FORENSIC RESEARCH AND EVIDENCE DOCUMENTATION GROUP
Factual Report

CHESTERFIED TWP, NJ

HWY-12-MH-007
(13 Pages)

NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C. 20594

FORENSIC RESEARCH AND EVIDENCE DOCUMENTATION GROUP
Factual Report

A. ACCIDENT

Type:	School Bus, Roll-Off Truck Intersection Related Accident
Date and Time:	February 16, 2012 8:15 AM. EDT
Location:	Bordentown-Chesterfield Rd (Burlington County Route 528) and Old York, Rd (Burlington County Route 660) Chesterfield Township, Burlington County, New Jersey
Vehicle #1:	2012 International 54-Passenger School Bus
Motor Carrier #1:	Garden State Transport Inc
Vehicle #2:	2004 Mack Granite Roll Off Truck
Motor Carrier #2:	Herman's Trucking, Inc
Fatalities:	01
Injuries:	18
NTSB #:	**HWY-12-MH-007**

B. FORENSIC RESEARCH AND EVIDENCE DOCUMENTATION GROUP

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C. ACCIDENT SUMMARY

For a summary of the accident, refer to the *Accident Summary* report which is available in the docket for this investigation.

D. FORENSIC DOCUMENTATION

The accident scene, related environment, and sight conditions were examined and scanned using a FARO Focus 3D Laser Scanner. Eleven linked scans were performed for the scene. The exterior of the accident school bus including the damage profile to both the driver and passenger sides was scanned (six scans). The accident truck was also fully scanned including an overhead scan of the load in the truck (eight scans). The interior of the accident school bus was also scanned (six scans) to document damage to the floor, intrusion in the passenger cabin and seat deformation. An exemplar vehicle was scanned to document pre-crash dimensions of the school bus (eight scans).

1. Accident Scene Documentation

Mapping targets were aligned along the accident scene to enable registration between individual scans. The documentation focused on physical evidence, impact location, final rest positions and sight distance information. Seven scans were performed initially with four additional scans added to improve sight distance and manually registered to the original seven. An isometric view of the scanned scene is shown in Figure 1. Overhead views of the accident scene with an overlay of the police survey and vehicle final rest positions are shown in Figure 2 and Figure 3.

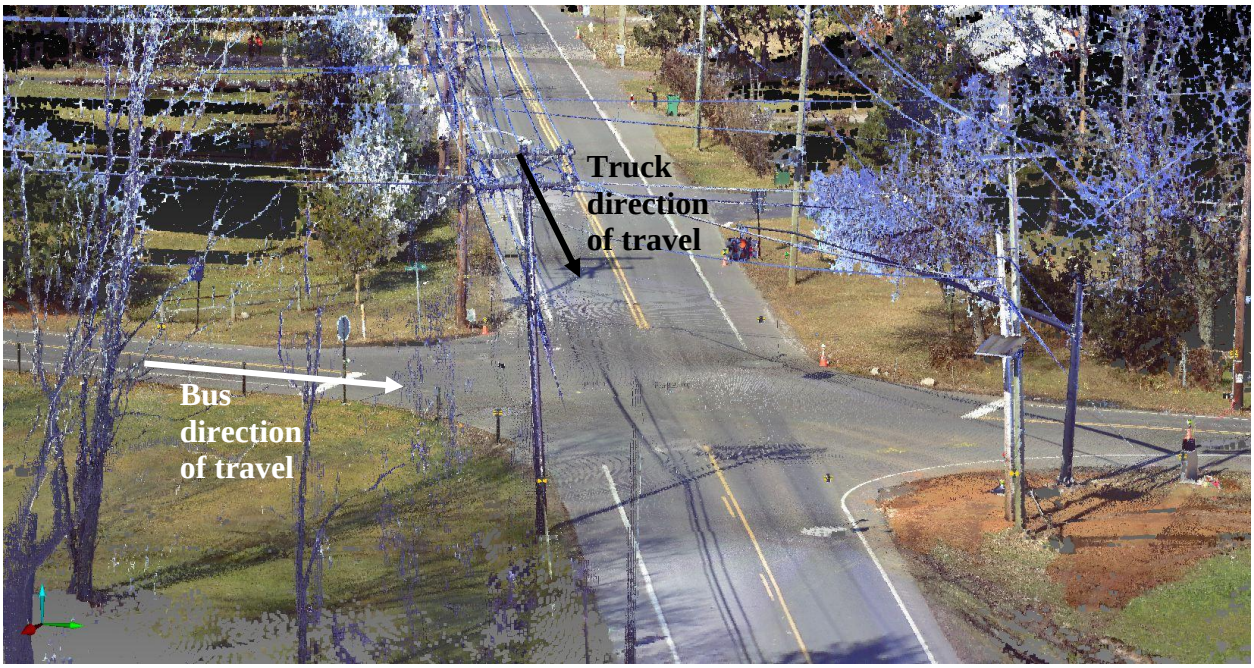

Figure 1: A still image from the combined 3D scan of the accident scene.

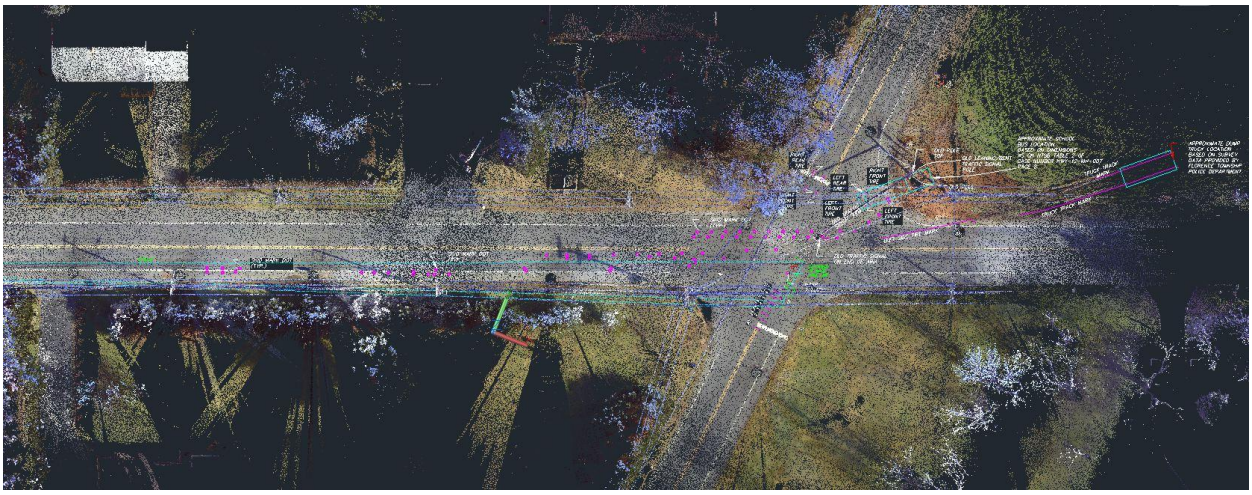

Figure 2: An overlay of the police survey of the accident scene and vehicle positions onto the 3D scan.

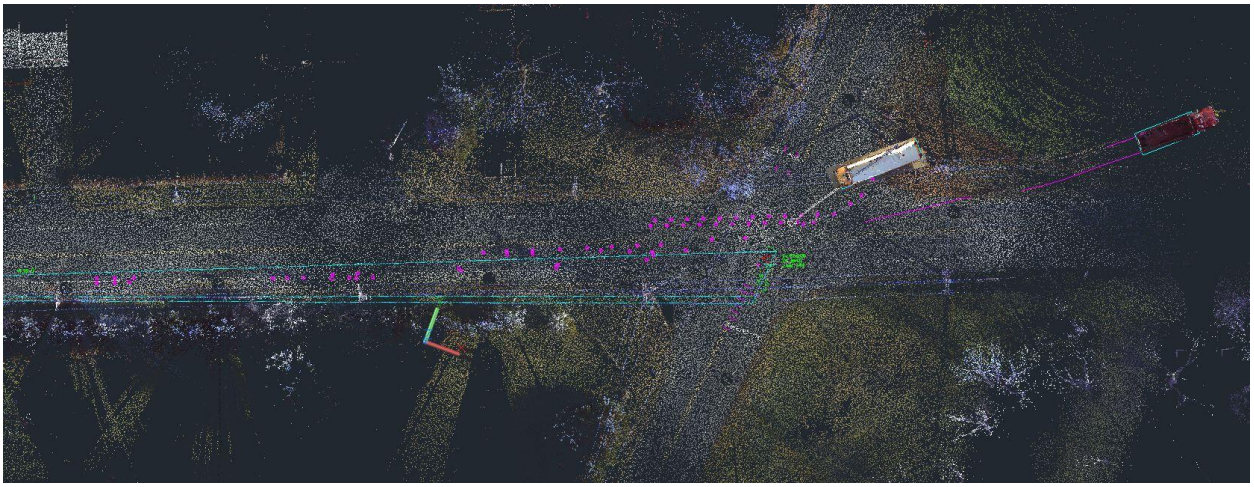

Figure 3: An overlay of the police survey of the accident scene and vehicle positions onto the 3D scan. The 3D scans of the school bus and truck are also shown in the final rest positions.

2. Accident Vehicle Documentation

a. General Information

The interior of the accident bus was scanned first followed by the exterior of the school bus and then the exterior of the accident truck.

b. Accident School Bus Interior

The interior of the accident school bus was scanned in six scans. Registration targets were placed throughout the interior of the bus to facilitate connection of each individual scan. An image from the 3D interior scan is shown in Figure 4.

Figure 4: An image of the school bus interior from the combined 3D scan.

1. Interior Dimensions and Deformation Measurements

Interior dimensions[1] were measured from the scanned data. The width of the seats on the driver's and passenger's sides of the bus was 45" and 30", respectively. The vertical distance from the floor to the top of the seat pan was approximately 16.8" and to the top of the seat back was approximately 42.3". The maximum vertical deformation of the floor in the area of intrusion was approximately 10". The damaged floor began approximately 45.5" forward of the rear emergency exit door and continued forward for about 71". The roof also showed damage that started approximately 37" forward of the rear emergency exit door and continued forward for about 95". The roof displacement vertically measured approximately 5.7". Some seats were also shifted both laterally into the aisle and vertically upwards. Seat 8 on the passenger side was shifted about 8.7" into the aisle. Seat 9 on the driver's side was shifted 3.7" into the aisle and 4.4" vertically upward compared to the undeformed seats at the front of the bus.

c. Accident School Bus Exterior

The exterior of the accident school bus was scanned in six scans, including a scan from an elevated surface to document damage to the roof. Registration targets were placed throughout the exterior environment but not on the actual accident vehicle to facilitate connection of each individual scan. The driver and passenger side of the accident school bus are shown in Figure 5 and Figure 6. General dimensions of the accident school bus are shown in Figure 7. Color coded depths along the accident bus highlight the intrusion from the pole, as shown in Figure 8.

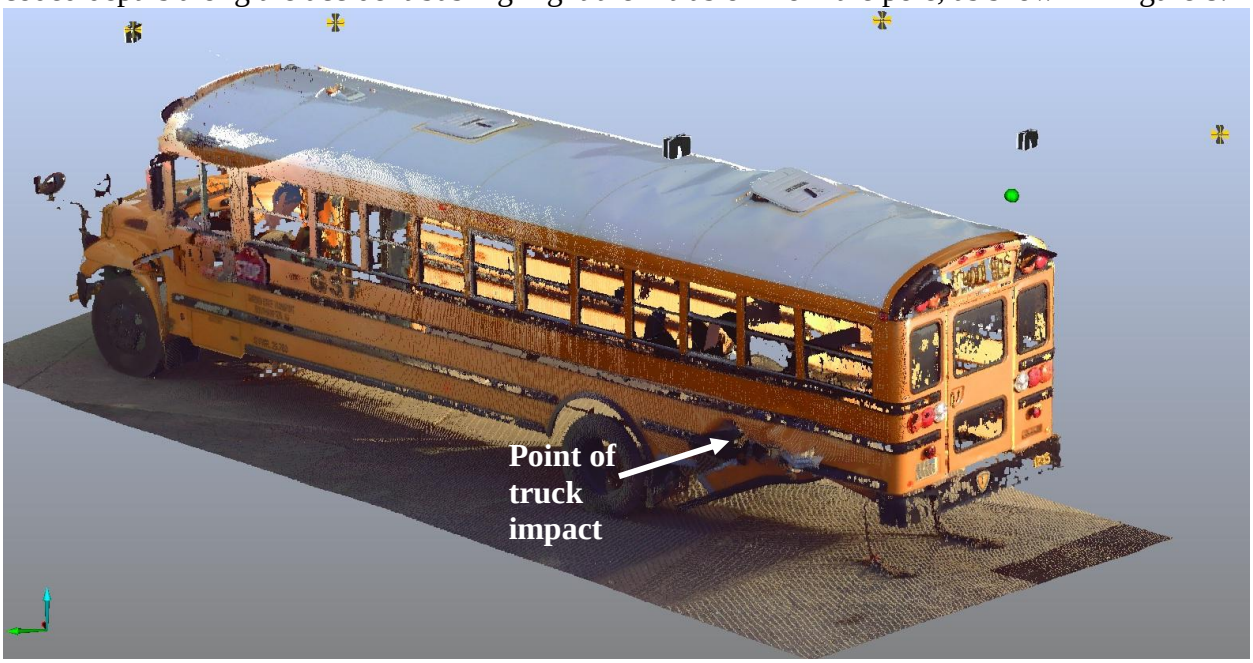

Figure 5: An image from the combined 3D scan of the driver's side of the accident school bus.

[1] FARO states that the maximum error in the distance measured by the Focus 3D scanner from its origin point to a point on a planar target is ±2.2 mm (±0.087 in) for targets tested at distances of 10 m (33 ft) and 25 m (82 ft), with a target reflectivity of either 10 % or 90 %. Additional uncertainty in dimensional data may result from the manual choice of points to represent a specific object from the entire 3D point cloud.

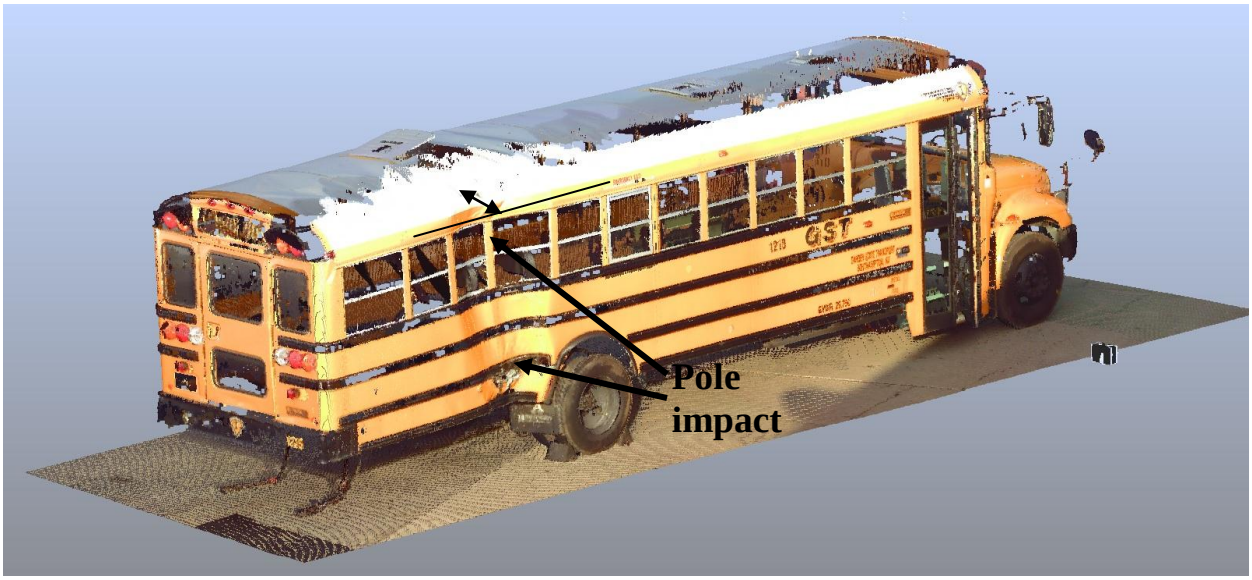

Figure 6: An image from the combined 3D scan of the passenger side of the accident school bus.

Figure 7: General dimensions of the accident school bus. (All measurements are in meters.)

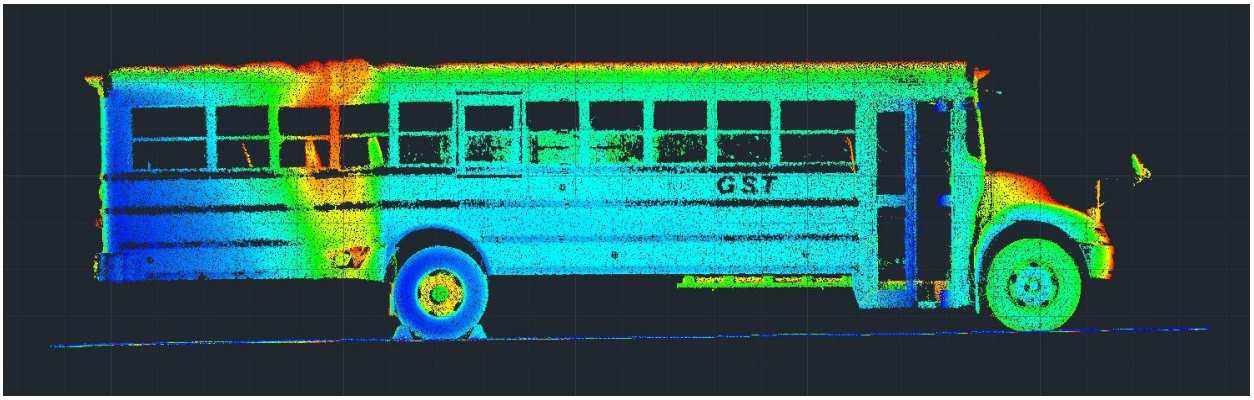

Figure 8: Color coded deformation at the intrusion from the pole impact.

2. Deformation Measurements

In order to measure the intrusion into the bus as a result of the pole impact at various vertical locations, five slices were taken at elevations representing a position below the occupant compartment (slice A), at approximately floor level (slice B), at hip level (slice C), at head level (slice D) and above head level (slice E). See Figure 9. Nine measurements were taken at consistent horizontal locations from the front of the bus at each vertical level (shown in Table 1 and Figure 10). Images of the measurements are shown in Figure 11 through Figure 15. Table 2 summarizes the measurements. The scanning equipment measures points in meters but for reference, the measurements were converted to English units in Table 3. The maximum intrusion was 10.38" seen above head level in the center of the pole impact. Generally, the crush depth was greater as the vertical slice height increased.

Table 1: Horizontal locations of each crush measurement for the pole intrusion.

Measurement	Location from front of the bus (m)
1	7.926
2	8.111
3	8.295
4	8.480
5	8.674
6	8.859
7	9.044
8	9.229
9	9.413

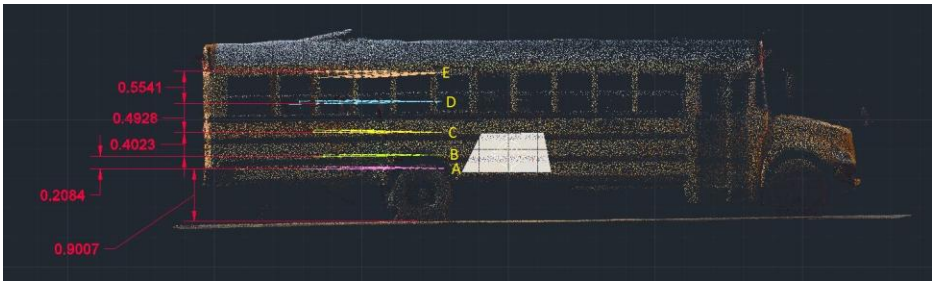

Figure 9: Location of each slice relative to the ground. (meters)

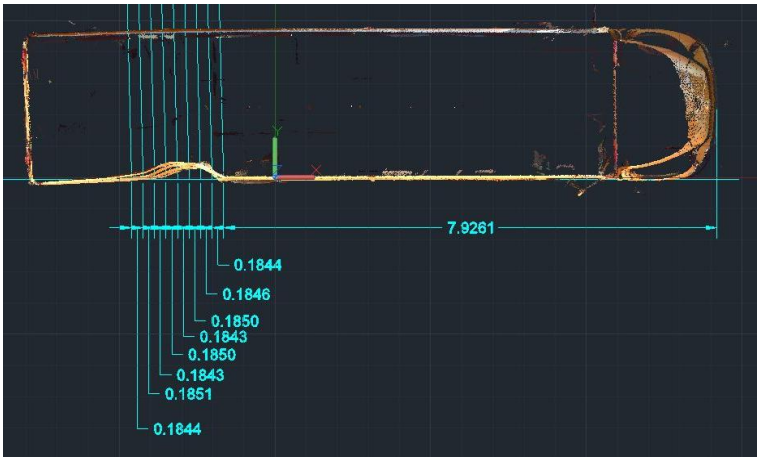

Figure 10: The horizontal location of each measurement for each vertical slice location. (meters)

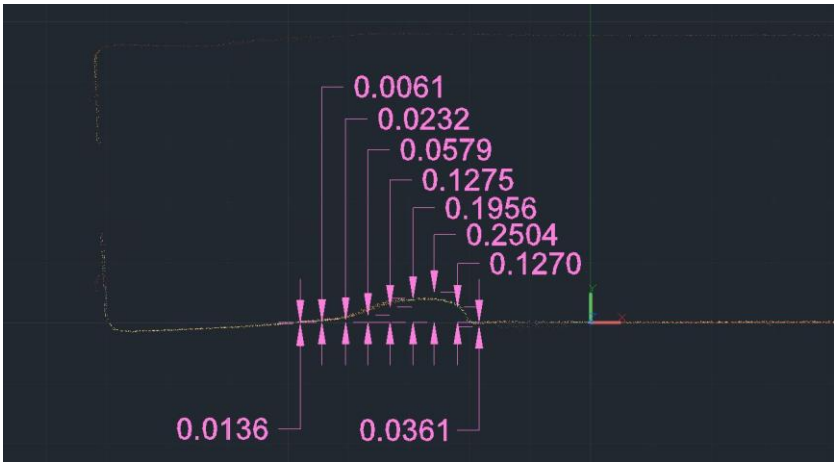

Figure 11: Crush measurements at slice A (below occupant compartment) on the accident school bus. (meters)

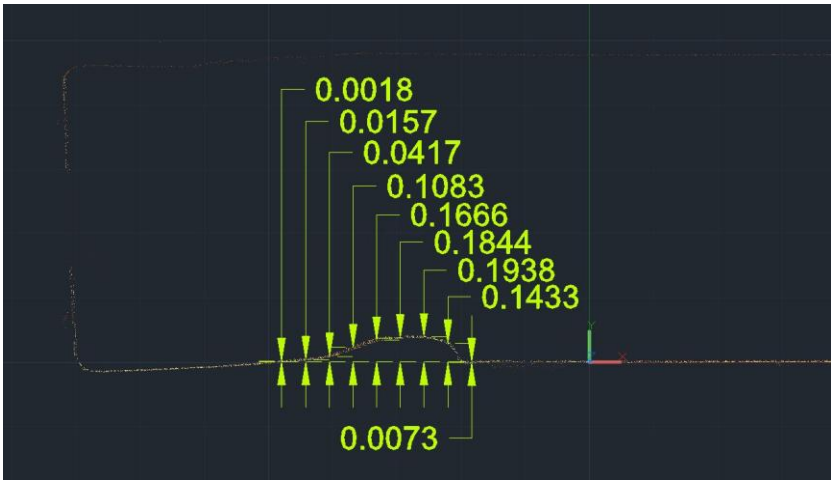

Figure 12: Crush measurements at slice B (floor level) on the accident school bus. (meters)

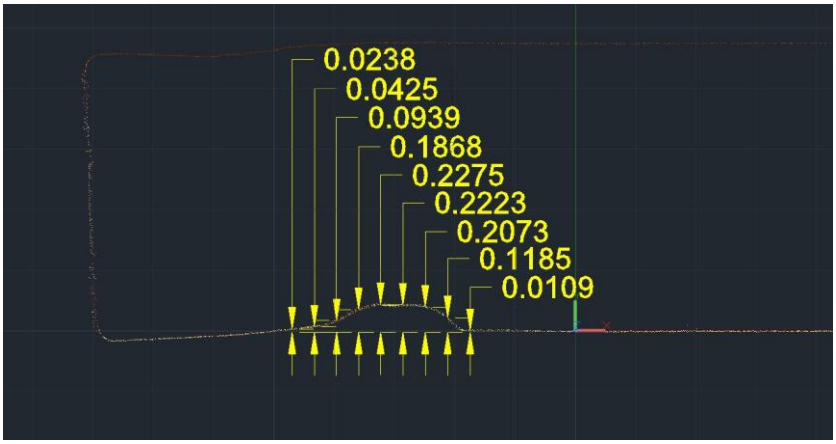

Figure 13: Crush measurements at slice C (hip level) on the accident school bus. (meters)

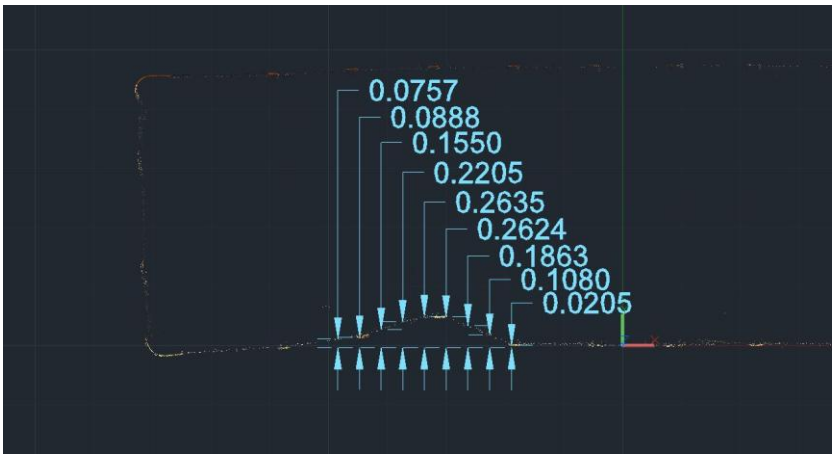

Figure 14: Crush measurements at slice D (head level) on the accident school bus. (meters)

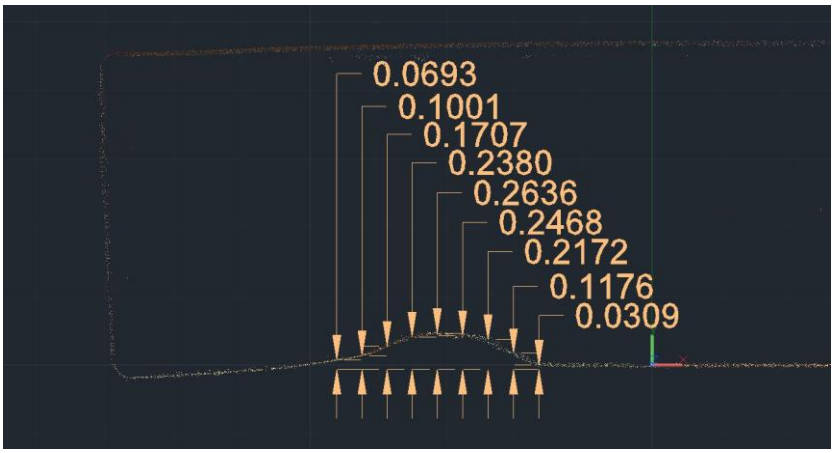

Figure 15: Crush measurements at slice E (above head level) on the accident school bus. (meters)

Table 2: Crush measurements at the location of the pole intrusion for each vertical location.

Slice Name	Distance from Ground (m)	Crush Measurement from front to back (m)								
		1	2	3	4	5	6	7	8	9
A	0.9007	-0.0361	0.127	0.2504	0.1956	0.1275	0.0579	0.0232	0.0061	-0.0136
B	1.1091	-0.0073	0.1433	0.1938	0.1844	0.1666	0.1083	0.0417	0.0157	0.0018
C	1.5114	0.0109	0.1185	0.2073	0.2223	0.2275	0.1868	0.0939	0.0425	0.0238
D	2.0042	0.0205	0.108	0.1863	0.2624	0.2635	0.2205	0.155	0.0888	0.0757
E	2.5583	0.0309	0.1176	0.2172	0.2468	0.2636	0.238	0.1707	0.1001	0.0693

Table 3: Crush measurements at the location of the pole intrusion for each vertical location in English units.

Slice Name	Distance from Ground (in)	Crush Measurement from front to back (in)								
		1	2	3	4	5	6	7	8	9
A	35.46	-1.42	5.00	9.86	7.70	5.02	2.28	0.91	0.24	-0.54
B	43.67	-0.29	5.64	7.63	7.26	6.56	4.26	1.64	0.62	0.07
C	59.50	0.43	4.67	8.16	8.75	8.96	7.35	3.70	1.67	0.94
D	78.91	0.81	4.25	7.33	10.33	10.37	8.68	6.10	3.50	2.98
E	100.72	1.22	4.63	8.55	9.72	10.38	9.37	6.72	3.94	2.73

d. Accident Truck Exterior

The exterior of the accident truck was scanned in eight scans, including a scan from an elevated surface to document the load in the truck. Registration targets were placed throughout the exterior environment but not on the actual accident vehicle to facilitate connection of each individual scan. An image of the 3D truck scan is shown in Figure 16.

General dimensions of the accident truck are shown in Figure 17. Detailed dimensions at the front of the truck, including the snow plow attachment, are shown in Figure 18.

Figure 16: An image from the combined 3D scan of the accident truck.

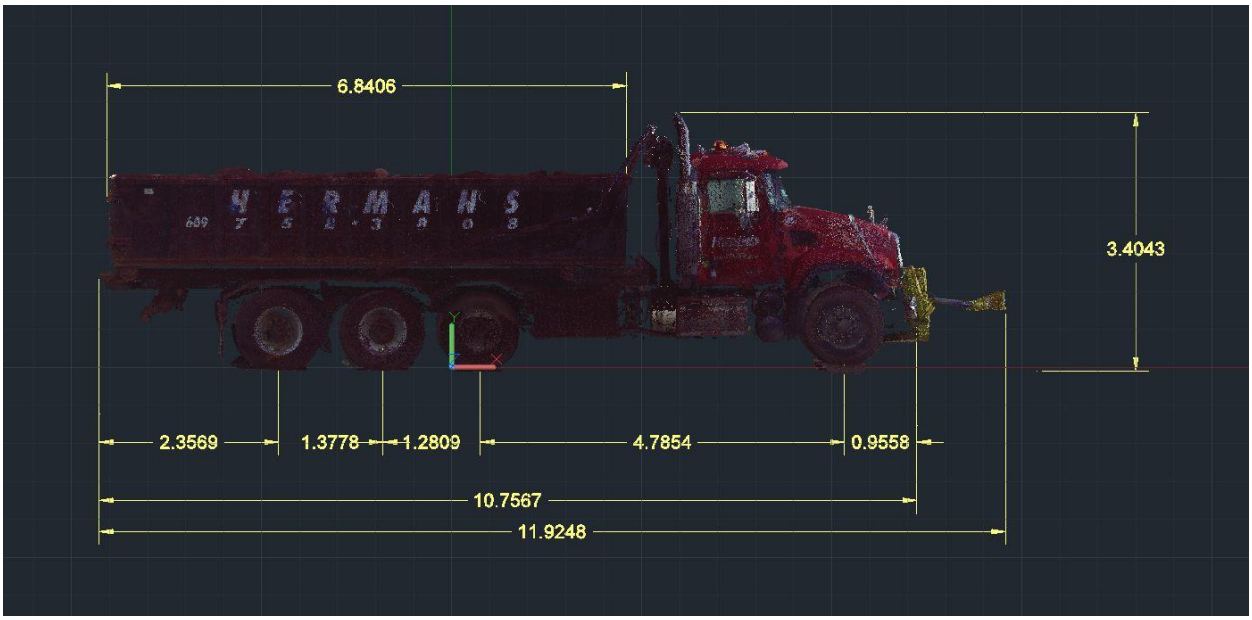

Figure 17: General dimensions of the accident roll-off truck. (meters)

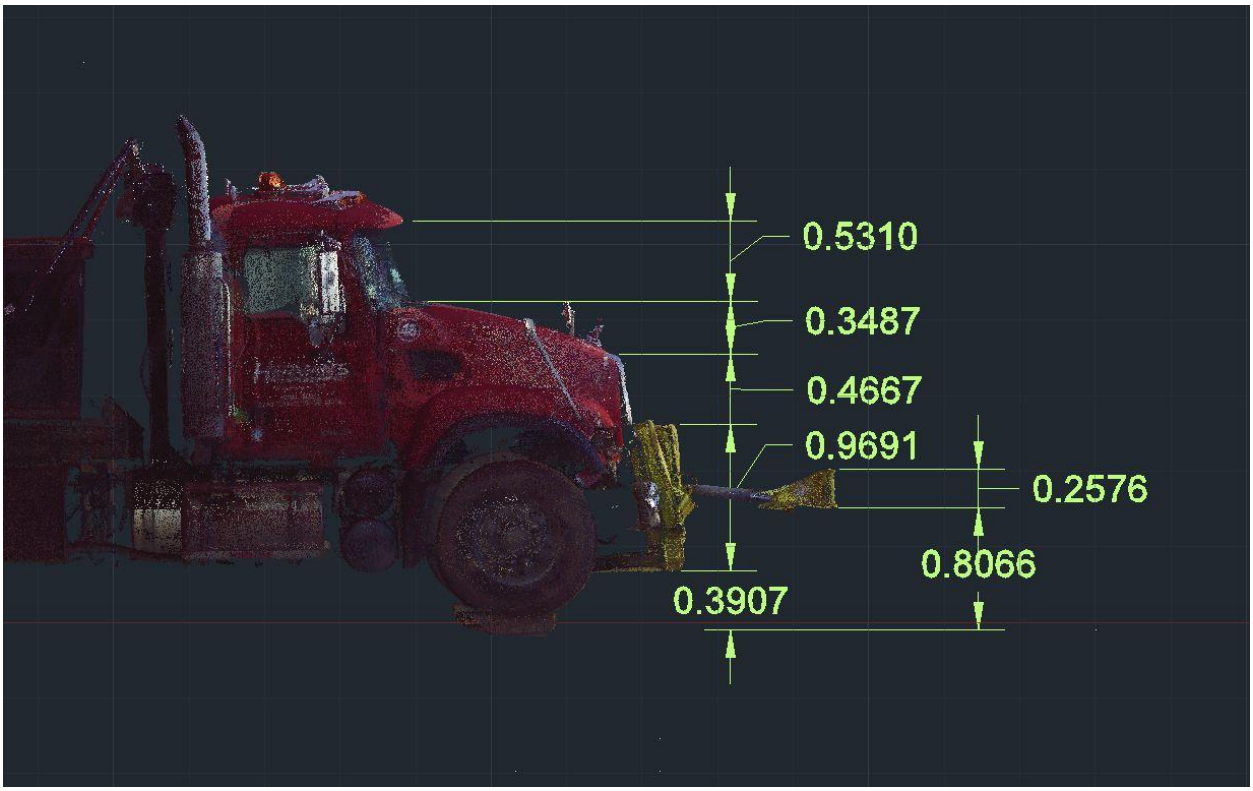

Figure 18: Dimensions of the front of the roll-off truck including the snow plow attachment. (meters)

3. Exemplar Vehicle Documentation

The exterior of an exemplar school bus was scanned in eight scans, including a scan from an elevated surface to document the roof. Registration targets were placed throughout the exterior environment but not on the actual accident vehicle to facilitate connection of each

individual scan. The driver's side of the exemplar school bus is shown in Figure 19. Dimensions of the exemplar school bus are shown in Figure 20.

Figure 19: An image from the 3D scan of the driver's side of the exemplar school bus.

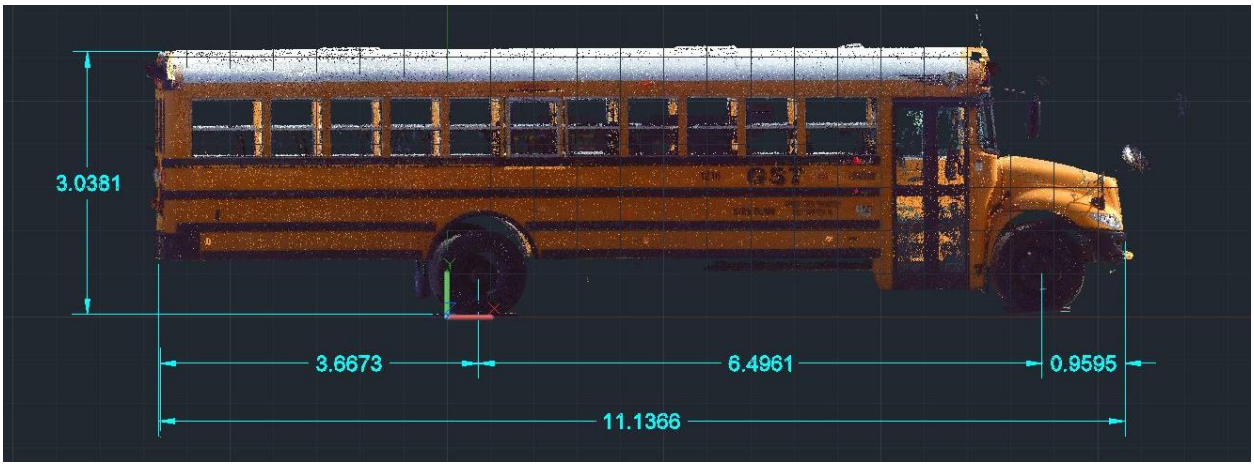

Figure 20: General dimensions of the exemplar school bus. (All measurements are in meters.)

END OF REPORT