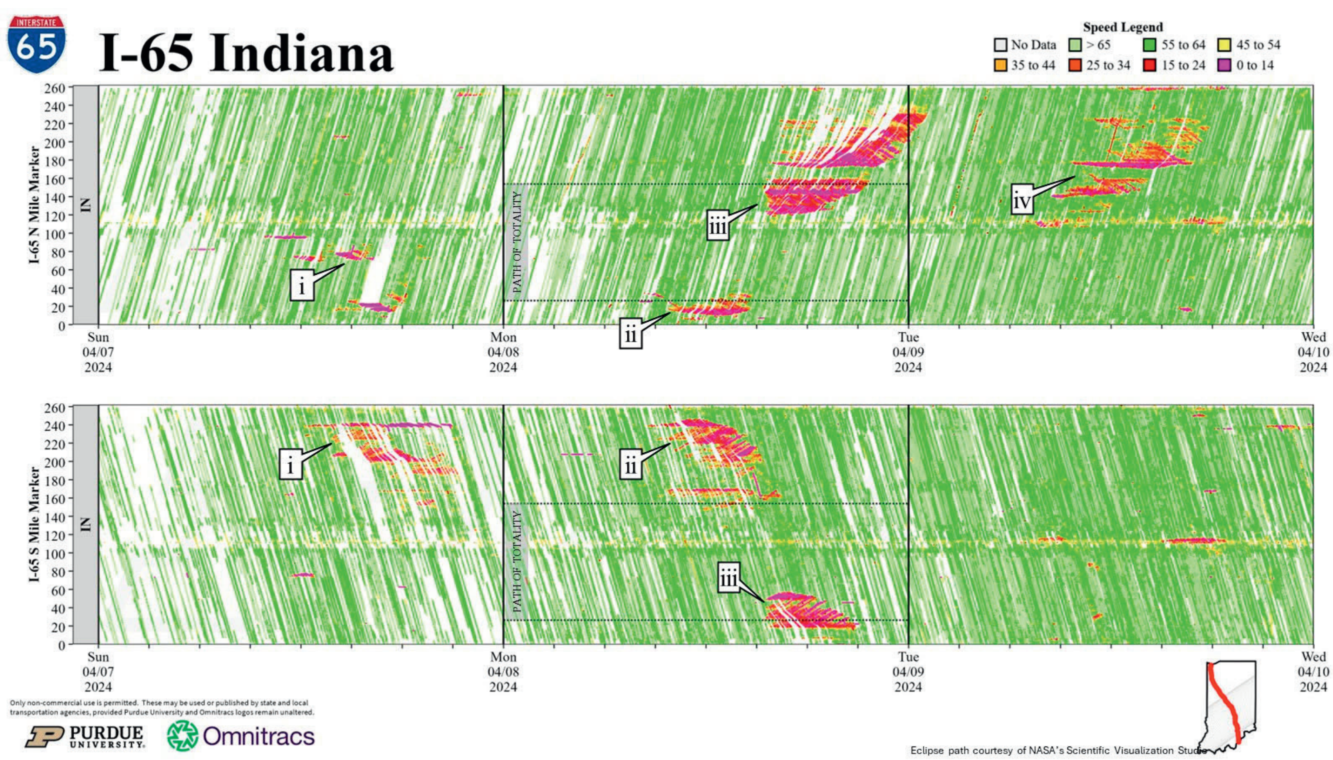


Figure 5.15 Traffic Speed Heatmap Along I-65 in Indiana Showing Impact on Day Before, Day of and Day After the Solar Eclipse.

Figure 5.16 Dash Camera Image Near Interstate Exit 188 Along I-65 SB in Indiana During the Totality.

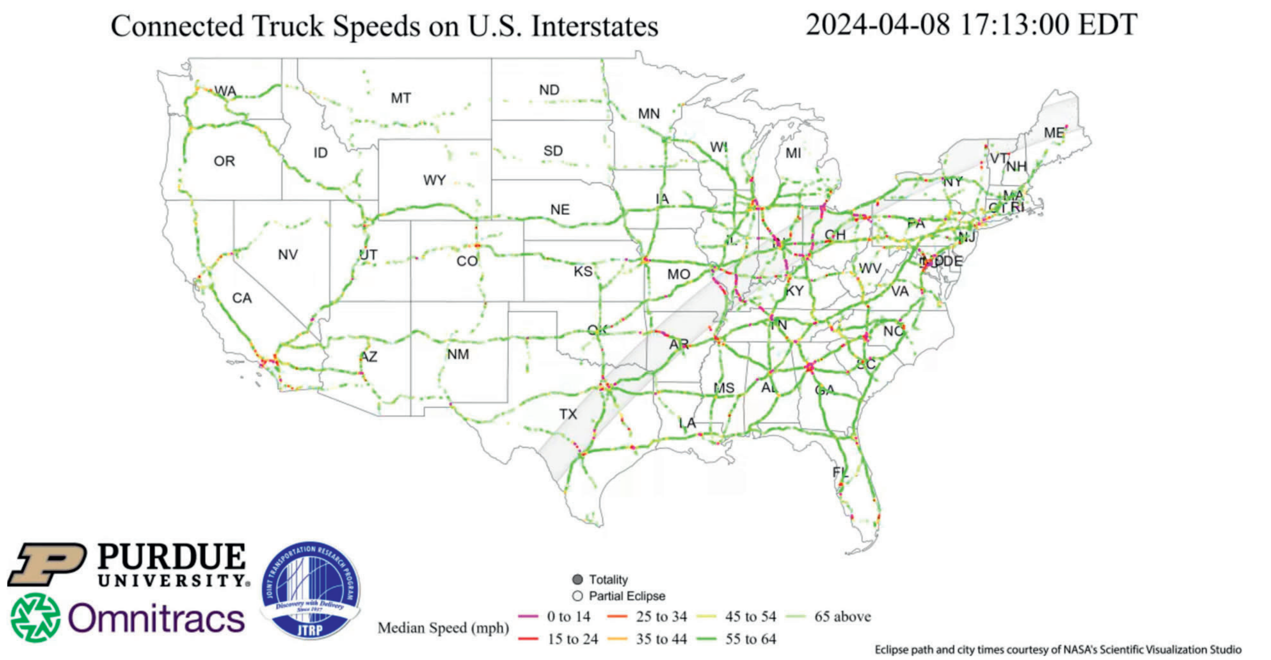


Figure 5.17 National Map of US Interstate Mobility Approximately 2 hr After Total Solar Eclipse Had Passed Over the US on Monday April 8, 2024 (Desai et al., 2024).

impact multiple states and jurisdictions and span state borders, CV data and dash camera images are well suited to providing stakeholders with a systematic outlook of roadway mobility and conditions, as well as documenting performance for after-action reviews and planning future events. Similar methods and visualizations could be developed for planning TIM strategies during upcoming large-scale events, such as the 2026 FIFA World Cup (to be hosted in cities across the United States, Canada, and Mexico) and the 2028 Olympics (to be hosted in Los Angeles, California), to name a few.

5.9 Case Study on Tornado Impact

Another special case for an after-action review that is unlike a traditional TIM after-action report is of a tornado's impact on traffic. The National Weather Service reported an outbreak of 23 tornadoes in Indiana on the evening of March 31, 2023. This marked the fifth largest tornado outbreak in Indiana's history and the largest in central Indiana since November 17, 2013.

Figure 5.18 shows the traffic speed heatmap for the 140-mile section of I-65 in the northbound direction (top) and southbound

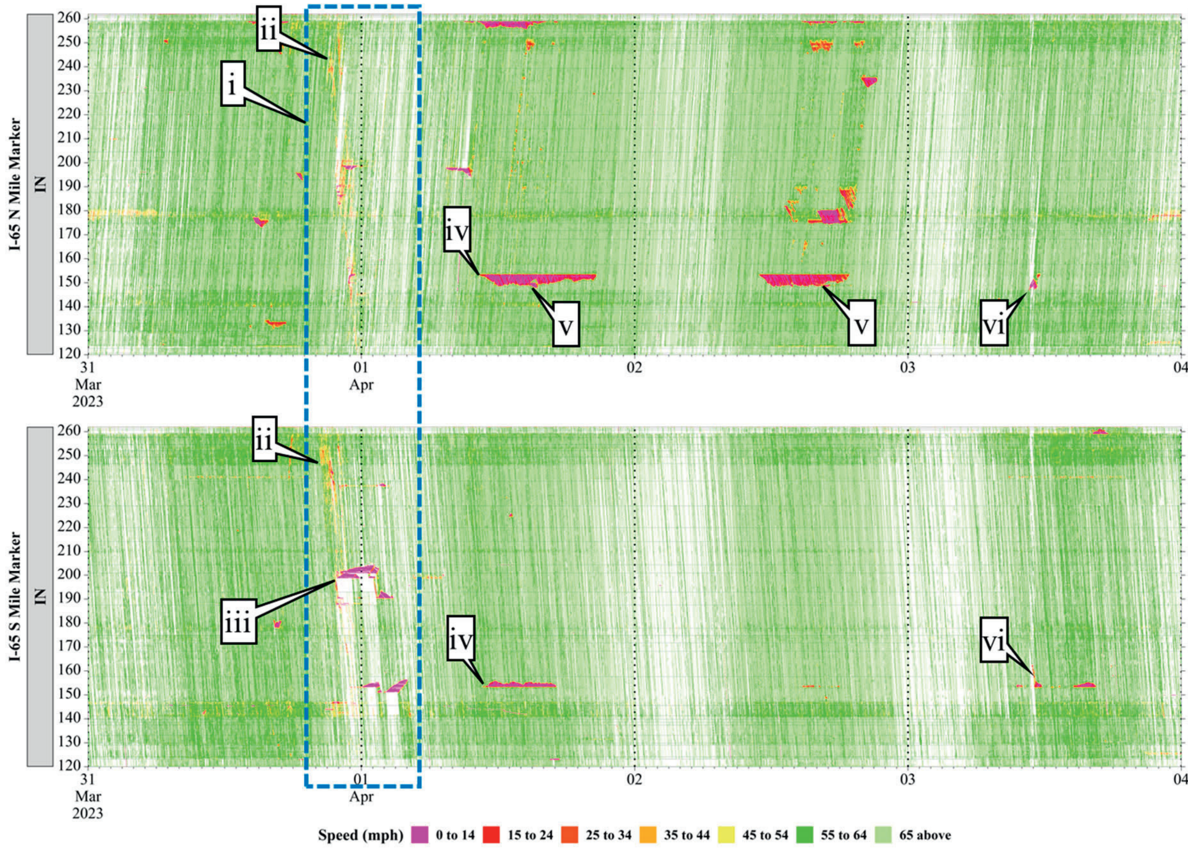


Figure 5.18 Traffic Speed Heatmap for Section of I-65 in Indiana from MM 120 to MM 260 Over a Duration of 4 Days From Friday, March 31 to Monday, April 3, 2023.

direction (bottom) from MM 120–260 over four days (Friday, March 31 through Monday, April 3, 2023). Figure 5.18, Callout i, highlighted by a blue dotted box, points to the impact of a tornado as it was moving southwards across I-65 between 9:00 p.m. March 31 and 3:00 a.m. April 2. Impacted traffic can be observed during this period by the change in speed bins from green to yellow or orange. Figure 5.18, Callout ii points to the tornado front. Severe winds during the storm caused a truck rollover incident around MM 199 southbound at approximately 10:20 p.m. (Figure 5.18, Callout iii) that closed the interstate for a few hours. Rubbernecking was also observed during the day on April 1 (Figure 5.18, Callout iv) and April 2 as motorists were slowing down for the debris on the interstate. Figure 5.19 shows slowed traffic on the interstate and debris deposited from a nearby site that was impacted by the storms. The queue formed due to these slowdowns resulted in two back-of-queue incidents (Figure 5.18, Callout v). Rolling slowdown operations were performed in both directions on April 3 to clear the debris on and around the interstate (Figure 5.18, Callout vi).

5.10 Special Case Studies Outside of Indiana

The various datasets and associated techniques to extract TIM event sequences for after-action review, as described in the preceding sections, are highly scalable and not spatially constrained. Given the availability of data, the same procedures could be repeated to document TIM practices for any geographical region. This section presents a high-level overview of selected case studies from around the United States for events ranging from hurricanes, bridge collapses, eclipses, and winter storms. As these events represent nontraditional TIM scenarios, instead of an event sequence, the subsections that follow utilize heatmaps and commercial vehicle dash camera images to document and contextualize roadway mobility and prevailing conditions. While the entire TIM event sequence may not apply directly to most case studies in this section, the connected vehicle data and commercial vehicle dash camera images used to demonstrate roadway impacts can still be valuable sources of information, specifically relating to Table 3.1: time of incident/event start, time of incident/event clearance, and time at which traffic conditions return to normal (or a new normal, as some of the upcoming case studies will highlight). Due to the availability of connected truck data nationwide, the heatmaps shown in these subsections utilize connected truck data to observe roadway mobility.

5.10.1 Impact of Hurricane Milton on Florida Interstate Mobility

Hurricane Milton made landfall as a Category 3 hurricane on Wednesday, October 9, 2024, near Siesta Key and significantly impacted East Central Florida (National Weather Service, n.d.).

Figure 5.19 (a) Debris on I-65 and Slowed Down Traffic Due to Rubbernecking From Motorists Slowing Down to See (b) the Impact of Tornado (By Seth Tocco, 2023; Used with Permission).

Connected truck data available nationwide at 10–60 s reporting frequency allows for near real-time monitoring of roadway mobility on any chosen section of roadway that has a sufficient volume of commercial vehicles passing through. The research team tracked the impacts of Hurricane Milton on Florida interstates in near real time the week of Monday, October 7, 2024, through traffic speed heatmaps, such as the ones shown by Figure 5.20 and Figure 5.21. Both heatmaps depict significant traffic impacts in the days leading to Hurricane Milton's landfall, possibly pointing to traffic queuing from evacuating motorists on interstates. Wednesday and Thursday show minimal truck traffic on I-4 and I-75 as the inclement weather made landfall and created hazardous driving conditions. Once the hurricane had passed, returning traffic and associated queuing were visible for Thursday, Friday, Saturday, and Sunday on both interstates. These heatmaps provide comprehensive but easy to understand visualizations that briefly show how traffic was impacted by Hurricane Milton and can easily be applied for after-action review of other such inclement weather instances that have widespread spatial and temporal impacts on a state's roadway network. Additionally, access to such heatmap visuals and underlying data in near real time can aid emergency management stakeholders in agilely adapting their strategies by reacting to evolving traffic and weather conditions.

5.10.2 Impact of Hurricane Helene on North Carolina and Tennessee Interstate Mobility

Hurricane Helene brought historic amounts of rainfall to parts of the southeastern United States with the mountains of North Carolina recording some of the highest amounts (National Centers for Environmental Information, 2024b).

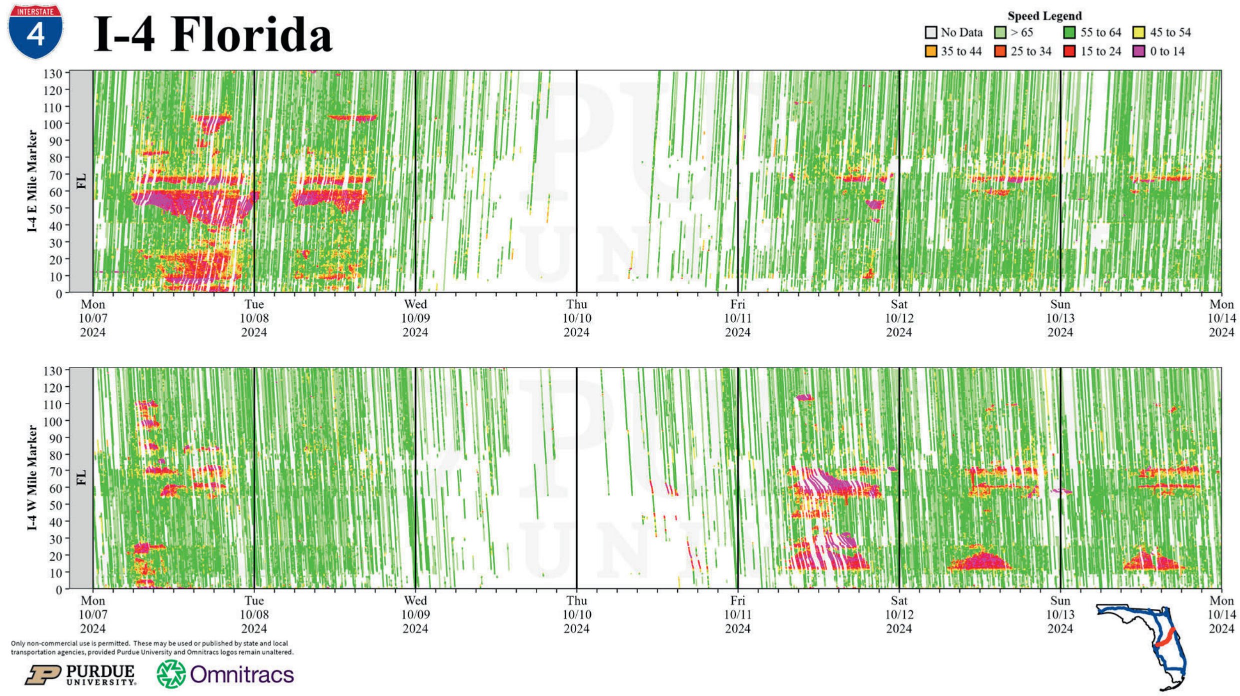


Figure 5.20 Traffic Speed Heatmap for I-4 in Florida for the Week of Monday, October 7, 2024.

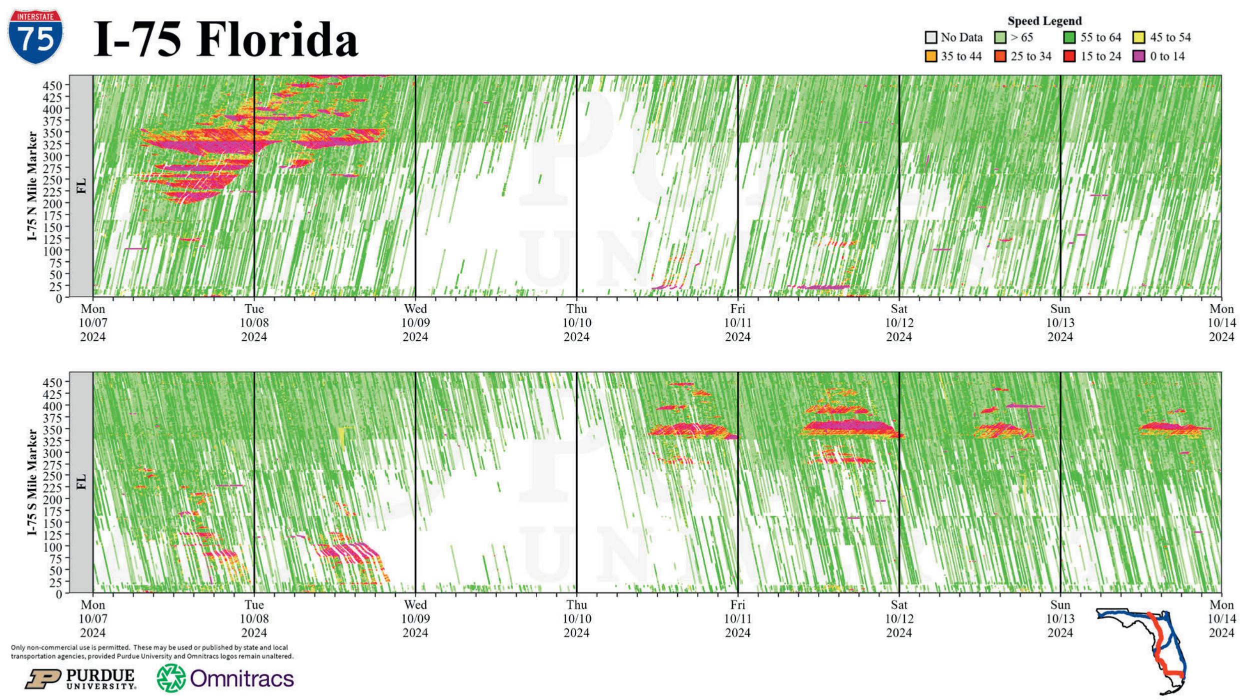


Figure 5.21 Traffic Speed Heatmap for I-75 in Florida for the Week of Monday, October 7, 2024.

A portion of I-40 in North Carolina, near the state line with Tennessee, was washed away resulting in a long-term closure, as evidenced by the heatmap in Figure 5.22. The roadway was reopened in a new temporary pattern (providing one lane of traffic in each direction) by NCDOT on Saturday, March 1, 2025, as shown by the connected truck data traffic heatmap in Figure 5.23. The reopened corridor had a reduced speed limit of 35 mph (NCDOT, 2025), also distinguishable when comparing the speed bands between heatmaps in Figure 5.22 and Figure 5.23. Figure 5.24 and Figure 5.25 show how truck traffic evolved and

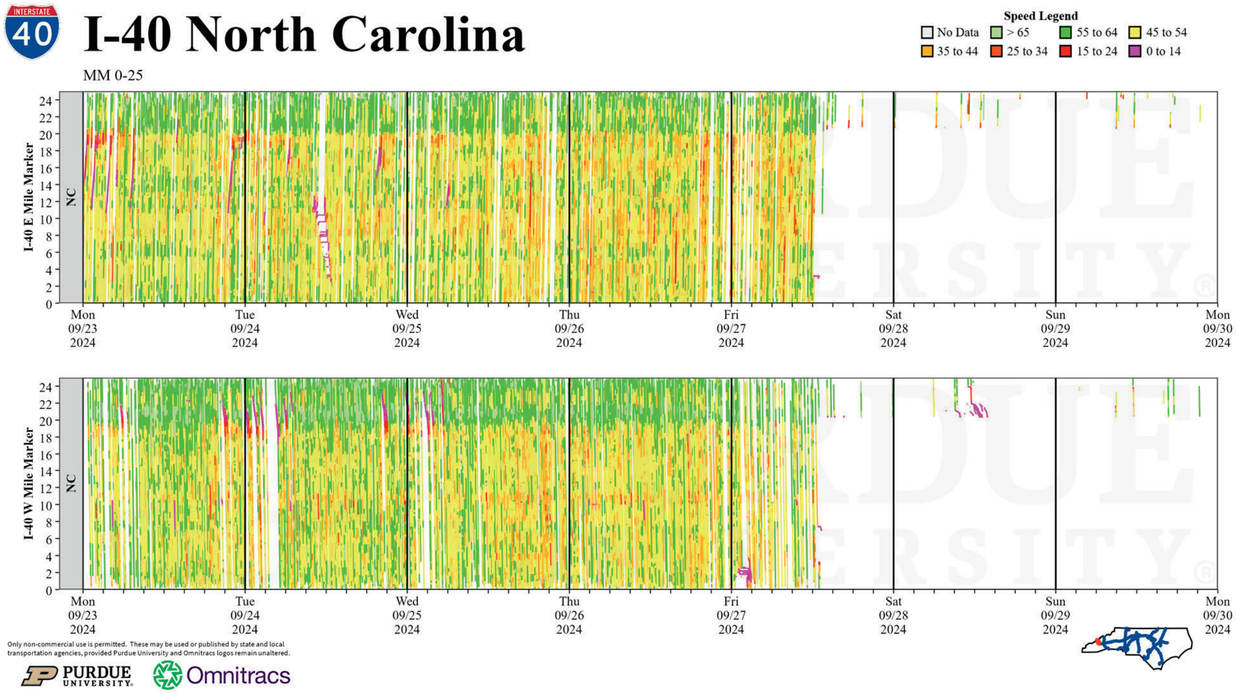


Figure 5.22 Traffic Speed Heatmap for I-40 MM0-25 in North Carolina for the Week of Monday, September 23, 2024.

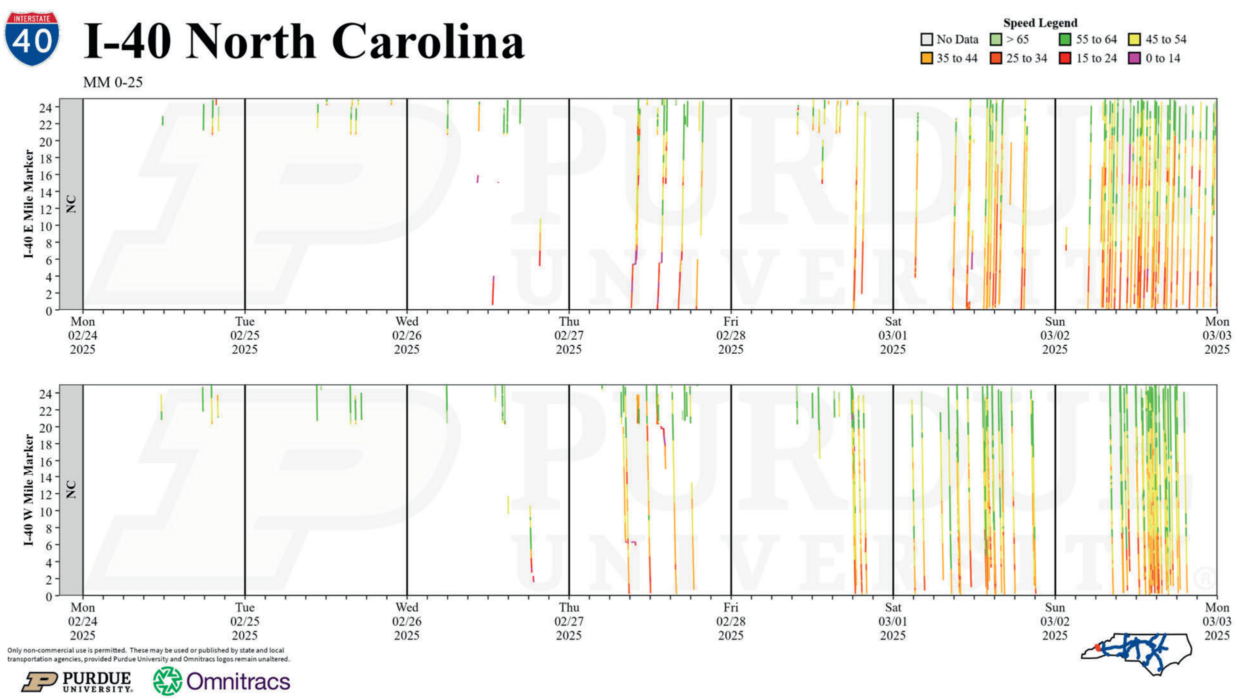


Figure 5.23 Traffic Speed Heatmap for I-40 MM0-25 in North Carolina for the Week of Monday, February 24, 2025.

adapted over this section of I-40 for the first full week following the reopening though the week of Monday March 24, 2025. The reduced speed limit is also easily discernible by the change in speed band coloration from yellow and green (Figure 5.22) to more red and yellow bands (Figure 5.25).

Hurricane Helene also caused significant damage to a portion of I-26 in Unicoi County in northeast Tennessee. The portion of I-26 was destroyed in both directions by flooding from the rise of the Nolichucky River to historic levels resulting in a weeks-long closure starting Friday, September 27, 2024

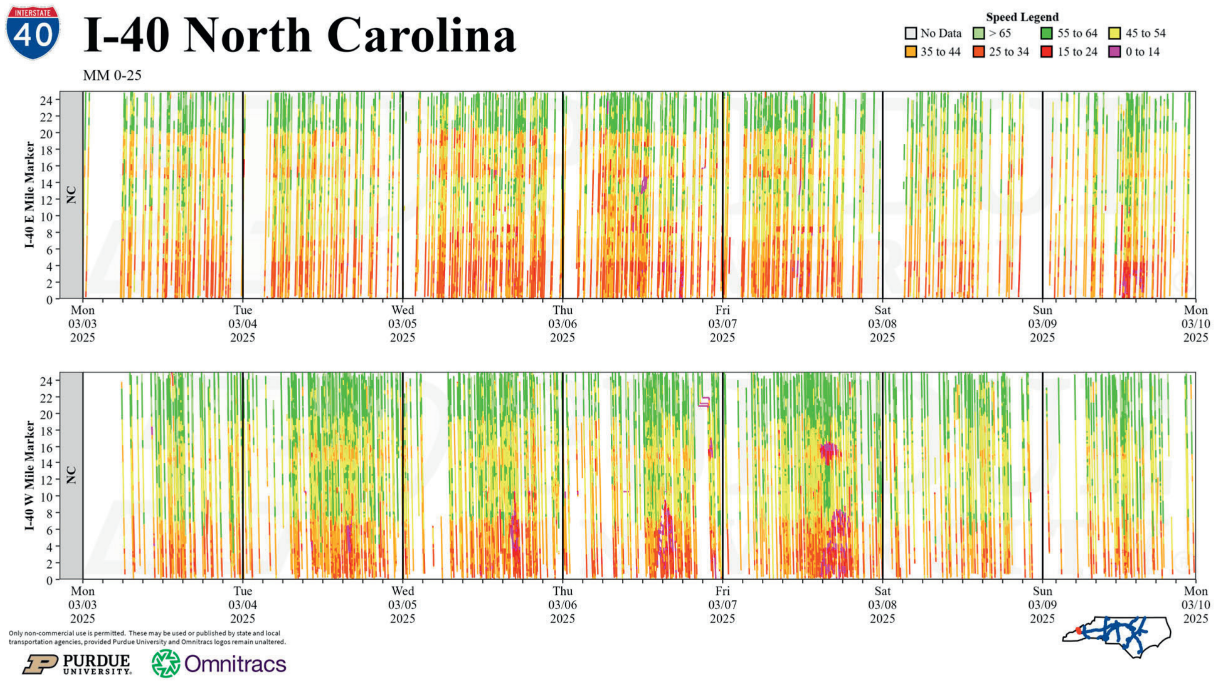


Figure 5.24 Traffic Speed Heatmap for I-40 MM0-25 in North Carolina for the Week of Monday, March 3, 2025.

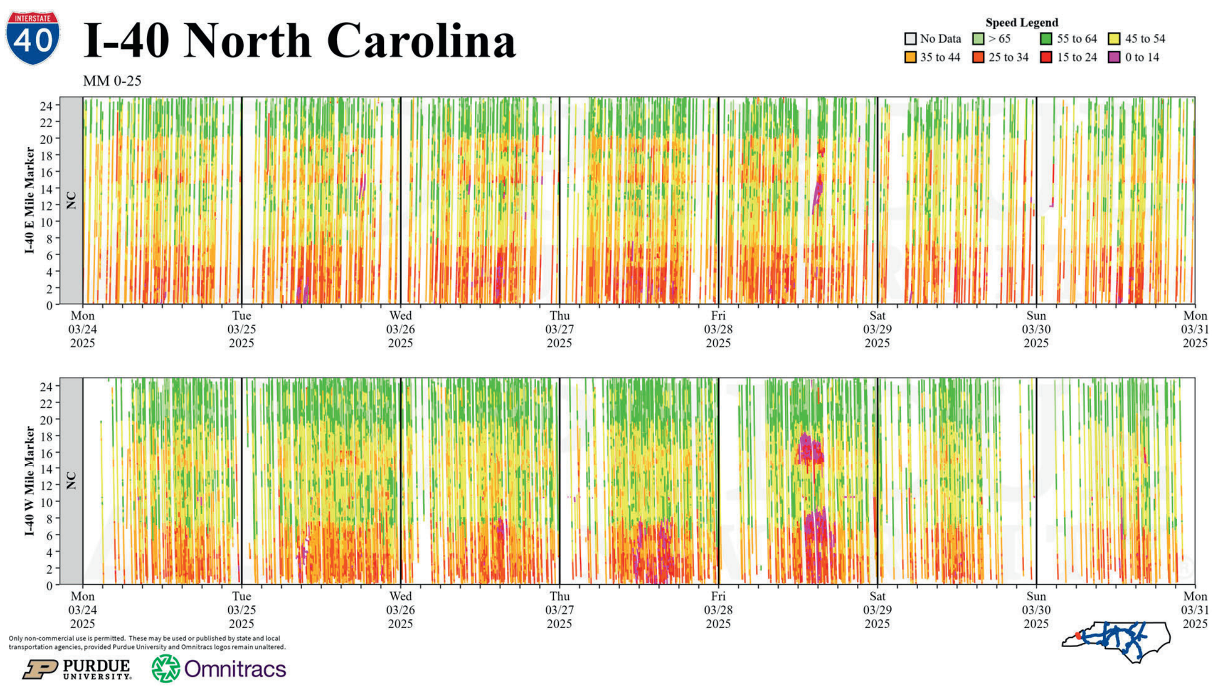


Figure 5.25 Traffic Speed Heatmap for I-40 MM0-25 in North Carolina for the Week of Monday, March 24, 2025.

(Figure 5.26). I-26 was reopened to traffic with some limitations on Wednesday, October 30, 2024, after the Tennessee Department of Transportation created a temporary roadway (*Interstate 26 Connecting North Carolina and Tennessee Reopens*, 2024). Figure 5.27 shows the first trucks passing through around noon. with the

5.10.3 Francis Scott Key Bridge Collapse in Baltimore, Maryland

At approximately 1:30 a.m. on Tuesday, March 26, 2024, a cargo ship leaving the Port of Baltimore struck the I-695 Francis Scott Key Bridge leading to a collapse (Maryland

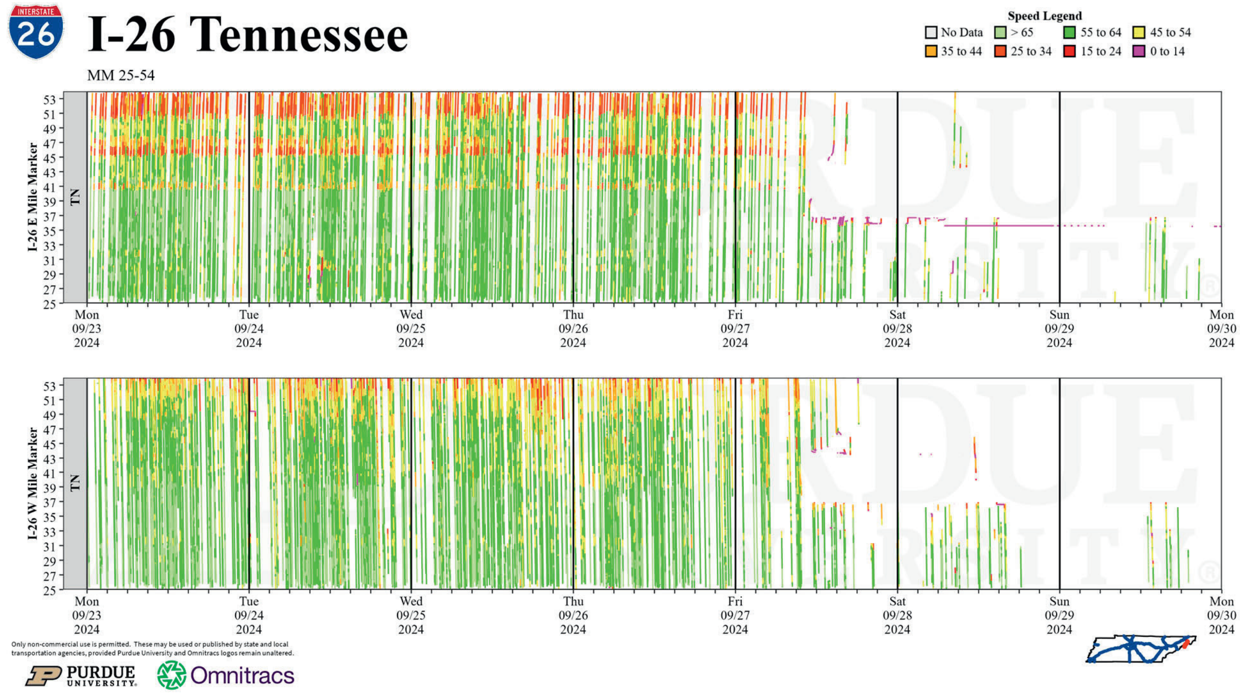


Figure 5.26 Traffic Speed Heatmap for I-26 MM25-54 in Tennessee for the Week of Monday, September 23, 2024.

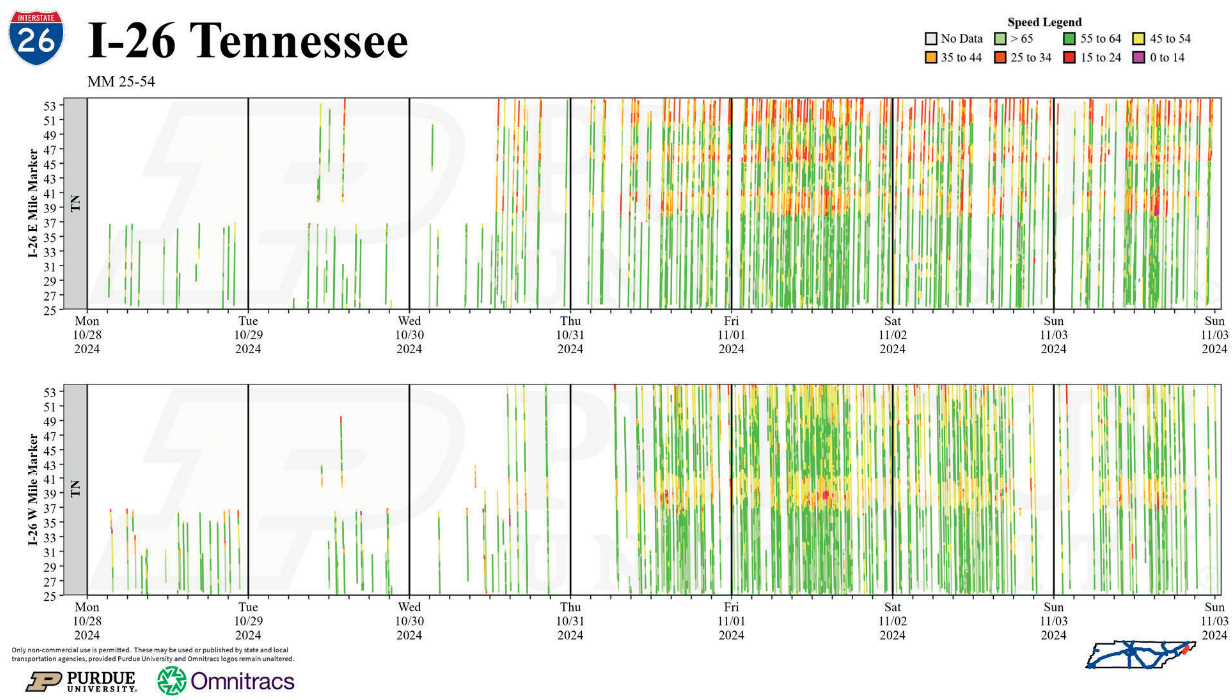


Figure 5.27 Traffic Speed Heatmap for I-26 MM25-54 in Tennessee for the Week of Monday, October 28, 2024.

Transportation Authority [MDTA], n.d.). Figure 5.28 shows a traffic speed heatmap for a 12-mile section of I-695 around Baltimore, with MM 48 indicating the approximate linear referenced location of the Francis Scott Key Bridge, for the week of Monday, March 18, 2024, before the collapse. Figure 5.29 shows a traffic speed heatmap for the same section for the week of Monday March 25, 2024. The traffic flowing through this section of I-695 on Monday, March 18 through Monday, March 25 presents a brief outlook on the level of traffic that was facilitated by the bridge on a daily basis. Following

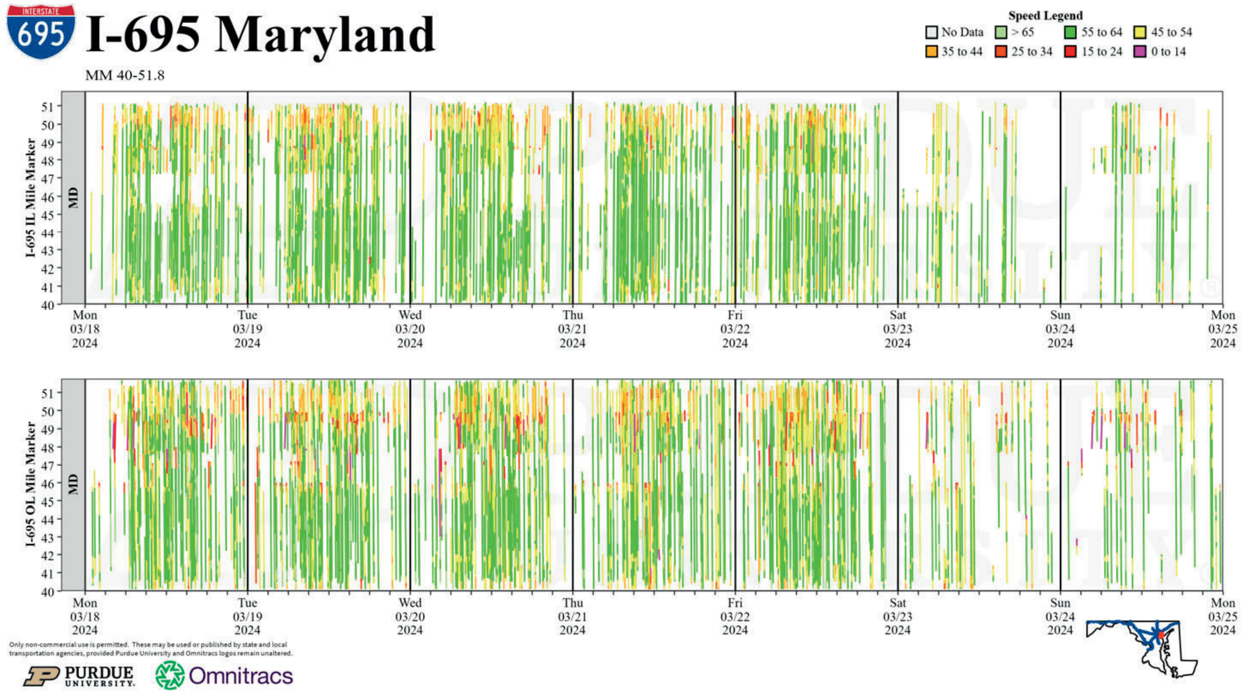


Figure 5.28 Traffic Speed Heatmap for I-695 MM40-51.8 in Maryland for the Week of Monday, March 18, 2024.

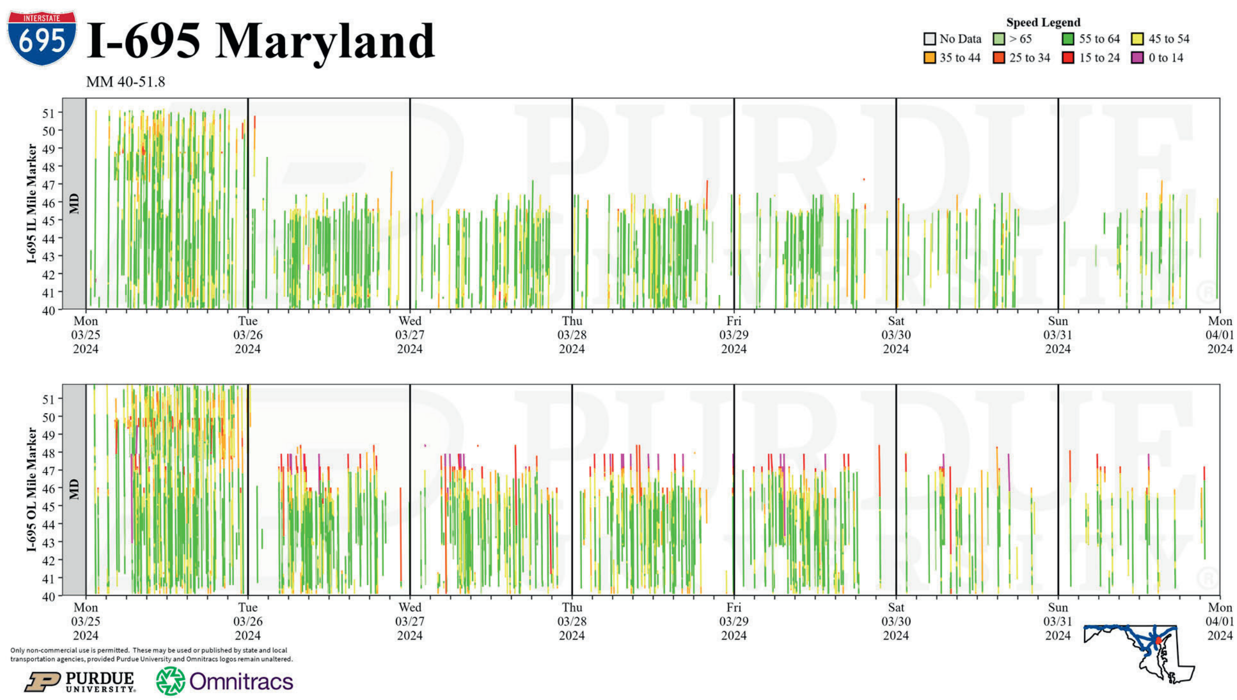


Figure 5.29 Traffic Speed Heatmap for I-695 MM40-51.8 in Maryland for the Week of Monday, March 25, 2024.

the collapse on March 26, 2024, the Inner Loop of the roadway was closed at MM 45.6 (Exit 42), while the Outer Loop closed at MM 2 (Exit 1) across the Patapsco River. Figure 5.30 shows how truck traffic patterns on the same I-695 section almost a year after the incident for the week of Monday, March 17, 2025. These heatmap visuals allow for a quick, qualitative analysis of change in traffic patterns year-over-year, and clearly show a modest, but not significant, reduction in truck traffic on this I-695 section as commercial vehicles have adapted over the year to using other officially designated alternate routes per MDTA (n.d.) of I-95, I-895 (tunnels), or western I-695 around the tunnels.

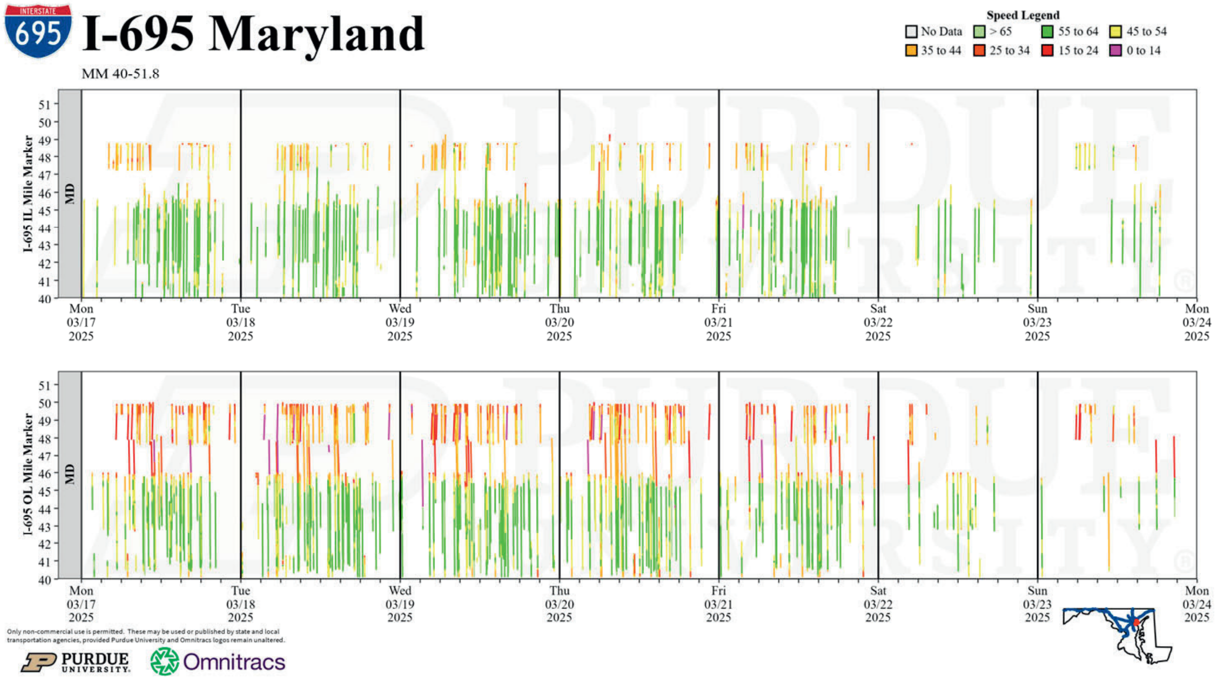


Figure 5.30 Traffic Speed Heatmap for I-695 MM40-51.8 in Maryland for the Week of Monday, March 17, 2025.

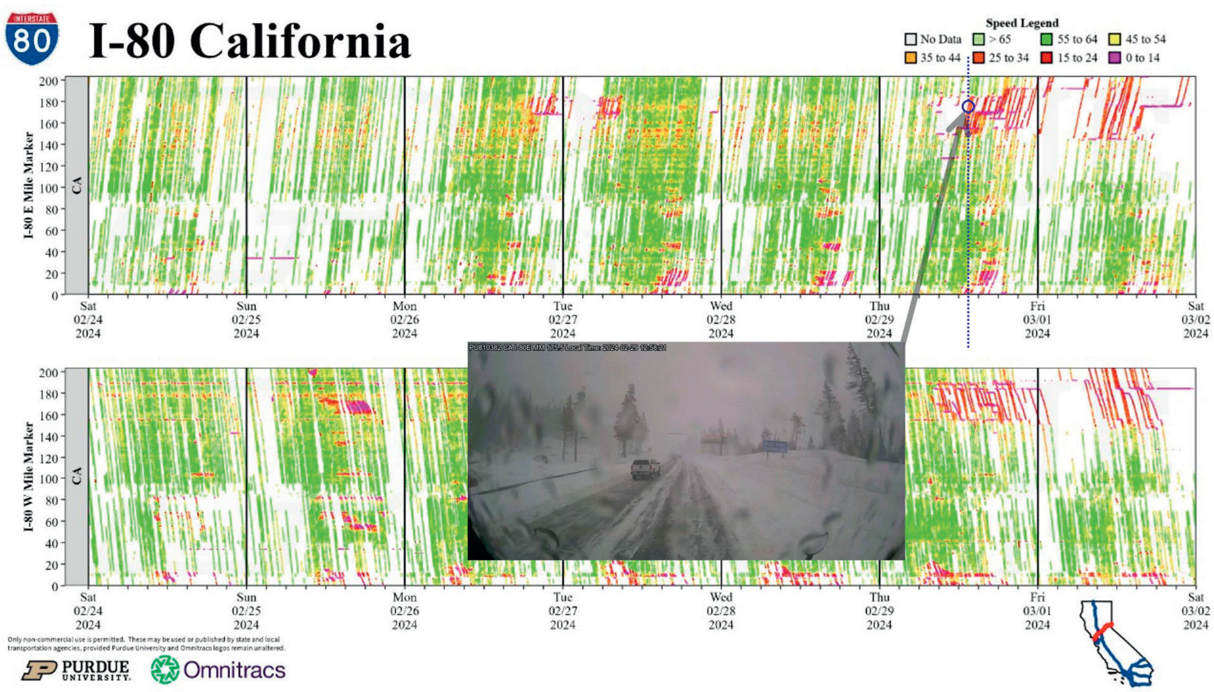


Figure 5.31 Traffic Speed Heatmap with Inset Dash Camera Image for I-80 in California for the Week Starting Saturday, February 24, 2024.

5.10.4 Winter Storm Impact on California's Donner Pass

The National Climate Report for March 2024 highlighted a four-day blizzard in early March which impacted California with 5–7 ft of snow fall (National Centers for Environmental Information, 2024a). The report observed cars and tractor trailers stranded overnight on I-80 as inclement weather conditions forced road closures. It was reported on March 1, 2024, that the California Highway Patrol had closed both directions of I-80 near Donner Summit (MM 180) with westbound traffic being turned around at the Nevada state line (MM 203.6) and eastbound motorists being turned around near Drum Forebay (MM 150; ABC7 Bay Area Digital Staff et al., 2024). The heatmap in Figure 5.31 shows the road closure going into effect in the

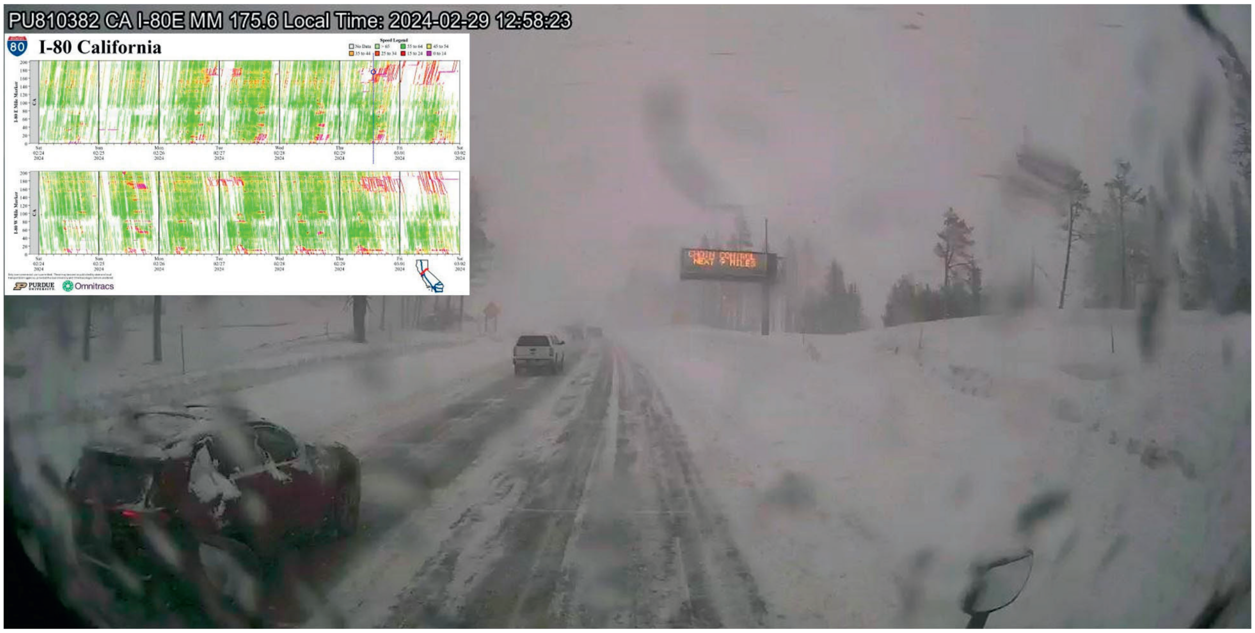


Figure 5.32 Dash Camera Image With Inset Heatmap for I-80 in California MM 175.6 on Thursday, February 29, 2024.

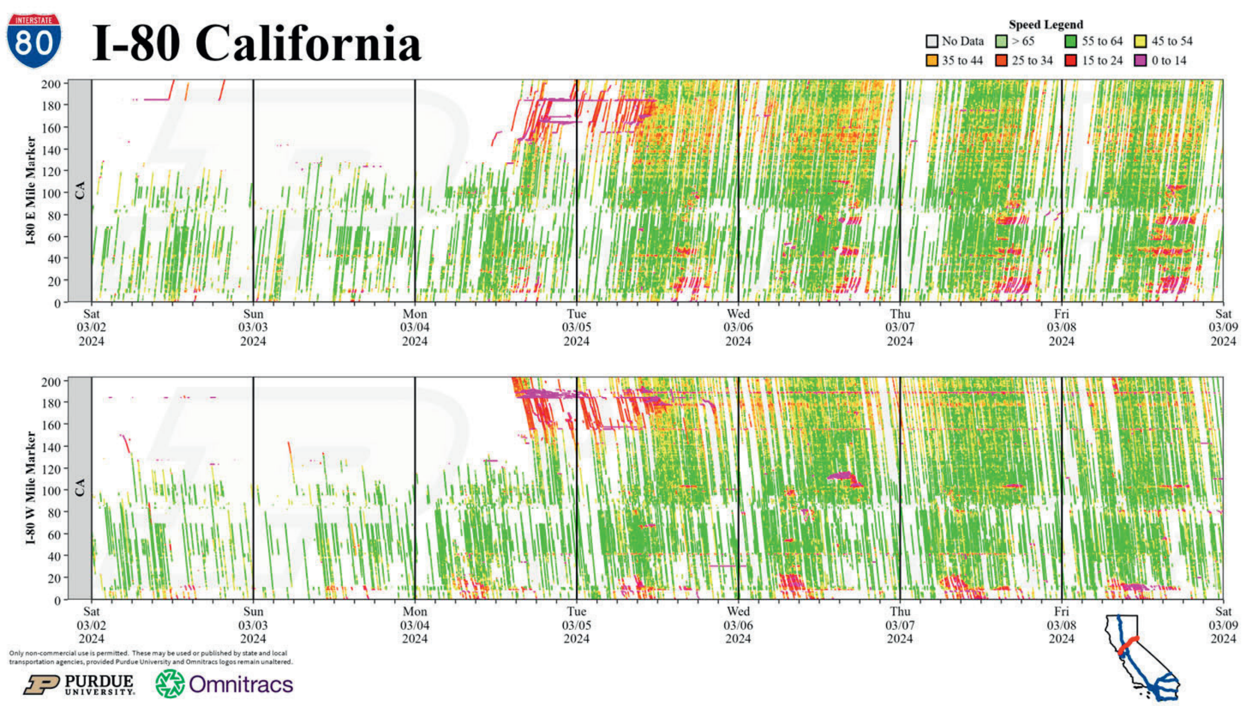


Figure 5.33 Traffic Speed Heatmap for I-80 in California for the Week Starting Saturday, March 2, 2024.

afternoon of March 1 from about MM 150. The closure is in effect for the next four days with the roadway reopening the afternoon of Monday, March 4, 2024, as shown by the heatmap in Figure 5.33. Commercial vehicle dash camera images obtained from trucks passing through Donner Pass just as this blizzard was starting to impact the area are seen by the inset image in Figure 5.31 and Figure 5.32. The overhead digital message sign in Figure 5.32 appears to read "CHAIN CONTROL NEXT 9 MILES." These visualizations and datasets can thus be used to assess roadway mobility during inclement weather events, lasting nearly four days and impacting 70 miles of roadway in this case.

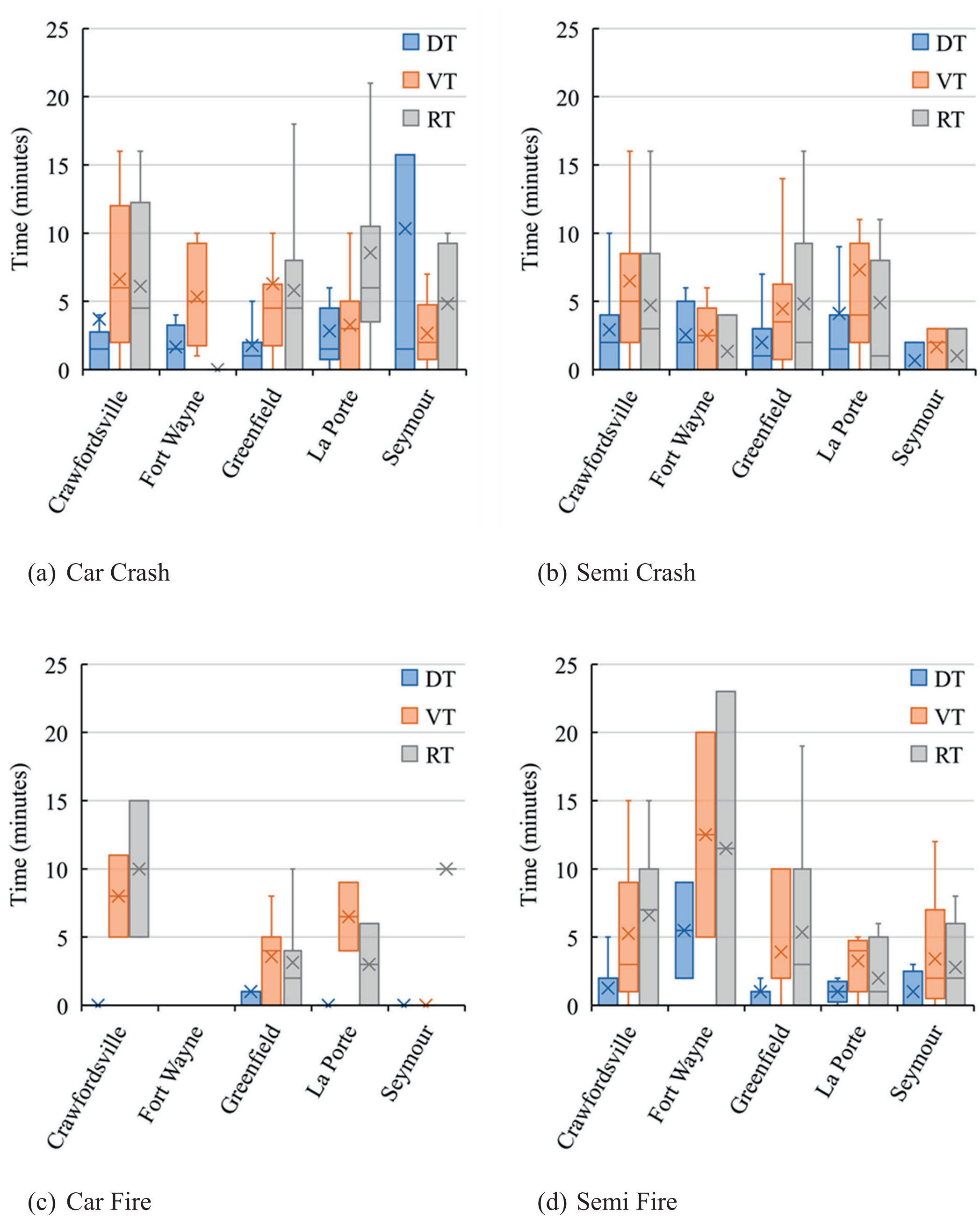
6. STATISTICS ON AFTER-ACTION REPORTS

TIM intervals are performance measures standardized by the FHWA to quantify the program's effectiveness at managing specific incidents. This allows for comparing incident types across the INDOT districts to determine where additional training and resources can be allocated to improve and lower the overall TIM intervals times of any incident. The five intervals that are being measured in this report are:

- Detection Time (DT) estimated as $T_1 - T_0$
- Verification Time (VT) estimated as $T_2 - T_1$
- Response Time (RT) estimated as $T_4 - T_2$
- Roadway Clearance Time (RCT) estimated as $T_5 - T_1$
- Incident Clearance Time (ICT) estimated as $T_6 - T_1$

6.1 Detection, Verification, and Response Time Intervals

Figure 6.1 illustrates the detection time, verification time, and response time TIM intervals for car and semi crashes as well as car and semi fire incidents across the districts. Table 6.1, Table 6.2, Table 6.3, and Table 6.4 show the 25th, 50th, and 75th percentiles of the detection times, verification times, and the responses times by incident type and district. No after-action



(a) Car Crash

(b) Semi Crash

(c) Car Fire

(d) Semi Fire

Figure 6.1 Box and Whisker Plot of Detection Time (DT), Verification Time (VT), and Response Time (RT) Intervals by Type and District. The X in Each Plot Indicates the Average Value for Each Interval.

TABLE 6.1
Detection, Verification, and Response Time Intervals in Minutes by District for Car Crashes (n = 90).

	Detection Time			Verification Time			Response Time		
District	25th	50th	75th	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 28)	0	2	2	3	6	11	0	5	12
Fort Wayne (n = 6)	0	2	3	3	5	8	0	0	0
Greenfield (n = 31)	0	1	2	2	5	6	0	5	8
La Porte (n = 19)	1	2	4	0	3	5	4	6	10
Seymour (n = 6)	0	2	2	1	2	4	1	5	8

TABLE 6.2
Detection, Verification, and Response Time Intervals in Minutes by Districtfor Semi Crashes (n = 154).

	Detection Time			Verification Time			Response Time		
District	25th	50th	75th	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 64)	0	2	4	2	5	9	0	3	9
Fort Wayne (n = 7)	1	2	5	0	3	4	0	0	3
Greenfield (n = 52)	0	1	3	1	3	6	0	2	8
La Porte (n = 27)	0	2	4	2	4	9	0	1	8
Seymour (n = 4)	0	0	1	1	2	3	0	0	2

TABLE 6.3
Summary Table of Detection, Verification, and Response Time Intervals in Minutes by Type and District for Car Fires (n = 12).

	Detection Time			Verification Time			Response Time		
District	25th	50th	75th	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 2)	0	0	0	7	8	10	8	10	13
Fort Wayne (n = 0)	–	–	–	–	–	–	–	–	–
Greenfield (n = 7)	0	1	1	2	4	5	1	2	4
La Porte (n = 2)	0	0	0	5	7	8	2	3	5
Seymour (n = 1)	0	0	0	0	0	0	10	10	10

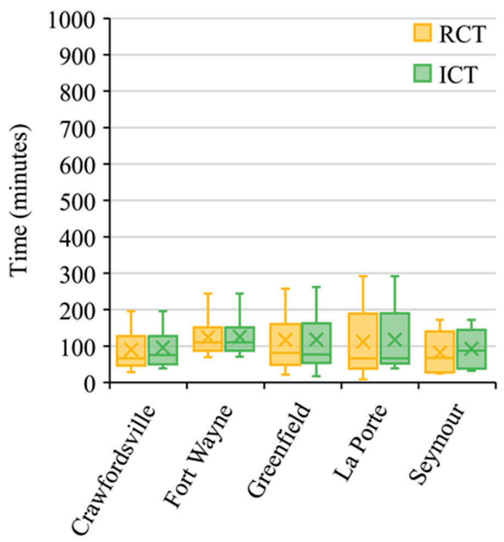
TABLE 6.4
Summary Table of Detection, Verification, and Response Time Intervals in Minutes by Type and District for Semi Fires (n = 38).

	Detection Time			Verification Time			Response Time		
District	25th	50th	75th	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 15)	0	0	2	2	3	8	1	7	10
Fort Wayne (n = 2)	4	6	7	9	13	16	6	12	17
Greenfield (n = 12)	0	0	1	2	2	7	1	3	9
La Porte (n = 4)	1	1	1	3	4	4	0	1	3
Seymour (n = 5)	0	0	2	1	2	2	0	2	4

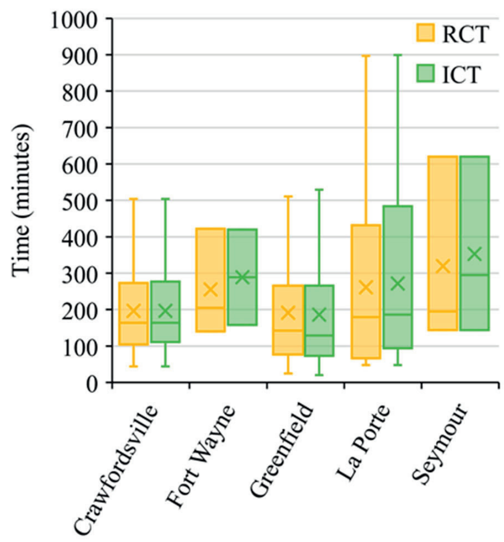
reports were prepared in the Vincennes district; thus, it is omitted from the plots and tables. For car fires, Fort Wayne did not have any after-action reports.

For car crashes (Table 6.1), the average 50th percentile for detection time for all the districts is 2 min. The average 50th percentile for verification time across all districts is 4 min. For response time, the average 50th percentile for Crawfordsville, Greenfield, and Seymour is 5 min, and La Porte is 6 min. Fort Wayne is 0 min likely due emergency vehicles being the verification of the incident instead of ITS cameras. The higher response time in La Porte can be due to heavily congested routes such as I-94. Crawfordsville, Seymour, and Greenfield response times can likely be higher due to rural areas in the district requiring longer times to respond.

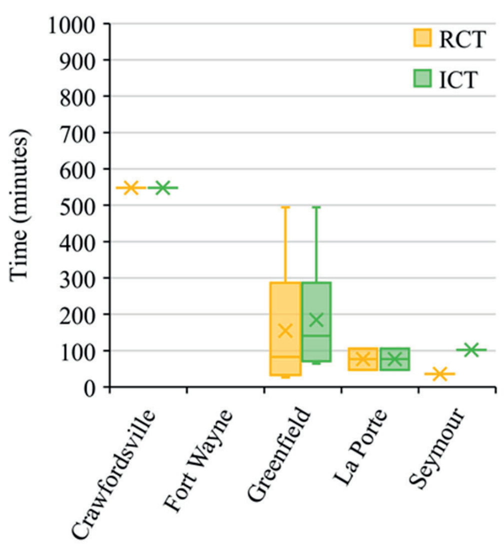
For semi crashes (Table 6.2), the average 50th percentile for detection time for all the districts is 1–2 min. The average 50th percentile for verification time across all districts is 3 min. For response time, the average 50th percentile for Crawfordsville, Greenfield, and La Porte is 2 min, where the average 50th percentile for Fort Wayne and Seymour is 0 min which can be due to the verification time and the arrival on scene time being the same.



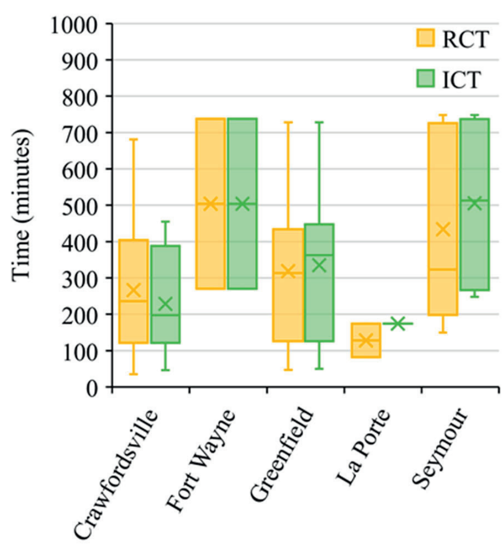
(a) Car Crash



(b) Semi Crash



(c) Car Fire



(d) Semi Fire

Figure 6.2 Box and Whisker Plot of Roadway Clearance Time (RCT and Incident Clearance Time (ICT) Intervals by Type and District. The X in Each Plot Indicates the Average Value for Each Interval.

For car fires (Table 6.3), the sample size was relatively low with only the Greenfield district having more than two after-action reports of a car fire. The average 50th percentile for detection time was 1 min, verification time was 4 min, and response time was 5 min.

For semi fires (Table 6.4), the detection time for Crawfordsville, Greenfield, La Porte, and Seymour were all low with the average 75th percentile of 1 min. The Fort Wayne district only had two semi fire after-action reports which did not allow for a stronger comparison of the TIM intervals. For verification time, the average 50th percentile of all districts except Fort Wayne was 2.5 min. For response time, the average 50th percentile for Greenfield, La Porte, and Seymour is 3 min,where the 50th percentile for Crawfordsville is 7 min which could be due to less ITS along the routes in the district.

6.2 Roadway Clearance and Incident Clearance Time Intervals

Figure 6.2 illustrates the RCT and ICT TIM intervals by district. Table 6.5, Table 6.6, Table 6.7, and Table 6.8 show the 25th, 50th, and 75th percentiles of the roadway clearance times and the incident clearance time by incident type and district. For car fires, Fort Wayne did not have any after-action reports with either of these intervals.

For car crashes (Table 6.5), roadway clearance and incident clearance times are similar time across the districts with the average 50th percentile being 70 for RCT and 77 min for ICT, with the exception of Fort Wayne being 111 min for both. The higher clearance times for the Fort Wayne District can be due to the rural areas outside of the Fort Wayne metro area which can increase the time to provide additional response if needed.

For semi crashes (Table 6.6), Crawfordsville, Greenfield, and La Porte's average 50th percentiles for roadway clearance times and incident clearance times were 162 min for both. The intervals are higher for Fort Wayne and Seymour districts with the average 50th percentiles for RCT and ICT being 200 and 290 min, respectively. This can be due to more rural areas requiring more time for recovery of the semis if overturned.

For car fires (Table 6.7), the Greenfield district cleared the incidents on the lower range in approximately 1 hr, but some car fires can be almost 5 hr depending on the complexity of the incident.

TABLE 6.5
Summary Table of Roadway Clearance Time and Incident Clearance Time Intervals in Minutes by Type and District for Car Crashes (n = 90).

	Roadway Clearance Time			Incident Clearance Time		
District	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 28)	48	67	115	52	75	117
Fort Wayne (n = 6)	95	111	120	95	111	120
Greenfield (n = 31)	52	81	155	54	77	153
La Porte (n = 19)	39	66	186	52	66	188
Seymour (n = 6)	29	68	123	48	88	127

TABLE 6.6
Summary Table of Roadway Clearance Time and Incident Clearance Time Intervals in Minutes by Type and District for Semi Crashes (n = 154).

	Roadway Clearance Time			Incident Clearance Time		
District	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 64)	107	164	272	113	164	268
Fort Wayne (n = 7)	173	205	314	224	289	355
Greenfield (n = 52)	78	142	266	76	129	266
La Porte (n = 27)	70	180	404	102	186	454
Seymour (n = 4)	170	195	408	220	295	458

TABLE 6.7
Summary Table of Roadway Clearance Time and Incident Clearance Time Intervals in Minutes by Type and District for Car Fires (n= 12).

	Roadway Clearance Time			Incident Clearance Time		
District	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 2)	548	548	548	548	548	548
Fort Wayne (n = 0)	–	–	–	–	–	–
Greenfield (n = 7)	52	83	188	80	141	217
La Porte (n = 2)	62	77	91	62	77	91
Seymour (n = 1)	36	36	36	102	102	102

TABLE 6.8
Summary Table of Roadway Clearance Time and Incident Clearance Time Intervals in Minutes by Type and District for Semi Fires (n= 38).

	Roadway Clearance Time			Incident Clearance Time		
District	25th	50th	75th	25th	50th	75th
Crawfordsville (n = 15)	129	236	389	129	198	292
Fort Wayne (n = 2)	387	504	621	387	504	621
Greenfield (n = 12)	172	314	391	174	363	413
La Porte (n = 4)	105	128	151	174	174	174
Seymour (n = 5)	246	323	703	304	513	714

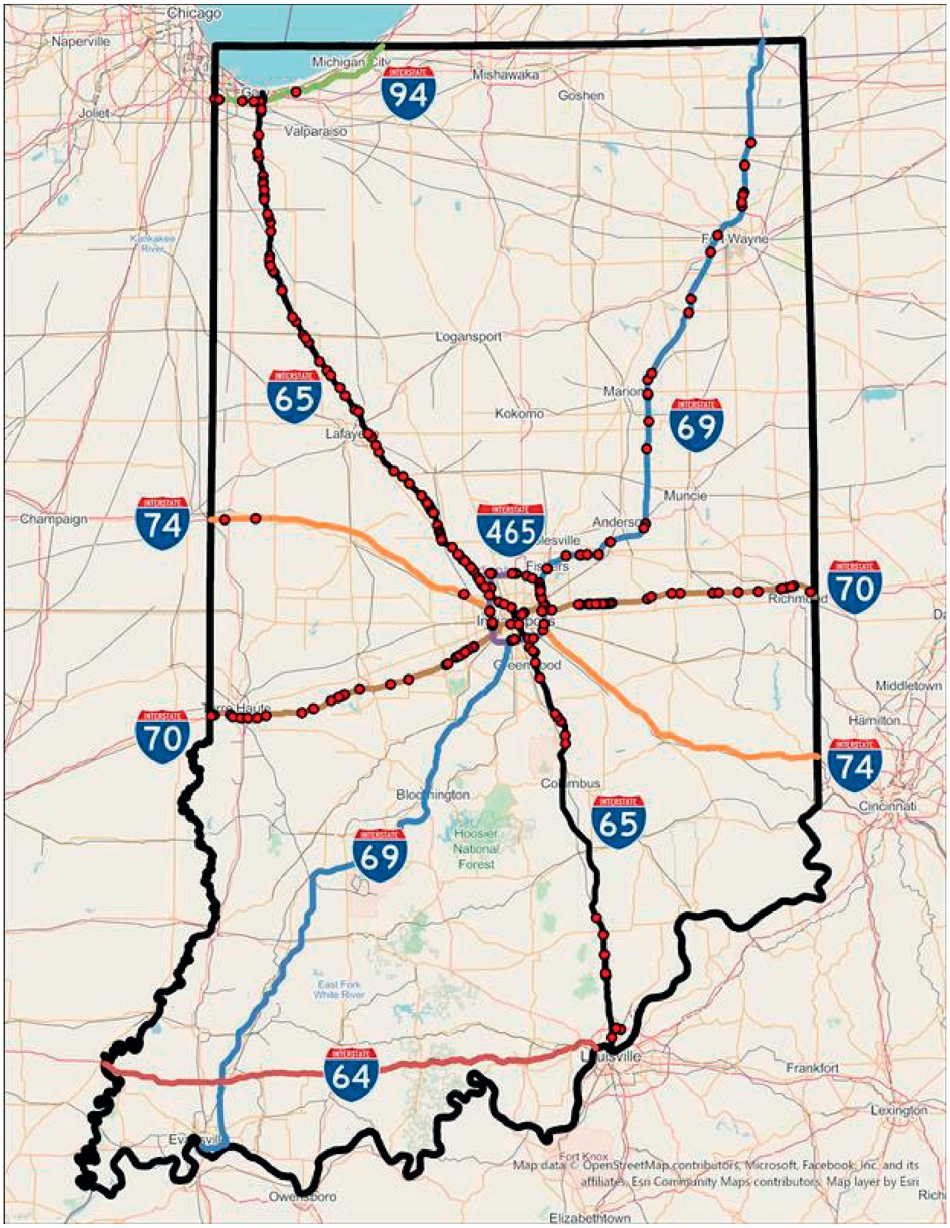


Figure 6.3 Map of Indiana Showing Completed 265 After-action reports by Interstate Route.

For semi fires (Table 6.8), the La Porte district cleared the scenes much quicker than the other districts with a 50th percentile of 128 min for the RCT and 174 for the ICT. Fort Wayne. Greenfield, and Seymour have an average 50th percentile of 460 min for ICT. Greenfield does have a higher ICT clearance time than Crawfordsville and Fort Wayne which likely means that, while they are able to open the roadways in a similar time, the incident may still be on the shoulder with all the travel lanes open.

Figure 6.3 provides a map of the Indiana primary interstates and all after-action reports completed and the location in which the incident occurred (solid red circles) over the course of the project period.

7. SUMMARY OF ENGAGEMENTS AND DISSEMINATION

A summary of engagements including presentations and training, both past and future, are included below as dissemination of research materials. The existing heatmap tool also provides real-time and historic traffic conditions on Indiana interstates using CV data and ITS cameras.

7.1 Past INTime Meetings

Table 7.1 summarizes the three field visits, two trainings, and five meetings attended by the research team over the course of this project.

TABLE 7.1
Field Visits and Trainings Attend by a Research Team in Indiana.

Title of Event	Date	Location	Reason
INTime Statewide Meeting	September 19, 2023	Virtual	Presentation
INTime Statewide Meeting	October 17, 2023	Virtual	Presentation
INTime Statewide Meeting	November 11, 2023	Virtual	Presentation
INTime Statewide Meeting	January 23, 2024	Virtual	Presentation
INTime Statewide Meeting	March 14, 2024	INDOT TMC	Presentation
TIM Training	March 14, 2024	INDOT TMC	TIM Training
FHWA EDC	October 30, 2024	INDOT TMC	Presentation
TIM Training	January 22, 2025	Daviess County	TIM Training
Indiana TIM Steering Committee	April 4, 2025	INDOT TMC	Meeting
TIM Training	April 15, 2025	Wayne County	TIM Training
TIM Training	May 3, 2025	Wayne County	TIM Training
TIM Training	May 14, 2025	Lake County	TIM Training

Figure 7.1 Indiana TIM Steering Committee Meeting on April 4, 2025.

Figure 7.1 is of an Indiana TIM Steering Committee meeting on April 4, 2025, with various stakeholders involved.

7.2 Heatmap Tools

The existing heatmap tool provides real-time information about the traffic conditions on Indiana highways from CV data and overlays ITS camera images for a systematic statewide scan, as shown in Figure 7.2. This tool has found widespread use across INDOT over the past several years and brings several datasets including CV data, ITS camera images, weather data, crash reports, maintenance vehicles telematics, and digital alerts into one combined visualization.

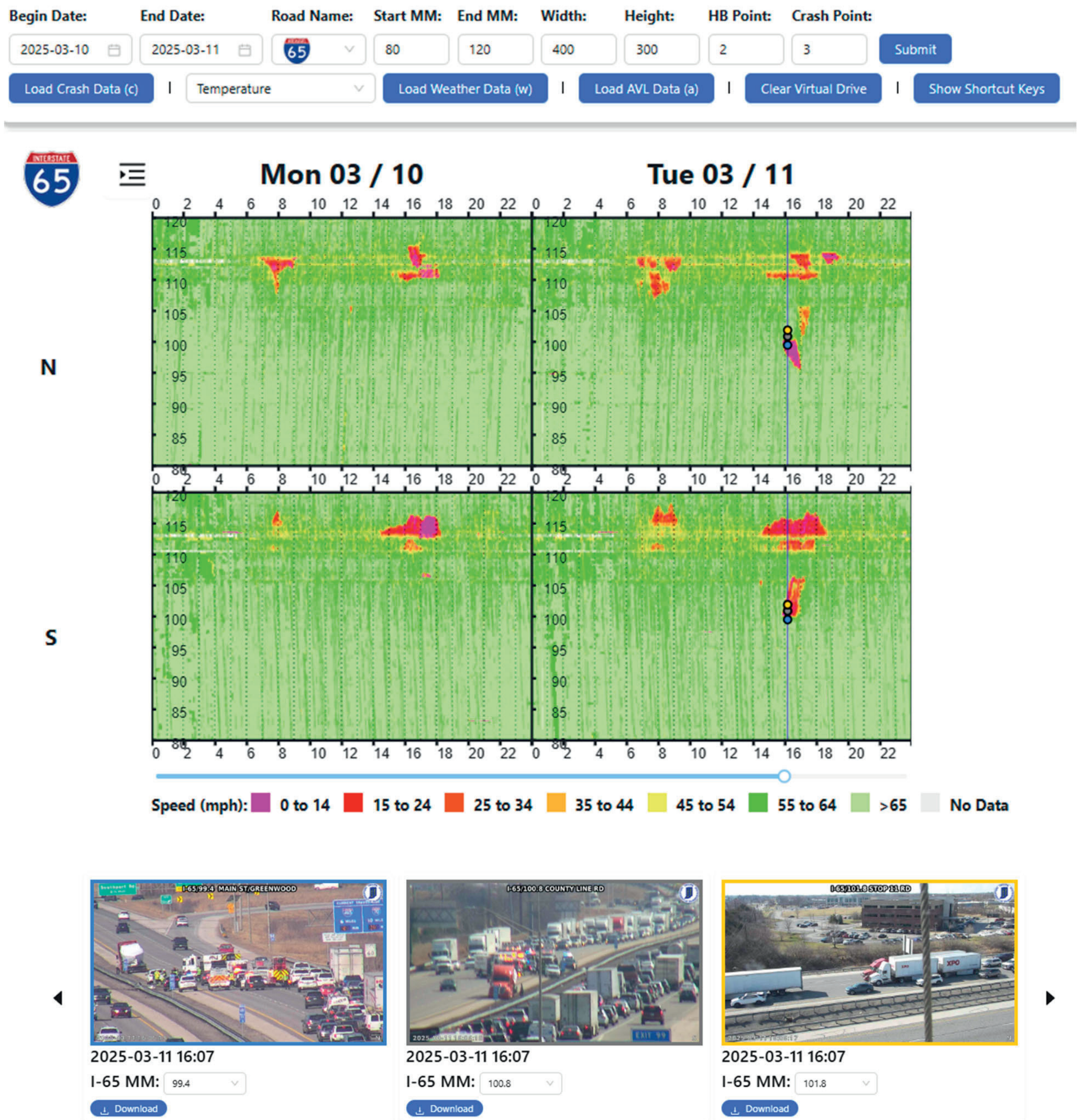


Figure 7.2 View of Heatmap Tool.

8. CONCLUSIONS

Secondary crashes occur frequently and can often be worse than the primary crash. There is consensus that developing relationships with a broad cross section of stakeholders and meeting regularly provides a foundation for effective incident response. Figure 7.1 shows a photo from one such meeting on April 4, 2025.

Through the course of this project, a number of supporting datasets as well as an evolved TIM timeline have been identified to help document the potential data sources that can be used to supply TIM event sequence times and subsequently document performance of current TIM practices. While this report utilizes a selection of case studies both within and outside of Indiana to demonstrate the applicability of datasets and the proposed extraction methodology, the research team has also created an online open-access repository where a comprehensive collection of all after-action reports generated through the course of this project are hosted and can be used as supporting material for future TIM trainings (Overall, Mukai, Sakhare, Desai, Horton, & Bullock, 2025).

The repository provides a rich collection of after-action reports involving a diverse cross section of incidents across Indiana that can be used by stakeholders for training and modeling beyond Indiana on good practices for objectively documenting incidents from initial events through response, clearance and ultimately restoration of traffic.

8.1 Future Scope

A number of studies, as well as ongoing research efforts, may aid and help enhance TIM data collection practices through the use of automatic ITS camera movements, dash camera images, radio message transcription and large language models, and in-vehicle alerts, as discussed in the following subsections.

8.1.1 Automatic Movement of ITS Cameras

TMC operators typically control the movement of ITS cameras along with other tasks such as verifying emergency calls, helping to dispatch emergency services to incidents, monitoring on-scene maintenance of traffic, and proactively monitoring the camera network for potential incidents. A parallel technology (Gartner et al., 2024; Mathew, Malackowski, Gartner, et al., 2023; Mathew, Malackowski, Koshan, et al., 2024) has been developed that can detect anomalies on highways using the response of Safety Service Patrols, such as Hoosier Helpers, and eventually from CV data and turn these cameras quickly to incidents and reduce the $T_{2,eye}$ time during an incident timeline.

8.1.2 Dash Camera Images

The technology of harnessing dash camera images directly from vehicles is evolving. This is presented in 19 events among the 267 after-action reports listed in Appendix A. The growth will continue to make these better and more frequent for all events on highways. Similar dash camera images harnessed from emergency response vehicles like Hoosier Helpers and/or Indiana State Police alongside the images crowdsourced from commercial trucks and passenger vehicles will continue to provide additional context during or after an active management of incidents on the roadways (Sakhare, 2023; Sakhare, Desai, Mathew, & Bullock, 2024a).

8.1.3 Audio Transcription

Studies are ongoing that anticipate using audio transmissions on public safety radio channels from first responders to facilitate active incident management as well as after-action reviews. The approach focuses on using open-source machine-learning audio transcription techniques to transcribe scanner radio recordings into text from which relevant events and geospatial information can be extracted. This will provide TMCs with context in areas with limited roadside ITS camera coverage and where limited or no ITS infrastructure are available.

8.1.4 In-Vehicle Alerts

Emerging technological developments in in-vehicle and in-cab alerts hold immense potential to be a proactive safety measure in aiding TIM practices. Multiple operators in collaboration with CV data providers currently push alerts directly to the electronic logging devices of commercial vehicle drivers approaching zones of recurring or nonrecurring congestion on limited access roadways giving them advance warning of roadway congestion. Studies conducted for corridors in Ohio and Indiana have shown that 19–25% of drivers receiving such in-cab alerts slow down by 5 mph or more within 30 s of such an alert (Desai, Mathew, & Bullock, 2024; Desai, Saldivar-Carranza, et al., 2024). The same alerting technology could be provisioned, for example, in case of a traffic incident that leads to a full or partial road closure and queuing while recovery operations are in progress, to warn drivers approaching the back of such a queue to reduce the risk of secondary crashes as well as improve first responder safety. Additionally, providers and states send out these alerts in case of emergency situations such as hurricanes and tornados, to warn drivers of upcoming hazardous driving conditions.

On the passenger vehicle front, in-vehicle alerting technology has evolved over the past decade ranging from navigation applications receiving incident or construction alerts to the vehicle's dashboard/infotainment system directly receiving these alerts when approaching a construction zone or active first responder vehicle. Studies have shown that queue warning trucks capable of sending digital alerts to motorists approaching queued traffic, through navigation applications such as Waze, result in a near 80% reduction in hard-braking events (Sakhare, Desai, Mahlberg, et al., 2021), a surrogate for crash incidents (Desai, Li, et al., 2021; Desai, Mathew, Li, et al., 2023), thus improving roadway safety for all involved. These digital alerts have since evolved to be sent directly to a vehicle's infotainment system. Future efforts may be directed towards provisioning such digital alerts for motorists approaching an active traffic incident so they can either safely navigate the incident scene through open lanes or safely stop at the back of queued traffic and be forewarned of active recovery operations taking place on scene.

The widespread availability of CV data enables practitioners to bring in enhanced performance measures for their incident management after-action reviews such as hard-braking and hard-acceleration events and will help them evaluate the pros and cons of various practices with quantifiable safety and mobility data.

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APPENDICES

Appendix A: List of Acronyms

Appendix B: List of Detailed After-Action Presentations

Appendix C: TIM Event Summary Intervals for Analyzed After-Action Events

Appendix A. List of Acronyms

ARIES	Automated Reporting Information Exchange System
AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CARS	Condition Acquisition Reporting System
CV	Connected Vehicle
DOT	Department of Transportation
DT	Detection Time
EB	Eastbound
ELD	Electronic Logging Devices
EMS	Emergency Medical Services
EST	Eastern Standard Time
FHWA	Federal Highway Administration
GPS	Global Positioning System
HRRR	High-Resolution Rapid Refresh
ICT	Incident Clearance Time
IL	Inner Loop
INDOT	Indiana Department of Transportation
IQR	Interquartile Range
ISP	Indiana State Police
ITS	Intelligent Transportation System
JTRP	Joint Transportation Research Program
MDTA	Maryland Transportation Authority
MM	Mile Marker
NB	Northbound
NHTSA	National Highway Traffic Safety Administration
NOAA	National Oceanic and Atmospheric Administration
OL	Outer Loop
RCT	Roadway Clearance Time
REM	Roadway Event Manager
RT	Response Time
SB	Southbound
TDOT	Tennessee Department of Transportation
TIM	Traffic Incident Management
TMC	Traffic Management Center
UAS	Unmanned Aerial Systems
USGS	United States Geological Survey
VT	Verification Time
WB	Westbound

Appendix B. List of Detailed After-Action Presentations

The tables below list all the detailed after-action reports prepared for 267 events during the period from August 21, 2016, to March 23, 2025.

Table B.1 After-Actions from February 2025–March 2025.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202503-04	3/23/25	I70W	142.0	Wayne	Overturned Semi with Back of Queue Crash	Semi Crash	Link
202503-03	3/19/25	I465OL	15.3	Marion	2 Passenger Vehicle Crash	Car Crash	Link
202503-02	3/13/25	I65N	126.2	Marion	Disabled Semi with Back of Queue Crash	Semi Crash	Link
202503-01	3/6/25	I65N	137.2	Boone	2 Semi Crash with Back of Queue Incident	Semi Crash	Link
202502-07	2/28/25	I94E	7.8	Lake	Passenger Vehicle Rear End Crash into Safety Service Patrol Vehicle	Car Crash	Link
202502-06	2/23/25	I465IL	27.6	Marion	3 Passenger Vehicle Crash	Car Crash	Link
202502-05	2/19/25	I94E	38.3	LaPorte	Semi Jackknife and 4 Passenger Vehicle Crash	Semi Crash	Link
202502-04	2/19/25	I70E	65.3	Hendricks	Semi Jackknife	Semi Crash	Link
202502-03	2/14/25	I65S	135.0	Boone	Semi Fire with Delayed Recovery	Semi Fire	Link
202502-02	2/13/25	I65S	126.8	Marion	2 Passenger Vehicle Crash	Car Crash	Link
202502-01	2/5/25	I70W	102.3	Hancock	Work Zone Passenger Vehicle Ran Off Road with 2 Back of Queue Crashes	Semi Crash	Link

Table B.2 After-Actions from January 2025.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202501-11	1/29/25	I94W	5.5	Lake	Semi Rollover	Semi Crash	Link
202501-10	1/24/25	I69	214.5	Hamilton	Semi Crash into Bridge Underpass	Semi Crash	Link
202501-09	1/23/25	I70W	0.1	Vigo	Cross Border Incident and Queuing into Indiana	Car Crash	Link
202501-08	1/23/25	I65N	86.8	Johnson	Passenger Vehicle Ran Off Road	Car Crash	Link
202501-07	1/20/25	I465IL	49.9	Marion	4 Passenger Vehicle Crash	Car Crash	Link
202501-06	1/17/25	I65S	75.7	Bartholomew	Temporary Work Zone with Back of Queue Semi Crash and Overnight Recovery	Semi Crash	Link
202501-05	1/16/25	I65N	165.8	Tippecanoe	Single Passenger Vehicle Rollover	Car Crash	Link
202501-04	1/15/25	I70E	10.0	Vigo	Semi Ran Off Road	Semi Crash	Link
202501-03	1/15/25	I69N	222.8	Madison	Passenger Vehicle Slide Off due to Ice	Car Crash	Link
202501-02	1/11/25	I65S	126.6	Marion	Passenger Vehicle Slide Off due to Icy Bridge	Car Crash	Link
202501-01	1/1/25	I65N	28.5	Scott	Semi Rollover	Semi Crash	Link

Table B.3 After-Actions from October 2024–December 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202412-09	12/30/24	I70E	103.8	Hancock	Work Zone Semi Ran Off Road	Semi Crash	Link
202412-08	12/28/24	I65N	235.7	Lake	2 Back of Queue Crashes due to Moving Operations	Car Crash	Link
202412-07	12/20/24	I65S	134.7	Boone	Passenger Vehicle and Semi Rear End	Semi Crash	Link
202412-06	12/19/24	I65S	102.9	Marion	Semi Crash with Fire	Semi Fire	Link
202412-05	12/17/24	1465IL	19.2	Marion	Passenger Vehicle Fire	Car Fire	Link
202412-04	12/16/24	I65N	140.4	Boone	Semi Jackknife	Semi Crash	Link
202412-03	12/13/24	I465OL	12.5	Marion	Overturned Semi	Semi Crash	Link
202412-02	12/10/24	I65N	95.7	Marion	Semi Fire	Semi Fire	Link
202412-01	12/5/24	I265E	8.8	Clark	Passenger Vehicle Ran Off Road	Car Crash	Link
202411-03	11/21/24	I65N	247.4	Lake	Semi Jackknife	Semi Crash	Link
202411-02	11/13/24	I69N	326.4	DeKalb	Work Zone Passenger Vehicle Crash into Semi	Semi Crash	Link
202411-01	11/12/24	I69N	326.6	DeKalb	Work Zone Semi Rear End	Semi Crash	Link
202410-08	10/31/24	I70W	60.2	Hendricks	Passenger Car Crash with Deer with 2 Back of Queue Crashes	Car Crash	Link
202410-07	10/31/24	I70W	66.2	Hendricks	Passenger Vehicle Ran Off Road	Car Crash	Link
202410-06	10/14/24	I69	231.8	Delaware	Semi Ran Off Road	Semi Crash	Link
202410-05	10/7/24	I465OL	45.6	Marion	Passenger Vehicle Crash with 3 Back of Queue Crashes	Car Crash	Link
202410-04	10/7/24	I69N	319.5	Allen	Motorcycle Crash with Back of Queue Crash	Car Crash	Link
202410-03	10/4/24	I65S	141.4	Boone	Semi and Passenger Vehicle Wrong Way Crash	Semi Crash	Link
202410-02	10/3/24	I70W	102.0	Hancock	Work Zone Disabled Semi with Back of Queue Crash	Semi Crash	Link
202410-01	10/2/24	I70W	63.0	Hendricks	3 Passenger Vehicle Crash due to Disabled Vehicle	Semi Crash	Link

Table B.4 After-Actions from August 2024–September 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202409-07	9/30/24	I65N	130.0	Boone	2 Passenger Vehicle Crash	Car Crash	Link
202409-06	9/26/24	I70W	105.4	Hancock	Work Zone Disabled Semi	Semi Crash	Link
202409-05	9/24/24	I69S	320.5	Allen	4 Passenger Vehicle Crash due to Heavy Rain	Car Crash	Link
202409-04	9/18/24	I65S	236.2	Lake	Work Zone Semi Ran Off Road	Semi Crash	Link
202409-03	9/18/24	I65N	147.0	Boone	Semi Rollover	Semi Crash	Link
202409-02	9/16/24	I65S	236.4	Lake	Work Zone Semi Ran Off Road	Semi Crash	Link
202409-01	9/4/24	I65N	257.4	Lake	Passenger Vehicle with Trailer Fire	Car Fire	Link
202408-16	8/30/24	I865E	4.9	Marion	Passenger Vehicle Barrier Wall Crash	Car Crash	Link
202408-15	8/29/24	I65N	43.5	Jackson	Semi Rollover	Semi Crash	Link
202408-14	8/28/24	I70E	104.7	Hancock	Work Zone Semi Crash and Median Barrier Replacement	Semi Crash	Link
202408-13	8/20/24	I465IL	38.6	Marion	Work Zone Semi Crash with Liquid Spill	Semi Crash	Link
202408-12	8/20/24	I65S	127.5	Hendricks	Overnight Work Zone with 3 Back of Queue Crashes	Semi Crash	Link
202408-11	8/17/24	I70W	95.0	Hancock	Disabled Semi	Semi Crash	Link
202408-10	8/17/24	I70W	104.0	Hancock	Work Zone 3 Vehicle Crash with Back of Queue Crash	Semi Crash	Link
202408-09	8/13/24	I69S	306.6	Allen	Work Zone 3 Passenger Vehicle Crash	Car Crash	Link
202408-08	8/13/24	I70W	147.3	Wayne	Temporary Work Zone with Back of Queue Crash	Semi Crash	Link
202408-07	8/12/24	I65S	255.6	Lake	3 Passenger Vehicle Crash	Car Crash	Link
202408-06	8/11/24	I65S	132.6	Boone	Passenger Vehicle Rollover	Car Crash	Link
202408-05	8/9/24	I65N	212.8	Jasper	Work Zone Back of Queue 2 Semi Crash	Semi Crash	Link
202408-04	8/6/24	I65N	238.0	Lake	Work Zone 3 Semi Rollover	Semi Crash	Link
202408-03	8/4/24	I65S	219.0	Jasper	Semi Sideswipe with Back of Queue Crash	Semi Crash	Link
202408-02	8/1/24	I465	39.0	Marion	Full Closure due to Flooding	Car Crash	Link
202408-01	8/1/24	I65S	18.5	Clark	2 Passenger Vehicle Ran Off Road Crashes due to Heavy Rain	Car Crash	Link

Table B.5 After-Actions from July 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202407-09	7/31/24	I65S	208.0	Jasper	Temporary Work Zone Back of Queue Semi Crash	Semi Crash	Link
202407-08	7/31/24	I70W	8.3	Vigo	Work Zone Truck Rollover with Back of Queue Crash	Semi Crash	Link
202407-07	7/31/24	I94E	14.3	Lake	Semi Rollover	Semi Crash	Link
202407-06	7/27/24	I65N	126.8	Marion	Passenger Vehicle Fire	Car Fire	Link
202407-05	7/21/24	I70W	100.5	Hancock	Work Zone 6 Passenger Vehicle Crash	Car Crash	Link
202407-04	7/11/24	I65S	238.1	Lake	Work Zone Semi Ran Off Road	Semi Crash	Link
202407-03	7/6/24	I65N	219.5	Jasper	2 Passenger Vehicle Crash due to Disabled Vehicle	Car Crash	Link
202407-02	7/3/24	I65	156.0	Clinton	4 Vehicle Crash with Overturned Semi Fire	Semi Fire	Link
202407-01	7/3/24	I65N	130.5	Boone	Semi Jackknife	Semi Crash	Link

Table B.6 After-Actions from June 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202406-14	6/29/24	I65S	116.1	Marion	Semi Crash and Car Fire with Back of Queue Semi Rollover	Car Fire	Link
202406-13	6/28/24	I70W	31.0	Putnam	Work Zone Semi Crash with 2 Back of Queue Crashes	Semi Crash	Link
202406-12	6/27/24	I70W	21.5	Clay	Semi and Pedestrian Crash	Semi Crash	Link
202406-11	6/25/24	I70W	101.0	Hancock	Work Zone Disabled Semi	Semi Crash	Link
202406-10	6/24/24	I70W	134.0	Henry	Semi Fire	Semi Fire	Link
202406-09	6/22/24	I65S	236.1	Lake	Work Zone Disabled Semi	Semi Crash	Link
202406-08	6/21/24	I70W	100.0	Hancock	Work Zone Passenger Vehicle with Trailer Fire	Car Fire	Link
202406-07	6/20/24	I65S	236.5	Lake	Work Zone Semi Crash	Semi Crash	Link
202406-06	6/17/24	I65S	236.7	Lake	Work Zone Semi Jackknife	Semi Crash	Link
202406-05	6/16/24	I70W	8.4	Vigo	Work Zone Semi Crash with Back of Queue Incident	Semi Crash	Link
202406-04	6/14/24	I70W	130.8	Henry	Head On 2 Semi Crash	Semi Crash	Link
202406-03	6/13/24	I70E	31.0	Putnam	Overturned Truck	Semi Crash	Link
202406-02	6/11/24	I74E	10.7	Fountain	Semi Ran Off Road	Semi Crash	Link
202406-01	6/3/24	I70E	34.2	Putnam	Semi Ran Off Road with Back of Queue Crash	Semi Crash	Link

Table B.7 After-Actions from May 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202405-20	5/28/24	I65S	251.7	Lake	Semi Fire	Semi Fire	Link
202405-19	5/27/24	I69N	205.7	Hamilton	Overturned Passenger Vehicle and Semi in Ditch	Semi Crash	Link
202405-18	5/25/24	I65S	149.8	Boone	Work Zone Semi Crash with Fire	Semi Fire	Link
202405-17	5/24/24	I465IL	3.3	Marion	Work Zone Semi Crash	Semi Crash	Link
202405-16	5/23/24	I65N	85.3	Johnson	Semi Fire	Semi Fire	Link
202405-15	5/22/24	I69N	209.6	Hamilton	Semi Fire	Semi Fire	Link
202405-14	5/22/24	I65S	99.6	Johnson	Semi Fire due to Debris in Roadway	Semi Fire	Link
202405-13	5/22/24	I65S	85.0	Johnson	Passenger Vehicle Fire	Car Fire	Link
202405-12	5/20/24	I465IL	29.9	Hamilton	3 Passenger Vehicle Crash	Car Crash	Link
202405-11	5/19/24	I69S	214.9	Madison	Overturned Semi	Semi Crash	Link
202405-10	5/16/24	I465OL	38.4	Marion	Work Zone Semi Fire	Semi Fire	Link
202405-09	5/16/24	I69N	316.6	Allen	3 Passenger Vehicle Crash with Back of Queue Crash	Car Crash	Link
202405-08	5/15/24	I65S	84.0	Johnson	Passenger Vehicle and Motorcycle Crash	Car Crash	Link
202405-07	5/10/24	I65S	239.5	Lake	Work Zone 3 Semi and 1 Passenger Vehicle Crash	Semi Crash	Link
202405-06	5/9/24	I65N	129.3	Boone	Semi Fire	Semi Fire	Link
202405-05	5/7/24	I70W	100.5	Hancock	Work Zone 2 Semi Crash with 2 Back of Queue Crashes	Semi Crash	Link
202405-04	5/7/24	I70E	65.2	Hendricks	Semi Ran Off the Road Jackknife	Semi Crash	Link
202405-03	5/6/24	I70W	88.0	Marion	Single Passenger Vehicle Ran Off the Road Crash	Car Crash	Link
202405-02	5/4/24	I465IL	45.0	Marion	3 Passenger Vehicle Rollover Crash	Car Crash	Link
202405-01	5/1/24	I65N	102.0	Marion	Single Passenger Vehicle Ran Off the Road Crash	Car Crash	Link

Table B.8 After-Actions from April 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202404-23	4/30/24	I65S	221.0	Jasper	Semi Fire	Semi Fire	Link
202404-22	4/30/24	I65N	119.4	Marion	Passenger Vehicle Fire	Car Fire	Link
202404-21	4/29/24	I69N	213.3	Hamilton	Single Passenger Vehicle Crash	Car Crash	Link
202404-20	4/25/24	I69N	269.0	Grant	Work Zone 2 Passenger Vehicle and 1 Semi Crash	Semi Crash	Link
202404-19	4/24/24	I65S	129.5	Boone	Semi Rear End Crash	Semi Crash	Link
202404-18	4/23/24	I65N	257.7	Lake	3 Passenger Vehicle Rear End Crash	Car Crash	Link
202404-17	4/22/24	I65S	31.0	Scott	3 Semi Crash with Fire	Semi Fire	Link
202404-16	4/18/24	I70E	60.0	Hendricks	Semi Ran Off Road	Semi Crash	Link
202404-15	4/17/24	I70W	100.5	Hancock	Work Zone Passenger Vehicle and Semi Crash	Semi Crash	Link
202404-14	4/17/24	I70W	103.0	Hancock	Work Zone Disabled Semi	Semi Crash	Link
202404-13	4/16/24	I70W	80.7	Marion	Truck with Trailer and School Bus Rollover	Car Crash	Link
202404-12	4/11/24	I65	104.4	Marion	6 Passenger Vehicle Crash due to Flooding	Car Crash	Link
202404-11	4/9/24	I465IL	53.0	Marion	Semi Rollover	Semi Crash	Link
202404-10	4/9/24	I94W	1.1	Lake	2 Passenger Vehicle Crash into Crash Attenuator	Car Crash	Link
202404-09	4/8/24	I65S	240.1	Lake	2 Passenger Vehicle Crash at Lane Drop	Car Crash	Link
202404-08	4/8/24	I65S	168.0	Tippecanoe	2 Passenger Vehicle Crash at Lane Drop	Car Crash	Link
202404-07	4/7/24	I65S	239.5	Lake	2 Passenger Vehicle Crash at Lane Drop	Car Crash	Link
202404-06	4/7/24	I65N	206.0	Jasper	2 Passenger Vehicle Sideswipe	Car Crash	Link
202404-05	4/7/24	I65N	96.2	Johnson	Single Passenger Vehicle Ran Off Road Crash	Car Crash	Link
202404-04	4/6/24	I65S	178.0	Tippecanoe	Work Zone 4 Passenger Vehicle Crash	Car Crash	Link
202404-03	4/2/24	I70E	150.1	Wayne	4 Semi Crash	Semi Crash	Link
202404-02	4/1/24	I70E	147.0	Wayne	Semi Ran Off Road	Semi Crash	Link
202404-01	4/1/24	I65N	257.0	Lake	3 Passenger Vehicle Crash with 4 Back of Queue Crashes	Car Crash	Link

Table B.9 After-Actions from March 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202403-14	3/30/24	I65S	179.0	Tippecanoe	Passenger Vehicle Rear End Crash into Semi	Car Crash	Link
202403-13	3/30/24	I65N	204.6	Jasper	Single Passenger Vehicle Ran Off Road Crash	Car Crash	Link
202403-12	3/28/24	I65N	124.8	Marion	Disabled Semi Blocking Lane	Semi Crash	Link
202403-11	3/27/24	I465OL	37.5	Marion	Work Zone Oversized Semi Load and Passenger Vehicle Crash	Semi Crash	Link
202403-10	3/27/24	I465IL	3.8	Marion	Work Zone Passenger Vehicle Rear End Rollover	Car Crash	Link
202403-09	3/26/24	I65S	193.3	White	Overturned Semi Load due to Heavy Winds	Semi Crash	Link
202403-08	3/23/24	I465OL	37.0	Marion	Work Zone Motorcycle Crash	Car Crash	Link
202403-07	3/18/24	I69N	302.0	Allen	Single Passenger Vehicle Rollover Crash	Car Crash	Link
202403-06	3/15/24	I70W	83.7	Marion	3 Semi Rear End Crash	Semi Crash	Link
202403-05	3/7/24	I465IL	43.5	Marion	2 Passenger Vehicle Crash	Car Crash	Link
202403-04	3/7/24	I69N	289.6	Huntington	Semi Rear End Crash	Semi Crash	Link
202403-03	3/5/24	I70W	63.5	Hendricks	Semi Ran Off Road with Back of Queue Crash	Semi Crash	Link
202403-02	3/5/24	I65S	116.0	Marion	6 Vehicle Crash due to Abandoned Vehicle Recovery	Semi Crash	Link
202403-01	3/1/24	I65N	202.0	Jasper	Passenger Vehicle Fire	Car Fire	Link

Table B.10 After-Actions from January 2024–February 2024.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202402-15	2/28/24	I70E	63.8	Hendricks	Semi Ran Off Road Crash	Semi Crash	Link
202402-14	2/28/24	I65N	218.0	Jasper	Semi Ran Off Road Crash	Semi Crash	Link
202402-13	2/28/24	I65N	156.0	Clinton	Semi Rollover due to Heavy Winds	Semi Crash	Link
202402-12	2/26/24	I70E	78.9	Marion	Single Passenger Vehicle Crash	Car Crash	Link
202402-11	2/23/24	I65S	130.0	Boone	Semi and Passenger Vehicle Crash	Semi Crash	Link
202402-10	2/17/24	I65N	198.0	White	Winter Weather Passenger Vehicle Slide Off	Car Crash	Link
202402-09	2/14/24	I465IL	52.8	Marion	Box Truck with Trailer Rollover Crash	Semi Crash	Link
202402-08	2/14/24	I465IL	34.9	Marion	Work Zone 3 Passenger Vehicle Crash	Car Crash	Link
202402-07	2/13/24	I65S	126.8	Marion	Single Vehicle Crash with Back of Queue Crash	Car Crash	Link
202402-06	2/8/24	I94W	9.5	Lake	4 Vehicle, Semi Rear End Crash	Semi Crash	Link
202402-05	2/7/24	I465OL	40.5	Marion	4 Vehicle, Semi Rear End Crash	Semi Crash	Link
202402-04	2/7/24	I65S	140.0	Boone	Semi Crash with Pedestrian	Semi Crash	Link
202402-03	2/5/24	I70W	1.2	Vigo	Semi Rollover	Semi Crash	Link
202402-02	2/1/24	I65N	232.0	Jasper	Semi Fire with Back of Queue Crash	Semi Fire	Link
202402-01	2/1/24	I65N	80.4	Shelby	Temporary Work Zone with 3 Back of Queue Crashes	Car Crash	Link
202401-03	1/31/24	I465IL	42.4	Marion	Passenger Truck with Trailer Fire	Car Fire	Link
202401-02	1/27/24	I69N	263.0	Grant	Semi Fire with Circus Animals	Semi Fire	Link
202401-01	1/18/24	I69N	286.0	Huntington	3 Semi Crash with 2 Back of Queue Crashes	Semi Crash	Link

Table B.11 After-Actions from December 2023.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202312-12	12/21/23	I65N	259.0	Lake	Semi Jackknife Crash	Semi Crash	Link
202312-11	12/21/23	I65S	149.3	Boone	Semi Crash into 2 Parked Semis	Semi Crash	Link
202312-10	12/20/23	I94W	20.2	Porter	Passenger Vehicle Ran Off Road Crash	Car Crash	Link
202312-09	12/18/23	I94E	11.5	Lake	3 Vehicle Semi Sideswipe Crash	Semi Crash	Link
202312-08	12/18/23	I65	219.0	Jasper	2 Semi Crashes	Semi Crash	Link
202312-07	12/18/23	I70E	30.9	Montgomery	2 Vehicle Crash with Back of Queue Crash	Semi Crash	Link
202312-06	12/17/23	I65N	231.4	Jasper	2 Passenger Vehicle Rollover Crash	Car Crash	Link
202312-05	12/14/23	I65N	165.4	Tippecanoe	Police Chase Crash with Back of Queue Crash	Semi Crash	Link
202312-04	12/7/23	I65N	148.0	Boone	Semi Crash	Semi Crash	Link
202312-03	12/6/23	I70W	23.0	Clay	Passenger Vehicle Fire	Car Fire	Link
202312-02	12/5/23	I70W	154.7	Wayne	Semi Jackknife Crash	Semi Crash	Link
202312-01	12/1/23	I74E	3.0	Vermillion	Semi Crash and Fire	Semi Fire	Link

Table B.12 After-Actions from October 2023–November 2023.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202312-12	12/21/23	I65N	259.0	Lake	Semi Jackknife Crash	Semi Crash	Link
202311-12	11/29/23	I65S	146.0	Boone	Work Zone Crash with Back of Queue Crash	Semi Crash	Link
202311-11	11/26/23	I65S	129.0	Boone	2 Passenger Vehicle Merging Crash	Car Crash	Link
202311-10	11/22/23	I465OL	47.1	Marion	2 Vehicle Crash with Back of Queue Crash	Car Crash	Link
202311-09	11/15/23	I94E	6.8	Lake	Work Zone 5 Vehicle Crash	Semi Crash	Link
202311-08	11/13/23	I465OL	37.3	Marion	Work Zone Crash with Back of Queue Crash	Semi Crash	Link
202311-07	11/11/23	I65S	141.0	Boone	4 Passenger Vehicle Rear End Crash	Car Crash	Link
202311-06	11/10/23	I65S	142.2	Boone	Work Zone Semi Ran Off Road	Semi Crash	Link
202311-05	11/9/23	I70W	91.4	Marion	Semi Fire	Semi Fire	Link
202311-04	11/7/23	I65S	3.8	Clark	4 Semi Crash and Fire	Semi Fire	Link
202311-03	11/7/23	I65N	134.0	Boone	2 Passenger Vehicle Crash	Car Crash	Link
202311-02	11/4/23	I70W	98.4	Hancock	Work Zone 4 Semi Crash with Fire	Semi Crash	Link
202311-01	11/2/23	I65N	172.0	Tippecanoe	Single Passenger Vehicle Crash with Pedestrian	Car Crash	Link
202310-07	10/26/23	I65S	219.0	Jasper	Passenger Vehicle with Trailer Jackknife Crash	Car Crash	Link
202310-06	10/23/23	I65S	144.0	Boone	Work Zone 2 Semi Crash	Semi Crash	Link
202310-05	10/19/23	I65	178.0	Tippecanoe	Work Zone 5 Vehicle Crash	Semi Crash	Link
202310-04	10/15/23	I65S	178.4	Tippecanoe	Work Zone Single Passenger Vehicle Rollover	Car Crash	Link
202310-03	10/8/23	I65N	171.0	Tippecanoe	Single Passenger Vehicle Crash and Fire	Car Fire	Link
202310-02	10/5/23	I465IL	23.1	Marion	5 Vehicle Rear End Crash	Car Crash	Link
202310-01	10/3/23	I70E	149.0	Wayne	Semi Fire	Semi Fire	Link

Table B.13 After-Actions from July 2023–September 2023.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202309-04	9/23/23	I70W	62.9	Hendricks	Semi Ran Off Road and Stalled Vehicle	Semi Crash	Link
202309-03	9/21/23	I70W	59.8	Hendricks	Single Passenger Vehicle Crash	Car Crash	Link
202309-02	9/14/23	I70W	6.0	Vigo	Semi Rear End Crash and Back of Queue Semi Fire	Semi Fire	Link
202309-01	9/12/23	I465OL	42.7	Marion	Semi Fire	Semi Fire	Link
202308-04	8/30/23	I69N	257.2	Grant	Semi Fire	Semi Fire	Link
202308-03	8/30/23	I65N	149.0	Boone	Semi Fire with Back of Queue Crash	Semi Fire	Link
202308-02	8/24/23	I65N	149.0	Boone	Truck Crash with Back of Queue Crash	Semi Crash	Link
202308-01	8/2/23	I70W	32.0	Montgomery	Semi Fire	Semi Fire	Link
202307-01	7/5/23	I65N	148.0	Boone	Semi Fire	Semi Fire	Link

Table B.14 After-Actions from April 2023–June 2023.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202306-03	6/22/23	I65S	142.0	Boone	Work Zone Semi Jackknife	Semi Crash	Link
202306-02	6/17/23	I69S	250.0	Delaware	Work Zone 2 Semi Crash	Semi Crash	Link
202306-01	6/9/23	I69S	263.0	Grant	Work Zone 2 Semi Crash	Semi Crash	Link
202305-03	5/27/23	I70E	64.8	Hendricks	Crash with 7 Vehicle Back of Queue Crash	Semi Crash	Link
202305-02	5/16/23	I74W	94.0	Marion	Semi Rollover	Semi Crash	Link
202305-01	5/15/23	I70E	84.1	Marion	Semi Fire	Semi Fire	Link
202304-05	4/26/23	I65S	241.0	Lake	Disabled Passenger Vehicle	Car Crash	Link
202304-04	4/20/23	I65S	177.0	Tippecanoe	Work Zone Semi Crash with Back of Queue Crash	Semi Crash	Link
202304-03	4/20/23	I465OL	33.2	Hamilton	Semi Fire	Semi Fire	Link
202304-02	4/19/23	I65N	152.0	Clinton	2 Semi Crash	Semi Crash	Link
202304-01	4/14/23	I70W	5.0	Vigo	Disabled Semi	Semi Crash	Link

Table B.15 After-Actions from January 2023–March 2023

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202303-07	3/28/23	I465OL	31.0	Hamilton	Semi Crash with Pedestrian	Semi Crash	Link
202303-06	3/26/23	I65S	131.0	Boone	Single Passenger Vehicle Ran Off Road	Car Crash	Link
202303-05	3/25/23	I65S	150.0	Boone	Crash	Car Crash	Link
202303-04	3/24/23	I65S	150.0	Boone	Crash	Car Crash	Link
202303-03	3/22/23	I65N	245.9	Lake	Work Zone Crash	Car Crash	Link
202303-02	3/14/23	I65S	222.0	Jasper	4 Passenger Vehicle Crash	Car Crash	Link
202303-01	3/2/23	I465OL	12.0	Marion	Semi Rollover	Semi Crash	Link
202302-03	2/9/23	I65S	201.0	Jasper	Semi Rollover due to High Winds	Semi Crash	Link
202302-02	2/3/23	I70E	14.0	Vigo	Semi Fire	Semi Fire	Link
202302-01	2/3/23	I70W	115.0	Hancock	Passenger Vehicle Crash into Semi on Shoulder	Semi Crash	Link
202301-02	1/20/23	I70W	38.0	Putnam	Crash	Car Crash	Link
202301-01	1/4/23	I65S	230.0	Jasper	Passenger Vehicle Crash due to Disabled Vehicle	Car Crash	Link

Table B.16 After-Actions from July 2022–December 2022.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202212-02	12/22/22	I465OL	39.0	Marion	Semi Jackknife	Semi Crash	Link
202212-01	12/2/22	I65S	140.0	Boone	Single Passenger Vehicle Crash	Car Crash	Link
202211-02	11/10/22	I465OL	30.0	Marion	Semi Rear End Crash	Semi Crash	Link
202211-01	11/4/22	I465OL	24.8	Marion	Semi Rollover	Semi Crash	Link
202210-04	10/22/22	I70E	50.0	Morgan	8 Vehicle Rear End Crash due to Debris on Roadway	Car Crash	Link
202210-03	10/10/22	I65N	258.0	Lake	Semi Fire with Back of Queue Crash	Semi Fire	Link
202210-02	10/6/22	I65S	141.0	Boone	Semi Crash	Semi Crash	Link
202210-01	10/3/22	I65N	142.5	Boone	Work Zone Single Passenger Vehicle Rollover	Car Crash	Link
202209-01	9/2/22	I65N	213.0	Jasper	Semi and Passenger Vehicle Rear End Crash	Semi Crash	Link
202208-01	8/27/22	I70W	105.6	Hancock	Semi Fire with Back of Queue Crash	Semi Fire	Link
202207-02	7/7/22	I65S	142.6	Boone	Work Zone Semi Crash with Back of Queue Crash	Semi Crash	Link
202207-01	7/6/22	I69S	232.2	Delaware	2 Truck Rear End Crash	Semi Crash	Link

Table B.17 After-Actions from January 2022–June 2022.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202206-02	6/28/22	I70W	26.0	Clay	2 Semi Crash & Fire	Semi Fire	Link
202206-01	6/21/22	I65N	133.2	Boone	Passenger Vehicle Rear End Crash into Semi	Semi Crash	Link
202205-02	5/23/22	I94W	0.1	Lake	Semi and Pedestrian Crash	Semi Crash	Link
202205-01	5/18/22	I65N	190.0	White	Crash	Car Crash	Link
202204-01	4/26/22	I70W	63.7	Hendricks	2 Semi and 2 Passenger Vehicle Crash	Semi Crash	Link
202203-03	3/30/22	I74W	69.0	Hendricks	Back of Queue Passenger Vehicle Crash	Car Crash	Link
202203-02	3/11/22	I65S	205.0	Jasper	Passenger Vehicle Rollover	Car Crash	Link
202203-01	3/10/22	I65S	142.0	Boone	Semi Rollover	Semi Crash	Link
202201-05	1/28/22	I69N	217.0	Madison	Semi Crash into Disabled Vehicle	Semi Crash	Link
202201-04	1/23/22	I65S	177.0	Tippecanoe	Passenger Vehicle Ran Off Road	Car Crash	Link
202201-03	1/16/22	I70E	104.0	Hancock	Semi Rollover	Semi Crash	Link
202201-02	1/16/22	I465IL	3.0	Marion	Passenger Vehicle Rollover	Car Crash	Link
202201-01	1/11/22	I65N	183.0	Tippecanoe	Semi Fire	Semi Fire	Link

Table B.18 After-Actions from Dec 2021 and Older.

Event number	Date	Route	Mile Marker	County	Short Description	Type	Link
202111-01	11/14/21	I70E	32.0	Montgomery	Passenger Vehicle Crash	Car Crash	Link
202110-01	10/26/21	I70W	114.5	Henry	Semi Crash	Semi Crash	Link
202107-01	7/9/21	I65N	158.5	Tippecanoe	Semi Crash	Semi Crash	Link
202106-02	6/12/21	I70E	62.5	Hendricks	Work Zone Semi Rollover & Back of Queue Crash	Semi Crash	Link
202106-01	6/11/21	I65N	189.0	White	Passenger Vehicle Lane Departure Crash	Car Crash	Link
202105-03	5/21/21	I65N	227.8	Jasper	3 Passenger Vehicle Back of Queue Crash	Car Crash	Link
202105-02	5/14/21	I65N	162.0	Tippecanoe	2 Passenger Vehicle Rear End Crash	Car Crash	Link
202105-01	5/4/21	I65S	140.2	Boone	Work Zone Semi Crash	Semi Crash	Link
202104-01	4/10/21	I74W	165.0	Dearborn	Semi Fire	Semi Fire	Link
202103-01	3/18/21	I74E	67.2	Hendricks	Semi Crash Due to Crosswinds	Semi Crash	Link
202009-02	9/17/20	I70W	123.0	Henry	Work Zone 5 Vehicle Back of Queue Crash with Fire	Semi Fire	Link
202009-01	9/16/20	I69N	332.0	DeKalb	Work Zone 7 Vehicle Back of Queue Crash	Semi Crash	Link
202008-01	8/26/20	I70E	67.6	Hendricks	Work Zone Semi Fire	Semi Fire	Link
202007-01	7/29/20	I65S	190.0	White	3 Passenger Vehicle Rear End Crash	Car Crash	Link
202006-01	6/3/20	I65N	148.0	Boone	Semi Rollover	Semi Crash	Link
201608-01	8/21/16	I65N	171.3	Tippecanoe	Semi Fire	Semi Fire	Link

Appendix C. TIM Event Summary Intervals for Analyzed After-Action Events

The tables below detail the TIM summary intervals for 294 after-action report events of 267 after-action reports as detailed in Appendix B. The event number corresponds with the event number in Appendix B, as well.

Table C.1 TIM Summary Intervals for January 2025–March 2025.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202503-04S	Wayne	GRN	0	2	4	228	312
202503-04P	Wayne	GRN	0	-	-	-	-
202503-03	Marion	GRN	0	10	0	32	54
202503-02S	Marion	GRN	3	8	0	-	112
202503-02P	Marion	GRN	0	6	0	-	20
202503-01	Boone	CRW	3	0	0	123	123
202502-07	Lake	LAP	0	0	12	186	188
202502-06	Marion	GRN	0	2	2	36	46
202502-05	LaPorte	LAP	0	10	4	76	76
202502-04	Hendricks	CRW	0	10	0	332	332
202502-03	Boone	CRW	6	0	0	35	46
202502-02	Marion	GRN	1	5	10	-	69
202502-01	Hancock	GRN	4	6	0	71	72
202501-11	Lake	LAP	0	8	0	372	578
202501-10	Hamilton	GRN	0	0	0	66	66
202501-09	Vigo	CRW	-	-	-	-	-
202501-08	Johnson	SEY	0	2	9	104	104
202501-07	Marion	GRN	0	2	14	22	56
202501-06S	Bartholomew	SEY	0	0	0	144	144
202501-06P	Bartholomew	SEY	2	3	3	195	295
202501-05	Tippecanoe	CRW	1	7	0	196	196
202501-04	Vigo	CRW	2	1	9	79	79
202501-03	Madison	GRN	1	6	0	77	77
202501-02	Marion	GRN	0	4	28	184	184
202501-01	Scott	SEY	0	2	0	620	620

Table C.2 TIM Summary Intervals for October 2024–December 2024.

Event number	**County**	**District**	**Detection time,** $T_1 - T_0$ (minutes)	**Verification time,** $T_2 - T_1$ (minutes)	**Response time,** $T_4 - T_2$ (minutes)	**Roadway Clearance Time RCT,** $T_5 - T_1$ (minutes)	**Incident Clearance Time ICT,** $T_6 - T_1$ (minutes)
202412-09	Hancock	GRN	0	4	0	90	90
202412-08	Lake	LAP	2	6	6	94	94
202412-07	Boone	CRW	3	7	0	47	47
202412-06	Marion	GRN	0	3	0	357	357
202412-05	Marion	GRN	0	3	4	71	71
202412-04	Boone	CRW	2	4	0	102	102
202412-03	Marion	GRN	0	2	0	228	228
202412-02	Marion	GRN	2	2	19	728	728
202412-01	Clark	SEY	2	4	0	32	32
202411-03	Lake	LAP	0	2	0	484	484
202411-02	DeKalb	FTW	4	0	0	205	-
202411-01	DeKalb	FTW	2	1	0	-	-
202410-08	Hendricks	CRW	2	6	6	252	252
202410-07	Hendricks	CRW	2	20	5	102	102
202410-06	Delaware	GRN	0	7	0	168	168
202410-05	Marion	GRN	0	6	4	54	54
202410-04S	Allen	FTW	4	2	0	120	120
202410-04P	Allen	FTW	0	10	0	244	244
202410-03	Boone	CRW	0	6	0	164	164
202410-02S	Hancock	GRN	0	16	0	78	78
202410-02P	Hancock	GRN	0	-	-	145	145
202410-01	Hendricks	CRW	5	5	0	57	191

Table C.3 TIM Summary Intervals for July 2024–September 2024.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202409-07	Boone	CRW	0	-	-	47	47
202409-06	Hancock	GRN	0	8	0	40	40
202409-05	Allen	FTW	3	4	0	119	119
202409-04	Lake	LAP	9	9	0	-	-
202409-03	Boone	CRW	4	7	0	140	140
202409-02	Lake	LAP	1	4	-	-	-
202409-01	Lake	LAP	0	4	6	106	106
202408-16	Marion	GRN	4	2	8	54	54
202408-15	Jackson	SEY	-	-	-	-	-
202408-14	Hancock	GRN	2	3	0	98	98
202408-13	Marion	GRN	0	0	14	246	246
202408-12S	Hendricks	CRW	4	0	1	338	338
202408-12P	Hendricks	CRW	0	0	-	486	486
202408-11	Hancock	GRN	-	-	-	-	-
202408-10S	Hancock	GRN	3	5	2	77	77
202408-10P	Hancock	GRN	9	15	0	69	69
202408-09	Allen	FTW	0	9	0	93	93
202408-08S	Wayne	GRN	0	0	0	152	152
202408-08P	Wayne	GRN	0	0	0	266	266
202408-07	Lake	LAP	1	1	6	37	63
202408-06	Boone	CRW	1	3	0	91	91
202408-05	Jasper	LAP	0	31	0	607	607
202408-04	Lake	LAP	0	7	-	-	-
202408-03S	Jasper	LAP	3	3	0	50	50
202408-03P	Jasper	LAP	1	3	0	-	-
202408-02	Marion	GRN	0	50	0	180	180
202408-01S	Clark	SEY	57	7	0	25	71
202408-01P	Clark	SEY	0	2	10	28	40
202407-09	Jasper	LAP	1	29	-	-	-
202407-08	Vigo	CRW	3	0	0	341	341
202407-07	Lake	LAP	3	4	0	897	899
202407-06	Marion	GRN	1	5	10	33	141
202407-05	Hancock	GRN	0	0	6	144	144
202407-04	Lake	LAP	3	10	1	-	-
202407-03	Jasper	LAP	1	3	5	39	39
202407-02	Clinton	CRW	2	3	0	132	132
202407-01	Boone	CRW	0	5	0	147	151

Table C.4 TIM Summary Intervals for June 2024.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202406-14S	Marion	GRN	4	0	2	494	494
202406-14P	Marion	GRN	1	5	0	287	287
202406-13S	Putnam	CRW	0	5	5	-	-
202406-13P	Putnam	CRW	10	7	0	-	-
202406-12	Clay	CRW	2	-	-	-	-
202406-11	Hancock	GRN	0	2	0	132	132
202406-10	Henry	GRN	0	10	8	270	270
202406-09	Lake	LAP	-	-	-	-	-
202406-08	Hancock	GRN	0	8	2	88	146
202406-07	Lake	LAP	16	9	0	116	116
202406-06	Lake	LAP	4	3	1	187	193
202406-05	Vigo	CRW	5	3	4	113	113
202406-04	Henry	GRN	1	-	-	511	529
202406-03	Putnam	CRW	0	0	0	-	-
202406-02	Fountain	CRW	0	5	0	-	-
202406-01S	Putnam	CRW	9	4	-	-	-
202406-01P	Putnam	CRW	0	11	-	-	-

Table C.5 TIM Summary Intervals for May 2024.

Event number	**County**	**District**	**Detection time,** $T_1 - T_0$ (minutes)	**Verification time,** $T_2 - T_1$ (minutes)	**Response time,** $T_4 - T_2$ (minutes)	**Roadway Clearance Time RCT,** $T_5 - T_1$ (minutes)	**Incident Clearance Time ICT,** $T_6 - T_1$ (minutes)
202405-20	Lake	LAP	0	4	2	174	174
202405-19	Hamilton	GRN	0	4	2	300	296
202405-18	Boone	CRW	1	7	0	381	436
202405-17	Marion	GRN	1	1	14	333	333
202405-16	Johnson	SEY	0	1	8	323	323
202405-15	Hamilton	GRN	0	2	0	368	368
202405-14	Johnson	SEY	0	2	4	246	248
202405-13	Johnson	SEY	0	0	10	36	102
202405-12	Hamilton	GRN	14	6	0	60	60
202405-11	Madison	GRN	2	6	0	404	484
202405-10	Marion	GRN	0	2	4	142	142
202405-09	Allen	FTW	2	1	0	69	71
202405-08	Johnson	SEY	1	1	6	129	135
202405-07	Lake	LAP	2	2	2	414	424
202405-06	Boone	CRW	0	2	0	118	118
202405-05S	Hancock	GRN	-	-	-	-	-
202405-05P	Hancock	GRN	2	2	16	94	94
202405-04	Hendricks	CRW	10	3	0	165	165
202405-03	Marion	GRN	2	0	8	258	262
202405-02	Marion	GRN	1	1	2	105	105
202405-01	Marion	GRN	-	-	-	-	-

Table C.6 TIM Summary Intervals for April 2024.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202404-23	Jasper	LAP	1	0	6	82	-
202404-22	Marion	GRN	0	4	4	26	64
202404-21	Hamilton	GRN	1	3	0	47	47
202404-20	Grant	FTW	5	6	0	-	-
202404-19	Boone	CRW	1	4	0	180	180
202404-18	Lake	LAP	4	0	2	259	264
202404-17	Scott	SEY	2	12	0	748	748
202404-16	Hendricks	CRW	0	0	9	254	254
202404-15	Hancock	GRN	2	0	0	54	54
202404-14	Hancock	GRN	0	0	28	72	72
202404-13	Marion	GRN	0	0	4	76	76
202404-12	Marion	GRN	0	6	6	138	138
202404-11	Marion	GRN	0	0	0	266	266
202404-10	Lake	LAP	6	0	6	34	52
202404-09	Lake	LAP	0	0	2	8	-
202404-08	Tippecanoe	CRW	0	14	0	39	39
202404-07	Lake	LAP	15	0	20	-	40
202404-06	Jasper	LAP	1	4	27	66	66
202404-05	Johnson	SEY	2	0	4	172	172
202404-04	Tippecanoe	CRW	0	4	10	67	99
202404-03	Wayne	GRN	8	0	0	114	114
202404-02	Wayne	GRN	1	6	0	222	222
202404-01	Lake	LAP	1	5	8	57	57

Table C.7 TIM Summary Intervals for January 2024–March 2024.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202403-14	Tippecanoe	CRW	0	6	0	44	56
202403-13	Jasper	LAP	0	4	6	52	52
202403-12	Marion	GRN	0	7	12	69	69
202403-11	Marion	GRN	3	1	6	41	61
202403-10	Marion	GRN	0	6	17	144	144
202403-09	White	CRW	0	4	14	144	144
202403-08	Marion	GRN	1	1	18	185	185
202403-07	Allen	FTW	1	6	0	102	102
202403-06	Marion	GRN	3	0	4	126	126
202403-05	Marion	GRN	0	5	0	163	201
202403-04	Huntington	FTW	6	-	-	-	-
202403-03	Hendricks	CRW	2	36	24	204	204
202403-02	Marion	GRN	0	0	2	210	210
202403-01	Jasper	LAP	0	9	0	47	47
202402-15	Hendricks	CRW	1	16	0	504	504
202402-14	Jasper	LAP	4	3	0	542	544
202402-13	Clinton	CRW	1	2	0	-	-
202402-12	Marion	GRN	0	7	6	70	70
202402-11	Boone	CRW	9	15	0	107	109
202402-10	White	CRW	-	-	-	-	-
202402-09	Marion	GRN	7	1	0	85	85
202402-08	Marion	GRN	1	1	14	47	47
202402-07	Marion	GRN	10	10	0	136	136
202402-06	Lake	LAP	0	6	25	68	94
202402-05	Marion	GRN	1	2	0	176	184
202402-04	Boone	CRW	0	2	0	268	268
202402-03	Vigo	CRW	5	7	0	85	131
202402-02S	Jasper	LAP	2	5	0	-	-
202402-02P	Jasper	LAP	1	4	0	-	-
202402-01P2S	Shelby	GRN	5	15	0	-	17
202402-01P2	Shelby	GRN	0	20	0	207	207
202402-01P1	Shelby	GRN	0	2	6	40	40
202401-03	Marion	GRN	1	0	0	83	89
202401-02	Grant	FTW	9	5	0	270	270
202401-01	Huntington	FTW	0	0	0	140	158

Table C.8 TIM Summary Intervals for October 2023–December 2023.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202312-12	Boone	CRW	0	19	0	293	293
202312-11	Lake	LAP	0	2	10	130	130
202312-10	Porter	LAP	946	0	0	148	148
202312-09	Lake	LAP	0	4	10	60	60
202312-08P2	Jasper	LAP	6	2	7	186	186
202312-08P1	Jasper	LAP	40	0	0	48	48
202312-07S	Montgomery	CRW	3	10	10	-	-
202312-07P	Montgomery	CRW	6	11	11	-	-
202312-06	Jasper		0	9	9	-	-
202312-05S	Tippecanoe	CRW	2	5	5	-	-
202312-05P	Tippecanoe	CRW	0	0	0	-	-
202312-04	Boone	CRW	1	7	7	-	-
202312-03	Clay	CRW	0	5	5	-	-
202312-02	Wayne	GRN	3	4	27	91	97
202312-01	Vermillion	CRW	0	7	7	229	-
202311-12S	Boone	CRW	0	3	3	272	286
202311-12P	Boone	CRW	0	6	6	275	61
202311-11	Boone	CRW	-	-	-	-	-
202311-10	Marion	GRN	2	0	0	74	74
202311-09	Lake	LAP	0	1	7	-	125
202311-08S	Marion	GRN	10	11	11	72	72
202311-08P	Marion	GRN	11	0	2	25	51
202311-07	Boone	CRW	0	4	-	-	-
202311-06	Boone	CRW	0	6	6	400	390
202311-05	Marion	GRN	1	2	2	540	540
202311-04	Clark	SEY	3	0	0	703	703
202311-03	Boone	CRW	8	2	2	75	75
202311-02	Hancock	GRN	1	5	5	421	421
202311-01	Tippecanoe	CRW	2	15	15	123	123
202310-07	Jasper	LAP	6	4	4	192	192
202310-06	Boone	CRW	1	9	9	161	161
202310-05	Tippecanoe	CRW	3	7	10	210	210
202310-04	Tippecanoe	CRW	1	12	12	50	50
202310-03	Tippecanoe	CRW	0	11	15	548	548
202310-02	Marion	GRN	1	3	5	470	490
202310-01	Wayne	GRN	0	10	10	399	399

Table C.9 TIM Summary Intervals for July 2023–September 2023.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202309-04	Hendricks	CRW	2	3	3	111	129
202309-03	Hendricks	CRW	2	6	16	50	50
202309-02S	Vigo	CRW	3	2	2	154	154
202309-02P	Vigo	CRW	0	3	3	117	-
202309-01	Marion	GRN	-	-	-	-	-
202308-04	Grant	FTW	2	20	23	738	738
202308-03	Boone	CRW	0	0	15	243	241
202308-02S	Boone	CRW	1	5	5	44	44
202308-02P	Boone	CRW	2	5	12	201	201
202308-01	Montgomery	CRW	4	13	13	-	-
202307-01	Boone	CRW	1	15	15	412	-

Table C.10 TIM Summary Intervals for April 2023–June 2023.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202306-03	Boone	CRW	0	0	8	244	244
202306-02	Delaware	GRN	1	14	14	-	-
202306-01	Grant	FTW	1	4	4	422	420
202305-03S	Hendricks	CRW	12	6	6	342	348
202305-03P	Hendricks	CRW	2	0	0	92	94
202305-02	Marion	GRN	2	4	4	280	284
202305-01	Marion	GRN	6	2	2	78	78
202304-05	Lake	LAP	-	2	-	-	-
202304-04S	Tippecanoe	CRW	0	0	0	-	-
202304-04P	Tippecanoe	CRW	3	9	9	-	-
202304-03	Hamilton	GRN	1	0	3	260	417
202304-02	Clinton	CRW	2	0	0	-	-
202304-01	Vigo	CRW	-	-	-	-	-

Table C.11 TIM Summary Intervals for January 2023–March 2023.

Event number	County	District	Detection time, T_1 - T_0 (minutes)	Verification time, T_2 - T_1 (minutes)	Response time, T_4 - T_2 (minutes)	Roadway Clearance Time RCT, T_5 - T_1 (minutes)	Incident Clearance Time ICT, T_6 - T_1 (minutes)
202303-07	Hamilton	GRN	5	6	2	142	145
202303-06	Boone	CRW	2	1	3	139	139
202303-05	Boone	CRW	-	-	-	-	-
202303-04	Boone	CRW	-	-	-	-	-
202303-03	Lake	LAP	3	2	8	56	110
202303-02	Jasper	LAP	2	2	2	292	292
202303-01	Marion	GRN	0	1	2	634	661
202302-03	Jasper	LAP	8	21	21	239	243
202302-02	Vigo	CRW	5	6	6	-	-
202302-01	Hancock	GRN	3	16	16	-	-
202301-02	Putnam	CRW	-	-	-	-	-
202301-01	Jasper	LAP	2	5	8	132	132

Table C.12 TIM Summary Intervals for January 2022–December 2022.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202212-02	Marion	GRN	2	4	4	80	82
202212-01	Boone	CRW	3	2	2	64	65
202211-02	Marion	GRN	2	4	4	152	156
202211-01	Marion	GRN	2	3	10	405	427
202210-04	Morgan	LAP	0	10	10	-	-
202210-02	Boone	CRW	-	0	-	-	-
202210-01	Boone	CRW	3	7	7	66	56
202209-01	Jasper	CRW	0	4	6	-	-
202208-01S	Hancock	GRN	4	7	7	85	112
202208-01P	Hancock	GRN	1	10	11	47	50
202207-02	Boone	CRW	5	8	8	-	-
202207-01	Delaware	GRN	1	12	12	470	-
202206-02	Clay	CRW	0	9	9	681	-
202206-01	Boone	CRW	6	4	4	184	184
202205-02	Lake	LAP	3	11	11	173	203
202205-01	White	CRW	-	-	-	-	-
202204-01	Hendricks	CRW	32	16	16	-	-
202203-03	Hendricks	CRW	-	-	-	-	-
202203-02P2	Jasper	LAP	6	0	0	-	-
202203-02P1	Jasper	LAP	3	7	21	-	-
202203-01	Boone	CRW	1	7	7	-	-
202201-05	Madison	GRN	1	2	2	-	-
202201-04	Tippecanoe	CRW	7	0	0	28	75
202201-03	Hancock	GRN	1	2	2	375	375
202201-02	Marion	GRN	3	5	5	35	35
202201-01	Tippecanoe	CRW	0	9	9	-	-

Table C.13 TIM Summary Intervals for December 2021 and Older.

Event number	County	District	Detection time, $T_1 - T_0$ (minutes)	Verification time, $T_2 - T_1$ (minutes)	Response time, $T_4 - T_2$ (minutes)	Roadway Clearance Time RCT, $T_5 - T_1$ (minutes)	Incident Clearance Time ICT, $T_6 - T_1$ (minutes)
202111-01	Montgomery	GRN	39	0	0		
202110-01	Henry	CRW	1	9	9		
202107-01	Tippecanoe	CRW					
202106-02S	Hendricks	CRW	0	0	0		
202106-02P	Hendricks	CRW	4	14	14		
202106-01	White	CRW	4	16	16		
202105-03	Jasper	LAP	1	10	10		
202105-02	Tippecanoe	CRW	2	13	13		
202105-01	Boone	CRW	0	3	3		
202104-01	Dearborn	SEY	0	2	2	150	
202103-01	Hendricks	CRW	0	4	4	141	141
202009-02	Henry	GRN	0	0	0		
202009-01	DeKalb	FTW	0	4	4		
202008-01	Hendricks	CRW	1	15	15		
202007-01	White	CRW	0	0	0		
202006-01	Boone	CRW	0	25	25		
201608-01	Tippecanoe	CRW	0	1	10	455	455

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at https://docs.lib.purdue.edu/jtrp/.

Further information about JTRP and its current research program is available at https://engineering.purdue.edu/JTRP.

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