



**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C.**

**TECHNICAL RECONSTRUCTION GROUP CHAIRMAN'S
FACTUAL REPORT**

A. CRASH INFORMATION

Location: State Highway 2 (SH-2), Randolph, Coos County, New Hampshire

Vehicle 1: 2016 Ram 2500 Tradesman crew cab pick-up towing a 2015 Quality flatbed trailer

Operator 1: 23-year-old male (no injuries)

Vehicle 2: 1998 Harley Davidson FLHT

Operator 2: 59-year-old male (deceased)

Vehicle 3: 2019 Harley Davidson FLTRXS

Operator 3: 48-year-old male (no injuries)

Passenger 3: 47-year-old female (no injuries)

Vehicle 4: 2006 Harley Davidson FLSTI

Operator 4: 45-year-old male (injured)

Vehicle 5: 2012 Harley Davidson FLHTCUSE7

Operator 5: 58-year-old male (deceased)

Vehicle 6: 2012 Harley Davidson FLSTI

Operator 6: 57-year-old male (injured)

Vehicle 7: 2005 Harley Davidson FLHTCU

Operator 7: 62-year-old male (deceased)

Vehicle 8: 2007 Harley Davidson FLHTCU

Operator 8: 58-year-old male (deceased)

Passenger 8: 58-year-old female (deceased)

Vehicle 9: 2012 Harley Davidson FLHTKEL

Operator 9: 45-year-old male (deceased)

Passenger 9: 42-year-old female (deceased)

Vehicle 10: 2015 Harley Davidson FLST
Operator 10: 52-year-old female (injured)
Vehicle 11: 2007 Harley Davidson FLHRSE3
Operator 11: 51-year-old male (injured)
Vehicle 12: 2019 Harley Davidson FLXH
Operator 12: 53-year-old male (no injuries)
Vehicle 13: 2006 Harley Davidson FLTRI
Operator 13: 70-year-old male (injured)
Passenger 13: 69-year-old female (injured)
Vehicle 14: 2015 Harley Davidson FLHTK
Operator 14: 46-year-old male (no injuries)
Passenger 14: 48-year-old female (injured)

Date: Friday, June 21, 2019

Time: 6:26 p.m. EDT

NTSB #: **HWY19MH010**

B. TECHNICAL RECONSTRUCTION GROUP

Robert Squire – Highway Crash Investigator, Group Chairman
NTSB Office of Highway Safety
490 L'Enfant Plaza East, S.W., Washington, DC 20594

C. CRASH SUMMARY

For a summary of the crash, refer to the *Crash Summary Report* in the docket for this investigation.

D. DETAILS OF THE TECHNICAL RECONSTRUCTION INVESTIGATION

The Technical Reconstruction Group for this investigation was convened after the NTSB Office of Highway Safety initiated a crash investigation and determined that data acquired during the investigation could benefit from additional analysis. The portion of the investigation undertaken by the Technical Reconstruction Group was limited to analyzing data received from the New Hampshire State Police (NHSP), New Hampshire Department of Transportation (NHDOT), and other NTSB investigative groups.

Factual reports prepared by the other NTSB investigative groups should be consulted for specific information related to those areas of the investigation.

1. Introduction, Data Sources, Collision Site and Highway Description

The collision occurred June 21, 2019 at approximately 6:26 p.m. EDT, during daylight hours in clear weather with dry road surface conditions. The crash configuration involved multiple impacts between a full-sized pickup truck towing a flatbed trailer and several motorcycles. The vehicles included a 2016 Ram 2500 crew cab pickup towing a 2015 Quality vehicle hauling trailer and a group of 15 motorcycles traveling in the opposing direction. This report will focus primarily on 13 of the motorcycles and rider/passengers that were documented by NHSP investigators at the scene following the crash.

The collision occurred on U.S. Route 2 (US-2) after the Ram, traveling westbound intruded upon the opposing eastbound lane and collided with the first motorcycle in an offset head-on/side-swipe impact. As the Ram continued to enter the oncoming lane it collided with a second motorcycle also in an offset head-on/side-swipe impact. The Ram then entered a more substantial leftward arc eventually crossing the entire eastbound lane before coming to rest along the southern roadside. As the truck and trailer crossed the oncoming lane it collided with or led to other impacts that involved five additional motorcycles. At least three motorcycles in proximity of the errant truck took or may have taken evasive maneuvering to avoid the vehicle. Two of those motorcycles capsized and came to rest overturned.

1.1. Data Sources

Data used by the Technical Reconstruction Group included material received from the NHSP, NHDOT and other NTSB investigative groups. NHSP material reviewed included on-scene photographs, sUAS aerial images, total station mapping data and a supplemental mapping report.¹ NHDOT data reviewed (in cooperation with the NTSB Highway Factors Group) included highway construction plans titled “*Construction Plans X-A000(211), N.H. Project 13602A, U.S. Route 2*” dated April 2009. Data from other NTSB investigative groups included vehicle photographs (Survival Factors and Vehicle Factors Groups) and post-crash vehicle inspection information (Vehicle Factors Group).

¹ sUAS – “small unmanned aircraft system” as defined by 14 CFR Part 107. Also commonly referred to as a “drone”.

1.2. Basic Highway Description Relative to Collision Site

US-2 through the area of the collision is an east-west, two-lane highway with a posted speed limit of 50 miles per hour. The travel lanes measure approximately 12 feet wide. The initial impact occurred toward the end of a 701-foot long tangent segment that separated two horizontal curves. The tangent exhibited a nearly west ($\sim 280^\circ$) to east ($\sim 100^\circ$) orientation. The area of impact between the Ram and first motorcycle occurred about four (4) feet before the western end after the truck had traversed about 697 feet of the tangent segment.

Traveling in a westbound direction preceding the crash, the Ram traversed a 323-foot long, 1,640-foot radius rightward curve before entering the tangent segment. As indicated by the highway plans, the roadway through this curve exhibits an approximate 0.87% ascending vertical grade. After exiting this curve, the ascending grade increases eventually transitioning into a crest vertical curve with a maximum ascending grade of 3.21%. The vertical crest was located approximately 105 feet east of (before) the first area of impact. Westward of the vertical crest, the highway plan depicted a descending grade of about -4.37%. Total length of the vertical curve is 541 feet.

Approximately four (4) feet west of the initial impact, the highway transitioned to a 511-foot long, 2,625-foot radius, leftward horizontal curve. Visual detection of the curve onset may be delayed as it begins about 109 feet past the crest vertical curve. The Ram came to rest approximately 137 feet into this leftward curve, or about 150 feet west of the area of impact with the first motorcycle.²

The descending grade further west of the vertical curve decreased to about -0.55% at the intersection with Valley Road, located about 1,116 feet west of the initial impact area. Information was conveyed that the motorcycle group began their trip from a motel located on the north side of this intersection.

1.3. Roadway Evidence and Documentation

The crash site was documented by NHSP investigators who provided the NTSB with aerial (sUAS) and terrestrial photographs, in addition to total station mapping data. The aerial photographs included day and nighttime images, with the night images depicting the vehicles at their positions of rest. Daytime image meta data indicate the photos were taken a week post-crash on June 28. While some roadway evidence remains visible in the daytime images, evidence more sensitive to being obliterated by time and traffic is no longer present.

² As measured along the highway centerline to approximate CG of the pickup truck.

The sUAS images were rendered in a commercial software package to generate orthomosaic images and 3D point clouds from which additional measurements could be acquired.³ The night and daytime photogrammetry projects covered a portion of the highway, including the crash site, over distances of about 367 and 411 feet respectively. The total station data covered about 333 feet of the highway and documented significant roadway evidence as well as the post-collision positions of rest for vehicles and fatally injured persons. **Figures 1** and **2** depict screen captures of the point clouds rendered from the aerial photographs taken during darkness and daylight, respectively.



Figure 1: Screen capture of point cloud rendered from nighttime aerial photographs provided by NHSP. Supplemental location lighting was used to illuminate the scene but also created shadows. Motorcycle positions are highlighted for additional clarity.

³ The aerial photographic images were processed in the Pix4Dmapper® software.



Figure 2: Screen capture of point cloud rendered from daytime aerial photographs provided by NHSP.

Roadway evidence consisted of numerous overlapping tire friction marks, areas of fluid trails and deposits, pavement surface metal scars and scattered vehicle components from the Ram and motorcycles. Fluid debris exhibited characteristics of having originated with vehicles and human riders. Roadway evidence was predominantly confined to the eastbound travel lane and right roadside, although some tire marks and vehicle debris were located in the westbound lane. Some evidence was superimposed over other evidence illustrating a progression of events. The entire crash scene encompassing the vehicles and evidence covered about 250 feet of the highway.

Most of the roadway evidence could be characterized or identified as being impact or post-impact related. Vehicle positions of rest assisted with roadway evidence identification and will be discussed in greater detail in the succeeding section of this report. A series of parallel arced tire friction marks were identified as beginning about 166 feet eastward of the Ram's position of final rest. The distance is based upon the total station data as measured from the onset of the mark furthest east and continuing along the arc to follow the truck's approximate center of gravity to its position of rest. The parallel marks exhibited a lateral separation distance consistent with the wheel track of the truck and depicted a near continuous track from onset to the Ram's position of rest.⁴ These tire marks were identified as having been created by the Ram pickup. While the wheel track dimensions of the trailer were not conveyed in the documentation provided, rough dimensions acquired from the total station and photographic point cloud data depict a trailer deck width of about seven (7) feet.

⁴ Ram wheel track was cited at 5.67 feet (source Expert Autostats) and the lateral separation between arcs was measured at about 5.5 feet.

Approximately 150 feet eastward of the Ram, the onset of a tire friction mark atop the highway centerline exhibited characteristics consistent with an impact that led to an instability and deflation of the tire. Trailing westward from the onset, the mark exhibited oscillation and characteristics of sidewall over-deflection. Westward from its onset, the mark exhibited a leftward angular heading of about 2.5° (relative to the centerline) toward the oncoming eastbound travel lane. This mark established the first area of impact between a motorcycle and the Ram and was created by the truck's driver side (left) front tire. About six (6) feet east of the onset of this mark, a fluid trail exhibiting characteristics of blood and other biological material was deposited on the road surface. The onset of this fluid trail was adjacent the centerline in the eastbound travel lane and angled toward the right shoulder. Some light roadway surface scratches were observed between these areas of evidence.

About 22 feet west of the onset of the left front tire mark and about two (2) feet into the eastbound lane, the onset of another fluid trail was observed. This deposit was consistent with a sudden discharged of fluid from a vehicle. This area was identified as the location of the second motorcycle impact.

Contemporaneous with the fluid deposit, the parallel tire marks created on the right (passenger) side of the Ram exhibited a visually significant increase in intensity and evidence of right-angle striations. These characteristics were indicative of lateral wheel slip and were consistent with an application of force such as an impact. As the truck's left front tire mark continued west from this area the characteristics were altered. The intensity of the mark significantly increased and exhibited evidence of increased oscillation or instability. Following this second area of impact, the approximate angular heading of the Ram (relative to the centerline) increased to more than 17° .

Approximately 31 feet further west of the second impact (53 feet west of the first impact), roadway pavement gouging and fluid debris were located about 2.6 feet into the eastbound lane. The pavement scars exhibited characteristics consistent with a hard pavement strike and displayed possible slight arcing relative to the centerline. The fluid debris adjacent to the gouges exhibited a westward discharge pattern. In addition, light pavement surface scrapes extended from this area along a path consistent with Ram and trailer. This evidence was consistent with an impact.

As the tire friction marks from the Ram continued across the eastbound travel lane, a fourth impact area was identified approximately 81 feet west of the initial collision. Tire friction marks (scuffs), vehicle fluid debris, pavement gouging and vehicle debris were all located in this area. About 18 feet east of this area the Ram's right-side tire mark exhibited a noticeable divergence. Adjacent to this area of impact, the Ram's right-side running board was located in the westbound lane.

As the Ram and trailer approached the right shoulder of the eastbound travel lane its angular heading relative to the centerline increased to more than 21° . The tire mark created by the left front tire became more pronounced and developed characteristics more consistent with sliding. Beginning just over four (4) feet outward from the edge line, pavement gouging appeared within the tire mark. Pavement scraping was visible until the wheel departed the paved surface.

Similarly, several feet westward of the tire mark additional pavement surface material transfer and scrapes were observed. The pavement marks and vehicle debris scattered about this area were consistent with another area of impact where the front of the Ram collided with another motorcycle.

As the Ram departed the pavement it encountered a soil surface and a low embankment that was offset from the pavement about six (6) feet. As the Ram encountered the soil surface, evidence of wheel furrowing and additional counterclockwise rotation of the truck followed. Photographs depict that the left front tire had separated from the rim and came to rest against the left front corner of the trailer. As conveyed in the NTSB Vehicle Factors Group report, post-collision the steering tie rod of the Ram had been displaced from the vehicle. As observed in photographs and depicted in **Figure 3**, the left front tire sidewall exhibited two areas where it been breached. The truck body exhibited evidence of multiple points of direct contact or impact.

Figure 4 depicts a post-collision scaled diagram based on total station data collected by NHSP investigators. The data appear to represent most of the significant evidence although certain individual marks and vehicle debris were not captured.



Figure 3: Post-collision photograph of Ram depicting position of rest and the separated left front tire.
Source: NHSP

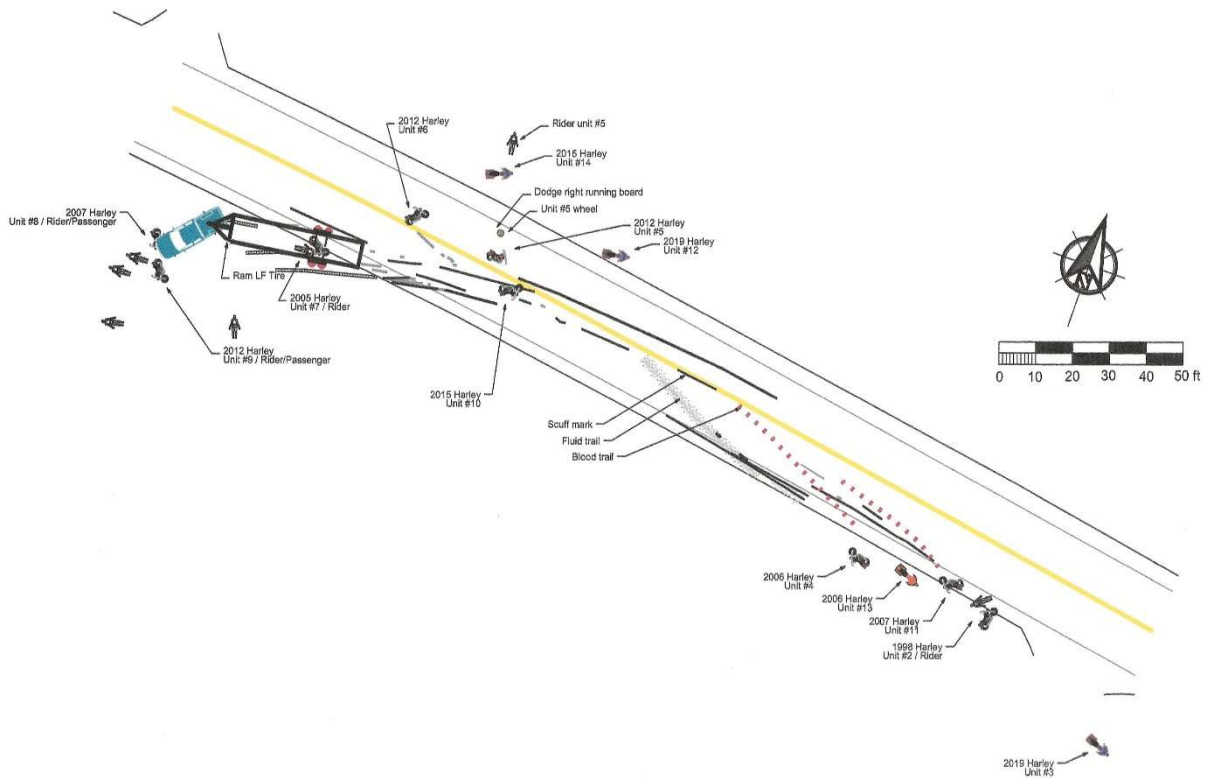


Figure 4: Post-collision diagram based on total station documentation data provided by NHSP investigators. (Labeling convention follows vehicle identification in introduction.)

2. Vehicle Position of Rest and Documentation

Following the crash, NHSP investigators documented the locations of 13 motorcycles that remained at the scene. Seven exhibited evidence of having sustained a direct impact with the Ram pickup, trailer, or another motorcycle. Two (2) motorcycles exhibited evidence of having capsized to the pavement without contact with another vehicle. The remaining four (4) motorcycles were documented as having stopped upright without evidence of impact or capsizing. The Ram and two (2) of the seven motorcycles that sustained a direct impact were also involved in a post-crash fire. Additional examination and documentation of the of the vehicles was undertaken by the NTSB Vehicle and Survival Factors Groups. Those group reports should be consulted for additional information.

As presented in the succeeding sections, motorcycle data will be described based on their post-crash locations relative to the initial collision.

2.1. 2015 Ram 2500 and 2015 Quality Trailer

As measured along the Ram's center of gravity path of travel, the truck travel about 150 feet between the first impact and its position of rest. At rest, the truck was off the pavement about two feet from the pavement edge at the closest point and was angled about 54° relative to the pavement edge. The trailer, which was connected to the truck by a fifth wheel coupler, was positioned at an angle of about 15° relative to the road edge. The trailer axles straddled the pavement edge such that the right tires were on the pavement and the left off the pavement. The rear of the trailer overhung the eastbound right shoulder and a portion of the travel lane.

As conveyed in the NTSB Vehicle Factors report, post-collision the steering tie rod between the left and right tie rod ends was missing. The connection points exhibited evidence of having fractured. The post-crash inspection likewise noted crash-induced displacement of the steering drag link and separation of the steering stabilizer (damper) at its connection with the tie rod. Photographs depicted impact damage to the left front rim at three locations circumferentially. The flange was clearly deformed with damage extending inboard to about the safety hump at one location.

Although post-collision fire damage destroyed most of the frontal exterior painted surfaces and exterior plastic appurtenances, body panel deformation due to direct impacts could be discerned. Unfortunately, the fire damage obliterated any evidence involving paint damage (scrapes) or material transfer. Areas of direct contact were identified as follows:

- Left front fender, beginning at the leading edge and progressing rearward to the trailing edge and leading edge of the driver's door.
- Front end about the longitudinal centerline and extending laterally outboard toward the driver's side with damage to the bumper and hood.
- Right front fender leading edge with evidence of lateral displacement toward the driver's side.
- Right side that included deformation to the trailing edge of the front fender, the passenger front door and lower edges of the passenger rear door and cargo bed forward of the rear axle. The right rear wheel rim flange exhibited impact damage and the axle appeared to be shifted rearward on the right side. Additionally, the right-side running board had been displaced and was deposited in the westbound lane about 82 feet northeast of the truck's position of rest.

The trailer was configured as a flatbed for use in transporting vehicles. While no specification data were available, measurements extracted from the police total station data indicate an approximate length of about 36 feet, excluding the goose neck coupler, and a width of about seven feet across the deck. The tandem wheels and fenders were mounted outboard of the deck, thereby adding some additional width.

Although the perimeter frame of the trailer exhibited no visual evidence of direct impact, the forward axle and a lateral frame crossmember exhibited deformation and rearward

displacement near their midsections. At final rest, a motorcycle and rider were respectively located under the trailer between and ahead of the axles.

2.2. 2019 Harley Davidson FLTRXS Road Glide Special (NTSB unit# 3)

Post-collision, this motorcycle was located at the far eastern end of the scene about 141 feet east of the first impact and 17 feet off the highway pavement in the grass on the right roadside. The vehicle was stopped upright, and although was reportedly unavailable for inspection, did exhibit possible minor damage to the front fender, as depicted in NHSP scene photographs.

2.3. 1998 Harley Davidson FLHT Electra Glide (NTSB unit# 2)

This motorcycle was involved in the first impact with the Ram. Post-collision it was located about 90 feet from the area of impact and partially off the eastbound pavement. The vehicle exhibited evidence of direct contact along its left side that resulted in the deformation or displacement of numerous components such as the handlebar, side guards, rider footrest and engine primary cover. While the vehicle came to rest on its left side, some protruding surfaces on the right side exhibited evidence of longitudinal scraping.

The rider of this motorcycle was fatally injured and was found beside the motorcycle at final rest.

2.4. 2007 Harley Davidson FLHRSE3 CVO Road King 3 (NTSB unit# 11)

Although located overturned on the eastbound shoulder about 15.5 feet west of the motorcycle referenced in section 2.3, it exhibited no evidence of impact with another vehicle. Its post-collision orientation and roadway evidence leading toward the vehicle indicate the motorcycle capsized due to a loss of stability.

2.5. 2006 Harley Davidson FLTRI Road Glide (NTSB unit# 13)

Post-collision, the motorcycle was documented as stopped upright about three (3) feet off the eastbound lane paved surface and 12.5 feet west of the unit referenced in section 2.4. Tire impressions in the roadside soil indicate this vehicle came to a controlled stop. There was no reported damage to this motorcycle. Information indicates this vehicle was subsequently removed by the rider and was not viewed by NTSB investigators.

2.6. 2006 Harley Davidson FLSTI Heritage Softail (NTSB unit# 4)

This motorcycle was identified as having been the second vehicle to collide with the Ram truck. Post-collision, the motorcycle was documented on its left side about 5.5 feet off the eastbound lane pavement and 13.5 feet west of the unit referenced in section 2.5.

The vehicle exhibited evidence of direct contact along its left side that resulted in the deformation or displacement of numerous components such as the handlebar, rider footrest and engine primary cover and crankcase thus exposing internal engine components.

2.7. 2015 Harley Davidson FLST Softail Deluxe (NTSB unit# 10)

The motorcycle was located overturned on its right side within the eastbound lane adjacent to the centerline about 62 feet west of the first area of impact. The motorcycle exhibited no evidence of impact with another vehicle. Its post-collision orientation and lack of damage related to sliding indicate the vehicle capsized due to a loss of stability or rider balance at a low speed. Evidence indicates the motorcycle came to rest after the Ram and trailer had passed its path of travel.

2.8. 2012 Harley Davidson FLHTCUSE7 CVO Ultra Classic Electra Glide (NTSB unit# 5)

The motorcycle was located overturned on its left side within the westbound lane adjacent to the centerline about 70 feet west of the first area of impact. The motorcycle exhibited extensive frontal impact damage that resulted in the displacement of the front wheel assembly, fairing and most of the forward lighting. The vehicle exhibited evidence that the front wheel and fender assembly had been displaced rearward into contact with the engine before separating. The wheel assembly was also located in the westbound lane closer to the shoulder. The engine guards also exhibited a rearward displacement. The damage was consistent with striking the Ram along the right side and then being redirected into the westbound lane.

This motorcycle also exhibited evidence of a rear end impact with the damage confined to the fender, rear lighting, and tour pack. This damage was consistent with having been struck by a trailing motorcycle as described in section 2.9.

Scene documentation located the post-collision position of this motorcycle's rider about 31 feet northward of the vehicle and 16 feet off the highway pavement on the westbound roadside. The rider was fatally injured.

2.9. 2012 Harley Davidson FLSTI Electra Glide Ultra Unlimited (NTSB unit# 6)

The motorcycle was located overturned on its left side within the westbound lane adjacent to the centerline about 25 feet west of the motorcycle referenced in section 2.8. This unit exhibited frontal impact damage with visible damage to the fender forward of the suspension forks. As viewed in the post-crash photographs, the front forks also appeared to have experienced some rearward displacement. This damage is consistent with striking the rear of the motorcycle traveling ahead of it.

2.10. 2005 Harley Davidson FLHTCU Electra Glide Ultra Classic (NTSB unit# 7)

The motorcycle was located overturned on its right side beneath the trailer and partially off the pavement. At rest, the front of the motorcycle was facing the rear of the trailer. The motorcycle exhibited contact damage primarily to the left side although the right side exhibited significant evidence of sliding. The damage was indicative of the motorcycle having been overturned onto its right side at the time of impact with the trailer.

The fatally injured rider of this motorcycle was located beside the vehicle beneath the trailer. There was no evidence that he was ejected from the motorcycle due to impact with the trailer.

2.11. 2012 Harley Davidson FLHTKEL Electra Glide Ultra Limited NTSB unit# 9)

The motorcycle was located off the westbound roadside about three (3) feet forward of the Ram near the left side and 25 feet off the pavement. It was overturned onto its right side. The vehicle exhibited evidence of frontal and left side impact damage that included the separation of the front wheel assembly at the front forks. The vehicle also sustained significant post-collision fire damage that appeared to consume most, if not all, non-metallic components that had remained attached following impact with the truck. Post-collision photographs depict a hole in the left, forward, side of the fuel tank in the proximity of deformation damage.

Post-crash, the two occupants of this motorcycle were located east and south of the motorcycle at distances of 25 and 19 feet, respectively. Both had sustained fatal injuries.

2.12. 2007 Harley Davidson FLHTCU Electra Glide Ultra Classic (NTSB unit# 8)

The motorcycle was located off the westbound roadside partially beneath the right front of the Ram and about 16.5 feet off the pavement. It was overturned onto its right side with the front half partially consumed by post-crash fire. The vehicle exhibited evidence of frontal and left side impact damage that included the separation of the front wheel assembly at the front forks. Front wheel components not consumed by fire were displaced rearward and toward the left.

Post-crash, the two occupants of this motorcycle were located directly ahead of the truck and their motorcycle at distances of about seven and 13 feet. Both had sustained fatal injuries.

2.13. 2019 Harley Davidson FLXH Street Glide (NTSB unit# 12)

Post-collision, the motorcycle was documented as stopped upright off the westbound pavement. No damage to the motorcycle was reported and it was apparently removed from the scene by its rider. The vehicle orientation at rest indicates it had been brought to a controlled stop.

2.14. 2015 Harley Davidson FLHTK Electra Glide Ultra Classic (NTSB unit# 14)

Post-collision, the motorcycle was documented as stopped upright off the westbound pavement. No damage to the motorcycle was reported and it was apparently removed from the scene by its rider. This vehicle was not viewed by NTSB investigators. The vehicle orientation at rest indicates it had been brought to a controlled stop.

E. REFERENCES

- NTSB group factual investigative reports
- NHSP photographs and mapping data

F. DOCKET MATERIAL

The following attachments and photographs are included in the docket for this investigation:

LIST OF ATTACHMENTS

None

END OF REPORT

Robert J. Squire
Highway Accident Investigator