Review of County Wide LIDAR Data

Martin County, FL

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The Martin County LIDAR project consists of a county wide LIDAR project funded partially with a 3DEP grant from USGS in 2015. The LIDAR was acquired in January 2016 by the Surveying & Mapping consultant firm Woolpert, Inc. The project area covers Martin County and part of Palm Beach County as shown in Figure 1. The purpose of this report is to check the LIDAR for blunders and compare the pilot data to local survey elevations.

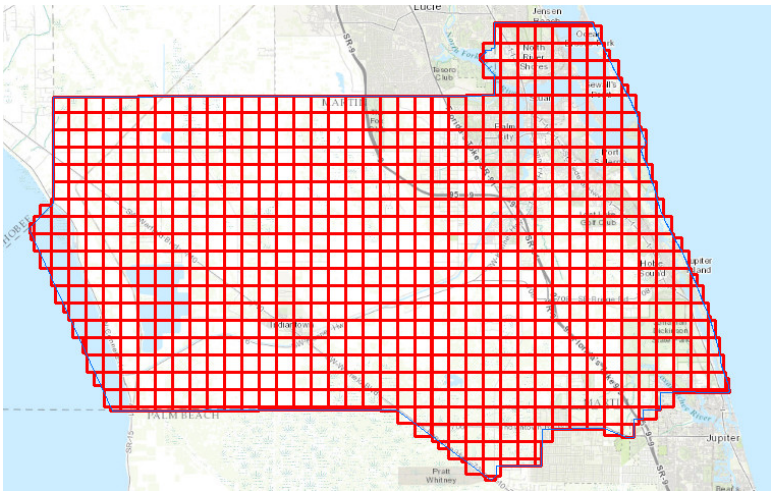

Figure 1 Pilot area

The pilot area was made up of 767 tiles. Each tile was 25,000,000 square feet or 0.89 square miles. The total area of the project was 630 square miles covering Martin and part of Palm Beach County.

The data was delivered with the following products:

- Tile Index
- Data Extent
- Control Shape File
- NVA Points Check Points
- VVA Points Check Points
- Breaklines
    - Lake
    - Stream
    - Bridge
- Digital Elevation Model
- Intensity image
- LAS v1.4 Classified Point Cloud
- LAS v1.4 Raw Unclassified Point Cloud Flight Line Strips
- FGDC Compliant Metadata
- Lidar Processing Report
- Survey Report

Tile Index

Tile Index covers more than enough for this project as shown in Figure 2 Tile Index. It was the same tile index that the Florida Department of Revenue (DOR) uses for its orthometric imagery. The data was provided in shape file format and has a single attribute of the tile name.

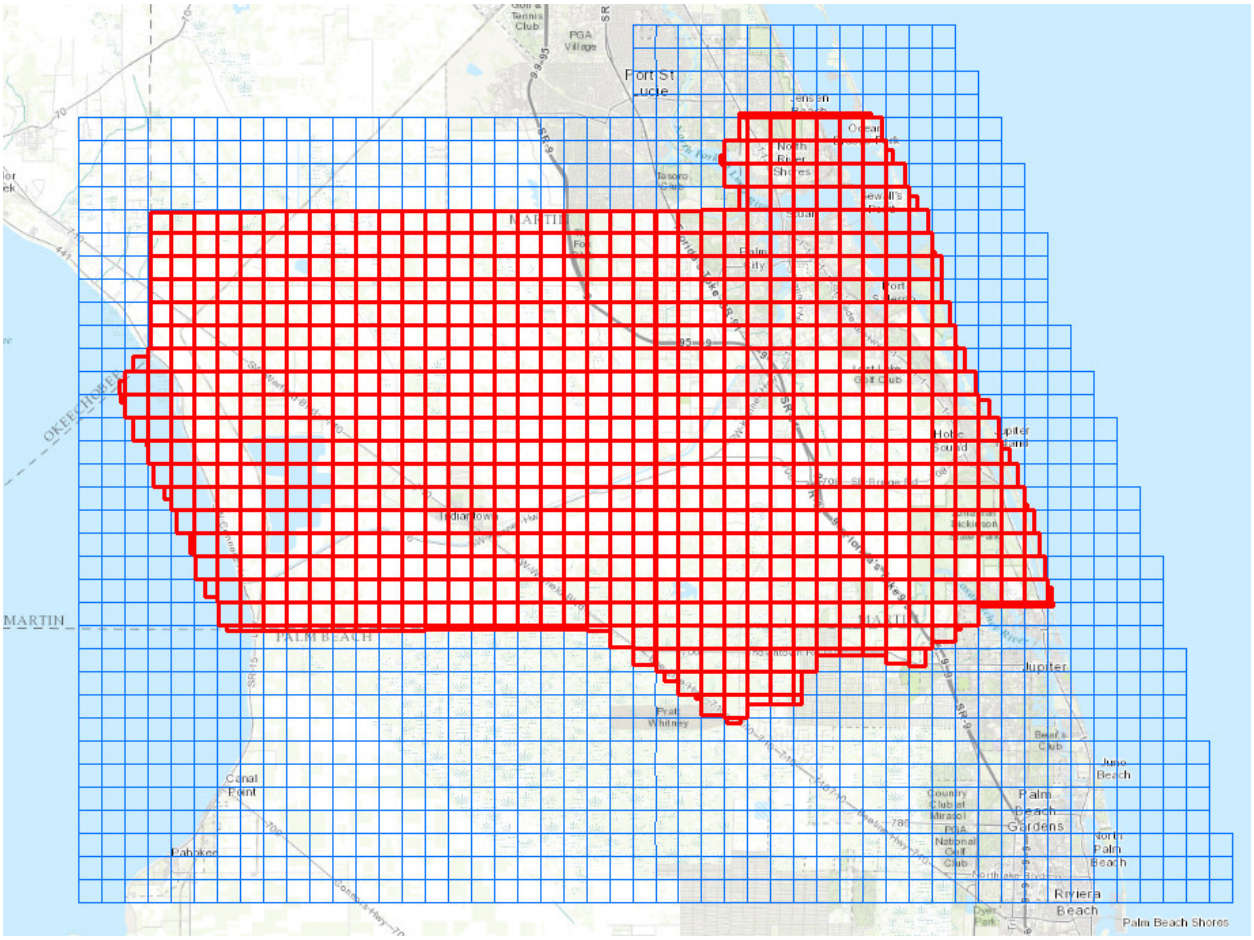

Figure 2 Tile Index

Data Extent

The data extent was a shape file of the area where data was collected for the project. There are no gaps between the tiles as shown in Figure 3 Project Data Extent.

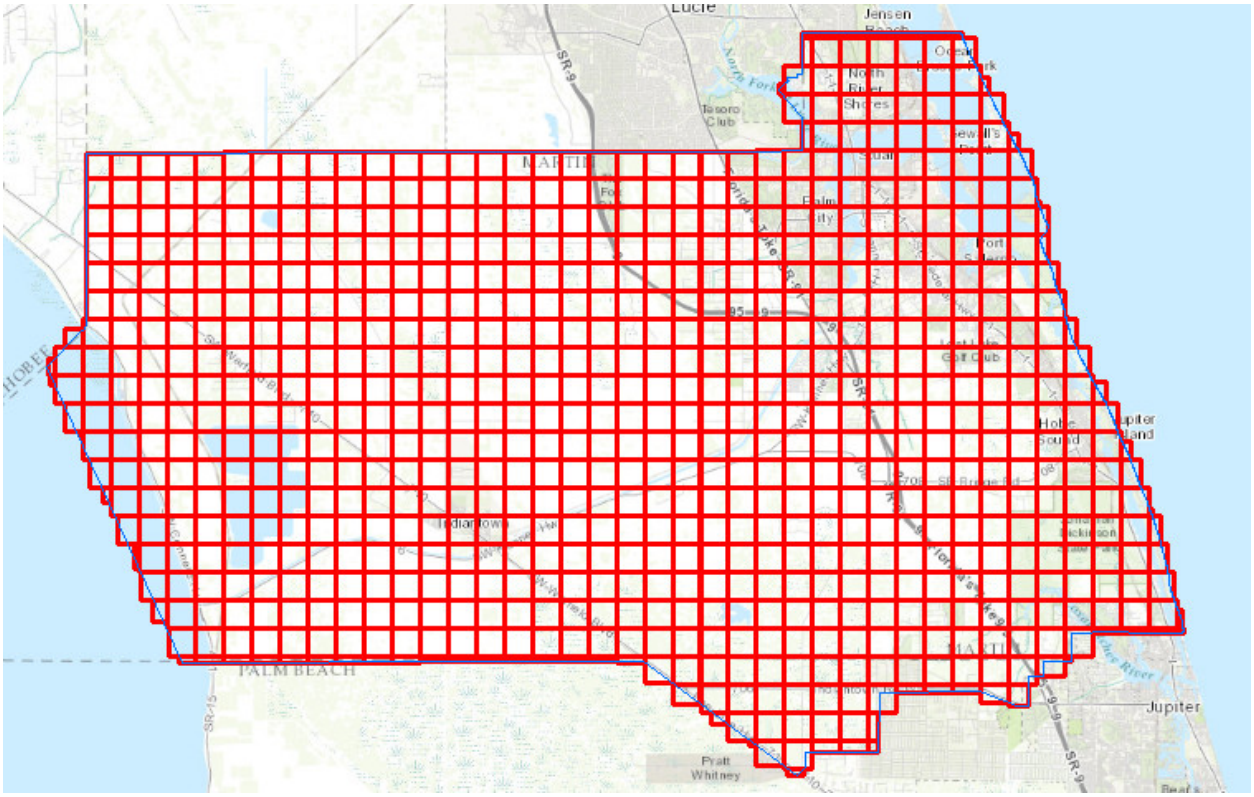

Figure 3 Project Data Extent

The only area that was not covered by the data extent was the St. Lucie Inlet jetty rocks as shown in Figure 4 St. Lucie Inlet with Data Extent.

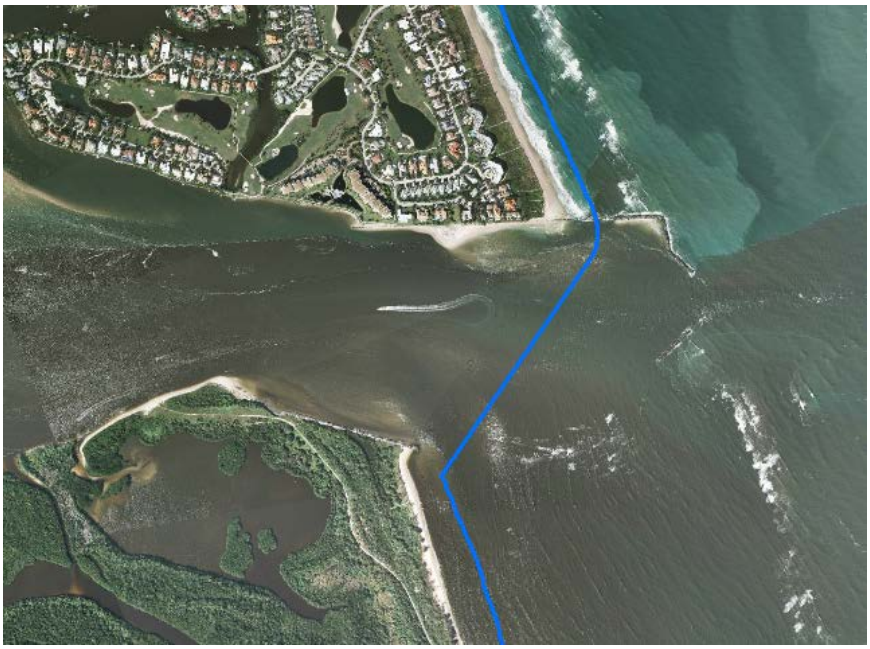

Figure 4 St. Lucie Inlet with Data Extent

Control

The control shape file was a set of 34 control points used in the project as shown in Figure 5 Control.

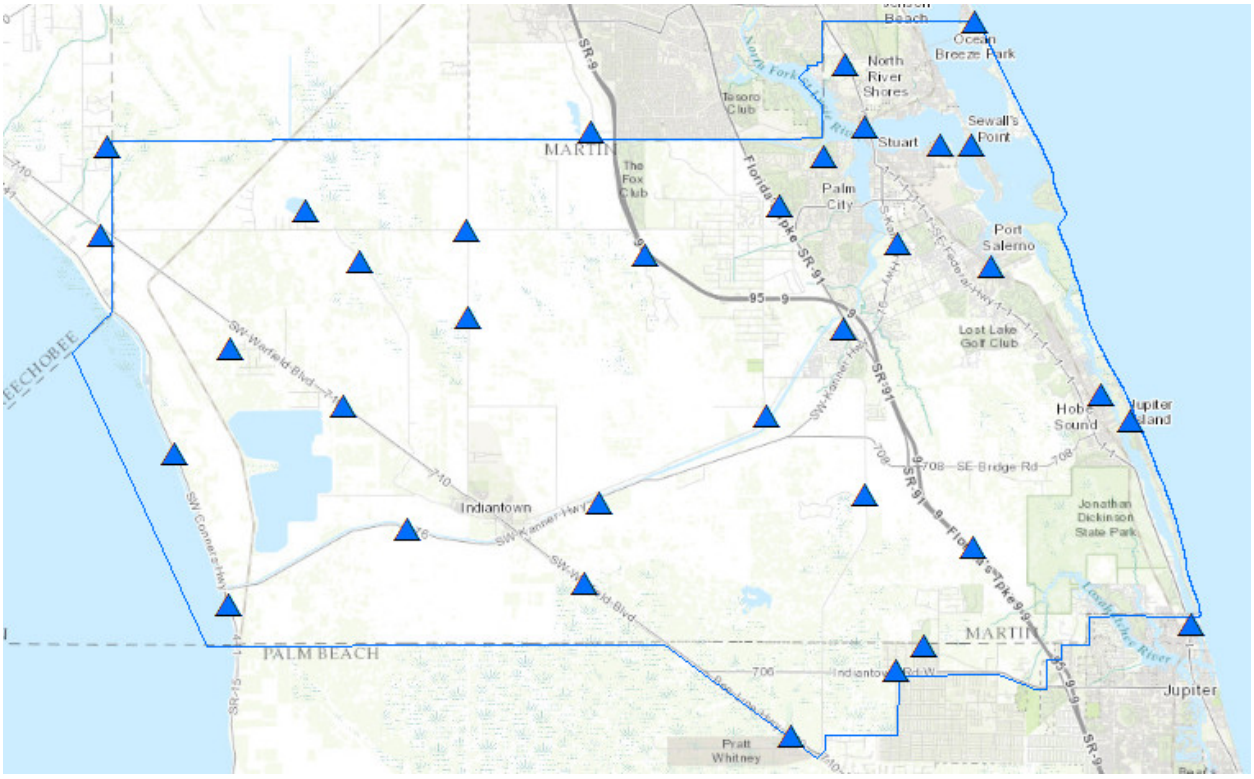

Figure 5 Control

Breakline Layers

The Breakline data was provided in a file geodatabase named “Breaklines.gdb”. This database contains feature classes including Bridge points, Lake polygons, and Stream polylines as shown in Figure 6 Lakes and Streams. The lakes layer shows all water bodies that are larger than 2 acres. The layer has 2 categories of “Lake” and “Island”. The islands are cut out of the lakes like a donut hole with no overlapping data. There are 1326 lake polygons in the layer with 1255 lakes and 71 islands. The Stream layer shows linear waterbodies such as the C-44 canal. There are 15 stream polylines in the layer with 10 streams and 5 stream islands. The hydrographic lakes and streams layers were used in the processing of the digital elevation model to flatten out all water bodies.

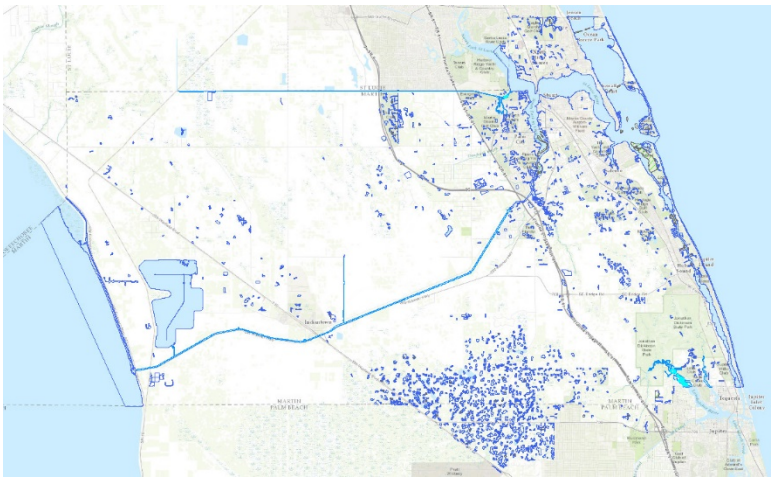

Figure 6 Lakes and Streams

Below is an image of an island that was included with the pilot data and is missing from the final deliverable as shown below in Figure 7 Missing Island. There were 23 additional examples of islands like this example.

Figure 7 Missing Island from Lake

The bridge breaklines was a point layer. The layer includes most of the bridges throughout Martin County. Some well known bridges were not included in this layer. They include the I-95 bridge over the C-44 canal, Palm City Bridge, Jensen Causeway Bridge, Ernest Lyons Bridge, Evans Crary Bridge, and many others.

Digital Elevation Model

The Digital Elevation Model (DEM) provides elevations in a raster format that can be used in other analysis. The DEM raster files are in Imagine IMG format with a cell size of 4 feet and a pixel depth of 32-bits. The DEM cell data provides elevations in feet. The areas that fall inside the hydro polygons layer are all hydro flattened in the DEM. The DEM dataset covers the entire pilot area without any voids as shown in Figure 8 Digital Elevation Model (DEM).

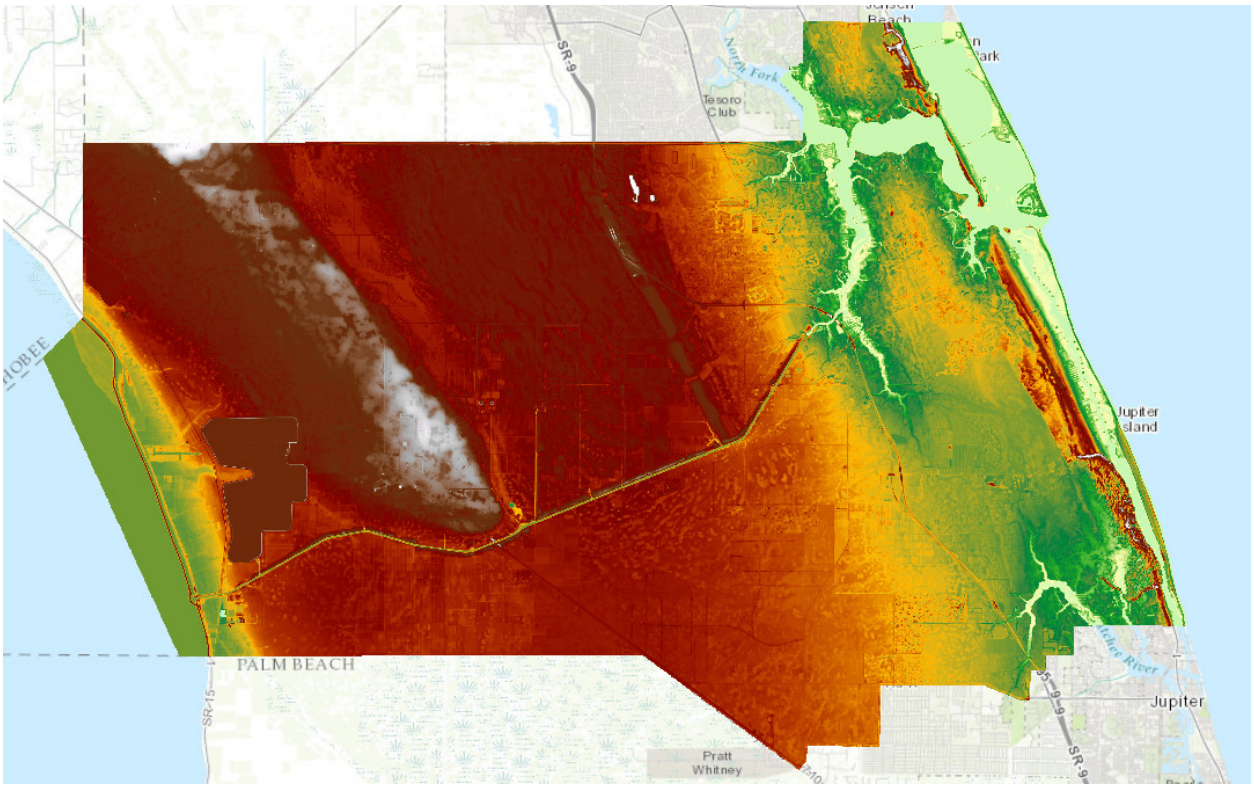

Figure 8 Digital Elevation Model (DEM)

Two named islands were excluded from hydrographic layer including Boy Scout Island and Bird Island as shown below in Figure 9 Islands Missing from DEM.

Figure 9 Islands Missing from DEM

Intensity

The intensity is a product of the how much light was returned from the ground back to the LIDAR sensor and delivered as a raster image as shown in Figure 10 Intensity. The intensity raster appears almost like a black and white picture with bright areas returning more light and dark areas such as water returning almost no light. The intensity rasters were provided in 16-bit floating point TIF format with 3 bands of data and a pixel size of 4 feet. The intensity rasters have 3 bands of the same information.

Figure 10 Intensity

LAS Files

The LAS files are point files with all of the LIDAR returns. The LAS files are in version 1.4 files. There were 768 LAS files in the project area, each file was approximately 1 GB in size. There were no significant data voids in the LAS files within the project area as shown in a sample area around the C-44 Locks Figure 11 LAS Points.

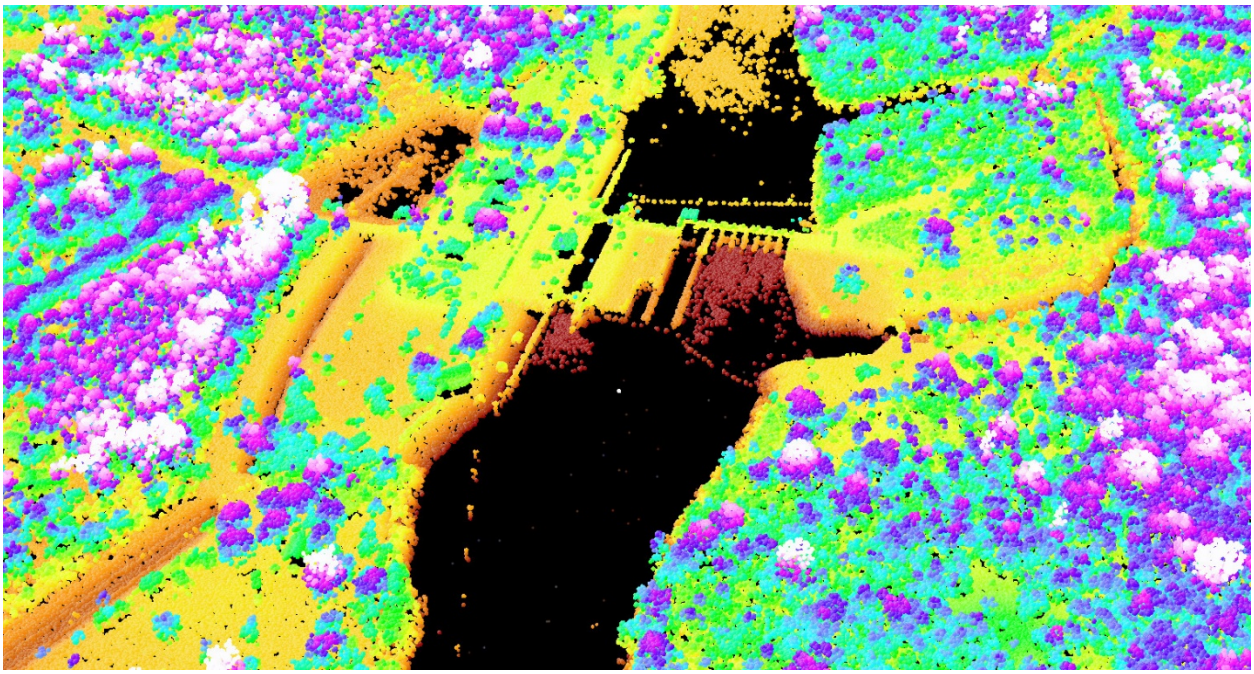

Figure 11 LAS Points

Comparison of LIDAR to Survey Data Points

Independent field measurements were made by using RTK GPS VRS and conventional survey methods. The analysis of the survey vs LIDAR data was performed by buffering the survey point by .564 meters to create a polygon. This number was derived by the following formulas:

$$\pi r^2 = A$$

$$\sqrt{\frac{A}{\pi}} = r$$

$$\sqrt{\frac{1\ meter}{\pi}} = 0.564\ meters$$

The analysis then used the ArcGIS "LAS Point Statistics by Area" tool. The following stats were computed for each polygon:

- Z minimum
- Z maximum
- Z mean
- Point count

- Standard deviation

Next, a field was added to compare the LIDAR Z mean to the survey elevation. Next, the field was populated by subtracting the LIDAR Z mean from the survey elevation. The output polygons were then converted back into points for ease of display.

Martin County Surveying provided survey data that is a mix of RTK GPS and conventional points that are located in the project area. 565 out of 636 or 89% of the RTK Survey ground truth locations were within 0.5 feet vertically. The maximum difference was 1.72 feet as shown in Figure 12 Survey vs LIDAR.

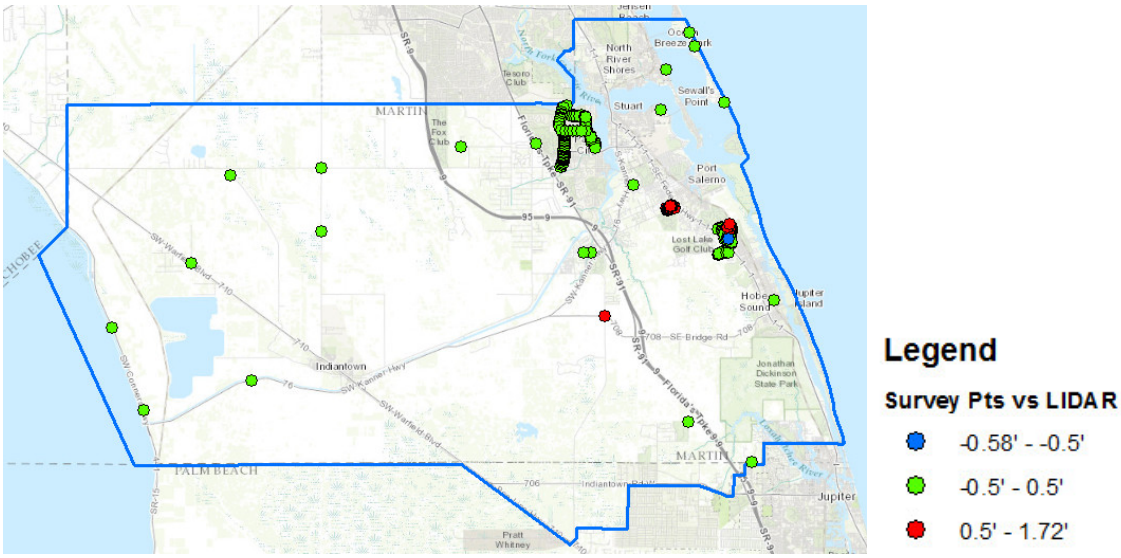

Figure 12 Survey vs LIDAR

Non-Vegetative Vertical Accuracy Quality Check Points (NVA)

Analysis of the NVA data provided by Woolpert resulted in similar results as to those found in the LIDAR report. 43 out of 43 points or 100% of the NVA survey ground truth locations were within 0.5 feet vertically. The maximum difference was 0.376 feet. Two points did not have any ground LIDAR points within the 0.564 Meter search radius and were not included in the analysis.

Vegetated Vertical Accuracy Quality Check Points (VVA)

Analysis of the VVA data provided by Woolpert resulted in similar results as to those found in the LIDAR report. 33 out of 33 points or 100% of the VVA survey ground truth locations were within 0.5 feet vertically. The maximum difference was 0.376 feet. Three points did not have any ground LIDAR points within the 0.564 Meter search radius and were not included in the analysis.

Data problems

There were 33 areas where the LIDAR points seemed to be classed incorrectly. 23 of the problem areas are islands that are classed as water. 8 of the problems areas are portions of water bodies that are classed as ground. An entire street, SE Star Island Way, was classed as water as shown in Figure 13 SE Star Island Way classed as water.

Figure 13 SE Star Island Way classed as water

There are lots of points classed as ground in the Southeastern section of the county in intracoastal waterway. Upon further inspection, an approximate one-foot vertical gap was discovered between the water and the ground points as shown in Figure 14 Gap between water and ground points. This same gap is also found in the Loxahatchee River.

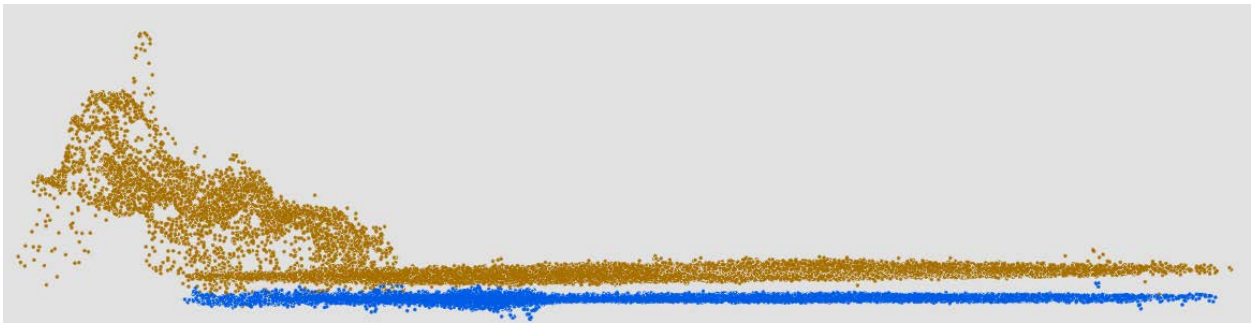

Figure 14 Gap between water and ground points

The most notable breakline problem is the West side of the Veterans Memorial Bridge. The breakline points are over 600 feet away from where the bridge deck starts as shown in Figure 15 Veterans Memorial Bridge Break Line Points. This issue affects the LAS Files and the DEM.

All of the problem areas were captured in a shape file and will be included with this report.

Figure 15 Veterans Memorial Bridge Break Line Points

Conclusion

The Martin County 3DEP LIDAR data collected by Woolpert, Inc. is a valuable dataset that may be used for years to come in infrastructure and flood plain management projects based on the facts of this study. There are concerns about breakline location of the West side of the Veterans Memorial Bridge, SE Star Island Way, the miss classification of many islands, and the missing islands, Boy Scout Island and Bird Island, from the DEM. The engineering and surveying communities need to be aware that while this LIDAR dataset is a great asset, it is not a replacement for topographic surveys in and around dense vegetation or water bodies. We look forward to using this dataset in many future projects.