2013 U.S. Virgin Islands Topographic Lidar

Quality Assurance Review

July 2014

The Baldwin Group on behalf of NOAA Coastal Services Center

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Introduction

This document summarizes the findings from the two rounds of quality assurance reviews of topographic lidar collected for the U.S. Virgin Islands. The Baldwin Group, on contract with the NOAA Coastal Services Center, collected field check point data and performed qualitative and quantitative assessments of the lidar products delivered by PhotoScience, Inc., a Quantum Spatial company.

Qualitative Assessment

Breaklines

Breaklines were well done along 90% of the shorelines. Typically, the portrayal of the very complex rocky shoreline was excellent. The one exception was along vegetated shorelines (Figure 1), primarily mangroves, where breakline placement appeared to be/could be landward of 'the actual shoreline'. We understand that this may be the most difficult place to get reliable data, but would rather err on the side of consistency with the imagery. Possibly generate breaklines prior to classification if using intensity or supplement with imagery in these areas.

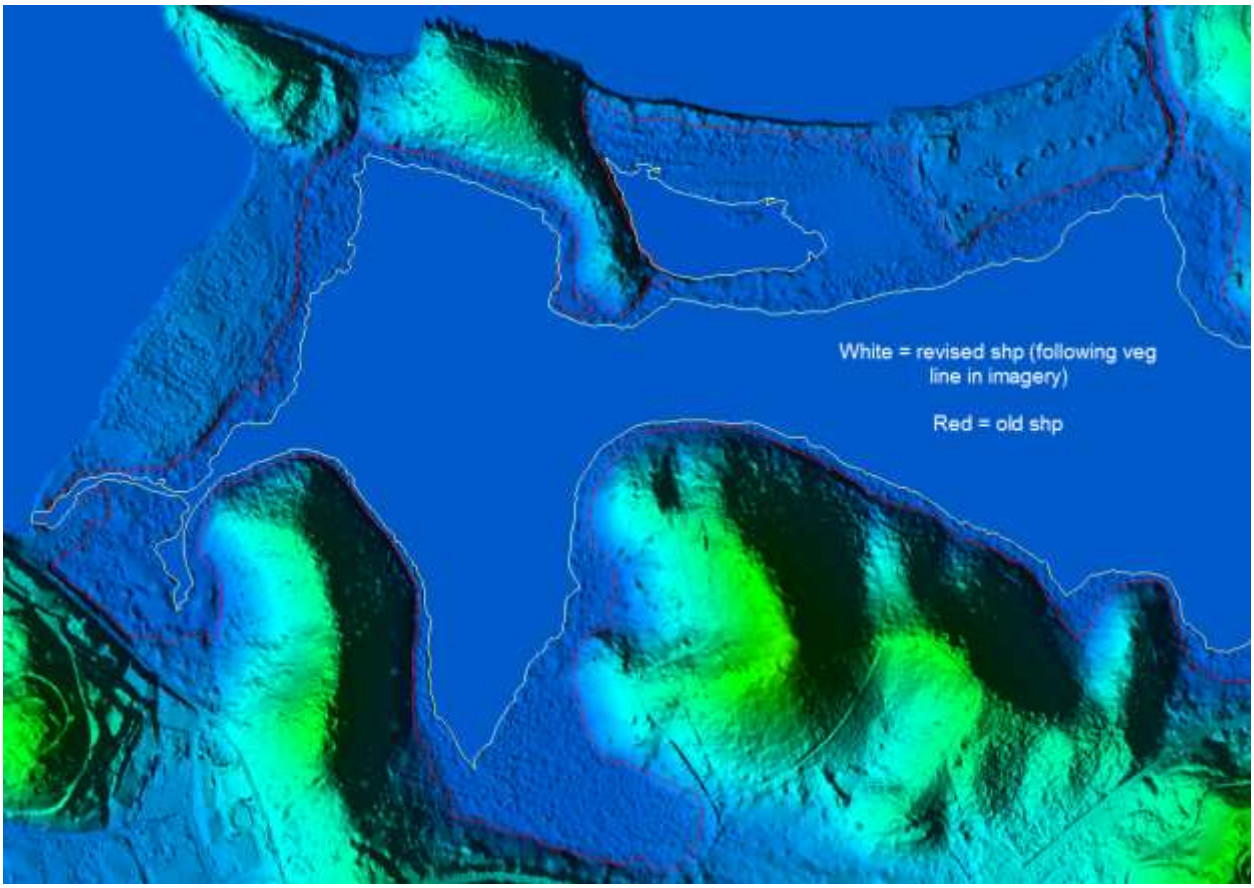

Figure 1. Breakline revisions showing imprvoved alignment with mangrove edges

The other area that the breakline placement appeared to cause inconsistencies was in harbors where buildings on piers created data voids next to the breakline (Figure 2). It would help if, where possible, points along the very edge of the seawall/pier/quay are moved to ground. There were only a few instances of this and they are noted in QA points.

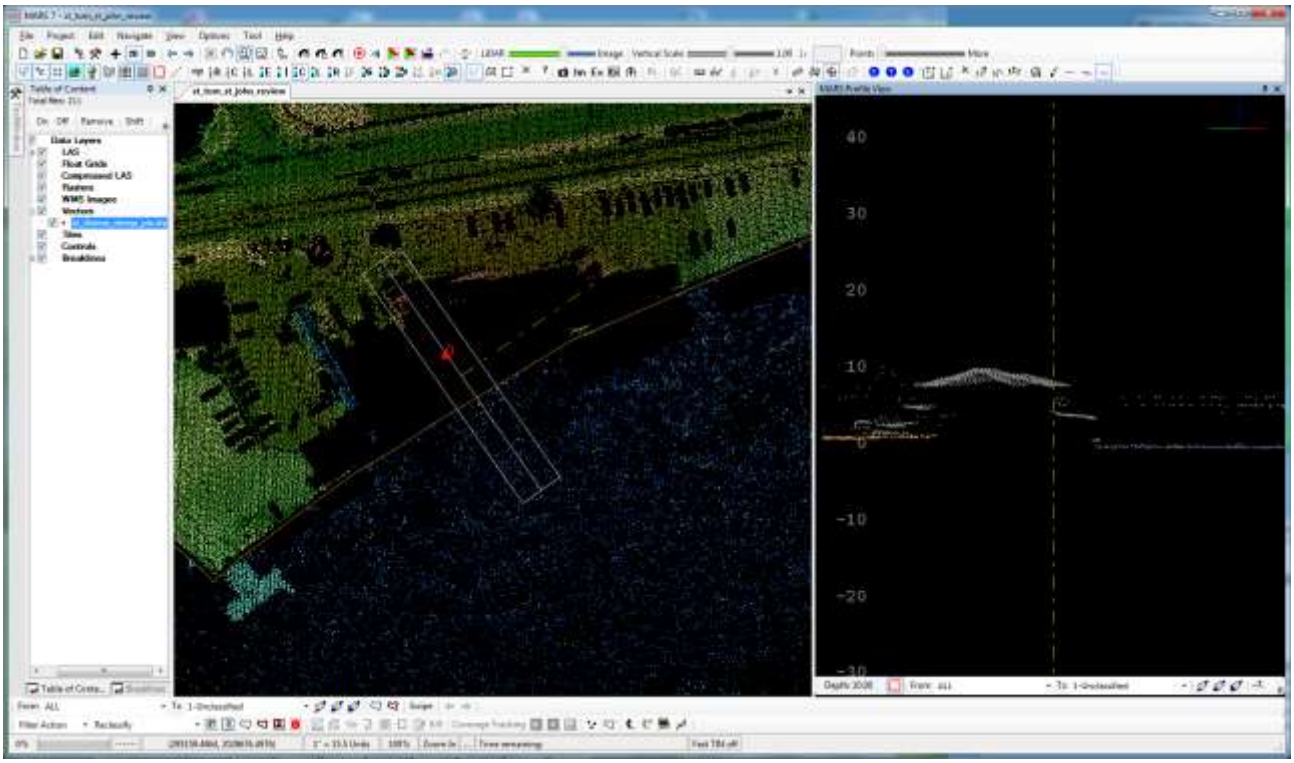

Figure 2. Pier edge partially obscured; a few 'pier-edge' points are visible and would help the DEM portray the actual land topography [First delivery]

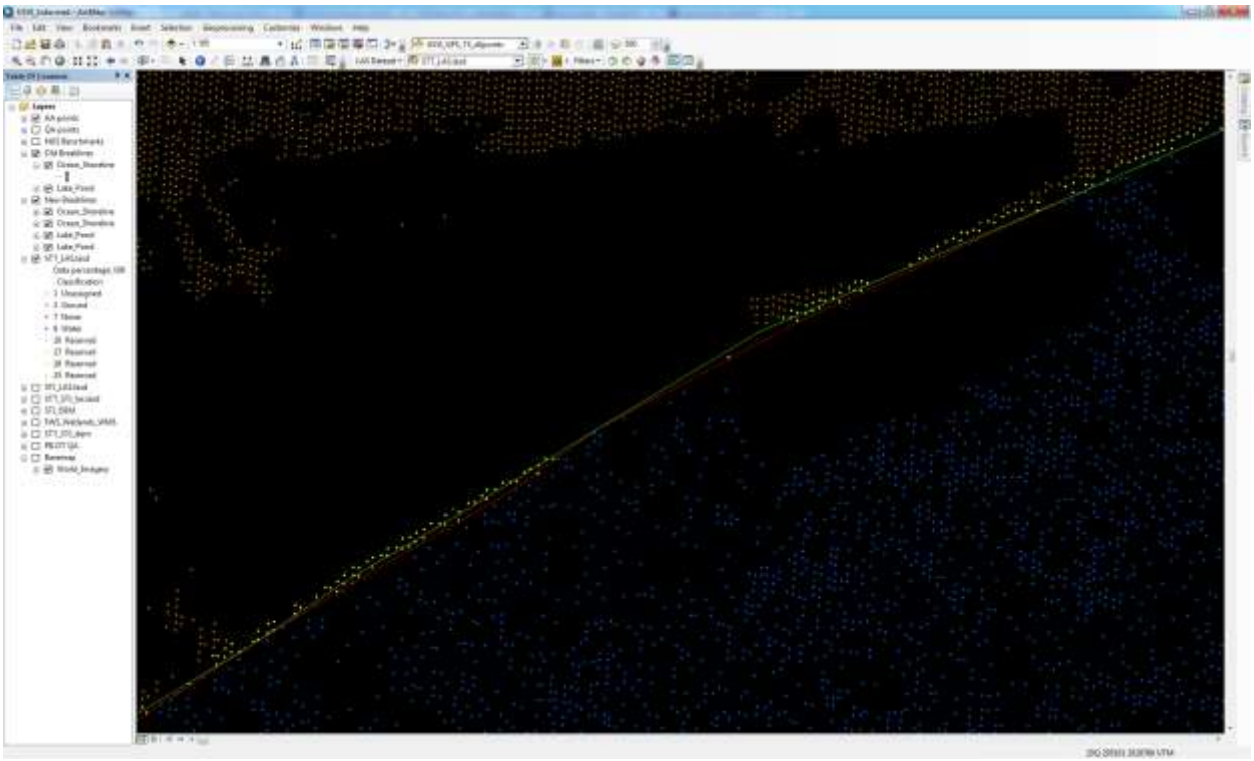

Figure 3. Breakline adjusted and points on water side of building now included (class 10) to better capture terrain [Second delivery]

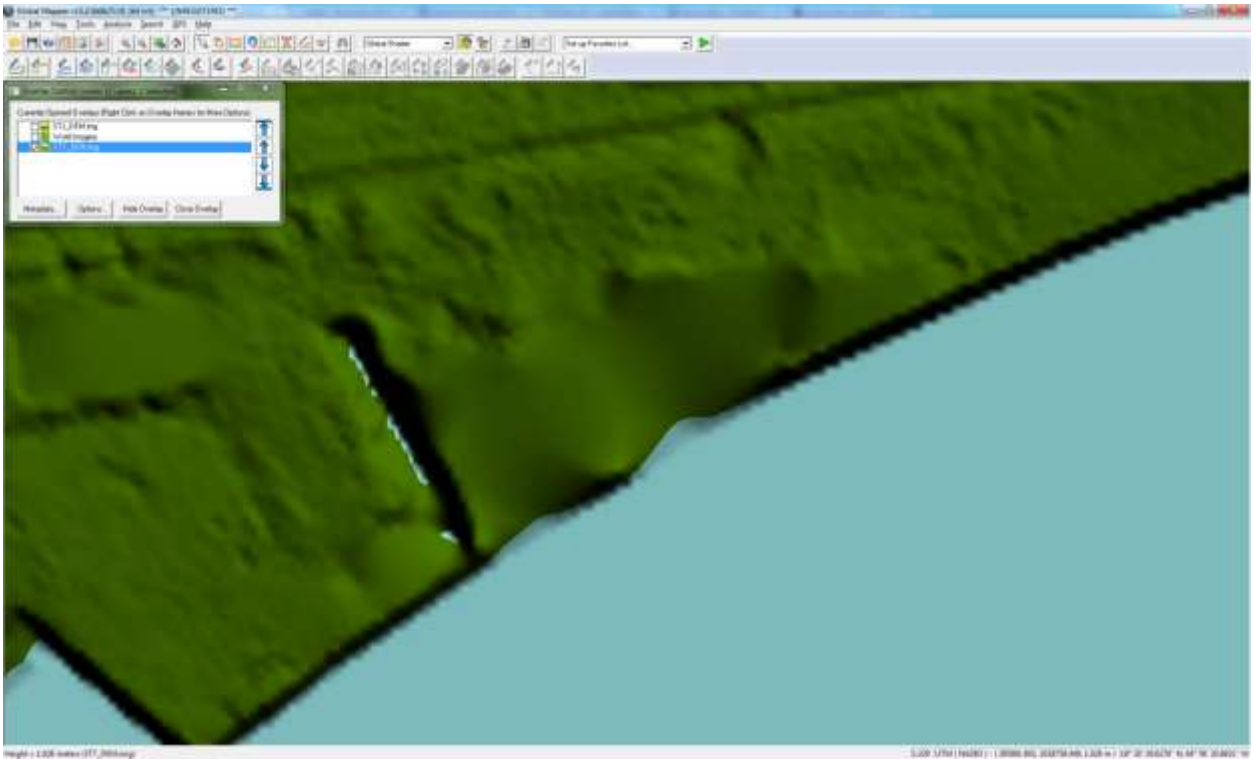

Figure 4. DEM of area depicted in Figure 3 showing better extension of ground surface [Second delivery]

Breakline elevations vary throughout the project area due to tide stage variations between flights. NOAA and the contractor discussed two options: generating a consistent shoreline elevation or using a variable-elevation shoreline. The former option would generate a flat ocean but would impose stretches of floating water (~1-1.5 feet at the shoreline), and the latter option would better characterize the adjacent near-shore water elevations at the time-of-flight. NOAA opted to proceed with the latter option, which resulted in a shoreline breakline having variable elevations and concomitant DEM water surface elevations that vary in irregular patterns.

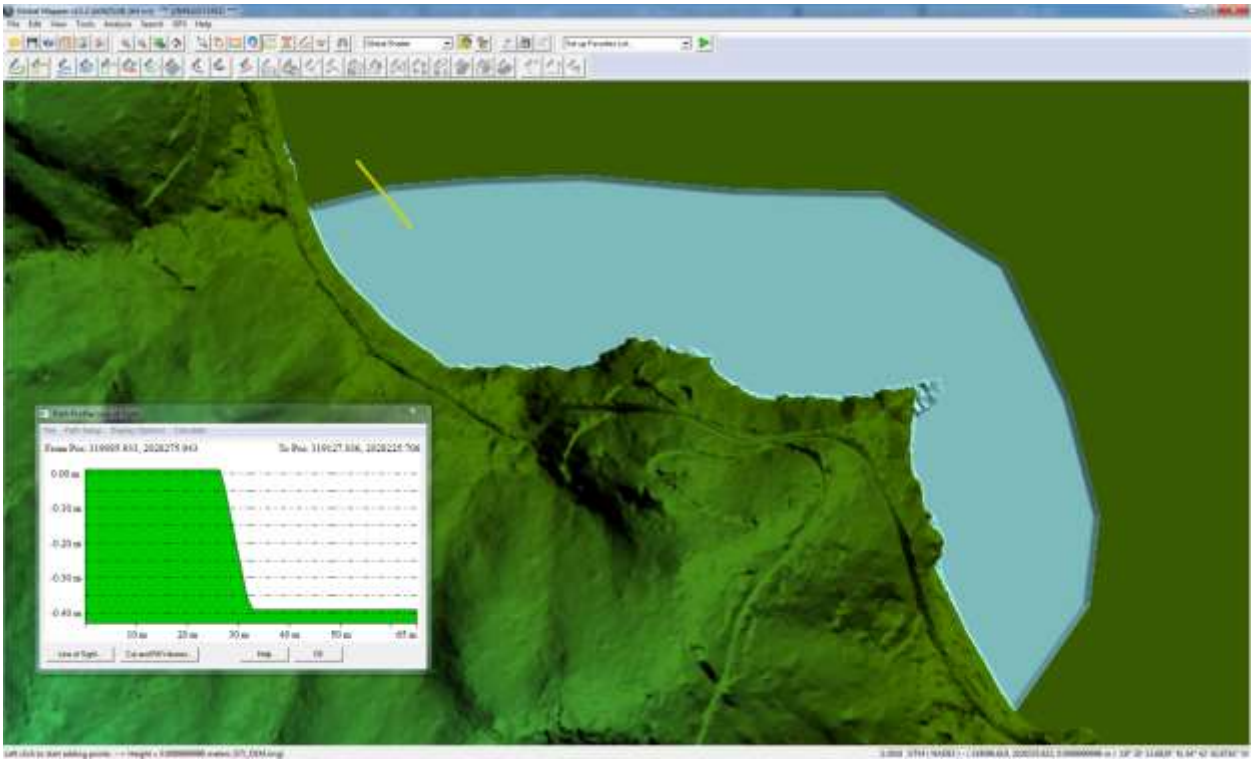

Figure 5. Water surface elevations in DEM vary due to breakline elevation variability (color breaks at 0 meters)

Noise Points

Figure 2 also highlights something we have not seen before – points over water that are 5 to 10m above the water (Figure 3). This was noted in both St Thomas and St Croix, but may also be in St John as well. Moving them to 'noise' appears to be more consistent than calling them 'unclassified' given the systematic (high humidity?) occurrence throughout the data set.

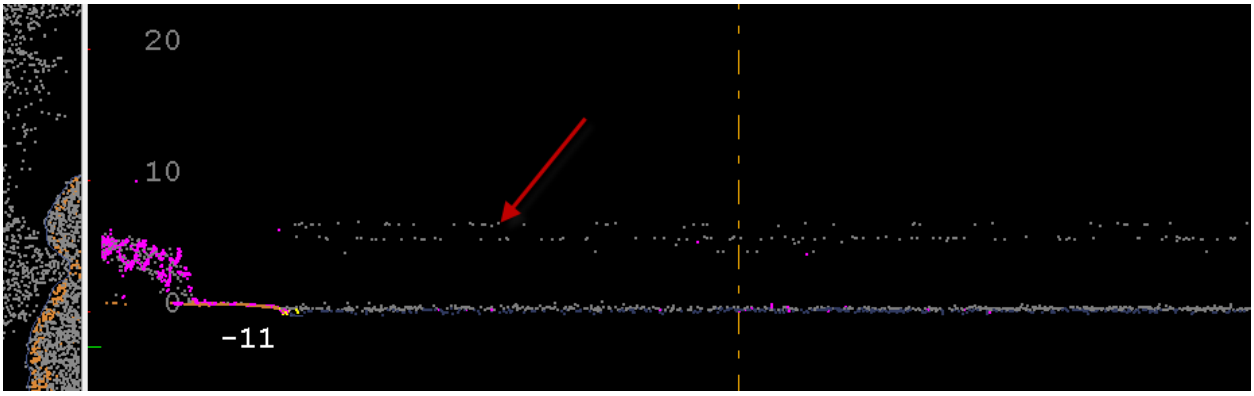

Figure 6. Unclassified noise points above water [First delivery]

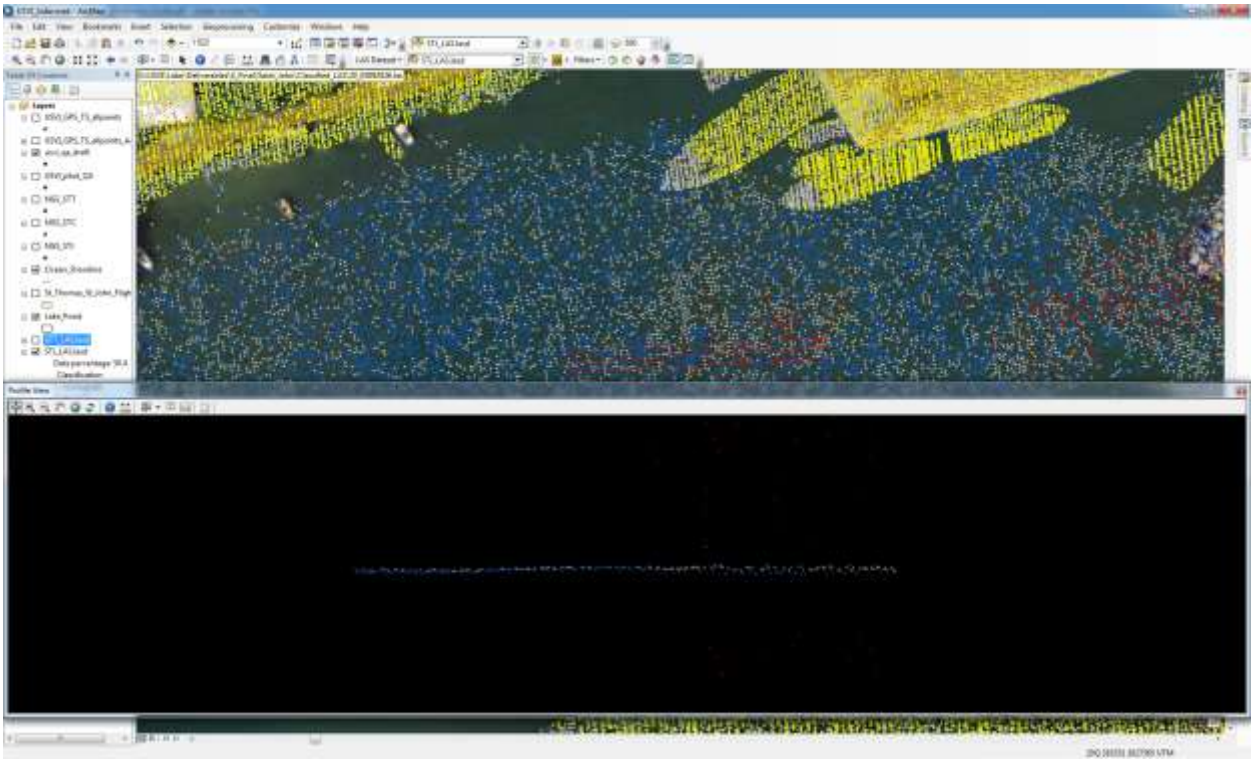

Figure 7. Classified noise points above and below water (7) [Second delivery]

Point Density

Point density (first returns, non-overlap) on land was better than 1 pt/m over the majority of the collection area (Figure 4 and 5). A few small areas with less than 1 pt/m were noted but were isolated and may have been in small wet areas. They should not create any issues.

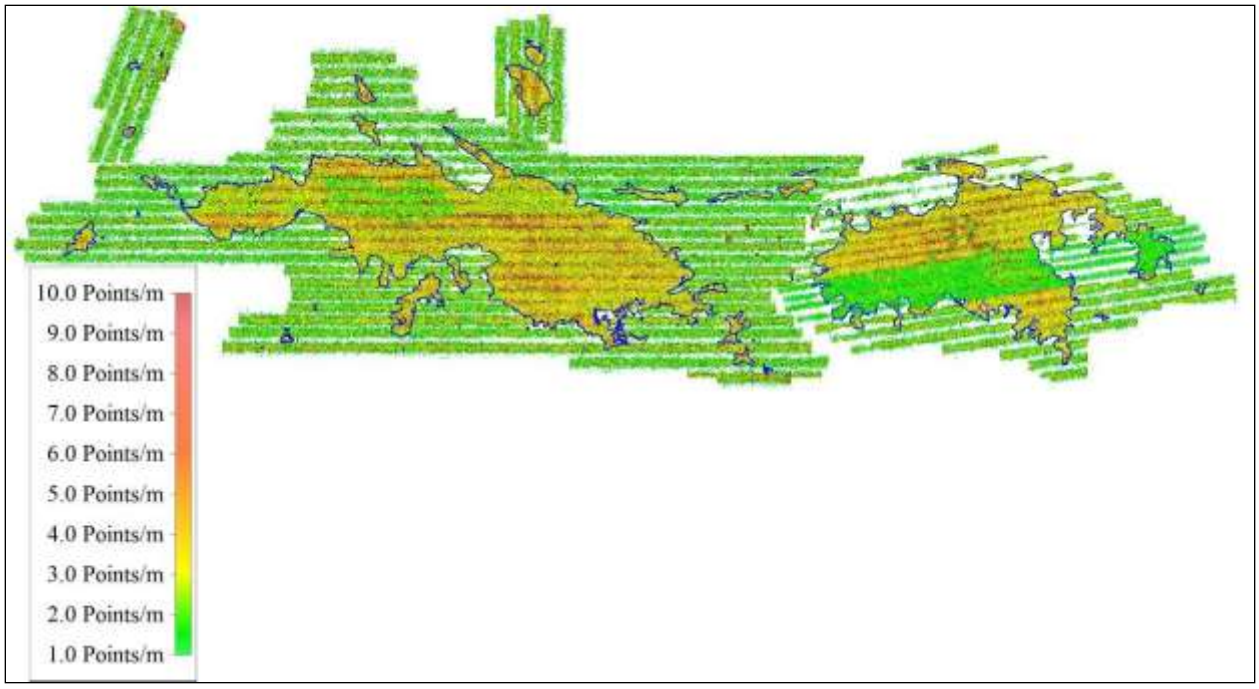

Figure 8. Point density on St. Thomas and St. John

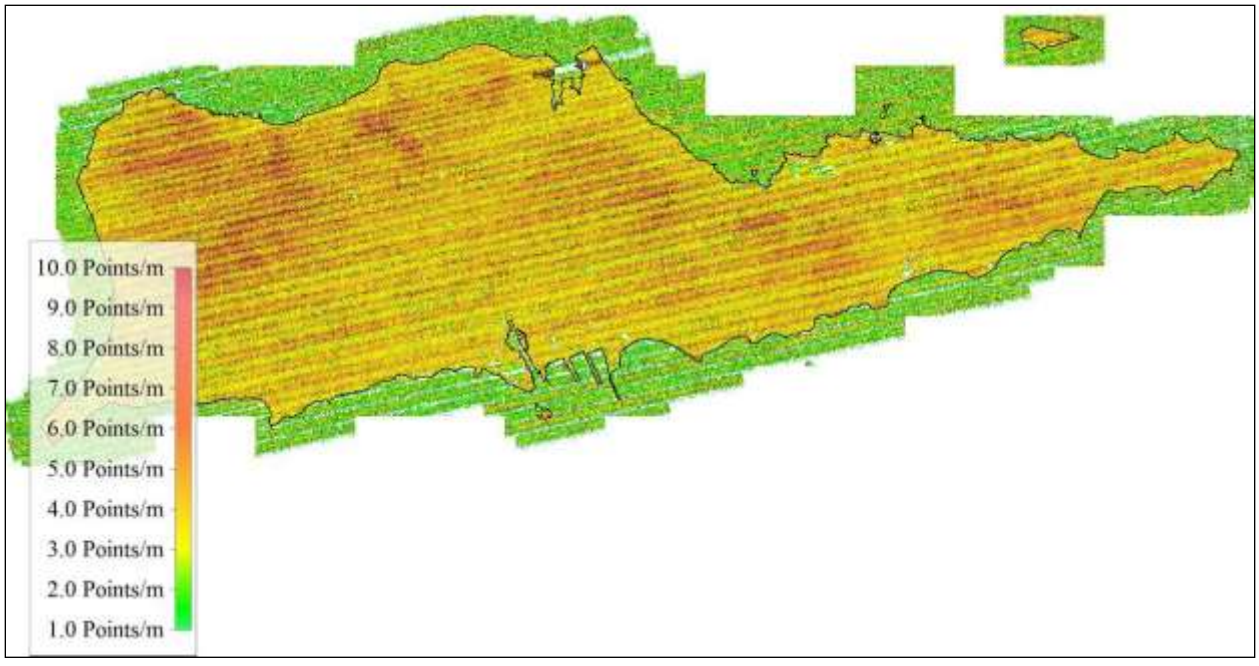

Figure 9. Point density on St Croix

Digital Elevation Models (DEMs)

Overall the DEMs were acceptable, but appear oversampled as a result of low ground point density (heavy vegetation), and is not a contractor issue as a 1 m DEM was specified. Incremental improvements to the DEMs were earned through breakline adjustments as noted in figures 1 and 3.

Another characteristic of the USVI lidar data that was observed on all islands is the appearance of divots where there is a single tree or a narrow line of trees that lie in areas of open, bare terrain. The cause appeared to be sub-canopy points that were lower than the surrounding land. In most cases these low points were lower than the true ground surface at those locations, but were classified as ground and retained in the point cloud for use in DEM generation. This issue was not addressed during revisions. See Figures 10 and 11.

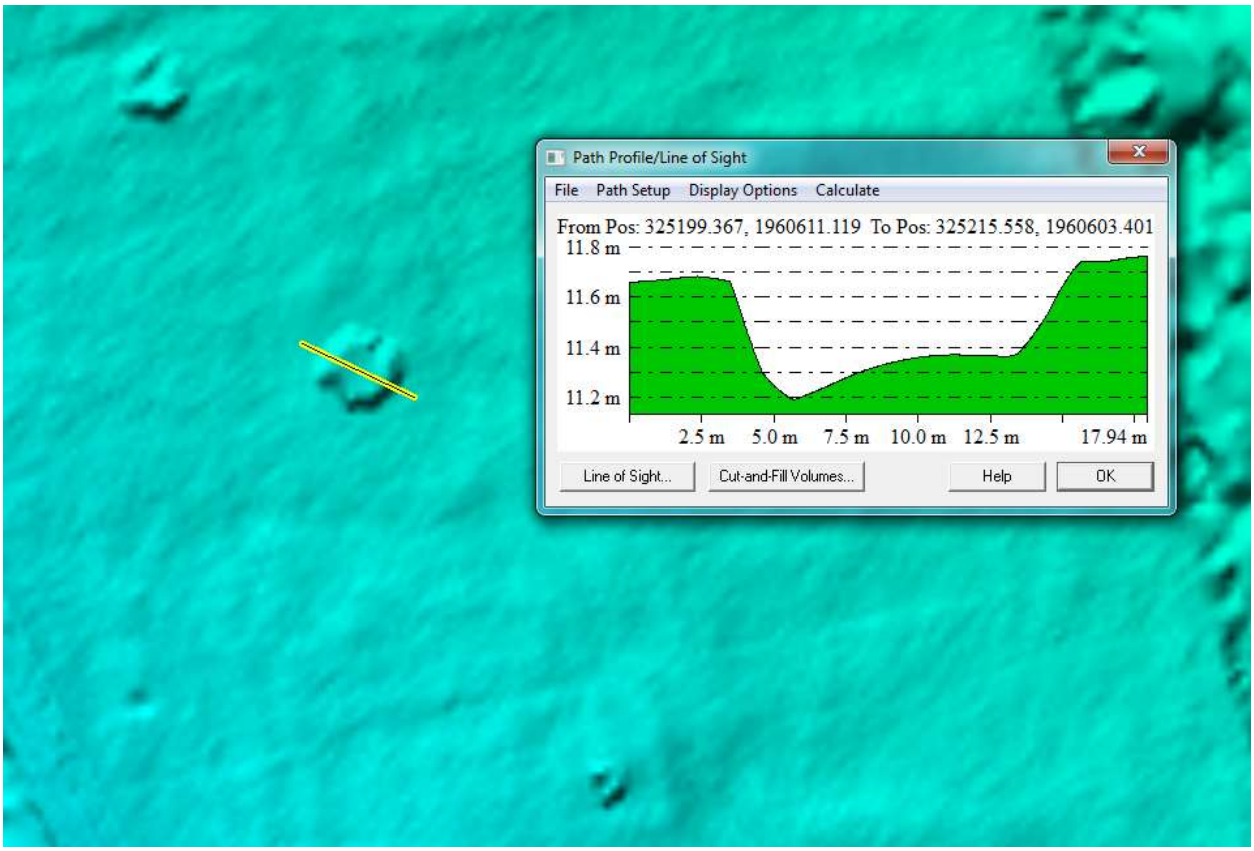

Figure 10. Apparent divot in land surface [First delivery]

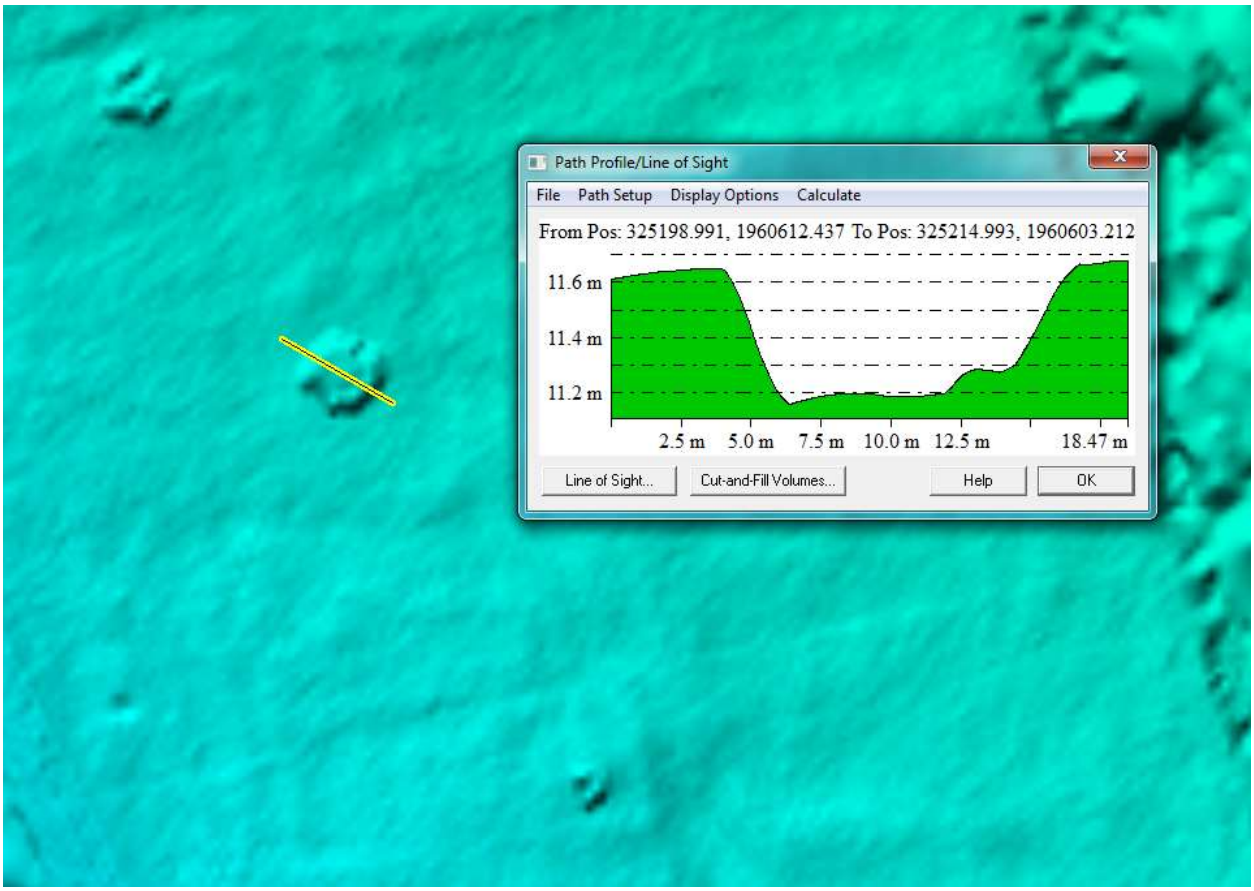

Figure 11. Apparent divot in land surface, with no change from previous delivery [Second delivery]

Metadata

Four records were provided in xml format: las, dem, breaklines, project.

These records are in compliance as tested using USGS' online metadata parser (http://geo-nsdi.er.usgs.gov/validation/).

Quantitative Assessment

The following section summarizes the results of statistical comparisons between field check point data and the classified lidar point data. The analyses were performed using a combination of tools, including MARS 7.1 and MS Office 2010. The point cloud data were used to construct triangulated irregular networks (TINs) which were subsequently tested against field check points collected in clear and open areas (as defined by the USGS' lidar base specification version 1.0).

Accuracy Assessment

The SOW accuracy specification is for a Fundamental Vertical Accuracy (FVA) RMSE of 9.25 cm; Consolidated Vertical Accuracy (CVA) is better than 36 cm (95%). There is a discrepancy on the SOW, with the CVA being sought to support 1 foot contours, but 36 cm at 95% being stated. We assume 36 cm (95%) is correct and it should have been specified as 2 foot contours.

The lidar data for all islands tested at 11 cm RMSE, failing to meet the SOW requirement (Table 1). However, the lidar data for all islands tested at 35 cm CVA at the 95th percentile in open, urban, tall grass, scrub/shrub, and forest land covers, which passes the SOW requirement. St. Thomas and St. John both passed the RMSE and CVA tests; however St. Croix did not and is the primary reason why the all-island RMSE value exceeded the contract specification. PhotoScience adjusted the final solutions of their ground control data and improved the accuracy of the data between the first and second deliveries, but it is clear that errors remain.

Table 1. Summary accuracy assessment statistics, all measurements in centimeters [Second delivery]

Island	FVA (RMSE), (N); *Spec 9.25*	Bare Earth Mean, (N); *Spec 0.0*	CVA (95%), (N); *Spec 36.0*	All Points Mean, (N); *Spec 0.0*
All Islands	11 (80)	-1 (80)	35 (173)	-3 (173)
St. Thomas	8 (30)	-5 (30)	33 (58)	-5 (58)
St. John	7 (19)	-3 (19)	34 (43)	-6 (43)
St. Croix	14 (31)	4 (31)	44 (72)	1 (72)

Conclusion

Overall, the deliverables provided by PhotoScience, Inc appear to be of high quality from a usability standpoint. The vertical accuracy of the data for all islands failed the contract requirement, but is still well within the minimum accuracy required for most standard lidar acquisition projects. The Baldwin Group recommends full acceptance of the data with the understanding that the vertical accuracy of the St. Croix data contributed greatly to the degraded all-island accuracy.