



**HIGHWAY FACTORS GROUP CHAIRMAN'S
FACTUAL REPORT**

Baltimore, MD

HWY17MH007

(9 pages)

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

**HIGHWAY FACTORS GROUP CHAIRMAN'S
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A. CRASH INFORMATION

Location: Eastbound Frederick Avenue between South Monastery Avenue and South Morley Street, Baltimore, Baltimore County, Maryland

Vehicle #1: 2015 IC 64-Passenger School Bus

Operator #1: AAAfordable Transportation, LLC

Vehicle #2: 2012 Ford Mustang

Operator #2: Private Operator

Vehicle #3: 2005 New Flyer Transit Bus

Operator #3: Maryland Transit Administration

Date: Tuesday, November 1, 2016

Time: Approximately 6:30 a.m. eastern standard time

NTSB #: **HWY17MH007**

B. HIGHWAY FACTORS GROUP

David S. Rayburn, Highway Factors Investigator, Group Chairman
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C. CRASH SUMMARY

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

D. DETAILS OF THE HIGHWAY FACTORS INVESTIGATION

The Highway Factors Group examined the security videos of the vehicles approach to the crash event from a nearby gas station, convenience store, church, and the transit bus on-board video. Additionally, the St. Joseph' Monastery video was calibrated to assist in determining the speed of the school bus. The group examined highway geometry, crash data, and highway metrics including the Average Daily Traffic (ADT) and 85th percentile speed studies. The scene was photographed and additional measurements were taken of the roadway and objects within the security camera field of view. Maryland Transit Administration Police and Baltimore City PD conducted a three-dimension scan and total station survey of the accident scene.

1. Prefatory Data

The two impacts involved in the crash sequence accident occurred between the 3800 and 3900 blocks of Frederick Avenue (State Route SR 144). The highway facility is owned and maintained by the City of Baltimore. The crash event involved two separate impacts. First, the school bus collided into the rear of a Ford Mustang, and then continued forward eastbound on Frederick, approximately 820 feet to where it collided into the left front side of a Maryland Transit Administration (MTA) transit bus that was traveling west on Frederick avenue. The first impact on Frederick Avenue was approximately 200 feet east of Loudon Avenue, and the second impact on Frederick Avenue was approximately 1000 feet east of Loudon Avenue, and approximately 210 feet west Morley Street. The GPS coordinates for the initial impact was 39 degrees 16 minutes 54.39 seconds north longitude by 76 degrees 40 minutes 52.40 seconds west latitude and the impact with the MTA bus was located at 39 degrees 16 minutes 54.78 seconds north longitude by 76 degrees 40 minutes 42.51 seconds west latitude. See Figure 1 for a map of the crash location and Figure 2 for a detailed view of the crash location showing points of impact and distances between impacts.

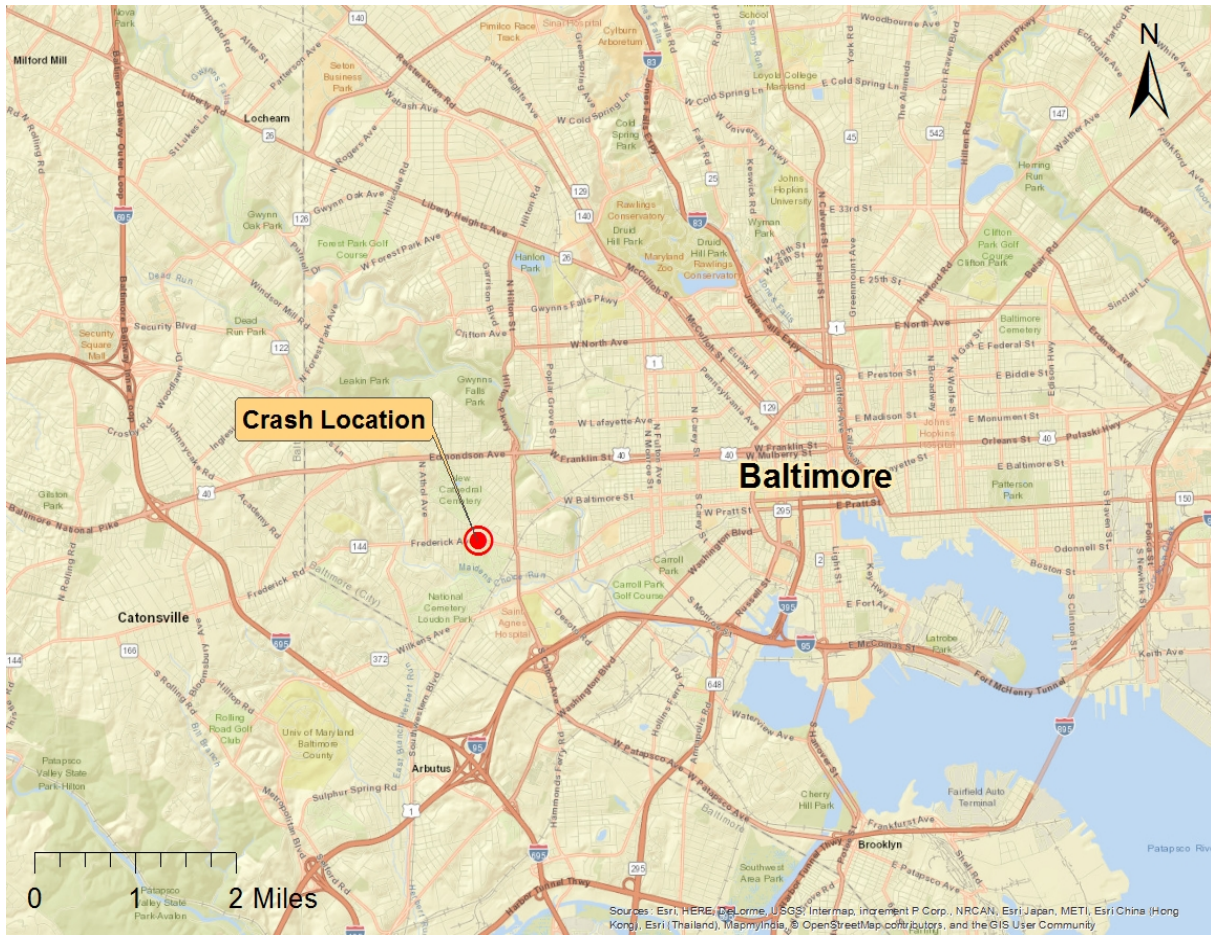


Figure 1. Crash Location in Relation to Downtown Baltimore

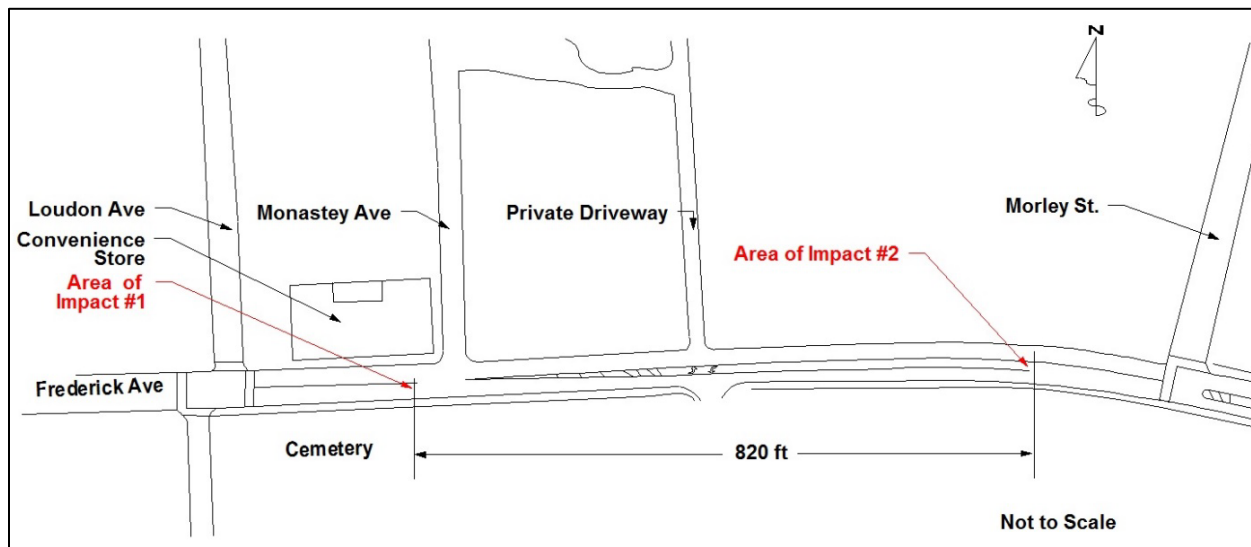


Figure 2. Location of Impact Area #1, Where the School Bus Struck the Mustang and Area #2, Where the School Bus Struck the Transit Bus

2. Security Video of School Bus Pre-Crash Travel

Security cameras located at the convenience store on Frederick Avenue, a gas station at the intersection of Frederick Avenue and Monastery Avenue and on the Chapel at St. Josephs Monastery recorded the bus as it passed their fields of view. According to the NTSB video study Report the school bus was traveling about 57 mph when it traveled through the security cameras' field of view moments before impact with the Ford Mustang. The restraint control module (RCM) recorder indicated the Mustang was travelling about 16 mph when it was struck from behind by the school bus. The school bus was traveling about 47 mph after the initial impact with the Mustang. It departed the camera field of view and traveled approximately 600 feet before the second impact with the MTA bus occurred. The MTA bus video indicated the school bus was traveling approximately 45 mph at impact. The curbside camera and forward facing camera on the MTA bus indicated the transit bus was traveling approximately 41 mph several seconds before the impact occurred, and approximately 39 mph at impact. For more detail, the see Recorder Group Factual Report and Video Study Report.

3. Traffic Metrics

The 85th percentile speed for Frederick Avenue was 37 mph in the posted 30 mph speed zone and the average speed was 33.5 mph in 2010 when the spot speed study was conducted.¹ The Average Daily Traffic (ADT) was 14,300 vehicles per day (VPD) in 2015. The highway facility is functionally classified as a principal arterial.² For more details, see Highway Attachment 1, Traffic Metrics

4. Frederick Avenue Accident History

Statistics of serious injury and fatal crashes along a one-mile section of Frederick Avenue for the preceding five-year-period from 2010-2014 were requested from the Baltimore City Department of Transportation (City DOT). The City DOT records showed that 26 non-capacitating injury accidents and 4 capacitating injury accidents occurred in the segment during the five-year-period. No other fatal accidents occurred during this period along Frederick Avenue in the accident area. The MTA provided transit bus involved crashes for the one-mile long area encompassing the accident area for the two-year-period November 1, 2014 through November 1, 2016, including this crash. There were 13 transit bus crashes during this period for the one-mile-long segment on Frederick Avenue. The subject crash was the only fatal crash and most of the other crashes involved only property damage. For more detail, see Highway Attachment 2, Accident History.

¹ The speed at which 85 percent of the traffic is traveling at or below. The study was conducted before the roadway was re-configured from two lanes in each direction to one lane and a bicycle lane with wider shoulders in each direction.

² Section 1.3.4 of "A Policy on Geometric Design of Highways and Streets" 6th Edition 2011 by the American Association of State Highway and Transportation Officials (AASHTO) provides the following description of urban principal arterials; "The urban principal arterial system serves the major centers of activity or urbanized areas, the highest traffic volume corridors, and the longest trip desires. This system carries a high proportion of the total urban travel even though it constitutes a relatively small percentage of the total roadway network."

5. Highway Information and Geometry

Frederick Avenue had two traffic lanes, one in the eastbound and one in the westbound direction. Both lanes had accompanying bicycle lanes and paved shoulders. The typical pavement cross section from curb to curb was 45 feet wide. Each travel lane was approximately 11 feet wide with shoulders varying in width from 7.5-8.5 feet wide. The bicycle lanes were approximately 4-4.5 feet wide. A 2.5-foot-wide grass area separated the shoulders from the paved, 5-foot-wide sidewalks on either side of the roadway. To the south of the roadway another 1.75-foot-wide grass area bordered the outside of the sidewalk where it terminated next to a metal fence that bordered the adjacent cemetery.

The bicycle lanes and shoulders were delineated from the travel lanes by a solid white pavement stripe. The travel lanes were separated by a double yellow centerline. The double yellow centerline began diverging into two double yellow centerlines, approximately 204 feet east of Loudon Avenue and formed an 11-foot-wide center turn lane approximately 373 feet from Loudon Avenue. Once the turn lane was fully formed, it was delineated from the travel lanes by a solid yellow pavement stripe that had dashed lines inside the solid markings at 30-foot-long intervals. Each dashed line was 10 feet long. In this area, the pavement began transitioning from level to an approximate 0.035 percent downgrade in the eastbound direction. The tangent roadway also began a right hand curve to the right in the eastbound direction. The curve was approximately 200 feet in length and had a curvature of approximately 3 degrees.

There was overhead highway safety lighting on both sides of Frederick Avenue between Loudon Avenue and Morley Street.

The Baltimore Police and Maryland Transportation Administration Police documented the roadway geometry and impact locations over the entire section of Frederick Avenue from Loudon Avenue to Morley Street. For more dimensional detail, see Highway Attachment 3, Baltimore City DOT Pavement Marking Plans.

6. Dimensions of Objects in Church Video

Several objects were located to supplement the calibration of the security video at St. Josephs Monastery. The camera itself was located at a height of 228 inches (or 19 feet) above the pavement next to the building. In addition, the pavement sloped downward on southbound Monastery Avenue on a 0.03 percent downgrade. The camera was positioned 48 feet 8 inches east of the east curb of Monastery Avenue and 526 feet from the north curb of Frederick Avenue. A tree line was located approximately 493.5 feet south of the camera along the southern border of the property. Five trees were located laterally from the east curb of Monastery Avenue.

Tree 1 – 26 feet east

Tree 2 – 83 feet east

Tree 3 – 107 feet east

Tree 4 - 130 feet east

Tree 5 – 142.75 feet east

7. Scene Information

The initial impact between the school bus and Ford Mustang was evidenced by scrapes in the pavement and collision scrub, tire-friction marks. The Mustang traveled approximately 74 feet from the initial impact to where it struck the south curb of Frederick Avenue, and then traveled 23 feet to where it collided with a brick wall and metal fence. From there it traveled back into the lane coming to a final position across the eastbound lane of Frederick Avenue. The total distance traveled by the Mustang from the initial impact to its final position was approximately 148 feet.

The impact area between the school bus and transit bus was evidenced by radiator splatter which, was located partially in the center turn lane and in the westbound lane of Frederick Avenue. The splatter fluid marks were approximately 15 feet forward of where the transit bus came to its final rest position. See Highway photographs 1-28 for views of impact areas, pavement markings, and roadway alignment.

E. DOCKET MATERIAL

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

LIST OF ATTACHMENTS

Highway Attachment 1 – Traffic Metrics

Highway Attachment 2 – Accident History

Highway Attachment 3 – Baltimore City DOT Pavement Marking Plans

Highway Attachment 4 – Baltimore City Police Crash Report

LIST OF PHOTOGRAPHS

Highway Photo 1 - Aerial view of Frederick Avenue from left to right or eastbound in photo. The Avenue depicted in the left of photo is Loudon Ave. where the Mustang turned right onto Frederick. The initial impact occurred in the center of the photo where the red and white tow trucks are parked. The far right edge of the photo shows the school bus and transit bus at impact location. **Highway photos 1-24 provided courtesy of the Baltimore Police Department (BPD)**

Highway Photo 2 - Eastbound view of Frederick Ave. with impact area and both buses at final positions.

Highway Photo 3 - View of gouges and scrapes in pavement on Frederick Ave. where the school bus struck the rear of the Mustang.

Highway Photo 4 - Eastbound view of school bus and truck at their final positions east of the impact area.

Highway Photo 5 - Eastbound view of Frederick Ave. showing the Mustang's post-crash tire friction marks, 820 feet west of the school bus-transit bus impact.

Highway Photo 6 - Aerial view of school bus-Mustang impact area depicted by orange pavement markings with the Mustang post-crash marks leading to the Loudon Cemetery wall and back into Frederick Avenue with the Mustang coming to a final position at Monastery Avenue.

Highway Photo 7 - View of the Mustangs post-crash travel path into the cemetery wall.

Highway Photo 8 - Closer aerial view of school bus-transit bus impact area with vehicles at their final positions, approximately 200 feet west of Morley Street.

Highway Photo 9 - Aerial view showing the depth of penetration by the school bus into the left side of the transit bus.

Highway Photo 10 - View of the Mustang's post-crash pavement gouges leading from the initial impact into the cemetery wall.

Highway Photo 11 - Aerial view of school bus-transit bus impact area.

Highway Photo 12 - North to south view of Mustang impact into cemetery wall.

Highway Photo 13 - Aerial view of the school bus-transit bus impact area depicted by fluid spatter and debris forward of the transit bus.

Highway Photo 14 - Close-up aerial view of impact area between the buses and the depth of penetration into the left side of the transit bus.

Highway Photo 15 - View of vehicle liquids drainage path from the impact area toward the curb on the upper part of the photograph.

Highway Photo 16 - Close-up view of damage to cemetery wall from the Mustang's secondary impact into the wall.

Highway Photo 17 - Continued view of Mustang's travel path into the wall and back into the street.

Highway Photo 18 - View standing near the area of final rest of the Mustang, looking eastbound on Frederick Avenue with the school bus and transit bus impact in the far background behind the caution tape.

Highway Photo 19 - Continued view looking east on Frederick Avenue showing the buses on the other side of a slight hill crest past the entrance to the cemetery.

Highway Photo 20 - View of buses at their final positions on the other side of the vertical curve or hill crest. Also note the presence of highway safety lighting on both sides of Frederick Avenue, which was on at the time of the accident.

Highway Photo 21 - View showing the center turn lane on the approach to the bus impact location.

Highway Photo 22 - View showing the eastbound approach to the impact area.

Highway Photo 23 - Additional view of eastbound approach to the accident area.

Highway Photo 24 - View of wet pavement from the school bus liquids spattered onto the center turn lane and westbound lane occupied by the transit bus. Area begins where the police officer is standing in the westbound lane near the yellow line of the center turn lane.

Highway Photo 25 - Westbound view of transit buse's approach from Morley street. Note the slope and curvature of the roadway. The impact area is near where the curve begins in the area covered by the shade of the trees.

Highway Photo 26 - Eastbound view of School bus driver's approach taken the day after the accident. Note the downhill slope and curvature of the roadway.

Highway Photo 27 - Additional view of eastbound approach with impact area located in the photo area where the tree shade crosses the pavement adjacent to the 30 mph speed limit sign.

Highway Photo 28 - View of eastbound approach to the curve with the impact area and Morley street in the background.

END OF INFORMATION

David S. Rayburn
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