



## **Project Report**

**TASK ORDER NAME: GA\_Statewide\_2018\_B18**

**TASK ORDER NUMBER: 140G0218F042**

**CONTRACT NUMBER: G16PC00042**

**ATLANTIC PROJECT NUMBER: 18066 - Block 02**

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## SECTION 1: PROJECT OVERVIEW AND PURPOSE

### 1.1 Aerial LiDAR Project

#### 1.1.1 Project Overview

USGS task order 140G0218F042 required Winter, 2018/Spring, 2019 LiDAR surveys to be collected over 32,562 square miles covering part or all of 82 counties in Georgia and 3 partial counties in South Carolina in support of the State of Georgia and the USGS 3DEP program. Aerial LiDAR data for this task order was planned, acquired, processed and produced at an aggregate nominal pulse spacing (ANPS) of  $\leq 0.71$  meters and in compliance with USGS National Geospatial Program LiDAR Base Specification version 1.3. The Block 02 area encompasses approximately 3,089 square miles.

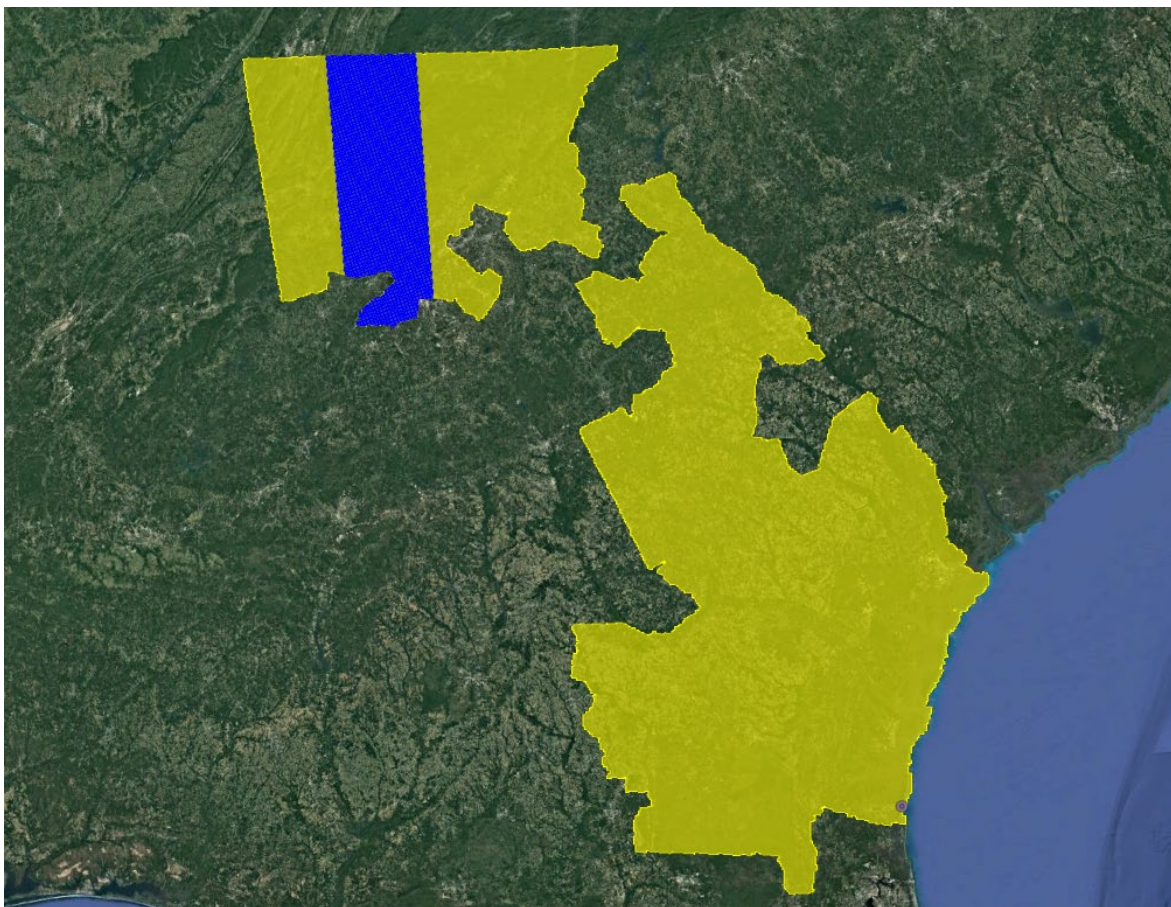


Figure 1: Aerial LiDAR Project Overview – Defined Project Area (DPA) in Yellow and Associated Areas of Interest (AOIs) in Blue

#### 1.1.2 Project Purpose

Aerial lidar was collected to support the mapping efforts of individual counties in the State of Georgia and the USGS 3DEP program.

### 1.1.3 Contract Deliverables

Item	Specification/Format
<b>Classified Point Cloud</b>	LAS v.14, tiled delivery
<b>Bare Earth Surface</b>	Raster DEM, 1m cell size, hydro flattened, .img format
<b>Breaklines</b>	Hydro breaklines to BPA limit, .gdb format
<b>Intensity Imagery</b>	1m cell size, 8-bit, 256 gray scale, GeoTIFF format
<b>Delivery Diagram</b>	.gdb format
<b>Metadata</b>	Per product, FGDC compliant, .xml format
<b>Project Report</b>	Field work procedures, QC procedures and results, overall accuracy, .pdf format

*Table 1: Aerial LiDAR Contract Deliverables*

## SECTION 2: FIELD OPERATIONS

### 2.1 Aerial LiDAR Project – Aerial Acquisition

#### 2.1.1 Aircraft and Sensor Information

Atlantic operated a PAC750 outfitted with an Optech Galaxy Prime LiDAR system during the collection of the project area. The specifications of this system are presented in the following table:

Parameter	Specification
<b>Model</b>	Galaxy Prime
<b>Manufacturer</b>	Optech
<b>Performance Envelope</b>	150 – 4700 m AGL, nominal
<b>Absolute Horizontal Accuracy</b>	1/10,000 x altitude
<b>Absolute Elevation Accuracy</b>	< 0.03 – 0.20 m RMSE from 150 – 4700 m AGL
<b>Topographic Laser</b>	1064-nm near-infrared
<b>Laser Classification</b>	Class IV
<b>Pulse Repetition Frequency (Effective)</b>	Programmable, 50 – 1000 kHz
<b>Beam Divergence</b>	0.25 mrad (1/e)
<b>Laser Range Precision</b>	< 0.008 m
<b>Minimum Target Separation Distance</b>	< 0.7 m (discrete)
<b>Range Capture</b>	Up to 8 range measurements, including last
<b>Intensity Capture</b>	Up to 8 intensity measurements, including last (12-bit)
<b>Scan Angle (Fov)</b>	10 – 60°
<b>Swath Width</b>	10 – 115% of altitude AGL
<b>Scan Frequency</b>	0 – 120 Hz advertised (0 – 240 scan lines/sec)
<b>Scan Product</b>	2000 maximum
<b>Roll Compensation</b>	±5° minimum
<b>Data Storage</b>	Internal solid-state drive (SSD)
<b>Power Requirements</b>	28 V; 300 W
<b>Dimensions and Weight</b>	Sensor: 0.34 x 0.34 x 0.25 m, 27 kg PDU: 0.42 x 0.33 x 0.10 m, 6.5 kg
<b>Operation Temperature</b>	0 to +35°C

Table 2: System Specifications – Galaxy Prime

### 2.1.2 Sensor Acquisition Information

The following table illustrates project specific system parameters for LiDAR acquisition on this project:

Parameter	Specification
<b>System</b>	Optech Galaxy Prime
<b>Nominal Pulse Spacing (m)</b>	0.6
<b>Nominal Pulse Density (pls/m<sup>2</sup>)</b>	2.4
<b>Nominal Flight Height (AGL meters)</b>	2000
<b>Nominal Flight Speed (kts)</b>	130
<b>Pass Heading (°)</b>	90
<b>Sensor Scan Angle (°)</b>	40
<b>Scan Frequency (Hz)</b>	55
<b>Pulse Rate of Scanner (kHz)</b>	300,000
<b>Line Spacing (m)</b>	1400
<b>Central Wavelength of Sensor Laser (nm)</b>	1064
<b>Sensor Operated with Multiple Pulses</b>	5
<b>Beam Divergence (mrad)</b>	0.25
<b>Nominal Swath Width (m)</b>	1674
<b>Nominal Swath Overlap (%)</b>	20
<b>Scan Pattern</b>	Triangle

*Table 3: Aerial LiDAR Sensor Acquisition Parameters*

### 2.1.3 Flight Plan Execution

Atlantic acquired 271 passes of the AOI as a series of perpendicular and/or adjacent flight-lines executed in 21 flight missions conducted between January 28, 2018 and April 23, 2019. Onboard differential Global Navigation Satellite System (GNSS) unit(s) recorded sample aircraft positions at 2 hertz (Hz) or more frequency. LiDAR data was only acquired when a minimum of six (6) satellites were in view.

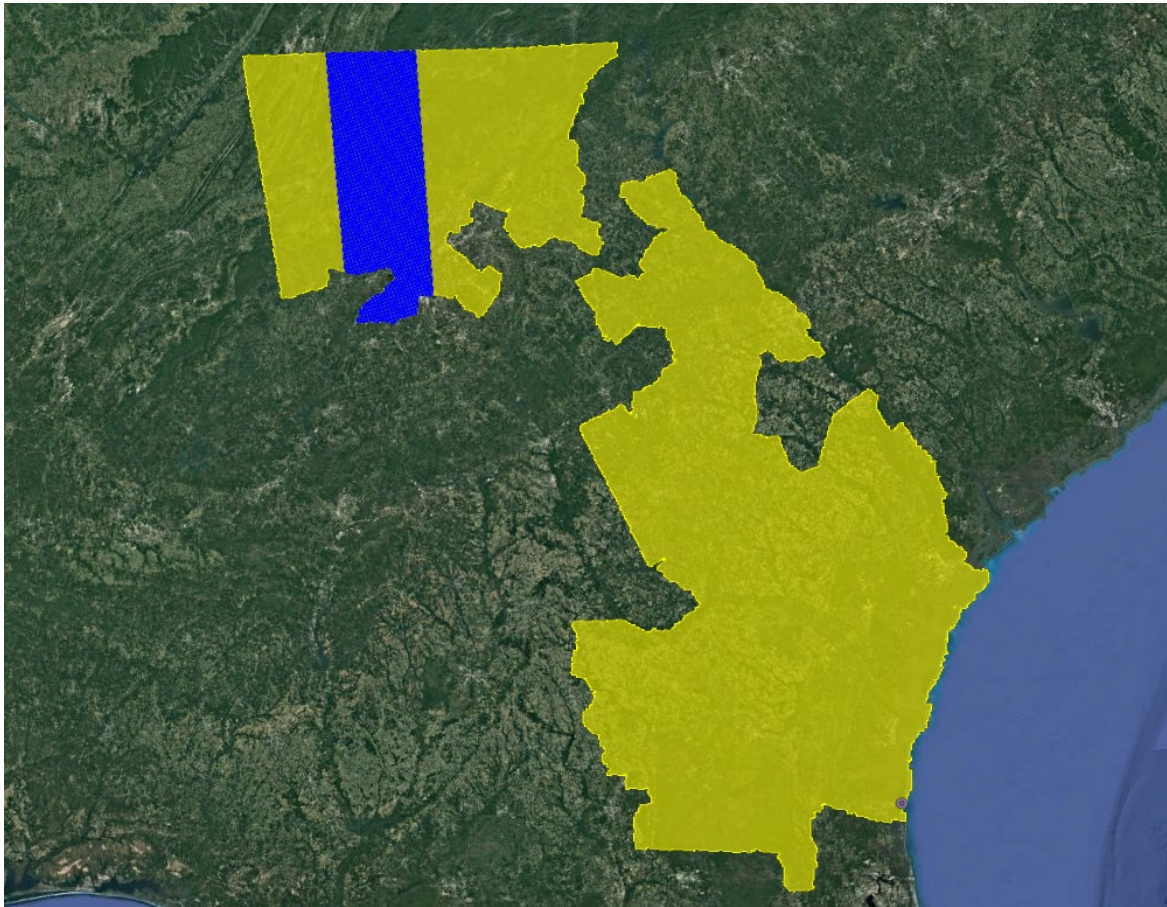


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

### 2.1.4 GNSS Reference Stations

Twenty-two (22) Continuously Operating Reference Stations (CORS) were used to control the LiDAR acquisition for the defined project area. The coordinates provided in below are in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

Designation	Type	PID	Latitude (N)	Longitude (W)	Elevation
ALAS	CORS	ALAS	N33°40'01.20716"	W85°49'50.49150"	203.112
ALCN	CORS	ALCN	N34°09'46.97943"	W85°39'31.04926"	164.905
ALCU	CORS	ALCU	N34°10'47.53658"	W86°50'41.56001"	222.816
ALHC	CORS	ALHC	N33°31'25.44556"	W85°38'05.50128"	256.549
ALLA	CORS	ALLA	N32°55'02.66212"	W85°24'01.80594"	237.158
FRKN	CORS	FRKN	N35°11'30.71108"	W83°23'41.77392"	619.545
GABN	CORS	GABN	N34°08'07.10674"	W83°46'38.52669"	277.224
GACC	CORS	GACC	N33°32'44.73037"	W82°08'01.72532"	98.568
GANW	CORS	GANW	N33°18'20.82421"	W84°46'02.50937"	259.992

Designation	Type	PID	Latitude (N)	Longitude (W)	Elevation
GTAC	CORS	GTAC	N34°42'39.84932"	W86°39'12.31500"	193.01
NCBC	CORS	NCBC	N35°22'21.58731"	W83°30'23.39888"	564.809
NCMU	CORS	NCMU	N35°04'06.80197"	W83°57'59.38914"	474.78
NCRB	CORS	NCRB	N35°19'15.71699"	W83°47'48.71726"	605.321
P779	CORS	P779	N35°12'06.98912"	W82°52'20.92954"	878.735
P804	CORS	P804	N32°57'47.83569"	W84°13'32.72093"	216.363
P806	CORS	P806	N32°57'47.92265"	W84°13'33.05711"	215.87
TN21	CORS	TN21	N35°03'51.76165"	W85°12'25.96382"	196.277
TN22	CORS	TN22	N35°23'25.74313"	W85°22'40.99934"	206.175
TN25	CORS	TN25	N35°22'01.47346"	W86°11'20.80775"	301.316
TN29	CORS	TN29	N35°14'46.29844"	W84°34'06.16379"	198.194
TN34	CORS	TN34	N35°25'34.74325"	W86°42'43.90718"	229.099
ZTL4	CORS	ZTL4	N33°22'46.87792"	W84°17'48.21521"	260.69

Table 4: GNSS Reference Stations



## 2.2 Aerial LiDAR Project – Ground Acquisition

### 2.2.1 Ground Control Survey

A total of 124 ground survey points were collected in support of this project, including 29 LiDAR Control Points (LCP), 57 Non-vegetated Vertical Accuracy (NVA) and 38 Vegetated Vertical Accuracy (VVA).

Point cloud data accuracy was tested against a Triangulated Irregular Network (TIN) constructed from LiDAR points in clear and open areas. A clear and open area can be characterized with respect to topographic and ground cover variation such that a minimum of five (5) times the Nominal Pulse Spacing (NPS) exists with less than 1/3 of the RMSEZ deviation from a low-slope plane. Slopes that exceed ten (10) percent were avoided.

Each land cover type representing ten (10) percent or more of the total project area were tested and reported with a VVA. In land cover categories other than dense urban areas, the tested points did not have obstructions forty-five (45) degrees above the horizon to ensure a satisfactory TIN surface. The VVA value is provided as a target. It is understood that in areas of dense vegetation, swamps, or extremely difficult terrain, this value may be exceeded.

The NVA value is a requirement that must be met, regardless of any allowed “busts” in the VVA(s) for individual land cover types within the project. Checkpoints for each assessment (NVA and VVA) are required to be well-distributed throughout the land cover type, for the entire project area.

The following tables and figures outline the coordinate values and distribution of LCP, NVA and VVA points collected in support of this project:

ID	Easting	Northing	Elevation
BLUE_CHERO_CP20	1027789.577	1298196.117	281.658
BLUE_CHERO_CP21	1053323.13	1310709.102	308.414
BLUE_CHERO_CP26	1039300.851	1309853.725	307.303
BLUE_GORDON_UA7	1028583.983	1324619.824	283.364
BLUE_MURRAY_OT1	1031832.439	1365778.096	502.215
BLUE_PICKENS_UA3	1037971.637	1331433.03	348.256
PIED_BARTOW_CP7	1027715.342	1314445.677	261.321
PIED_BARTOW_CP8	1023172.395	1292609.959	218.797
PIED_COBB_BE1	1049256.456	1266936.48	321.848
PIED_COBB_CP6	1049488.331	1281196.502	293.079
PIED_COBB_UA8	1035804.654	1280449.203	281.335
PIED_COBB_UA9	1050452.444	1273228.518	339.936
PIED_COBB_UA10	1039639.681	1261623.908	277.024
PIED_FULTON_CP8	1052910.603	1231977.406	305.923
PIED_FULTON_CP9	1065772.029	1250643.362	296.695
PIED_PAULD_FO10	1017593.52	1277460.085	269.561





ID	Easting	Northing	Elevation
BLUE_GILMER_CP4	1041281.409	1349288.047	464.447
BLUE_GILMER_OT4	1043479.227	1353837.262	378.046
BLUE_GORDON_CP2	1030309.473	1326873.559	291.319
BLUE_GORDON_FO3	1029328.742	1330360.953	263.955
BLUE_MURRAY_CP19	1026191.178	1343464.418	204.369
BLUE_MURRAY_OT10	1020097.093	1375157.754	266.356
BLUE_MURRAY_UA4	1024672.644	1360365.527	775.637
BLUE_PICKENS_CP3	1052394.446	1326678.56	409.185
BLUE_PICKENS_CP25	1043406.867	1337166.839	367.973
BLUE_PICKENS_FO4	1039870.31	1334816.337	344.57
BLUE_PICKENS_OT2	1049737.414	1330754.543	438.325
PIED_BARTOW_UA6	1020365.538	1291867.72	211.677
PIED_BARTOW_UA21	1022910.028	1297929.601	239.578
PIED_CHEROK_CP55	1049283.645	1298318.856	353.564
PIED_CHEROKEE_FO64	1045351.767	1290908.178	281.898
PIED_COBB_FO11	1035122.767	1269737.833	333.496
PIED_COBB_FO13	1050838.287	1257649.884	321.385
PIED_COBB_FO22	1055132.588	1283427.909	362.663
PIED_COBB_OT7	1038992.092	1268502.858	294.976
PIED_FULTON_FO17	1064631.601	1265219.822	248.818
PIED_FULTON_OT8	1033182.756	1228001.633	265.601
PIED_FULTON_OT9	1050475.525	1241758.192	251.242
PIED_FULTON_UA11	1044508.31	1232174.603	291.179
PIED_FULTON_UA12	1055531.101	1251498.506	268.446
PIED_PAULD_CP5	1018190.568	1273460.995	324.725
PIED_PAULD_CP5_1	1023397.707	1257824.781	323.877
PIED_PAULD_FO3	1025035.001	1264801.65	333.039
SWAPP_BART_FO7	1017550.034	1298893.547	230.537
SWAPP_BART_FO8	1009973.612	1316011.788	237.811
SWAPP_BARTOW_CP8	1023179.817	1292611.806	220.738
SWAPP_BARTOW_CP16	1015550.937	1301032.778	248.653
SWAPP_CATOO_FO21	990309.4627	1380844.098	267.914
SWAPP_GORD_FO12	1017686.265	1340375.898	196.572
SWAPP_GORD_FO13	1017623.312	1325236.144	216.707
SWAPP_GORDON_CP6	1027981.362	1324712.805	232.194
SWAPP_GORDON_CP6b	1027981.363	1324712.802	230.104

ID	Easting	Northing	Elevation
SWAPP_GORDON_CP18	1003374.391	1329545.239	195.782
SWAPP_GORDON_FO11	1003110.09	1326134.532	214.878
SWAPP_GORDON_UA8	1007913.74	1325168.039	204.992
SWAPP_GORDON_UA9	1011324.773	1333099.511	201.109
SWAPP_MURRAY_OT14	1013314.214	1348760.08	221.12
SWAPP_MURRAY_OT15	1016579.046	1363622.206	229.728
SWAPP_MURRAY_OT16	1014942.365	1378775.806	254.529
SWAPP_MURRAY_UA19	1016905.15	1367444.959	231.653
SWAPP_MURRAY_UA20	1021041.854	1353502.47	242.355
SWAPP_WHITFIELD_UA18	1002412.3	1358368.609	230.719
SWAPP_WHITFIELD_OT17	1000695.823	1353011.923	223.594
SWAPP_WHITFIELD_OT18	993653.6041	1362363.623	231.183
SWAPP_WHITFIELD_OT19	999487.75	1374389.743	239.251
SWAPP_WHITFIELD_OT19_1	999501.2199	1374375.326	236.304
SWAPP_WHITFIELD_UA17	999496.6585	1373338.478	238.523
SWAPP_WHITFIELD_UA17_1	999458.7215	1373336.11	236.249
SWAPP_WHITFIELD_UA23	999793.4218	1346331.762	235.025

Table 6: Non-Vegetated Vertical Accuracy (NVA) Point Coordinates

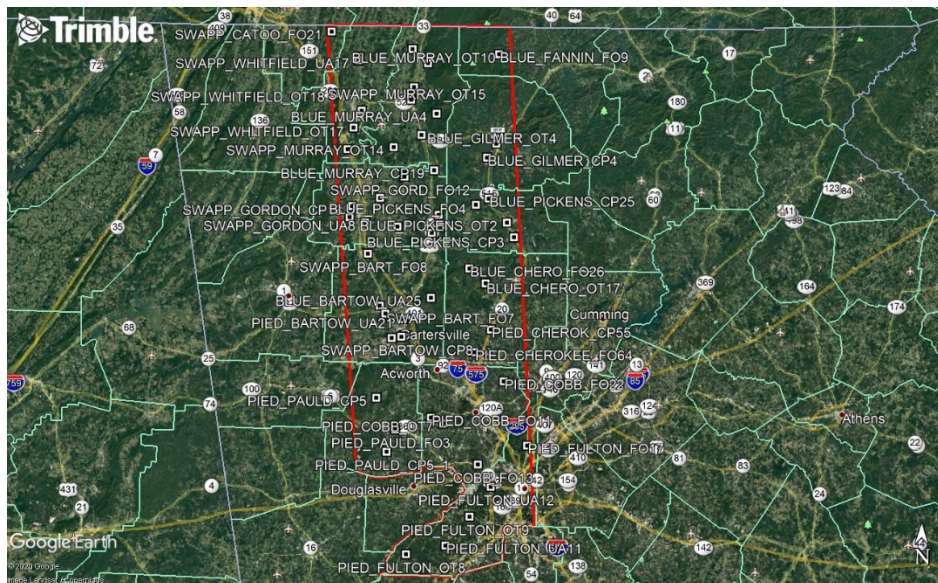


Figure 4: Non-Vegetated Vertical Accuracy (NVA) Point Distribution

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ID	Easting	Northing	Elevation
BLUE_CHERO_UA28	1049025.736	1305597.356	265.517
BLUE_GILMER_CP5	1046356.375	1364111.823	476.875
BLUE_GILMER_CP22	1038748.5	1356285.039	393.33
BLUE_GILMER_FO7	1041416.351	1355802.522	484.407
BLUE_GILMER_FO8	1038652.376	1367053.002	539.569
BLUE_GILMER_OT3	1034261.717	1340423.07	320.377
BLUE_GILMER_UA6	1043856.158	1351745.154	429.502
BLUE_MURRAY_CP1	1024455.173	1384448.877	336.675
BLUE_MURRAY_FO1	1023527.325	1383084.013	318.397
BLUE_MURRAY_FO2	1027335.084	1351703.072	420.65
BLUE_PICKENS_UA2	1050061.133	1329884.981	445.135
PIED_BARTOW_CP56	1034657.103	1285956.599	272.165
PIED_BARTOW_OT7	1009967.055	1290216.445	212.04
PIED_BARTOW_OT28	1025805.243	1307377.446	260.789
PIED_COBB_CP7	1042732.219	1258750.453	281.591
PIED_COBB_FO8	1033031.152	1281869.251	274.823
PIED_COBB_FO12	1035905.643	1259057.074	309.653
PIED_FULTON_CP10	1063443.543	1266070.001	263.344
PIED_FULTON_FO14	1058684.629	1248067.819	304.839
PIED_FULTON_FO15	1033747.552	1223279.724	249.378
PIED_FULTON_FO16	1051044.857	1238084.666	278.925
PIED_PAULD_UA7	1027426.196	1264766.775	321.709
PIED_PAULD_WE2	1016056.219	1275280.213	240.137
SWAPP_BARTOW_CP7	1027715.328	1314445.697	263.434
SWAPP_BARTOW_UA6	1020370.383	1291803.566	213.996
SWAPP_BARTOW_UA7	1007708.751	1315957.933	217.914
SWAPP_BARTOW_UA21	1022874.292	1297889.526	240.788
SWAPP_GORDON_OT9	1006338.643	1324526.347	197.499
SWAPP_GORDON_OT10	1026151.967	1332004.206	229.742
SWAPP_GORDON_TG2	1001319.118	1337142.161	224.68
SWAPP_MURR_FO25	1012173.224	1350213.812	204.218
SWAPP_MURR_FO26	1013270.822	1370308.203	234.32
SWAPP_MURR_FO26b	1013270.822	1370308.203	234.32
SWAPP_MURRAY_BR1	1015418.119	1360274.485	232.401
SWAPP_MURRAY_FO2	1017262.057	1375850.101	243.86

ID	Easting	Northing	Elevation
SWAPP_WHIT_FO22	1000791.937	1373456.479	231.546
SWAPP_WHIT_FO27	1002704.585	1344225.284	217.746
SWAPP_WHITFIELD_BR3	1001461.992	1376484.769	226.765
SWAPP_WHITFIELD_BR3_1	1001444.687	1376514.67	225.557

Table 7: Vegetated Vertical Accuracy (VVA) Point Coordinates

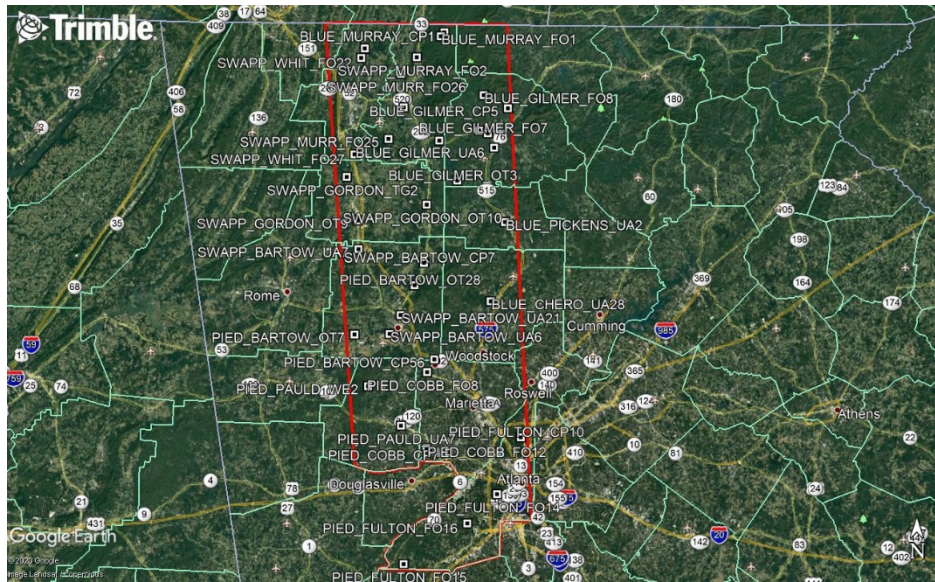


Figure 5: Vegetated Vertical Accuracy (VVA) Point Distribution

## SECTION 3: DATA PRODUCTION

### 3.1 Aerial LiDAR Project – Calibration/Classification

#### 3.1.1 LiDAR Point Cloud Generation

Atlantic used Leica software products to download the IPAS ABGNSS/IMU data and raw laser scan files from the airborne system. Waypoint Inertial Explorer is used to extract the raw IPAS ABGNSS/IMU data, which is further processed in combination with controlled base stations to provide the final Smoothed Best Estimate Trajectory (SBET) for each mission. The SBETs are combined with the raw laser scan files to export the LiDAR ASCII Standard (\*.las) formatted swath point clouds.

#### 3.1.2 Coordinate Reference System

Parameter	Specification
<b>Horizontal Datum</b>	NAD83 (NSRS2011)
<b>Coordinate System</b>	Albers Conic
<b>Vertical Datum</b>	NAVD88
<b>Geoid Model</b>	12B
<b>EPSG Code</b>	6350
<b>Units of Reference</b>	Meter

*Table 8: Coordinate Reference System*

#### 3.1.3 LiDAR Point Cloud Statistics

Category	Value
<b>Total Points (Nominal)</b>	28,510,397,984
<b>Nominal Pulse Spacing (M)</b>	0.5287
<b>Nominal Pulse Density (PLS/M<sup>2</sup>)</b>	3.5776
<b>Total Points (Aggregate)</b>	26,644,868,981
<b>Aggregate Pulse Spacing (M)</b>	0.4432
<b>Aggregate Pulse Density (PLS/M<sup>2</sup>)</b>	5.0912

*Table 9: LiDAR Point Cloud Statistics*

#### 3.1.4 Smooth Surface Repeatability (Interswath)

Departures from planarity of first returns within single swaths in non-vegetated areas were assessed at multiple locations with hard surface areas (parking lots or large rooftops) inside the project area. Each area was evaluated using signed difference rasters (maximum elevation – minimum elevation) at a cell size equal to 2 x ANPS, rounded to the next integer.

#### 3.1.5 LiDAR Calibration

Using a combination of GeoCue, TerraScan and TerraMatch; overlapping swath point clouds are corrected for any orientation or linear deviations to obtain the best fit swath-to-swath calibration. Relative calibration was evaluated using advanced plane-matching analysis and parameter corrections derived. This process was repeated

interactively until residual errors between overlapping swaths, across all project missions, was reduced to  $\leq 2\text{cm}$ . A final analysis of the calibrated lidar is preformed using a TerraMatch tie line report for an overall statistical model of the project area. Individual control point assessments for this project can be found in Section VI of this report.

Upon completion of the data calibration, a complete set of elevation difference intensity rasters (dZ Orthos) are produced. A user-defined color ramp is applied depicting the offsets between overlapping swaths based on project specifications. The dZ orthos provide an opportunity to review the data calibration in a qualitative manner. Atlantic assigns green to all offset values that fall below the required RMSDz requirement of the project. A yellow color is assigned for offsets that fall between the RMSDz value and 1.5x of that value. Finally, red values are assigned to all values that fall beyond 1.5x of the RMSDz requirements of the project.

### 3.1.6 LiDAR Classification

Multiple automated filtering routines are applied to the calibrated LiDAR point cloud identifying and extracting bare-earth and above ground features. GeoCue, TerraScan, and TerraModeler software was used for the initial batch processing, visual inspection and any manual editing of the LiDAR point clouds. Atlantic utilized collected breakline data to preform classification for class 9 (Water).

Code	Description
1	Processed but unclassified
2	Bare-earth ground
3	Low Vegetation (0.5 – 5 feet)
4	Medium Vegetation (5 – 20 feet)
5	High Vegetation (>20 feet)
6	Building footprints
7	Low Noise
9	Water
17	Bridge Decks
18	High Noise
20	Ignored ground (breakline proximity)
21	Snow (where reliable identifiable)
22	Temporal Exclusion (typically non-favored data in intertidal zones)

*Table 10: LiDAR Point Classification Codes and Descriptions*

### 3.1.7 LiDAR Intensity Imagery

LiDAR intensity imagery was created from the final calibrated and classified lidar point cloud. Intensity images were produced from all classified points and posted to a 1-meter cell size. Intensity images were cut to match the tile index and its corresponding tile names and delivered in GeoTIFF format.

### 3.1.8 Hydro-line Collection/Conflation

Hydro breaklines were compiled using LiDAR intensity data and surface terrain models of the entire project area. After the collection, all delineated hydro features were validated for monotonicity and vertical variance. This



procedure ensures that no points were floating above ground. Hydro-lines were then encoded into the LiDAR surface and used to hydro-enforce/flatten all significant water bodies. These final hydro-lines were then used in the production of bare Earth digital models to hydro flatten significant water bodies. This product was delivered as an ESRI geodatabase for the entire project area.

### 3.1.9 Bare-Earth Surface – Digital Elevation Model (DEM)

Bare earth Digital Elevation Models (DEMs) were derived using the hydro-lines and bare earth (ground) LiDAR points. All DEMs were created with a grid spacing of 1 meter. DEMs for this project were cut to match the tile index and its corresponding tile names and delivered in 32-bit floating point .img format.

## SECTION 4: ACCURACY ASSESSMENT

### 4.1 Aerial LiDAR Project – Vertical Accuracy Assessment

#### 4.1.1 Requirements

Per the table below, the Vertical Accuracy Assessment utilized the required parameters for Vertical Data Accuracy Class IV.

Vertical Data Accuracy Class	RMSEz in Non-Vegetated Terrain (cm)	Non-Vegetated Vertical Accuracy (NVA) at 95% Confidence Level (cm)	Vegetated Vertical Accuracy (VVA) at 95th Percentile (cm)
I	1.0	2.0	2.9
II	2.5	4.9	7.4
III	5.0	9.8	14.7
IV	10.0	19.6	29.4
V	12.5	24.5	36.8
VI	20.0	39.2	58.8
VII	33.3	65.3	98.0
VIII	66.7	130.7	196.0
IX	100.0	196.0	294.0
X	333.3	653.3	980.0

Table 11: Vertical Accuracy Standards, Source: ASPRS Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014)

\*The terms NVA and VVA are from the American Society for Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data v1.0 (2014). The term NVA refers to assessments in clear, open areas (which typically produce only single LiDAR returns); the term VVA refers to assessments in vegetated areas (typically characterized by multiple return LiDAR).

#### 4.1.2 Results

An overall statistical assessment of the check points can be found in the following two tables (values provided in meters):

Broad Land Cover Type	Points (#)	RMSEz	Confidence Level (95%)	Percentile (95th)
NVA (Point Cloud)	40	0.0501	0.0981	0.0808
NVA (DEM)	40	0.0493	0.0967	0.0784
VVA (Point Cloud)	27	0.0495	0.0970	0.0688
VVA (DEM)	27	0.0581	0.1138	0.0857

Table 12: NVA/VVA Accuracies

## SECTION 5: CERTIFICATION STATEMENTS

### 5.1 Aerial LiDAR Project

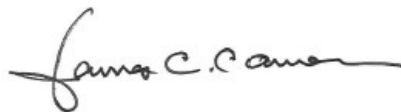
This accuracy assessment confirms that the data may be used for the intended applications stated in Section I of this document. This dataset may also be used as a topographic input for other applications, but the user should be aware that this LiDAR dataset was designed with a specific purpose and was not intended to meet specifications and/or requirements of users outside of the United States Geological Survey.

It should also be noted that LiDAR points do not represent a continuous surface model. LiDAR points are discrete measurements of the surface and any values derived within a triangle of three LiDAR points are interpolated. As such, the user should not use the resultant LiDAR dataset for vertical placement of a planimetric feature such as a headwall, building footprint or any other planimetric feature unless there is an associated LiDAR point that can be reasonably located on this structure.

Consideration should be given by the end user of this dataset to the fact that this LiDAR dataset was developed differently and separately than previous LiDAR datasets that may be available for this geographic location. It is likely that the data in this project was created using different geodetic control, a different Geoid, newer LiDAR technology and more up-to-date processing techniques. As such, any direct comparative analysis performed between this dataset and previous datasets could result in misleading or inaccurate results. Users are encouraged to proceed with caution while performing this type of comparative analysis and to completely understand the variables that make each of these datasets unique and not corollary.

It is encouraged that the user refers to the full FGDC Metadata and project reports for a complete understanding on the content of this dataset.

I, hereby, certify to the extent of my knowledge that the statements and statistics represented in this document are true and factual.



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James C. Cannon, ASPRS Certified Photogrammetrist #1594

## SECTION 6: CONTROL POINT ASSESSMENTS

### 6.1 Aerial LiDAR Project

#### 6.1.1 Point Cloud Check Point Assessment

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
BLUE_BARTOW_UA25	1030342.6703	1305392.7652	320.7280	320.7070	-0.0210	NVA
BLUE_CHERO_FO26	1040525.2258	1315617.6007	335.3120	335.3070	-0.0046	NVA
BLUE_CHERO_OT17	1045902.9246	1311857.2491	333.0500	333.1160	0.0660	NVA
BLUE_CHERO_UA28	1049025.7359	1305597.3565	265.5170	265.5320	0.0150	VVA
BLUE_FANNIN_FO9	1040711.0094	1380522.2872	567.0840	567.0870	0.0027	NVA
BLUE_GILMER_CP22	1038748.5000	1356285.0390	393.3300	393.2760	-0.0540	VVA
BLUE_GILMER_CP4	1041281.4087	1349288.0473	464.4470	464.3910	-0.0560	NVA
BLUE_GILMER_CP5	1046356.3753	1364111.8227	476.8750	476.8810	0.0058	VVA
BLUE_GILMER_FO7	1041416.3512	1355802.5222	484.4070	484.4460	0.0390	VVA
BLUE_GILMER_FO8	1038652.3761	1367053.0019	539.5690	539.6390	0.0700	VVA
BLUE_GILMER_OT3	1034261.7173	1340423.0700	320.3770	320.3280	-0.0490	VVA
BLUE_GILMER_OT4	1043479.2268	1353837.2618	378.0460	378.0200	-0.0260	NVA
BLUE_GILMER_UA6	1043856.1582	1351745.1538	429.5020	429.4340	-0.0680	VVA
BLUE_GORDON_CP2	1030309.4734	1326873.5585	291.3190	291.3420	0.0230	NVA
BLUE_GORDON_FO3	1029328.7423	1330360.9531	263.9550	264.0570	0.1020	NVA
BLUE_MURRAY_CP1	1024455.1727	1384448.8766	336.6750	336.6220	-0.0530	VVA
BLUE_MURRAY_CP19	1026191.1778	1343464.4183	204.3690	204.2930	-0.0760	NVA
BLUE_MURRAY_FO1	1023527.3253	1383084.0132	318.3970	318.3830	-0.0140	VVA
BLUE_MURRAY_FO2	1027335.0844	1351703.0722	420.6500	420.7440	0.0940	VVA
BLUE_MURRAY_OT10	1020097.0926	1375157.7536	266.3560	266.3490	-0.0067	NVA
BLUE_MURRAY_UA4	1024672.6444	1360365.5273	775.6370	775.5910	-0.0460	NVA
BLUE_PICKENS_CP25	1043406.8673	1337166.8392	367.9730	367.9050	-0.0680	NVA
BLUE_PICKENS_CP3	1052394.4462	1326678.5598	409.1850	409.1280	-0.0570	NVA
BLUE_PICKENS_FO4	1039870.3097	1334816.3368	344.5700	344.5810	0.0110	NVA
BLUE_PICKENS_OT2	1049737.4136	1330754.5429	438.3250	438.2310	-0.0940	NVA
BLUE_PICKENS_UA2	1050061.1331	1329884.9814	445.1350	445.0410	-0.0940	VVA
PIED_BARTOW_CP56	1034657.1031	1285956.5987	272.1650	272.1270	-0.0380	VVA
PIED_BARTOW_OT28	1025805.2426	1307377.4464	260.7890	260.8100	0.0210	VVA
PIED_BARTOW_OT7	1009967.0549	1290216.4453	212.0400	212.0430	0.0025	VVA
PIED_BARTOW_UA21	1022910.0279	1297929.6006	239.5780	239.5620	-0.0160	NVA
PIED_BARTOW_UA6	1020365.5385	1291867.7196	211.6770	211.7280	0.0510	NVA
PIED_CHEROK_CP55	1049283.6453	1298318.8559	353.5640	353.5500	-0.0140	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
PIED_CHEROKEE_F064	1045351.7667	1290908.1783	281.8980	281.8680	-0.0300	NVA
PIED_COBB_F011	1035122.7666	1269737.8332	333.4960	333.4810	-0.0150	NVA
PIED_COBB_F012	1035905.6427	1259057.0740	309.6530	309.7010	0.0480	VVA
PIED_COBB_F013	1050838.2873	1257649.8840	321.3850	321.3730	-0.0120	NVA
PIED_COBB_F022	1055132.5877	1283427.9091	362.6630	362.6390	-0.0240	NVA
PIED_COBB_F08	1033031.1517	1281869.2507	274.8230	274.7340	-0.0890	VVA
PIED_FULTON_CP10	1063443.5427	1266070.0010	263.3440	263.2970	-0.0470	VVA
PIED_FULTON_F014	1058684.6294	1248067.8189	304.8390	304.8830	0.0440	VVA
PIED_FULTON_F015	1033747.5522	1223279.7240	249.3780	249.3500	-0.0280	VVA
PIED_FULTON_F016	1051044.8571	1238084.6660	278.9250	278.9820	0.0570	VVA
PIED_FULTON_F017	1064631.6012	1265219.8218	248.8180	248.8170	-0.0010	NVA
PIED_FULTON_UA12	1055531.1009	1251498.5056	268.4460	268.3970	-0.0490	NVA
PIED_PAULD_F03	1025035.0015	1264801.6503	333.0390	332.9870	-0.0520	NVA
PIED_PAULD_WE2	1016056.2193	1275280.2130	240.1370	240.1260	-0.0110	VVA
SWAPP_BART_F07	1017550.0339	1298893.5474	230.5370	230.6330	0.0960	NVA
SWAPP_BART_F08	1009973.6124	1316011.7879	237.8110	237.8750	0.0640	NVA
SWAPP_CATOO_F021	990309.4627	1380844.0982	267.9140	267.9940	0.0800	NVA
SWAPP_GORD_F012	1017686.2646	1340375.8982	196.5720	196.6270	0.0550	NVA
SWAPP_GORD_F013	1017623.3119	1325236.1443	216.7070	216.7600	0.0530	NVA
SWAPP_GORDON_CP18	1003374.3906	1329545.2392	195.7820	195.7400	-0.0420	NVA
SWAPP_GORDON_CP6b	1027981.3633	1324712.8025	230.1040	230.1540	0.0500	NVA
SWAPP_GORDON_F011	1003110.0903	1326134.5323	214.8780	214.9180	0.0400	NVA
SWAPP_MURR_F025	1012173.2236	1350213.8122	204.2180	204.2480	0.0300	VVA
SWAPP_MURR_F026	1013270.8221	1370308.2027	234.3200	234.3860	0.0660	VVA
SWAPP_MURRAY_BR1	1015418.1187	1360274.4851	232.4010	232.3990	-0.0021	VVA
SWAPP_MURRAY_OT14	1013314.2143	1348760.0803	221.1200	221.1050	-0.0150	NVA
SWAPP_MURRAY_OT15	1016579.0463	1363622.2059	229.7280	229.7460	0.0180	NVA
SWAPP_WHIFIELD_UA18	1002412.3000	1358368.6086	230.7190	230.6310	-0.0880	NVA
SWAPP_WHIT_F022	1000791.9370	1373456.4785	231.5460	231.5830	0.0370	VVA
SWAPP_WHIT_F027	1002704.5852	1344225.2843	217.7460	217.7880	0.0420	VVA
SWAPP_WHITFIELD_BR3_1	1001444.6870	1376514.6700	225.5570	225.5510	-0.0057	VVA
SWAPP_WHITFIELD_OT17	1000695.8230	1353011.9229	223.5940	223.5530	-0.0410	NVA
SWAPP_WHITFIELD_OT18	993653.6041	1362363.6230	231.1830	231.1230	-0.0600	NVA
SWAPP_WHITFIELD_OT19_1	999501.2199	1374375.3263	236.3040	236.3240	0.0200	NVA
SWAPP_WHITFIELD_UA17_1	999458.7215	1373336.1099	236.2490	236.2720	0.0230	NVA

Table 13: Point Cloud Check Point Assessment

## 6.1.2 Digital Elevation Model (DEM) Check Point Assessment

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BLUE_BARTOW_UA25	1030342.6703	1305392.7652	320.7280	320.7049	-0.0231	NVA
BLUE_CHERO_FO26	1040525.2258	1315617.6007	335.3120	335.2962	-0.0158	NVA
BLUE_CHERO_OT17	1045902.9246	1311857.2491	333.0500	333.1281	0.0781	NVA
BLUE_FANNIN_FO9	1040711.0094	1380522.2872	567.0840	567.0918	0.0078	NVA
BLUE_GILMER_CP4	1041281.4087	1349288.0473	464.4470	464.3924	-0.0546	NVA
BLUE_GILMER_OT4	1043479.2268	1353837.2618	378.0460	378.0206	-0.0254	NVA
BLUE_GORDON_CP2	1030309.4734	1326873.5585	291.3190	291.3429	0.0239	NVA
BLUE_GORDON_FO3	1029328.7423	1330360.9531	263.9550	264.0598	0.1048	NVA
BLUE_MURRAY_CP19	1026191.1778	1343464.4183	204.3690	204.2924	-0.0766	NVA
BLUE_MURRAY_OT10	1020097.0926	1375157.7536	266.3560	266.3341	-0.0219	NVA
BLUE_MURRAY_UA4	1024672.6444	1360365.5273	775.6370	775.5860	-0.0510	NVA
BLUE_PICKENS_CP25	1043406.8673	1337166.8392	367.9730	367.9087	-0.0643	NVA
BLUE_PICKENS_CP3	1052394.4462	1326678.5598	409.1850	409.1302	-0.0548	NVA
BLUE_PICKENS_FO4	1039870.3097	1334816.3368	344.5700	344.5840	0.0140	NVA
BLUE_PICKENS_OT2	1049737.4136	1330754.5429	438.3250	438.2282	-0.0968	NVA
PIED_BARTOW_UA21	1022910.0279	1297929.6006	239.5780	239.5651	-0.0129	NVA
PIED_BARTOW_UA6	1020365.5385	1291867.7196	211.6770	211.7271	0.0501	NVA
PIED_CHEROK_CP55	1049283.6453	1298318.8559	353.5640	353.5497	-0.0143	NVA
PIED_CHEROKEE_FO64	1045351.7667	1290908.1783	281.8980	281.8781	-0.0199	NVA
PIED_COBB_FO11	1035122.7666	1269737.8332	333.4960	333.4867	-0.0093	NVA
PIED_COBB_FO13	1050838.2873	1257649.8840	321.3850	321.3620	-0.0230	NVA
PIED_COBB_FO22	1055132.5877	1283427.9091	362.6630	362.6440	-0.0190	NVA
PIED_FULTON_FO17	1064631.6012	1265219.8218	248.8180	248.8245	0.0065	NVA
PIED_FULTON_UA12	1055531.1009	1251498.5056	268.4460	268.4010	-0.0450	NVA
PIED_PAULD_FO3	1025035.0015	1264801.6503	333.0390	332.9919	-0.0471	NVA
SWAPP_BART_FO7	1017550.0339	1298893.5474	230.5370	230.6212	0.0842	NVA
SWAPP_BART_FO8	1009973.6124	1316011.7879	237.8110	237.8711	0.0601	NVA
SWAPP_CATOO_FO21	990309.4627	1380844.0982	267.9140	267.9787	0.0647	NVA
SWAPP_GORD_FO12	1017686.2646	1340375.8982	196.5720	196.6162	0.0442	NVA
SWAPP_GORD_FO13	1017623.3119	1325236.1443	216.7070	216.7570	0.0500	NVA
SWAPP_GORDON_CP18	1003374.3906	1329545.2392	195.7820	195.7378	-0.0442	NVA
SWAPP_GORDON_CP6b	1027981.3633	1324712.8025	230.1040	230.1588	0.0548	NVA
SWAPP_GORDON_FO11	1003110.0903	1326134.5323	214.8780	214.9124	0.0344	NVA
SWAPP_MURRAY_OT14	1013314.2143	1348760.0803	221.1200	221.1141	-0.0059	NVA
SWAPP_MURRAY_OT15	1016579.0463	1363622.2059	229.7280	229.7468	0.0188	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
SWAPP_WHIFIELD_UA18	1002412.3000	1358368.6086	230.7190	230.6287	-0.0903	NVA
SWAPP_WHITFIELD_OT17	1000695.8230	1353011.9229	223.5940	223.5470	-0.0470	NVA
SWAPP_WHITFIELD_OT18	993653.6041	1362363.6230	231.1830	231.1213	-0.0617	NVA
SWAPP_WHITFIELD_OT19_1	999501.2199	1374375.3263	236.3040	236.3254	0.0214	NVA
SWAPP_WHITFIELD_UA17_1	999458.7215	1373336.1099	236.2490	236.2714	0.0224	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BLUE_CHERO_UA28	1049025.7359	1305597.3565	265.5170	265.5386	0.0216	VVA
BLUE_GILMER_CP22	1038748.5000	1356285.0390	393.3300	393.2747	-0.0553	VVA
BLUE_GILMER_CP5	1046356.3753	1364111.8227	476.8750	476.8820	0.0070	VVA
BLUE_GILMER_FO7	1041416.3512	1355802.5222	484.4070	484.4465	0.0395	VVA
BLUE_GILMER_FO8	1038652.3761	1367053.0019	539.5690	539.6595	0.0905	VVA
BLUE_GILMER_OT3	1034261.7173	1340423.0700	320.3770	320.3268	-0.0502	VVA
BLUE_GILMER_UA6	1043856.1582	1351745.1538	429.5020	429.4443	-0.0577	VVA
BLUE_MURRAY_CP1	1024455.1727	1384448.8766	336.6750	336.6226	-0.0524	VVA
BLUE_MURRAY_FO1	1023527.3253	1383084.0132	318.3970	318.3813	-0.0157	VVA
BLUE_MURRAY_FO2	1027335.0844	1351703.0722	420.6500	420.7244	0.0744	VVA
BLUE_PICKENS_UA2	1050061.1331	1329884.9814	445.1350	445.0467	-0.0883	VVA
PIED_BARTOW_CP56	1034657.1031	1285956.5987	272.1650	272.1317	-0.0333	VVA
PIED_BARTOW_OT28	1025805.2426	1307377.4464	260.7890	260.8087	0.0197	VVA
PIED_BARTOW_OT7	1009967.0549	1290216.4453	212.0400	212.0416	0.0016	VVA
PIED_COBB_FO12	1035905.6427	1259057.0740	309.6530	309.6933	0.0403	VVA
PIED_COBB_FO8	1033031.1517	1281869.2507	274.8230	274.7869	-0.0361	VVA
PIED_FULTON_CP10	1063443.5427	1266070.0010	263.3440	263.2905	-0.0535	VVA
PIED_FULTON_FO14	1058684.6294	1248067.8189	304.8390	305.0271	0.1881	VVA
PIED_FULTON_FO15	1033747.5522	1223279.7240	249.3780	249.3589	-0.0191	VVA
PIED_FULTON_FO16	1051044.8571	1238084.6660	278.9250	278.9168	-0.0082	VVA
PIED_PAULD_WE2	1016056.2193	1275280.2130	240.1370	240.1105	-0.0265	VVA
SWAPP_MURRAY_BR1	1015418.1187	1360274.4851	232.4010	232.3977	-0.0033	VVA
SWAPP_MURR_FO25	1012173.2236	1350213.8122	204.2180	204.2433	0.0253	VVA
SWAPP_MURR_FO26	1013270.8221	1370308.2027	234.3200	234.3863	0.0663	VVA
SWAPP_WHITFIELD_BR3_1	1001444.6870	1376514.6700	225.5570	225.5513	-0.0057	VVA
SWAPP_WHIT_FO22	1000791.9370	1373456.4785	231.5460	231.6109	0.0649	VVA
SWAPP_WHIT_FO27	1002704.5852	1344225.2843	217.7460	217.7953	0.0493	VVA

Table 14: DEM Check Point Assessment