NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

UAS Aerial Imagery Report

6/7/2018

A. ACCIDENT RRD18MR007

Location: Alexandria, VA
Date: May 19, 2018
Time: 0700 Local Time (EDT)
Event: CSX Freight Train derailment

B. PERSONNEL

UAS RPIC: Bill English
National Transportation Safety Board
Washington, D.C.

UAS VO: Mike Bauer
National Transportation Safety Board
Washington DC

C. ACCIDENT SUMMARY

For a summary of the accident, refer to the Accident Synopsis Report in the docket for this investigation, NTSB Docket RRD18MR007.

D. DETAILS OF IMAGERY

1.0 Equipment and Procedures

Equipment

Mapping and viewpoint flights of the derailment area were conducted on May 20, 2018, using the NTSB DJI Phantom 4 Professional. The drone is equipped with a dual GPS/GLONASS receiver which provides georeference information on all still photos. The drone is equipped with an FC6310 camera using the Sony Exmor 1" CMOS sensor, with a focal length of 8.8 mm. Still photo resolution is 20 megapixels in JPG or RAW format. Videos were taken in MP4 format with 4K resolution at 60 frames per second.

Ground control points (GCP) were taken with a Trimble GEO7X differential GPS receiver in the derailment area, and processed using the Continuously Operating Reference Station (CORS) located at Greenbelt, Maryland (GODE).

Procedures

The accident site was in the Washington DC Flight Resticted Zone (FRZ) and Washington Reagan National Airport Class B airspace surface area. Special Government Interest (SGI) authorization was obtained from the FAA National Capitol Region Coordination Center and Special Operations Security Center as well as coordination with the Department of Homeland Security. Flights were conducted under the provisions of the SGI and 14 CFR Part 107. The derailment area was in an industrial area, with a rail overpass, other rail lines, and roads and parking areas. Some areas of trees were adjacent to the tracks. No significant hazards to flight were in the area.

The sUAS was flown in 3 overlapping double grids over the tracks from the initial derailment point, over the collapsed bridge area, and the tracks beyond. Additional sets of still images were taken for oblique viewpoints and to make panoramic views of the area for visualization and orientation. Total flight time was approximately 60 minutes.

Processing

Geo-referenced still imagery was processed using Pix4D photogrammetry software to provide a 3D point cloud, orthomosaic map, digital surface map, digital terrain map, and to calculate the volume of the ballast washout. Ground sample distance was 0.51 inches, resulting in a relative accuracy (within the map) of approximately 1 inch. Positional accuracy (outside the map) using the DGPS ground control points, was calculated to about 14 inches. Although better than uncorrected GPS, this positional accuracy is less than usual. Distance to the CORS correction station, and possible multipath interference from the rail bridge structure likely contributed to the error.

2.0 Imagery products

Approximately 750 high resolution photos were gathered. Select source photos, and excerpts from processed products are included below. The orthomosaic was exported in Google Earth tiles kmz format and entered into the docket. Select source photos and other processed outputs used for the volumetric measurement are also in the docket.

Figures 1 and 2 are overhead views of the damaged bridge, and the area of washed out track ballast at the initial derailment point.

Figure 1 – Photo of collapsed bridge area

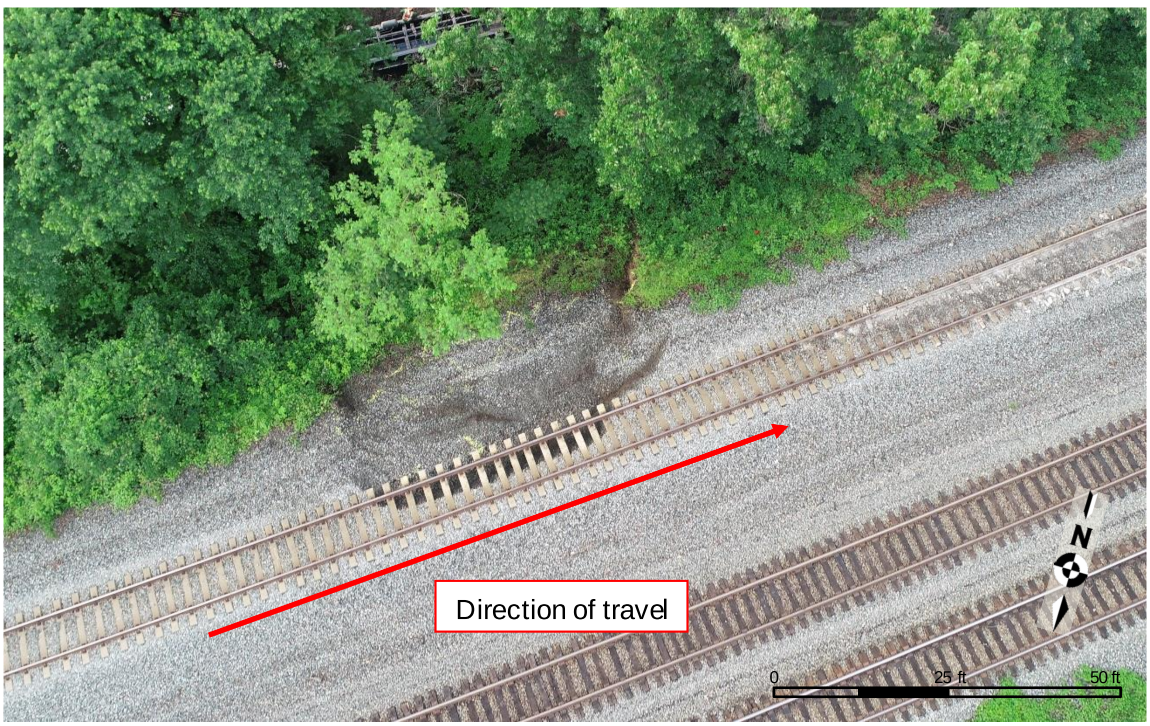

Figure 2 – Photo of ballast washout area

Figure 3 is an excerpt from the Google Earth orthomosaic map, looking obliquely in the direction of travel near the initial derailment. Figure 4 is an excerpt from the orthomosaic, beyond the bridge toward the secondary derailment area.

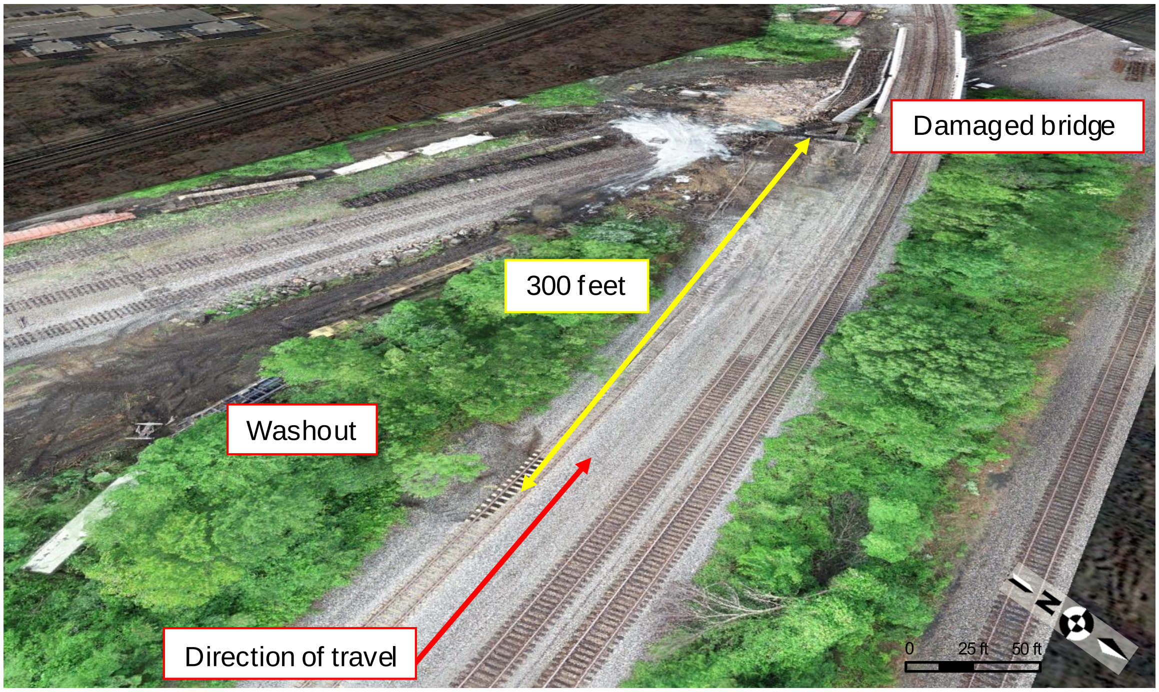

Figure 3 – Google Earth overlay initial derailment area

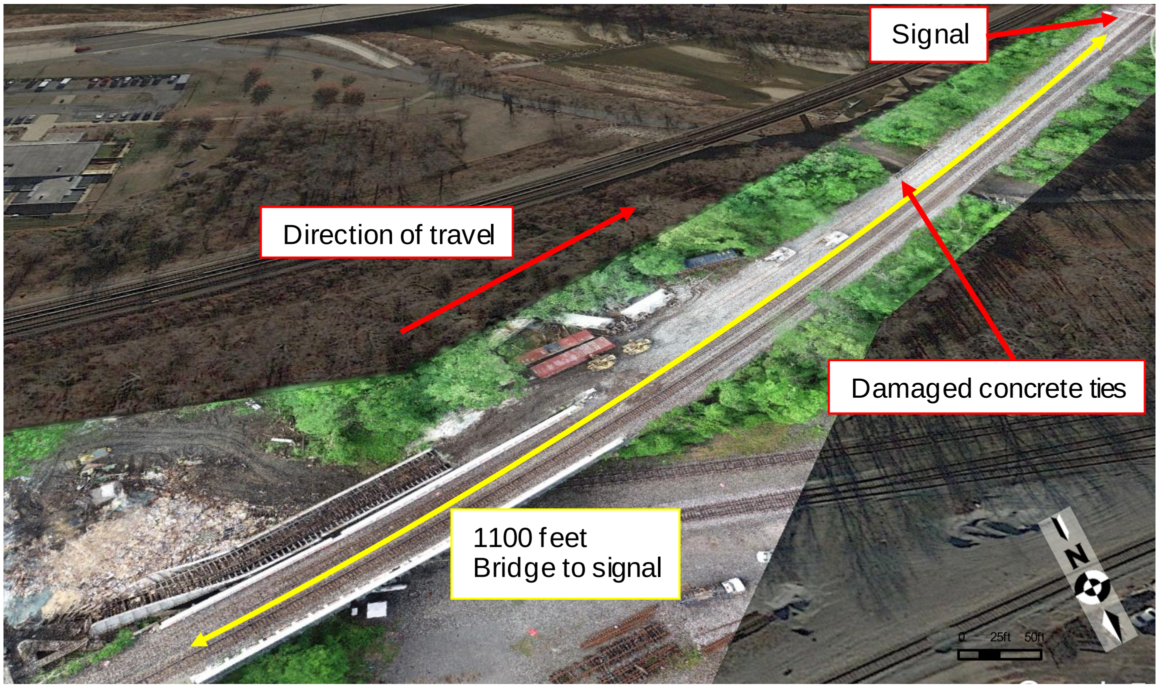

Figure 4 – Google Earth overlay beyond bridge

Figure 5 is a snapshot from the 3D point cloud, which enables measurements and calculations, looking in the direction of travel from the washout area. A video "fly-through" of the point cloud is included in the docket.

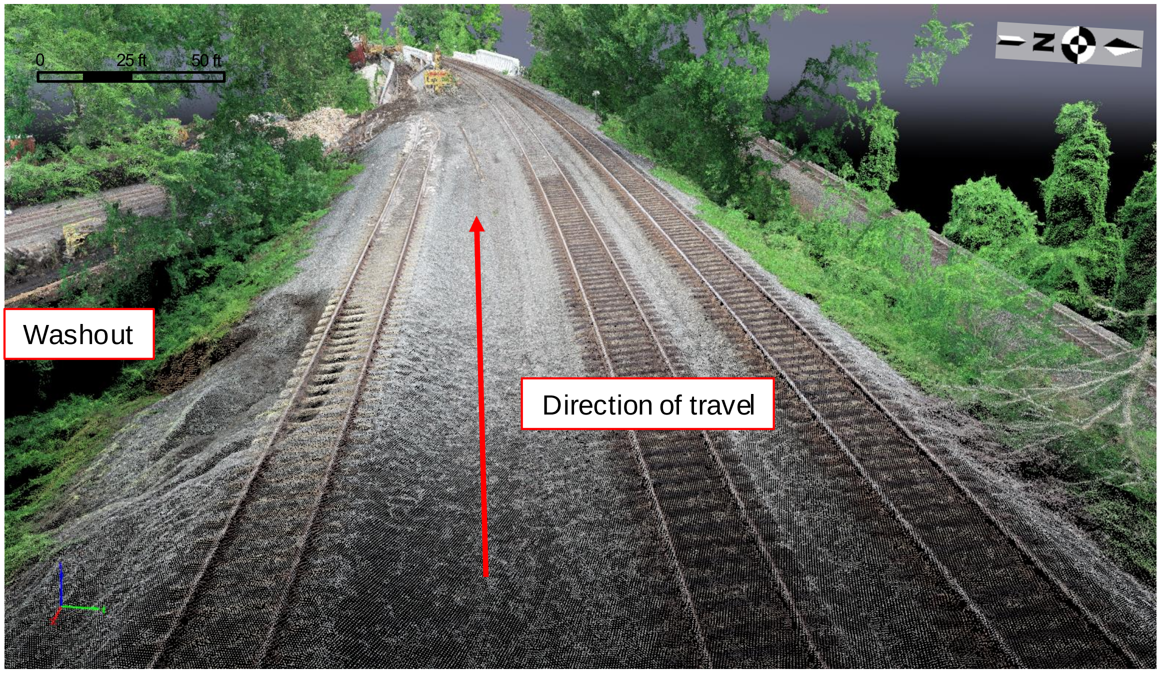

Figure 5 – Excerpt of point cloud

The area around the washout was examined using various tools. NTSB Rail investigators indicated that the ballast continued to subside after the derailment, and photos show less material was washed away initially. However, the point cloud enabled a close examination of the area. A steeply oblique view of the track reveals a visible downward bend, or sag, in the left (southerly) rail. Measuring against a straight line placed adjacent to the rail spanning the washed out area indicates a downward displacement of about 6 cm, (2.3 inches). Figure 6 is an excerpt of the point cloud showing the displacement, figure 7 zooms in closely and shows the measurement.

Figure 6 – Point cloud view of displaced rail.

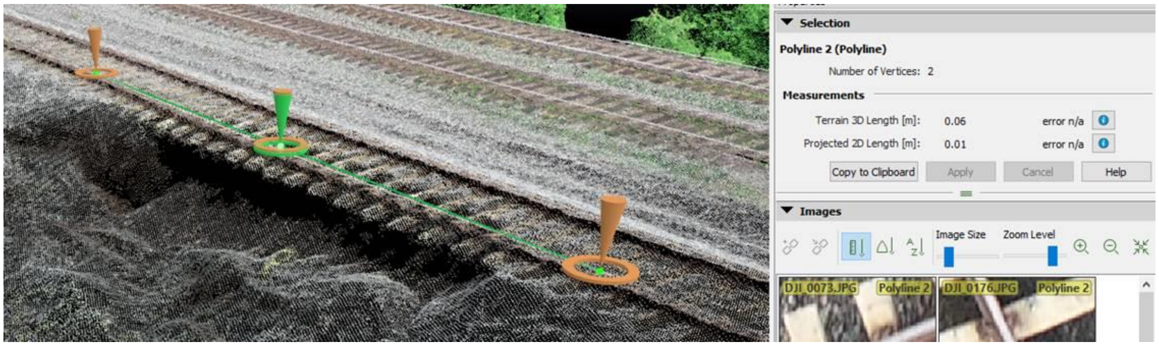

Figure 7 – Measurement of displacement

The photogrammetry outputs include a digital surface model (DSM), which includes the elevations of all visible objects; and a digital terrain model (DTM), which includes the elevation of the underlying terrain. Using the DTM, contours can also be generated and the products overlaid together in GIS software. Figure 8 is the DTM, color coded for elevation, overlaid with contour lines onto a commercial satellite imagery basemap.

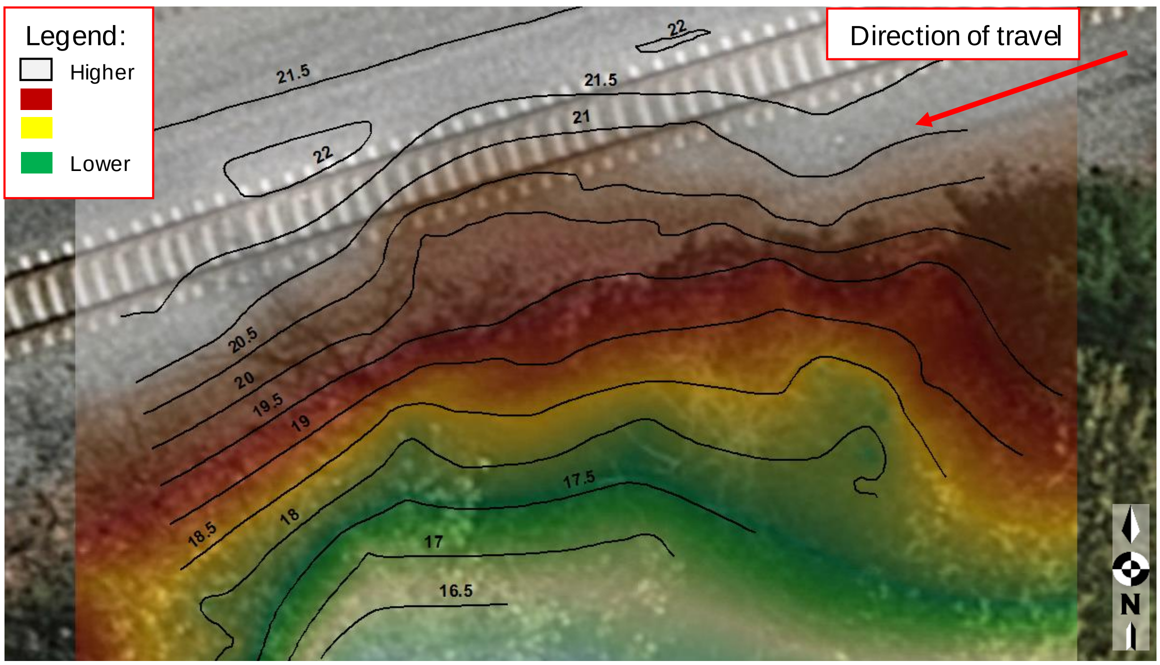

Figure 8 – Elevation and contours of terrain and washout (contours in meters above sea level)

The 3D point cloud was then modified to remove the surrounding vegetation in order to calculate the volume of the washed out ballast material. Pix4D has a classification algorithm which removed much of the vegetation, and then manual editing was used to remove the rest of the high vegetation so only the ballast was included.

Volumetric calculation provides a "cut volume" which is the amount above a specified surface, and "fill volume", the amount below the surface. Due to the uneven nature of the original ballast grading, multiple surfaces were used, to calculate segments of the lost volume, then added together for the total. At the time the data was gathered, approximately 50 cubic meters (1,750 cubic feet) of fill volume was missing. Figures 9 and 10.

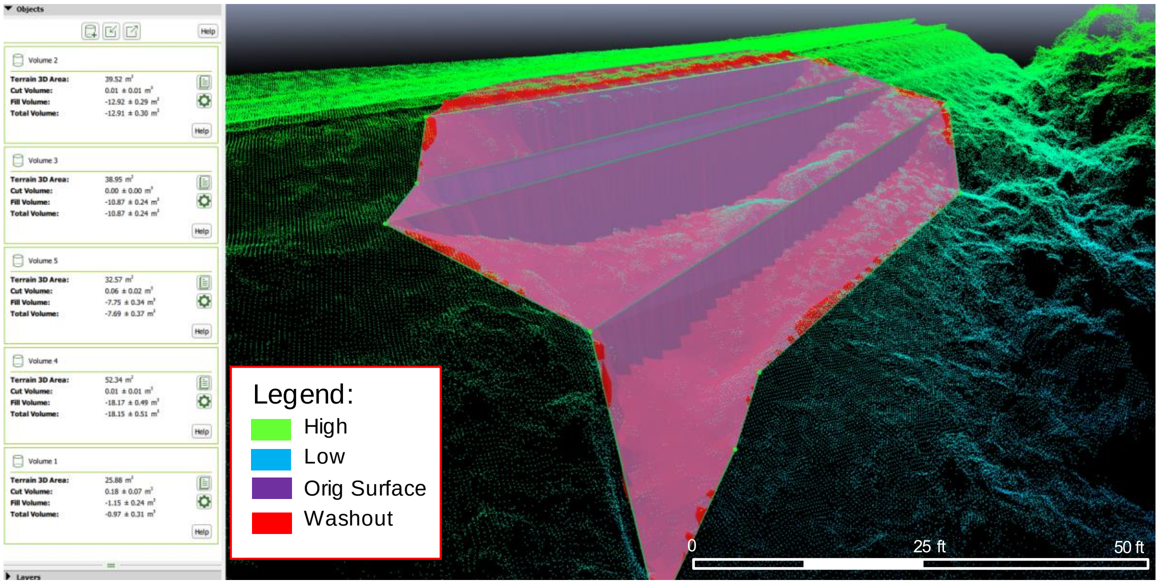

Figure 9 – Volumetric calculations of washed out ballast

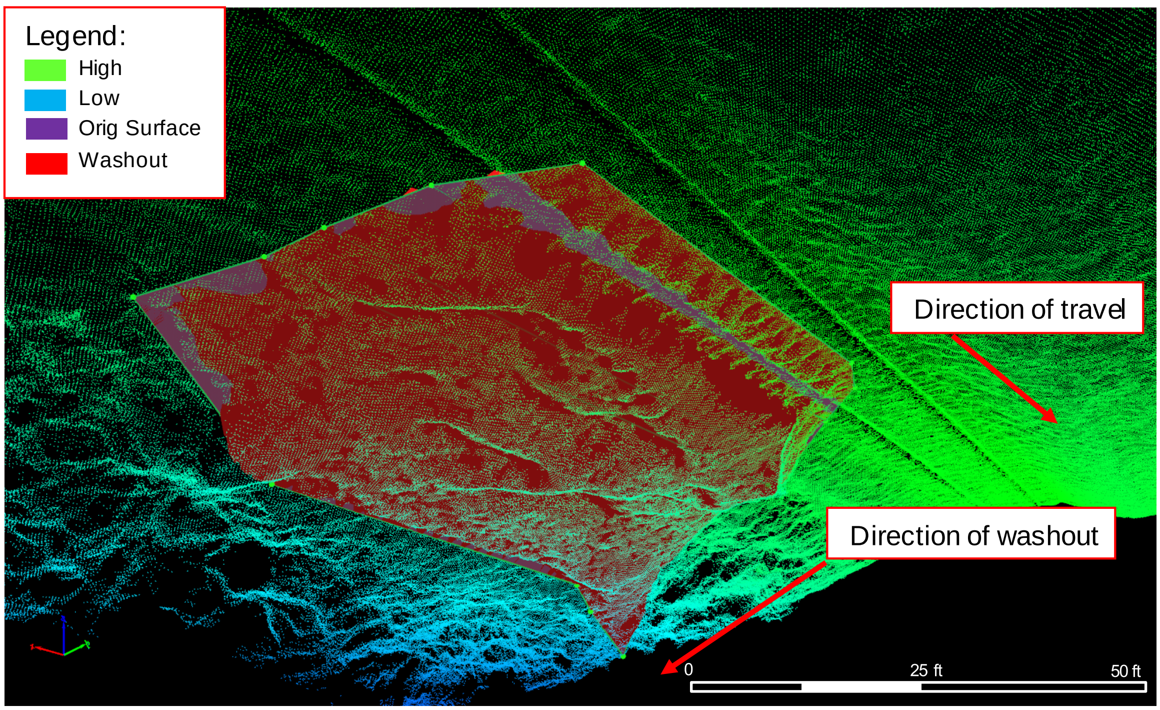

Figure 10 – View from "below" the washout area point cloud

Attachment 1 – Google Earth orthomosaic

Attachment 2 – Fly through of point cloud

Attachment 3 – Digital Terrain Model

Attachment 4 – Digital Surface Model

Attachment 5 – Exported point cloud

Attachment 6 – Washout contours shapefile