Project Report

TASK ORDER NAME: 2018 KANSAS QL1 LIDAR
TASK ORDER NUMBER: 00000000000000000000045674
EVENT ID: EVT0005991
ATLANTIC PROJECT NUMBER: 18073

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SECTION 1: PROJECT OVERVIEW AND PURPOSE

1.1 Aerial LiDAR Project

1.1.1 Project Overview

The State of Kansas Contract 00000000000000000000045674 required Leaf-off 2018 QL 1 LiDAR surveys to be collected over 2,384 square miles covering part or all of two counties in Kansas in support of the Kansas Department of Agriculture and Kansas Data Access and Support Center. Aerial LiDAR data for this task order was planned, acquired, processed and produced at an aggregate nominal pulse spacing (ANPS) of 0.35 meters and in compliance with USGS National Geospatial Program LiDAR Base Specification version 1.2.

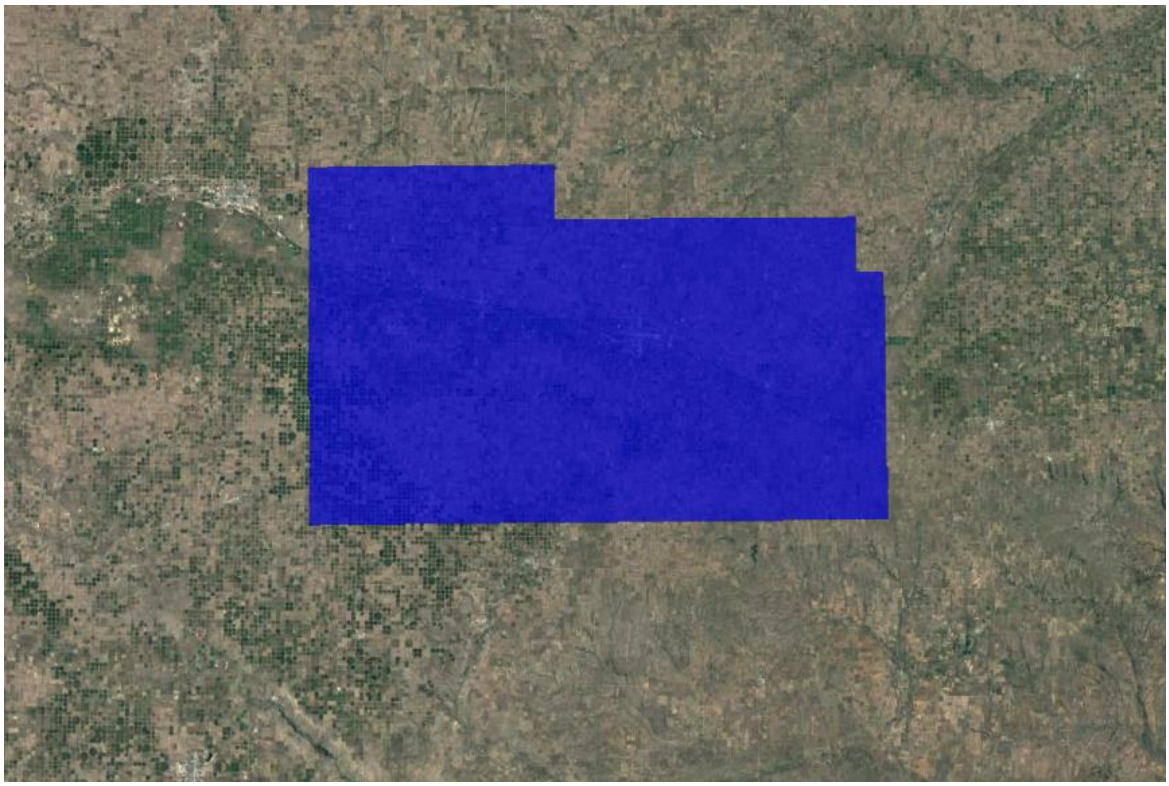


Figure 1: Aerial LiDAR Project Overview – Defined Project Area (DPA) and Associated Areas of Interest (AOIs)

1.1.2 Project Purpose

The State of Kansas, on behalf of the Kansas Department of Agriculture and Kansas Data Access and Support Center, has contracted with Atlantic for professional services related to the development of Light Detection and Ranging (LiDAR). Additional partners include the USDA Natural Resource Conservation Service, the U.S. Geological Survey, the Kansas GIS Policy Board, the Kansas Department of Transportation and the Kansas Water Office. These LiDAR elevation data will be used for conservation planning, design, research, floodplain mapping, wetlands identification, dam safety assessments, hydrologic modeling, and subsidence monitoring.

1.1.3 Client Contact Information

Client Contact Information	
Name of Contact	Tara Lanzrath, CFM
Organization	Kansas Department of Agriculture
Position	Floodplain Mapping Coordinator
Telephone	785-296-2513
E-Mail Address	Tara.Lanzrath@ks.gov
Mailing Address	6531 SE Forbes Ave., Suite B
City	Topeka
State or Province	Kansas
Postal Code	66619

Table 1: Aerial LiDAR Client Contact Information

1.1.4 Contract Deliverables

Click or tap here to enter text.

Item	Specification/Format
Metadata	FGDC compliant, xml format
Project Report	.pdf format
Raw Point Cloud	Swaths, LAS 1.4
Classified Point Cloud	LAS 1.4
Bare Earth DEM	ERDAS .IMG format, Hydroflattened
First Return DSM	ERDAS .IMG format
Hydro Polygon Breaklines	.gdb format
Intensity Imagery	ERDAS .IMG format

Table 2: 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 PACDV (N750DV) outfitted with a Leica ALS70-HP LiDAR system during the collection of the project area. The specifications of this system are presented in the following table:

Parameter	Specification
Model	ALS70-HP
Manufacturer	Leica
Platform	Fixed-Wing
Scan Pattern	Sine, Triangle, Raster
Maximum Scan Rate (Hz)	Sine: 200 Triangle: 158 Raster: 120
Field of View (°)	0 – 75 (Full Angle, User Adjustable)
Maximum Pulse Rate (kHz)	500
Maximum Flying Height (m AGL)	3500
Number of Returns	Unlimited
Number of Intensity Measurements	3 (First, Second, Third)
Roll Stabilization (Automatic Adaptive, °)	75 - Active FOV
Storage Media	Removable 500 GB SSD
Storage Capacity (Hours @ Max Pulse Rate)	6
Size (cm)	Scanner: 37 W x 68 L x 26 H Control Electronics: 45 W x 47 D x 36 H
Weight (kg)	Scanner: 43 Control Electronics: 45
Operation Temperature (°C)	0 – 40
Flight Management	FCMS
Power Consumption	927 @ 22.0 – 30.3 VDC

Table 3: System Specifications – ALS70-HP

2.1.2 Sensor Acquisition Information

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

Parameter	Specification
System	Leica ALS70-HP
Nominal Pulse Spacing (m)	0.3
Nominal Pulse Density (pls/m²)	8.3
Nominal Flight Height (AGL meters)	1073
Nominal Flight Speed (kts)	120

Parameter	Specification
Pass Heading (°)	90
Sensor Scan Angle (°)	45
Scan Frequency (Hz)	50.2
Pulse Rate of Scanner (kHz)	492,200
Line Spacing (m)	668
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	0.25
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	1
Beam Divergence (mrad)	0.15
Nominal Swath Width (m)	889
Nominal Swath Overlap (%)	20
Scan Pattern	Triangle

Table 4: Aerial LiDAR Sensor Acquisition Parameters

2.1.3 Flight Plan Execution

Atlantic acquired one hundred seventy-seven 177 passes of the AOI as a series of perpendicular and/or adjacent flight-lines executed in 14 flight missions conducted between December 30, 2018 and March 18, 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.

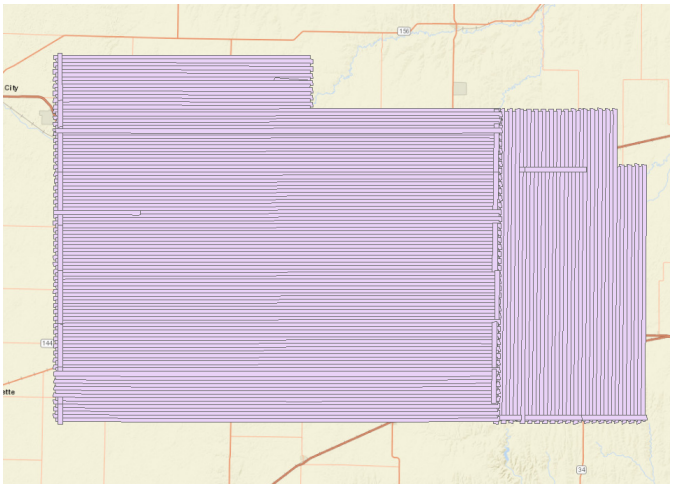


Figure 2: Orientation of Executed Flight-lines and LiDAR DPA

2.1.4 GNSS Reference Stations

Eight (8) 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
KSBK	CORS	KSBK	N37°33'03.92855"	W99°38'06.31398"	716.06
KSCM	CORS	KSCM	N37°51'36.45800"	W100°21'16.74779"	816.255
KSCW	CORS	KSCW	N37°16'24.89327"	W99°19'39.38531"	623.811
KSGC	CORS	KSGC	N37°58'08.68604"	W100°53'47.13445"	854.237
KSJM	CORS	KSJM	N38°04'01.29805"	W99°53'51.42400"	701.458
KSKY	CORS	KSKY	N37°54'40.32649"	W99°24'21.80811"	640.944
KSLC	CORS	KSLC	N38°31'55.09279"	W99°18'19.68121"	608.943
KSMD	CORS	KSMD	N37°17'06.43095"	W100°21'31.02756"	747.069

Table 3: GNSS Reference Stations

2.2 Aerial LiDAR Project – Ground Acquisition

2.2.1 Ground Control Survey

A total of 203 ground survey points were collected in support of this project, including 46 LiDAR Control Points (LCP), 88 Non-vegetated Vertical Accuracy (NVA) and 69 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
LCP001	358661.291	4148720.305	848.132
LCP002	373202.829	4148622.484	820.667
LCP003	360252.365	4205622.888	863.146
LCP004	358449.167	4197633.669	871.065
LCP005	359020.463	4166499.092	854.692
LCP006	412489.809	4196651.461	743.621
LCP007	393719.714	4196946.715	806.202
LCP008	392228.813	4202478.25	798.742
LCP009	407139.569	4187078.157	785.241
LCP010	392805.725	4166061.097	823.69
LCP011	390412.404	4164430.34	832.566
LCP012	397233.664	4149812.572	765.764
LCP013	405418.242	4156302.592	791.88
LCP014	433086.241	4146977.764	748.947
LCP015	453999.469	4151581.549	734.394
LCP016	427393.173	4198977.156	696.657

ID	Easting	Northing	Elevation
LCP017	433839.885	4196966.95	733.436
LCP018	440003.925	4193177.842	725.115
LCP019	446614.33	4191273.73	702.956
LCP020	441159.792	4185815.615	725.053
LCP021	427307.913	4190034.504	747.222
LCP022	427432.39	4181537.56	754.74
LCP023	443467.575	4182106.276	719.84
LCP024	450679.139	4178122.034	691.703
LCP025	453408.865	4173324.085	701.139
LCP026	433878.413	4161014.404	757.251
LCP027	430267.906	4156920.182	772.89
LCP028	427090.507	4157180.818	776.526
LCP029	447922.493	4163412.34	715.742
LCP030	418687.856	4155677.377	775.37
LCP031	417834.621	4155709.408	776.357
LCP032	416816.824	4167811.576	772.803
LCP033	416381.656	4170436.832	772.81
LCP034	364086.841	4179362.576	839.267
LCP035	372026.809	4174434.725	834.545
LCP036	383234.074	4197129.872	826.374
LCP037	386534.622	4178009.255	806.07
LCP038	404019.496	4170138.68	808.835
LCP039	364782.367	4185828.986	840.831
LCP040	449860.455	4193624.527	694.512
LCP041	428091.429	4170015.059	728.141
LCP042	371046.704	4177587.337	837.258
LCP043	452310.955	4186413.614	683.509
LCP044	360441.912	4155177.151	849.724
LCP045	381077.601	4206804.217	830.495
LCP046	354510.41	4182005.268	858.497

Table 5: LiDAR Control Point Coordinates

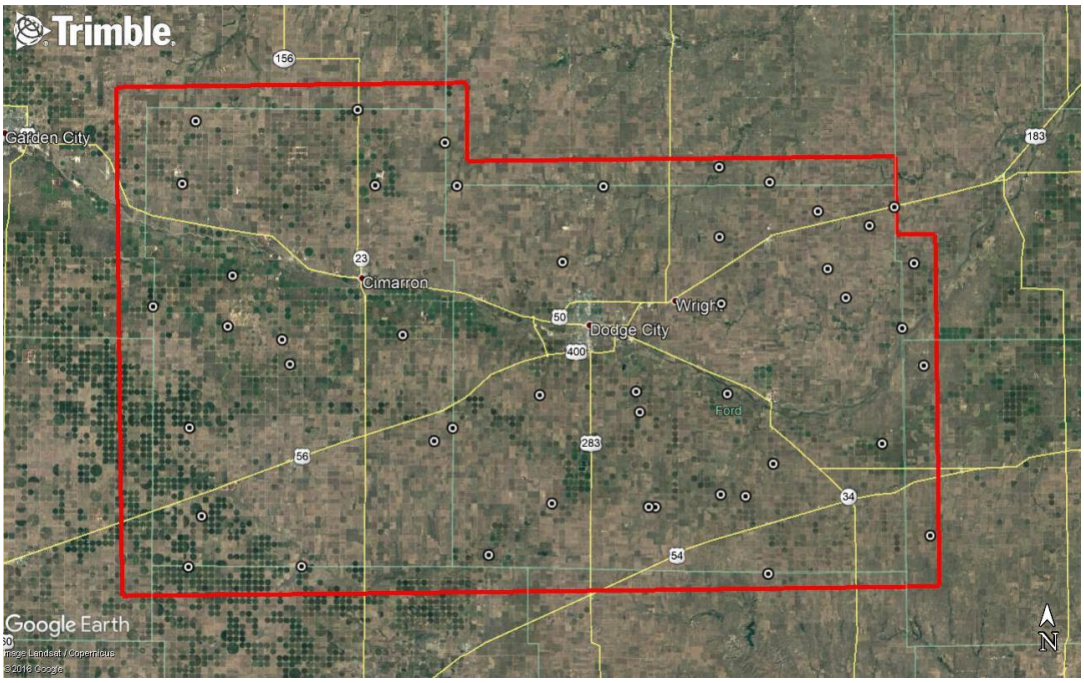


Figure 3: LiDAR Control Point Distribution

ID	Easting	Northing	Elevation
BE001	433088.375	4146976.586	748.948
BE002	373220.786	4148627.423	820.614
BE003	372037.994	4174442.666	833.747
BE004	426578.519	4178274.663	750.903
BE005	416379.892	4170385.918	772.385
BE006	358683.476	4148740.409	848.486
BE007	358438.096	4197649.508	870.539
BE008	412485.592	4196657.884	743.74
BE009	443482.545	4182092.544	719.306
BE010	392796.421	4166060.607	823.638
BE011	392236.495	4202483.493	798.153
BE012	364067.391	4179373.868	838.934
BE013	359037.779	4166493.105	854.586
BE014	390428.751	4164435.798	832.609
BE015	360239.685	4205619.481	863.137
BE016	393721.099	4196974.308	805.865
BE017	397235.528	4149820.711	765.74
BE018	430274.969	4156936.298	772.236

ID	Easting	Northing	Elevation
BE019	454002.996	4151581.44	734.323
BE020	453414.048	4173331.309	700.835
BE021	433813.46	4197004.096	734.78
BE022	407151.88	4187070.056	785.305
BE023	405422.831	4156303.567	791.837
BE024	422491.413	4189757.544	746.691
BE025	401717.606	4196421.04	790.348
BE026	391317.057	4173900.573	823.359
BE027	422862.918	4147226.651	780.469
BE028	381857.193	4184336.508	794.849
BE029	434261.165	4180624.669	734.916
BE030	421596.348	4163747.345	781.962
BE031	369679.044	4174432.528	835.962
BE032	351927.903	4148830.625	867.084
BE033	379481.402	4205210.243	834.374
BE034	358370.307	4192624.422	834.593
OT001	392685.312	4157288.663	807.826
OT002	421591.244	4163759.07	781.818
OT003	381642.616	4187354.271	837.044
OT004	380917.031	4197147.554	832.92
OT005	369714.966	4206989.655	843.223
OT006	353893.751	4209008.632	873.425
OT007	354359.697	4176021.901	850.742
OT008	395156.317	4188256.758	810.038
OT009	386553.086	4178014.133	805.457
OT010	374369.169	4154973.525	833.074
OT011	442641.589	4171665.585	724.497
OT012	447922.889	4163377.722	715.692
OT013	370151.576	4180103.312	831.15
OT014	371252.953	4197803.813	844.671
OT015	364779.425	4185807.95	840.107
OT016	368766.925	4169987.933	838.524
OT017	368419.947	4152389.17	833.022
OT018	390830.689	4148314.86	778.79
OT019	400834.113	4162270.549	806.994
OT020	403401.292	4179905.463	772.729

ID	Easting	Northing	Elevation
OT021	414432.688	4188895.075	751.615
OT022	434255.849	4180637.707	734.879
OT023	440173.336	4188705.305	730.821
OT024	434591.723	4173626.313	737.077
OT025	439817.561	4162253.571	732.438
OT026	436628.106	4153575.327	758.545
UR001	381425.931	4161346.58	845.624
UR002	371977.086	4187693.35	813.763
UR003	410427.543	4178876.963	759.92
UR004	433273.401	4189681.246	748.89
UR005	444087.61	4155460.204	731.518
UR006	453978.852	4160021.311	712.344
UR007	350768.113	4154658.7	871.431
UR008	372615.657	4162107.806	847.357
UR009	410161.681	4147845.93	787.333
UR010	433527.735	4166060.01	728.412
UR011	420769.24	4149061.335	787.564
UR012	352422.374	4193826.164	838.694
UR013	361748.329	4158400.257	836.821
UR014	381249.025	4149184.643	810.683
UR015	397664.874	4172738.608	812.903
UR016	394554.611	4183126.576	794.163
UR017	381084.624	4206798.407	830.325
UR018	362366.416	4191916.918	827.357
UR019	449872.542	4193623.499	695.542
UR020	409788.823	4182898.253	785.866
UR021	410465.188	4168952.384	794.273
UR022	410247.267	4154354.067	803.197
UR023	381707.574	4175898.744	817.589
UR024	422537.964	4182727.785	770.41
UR025	444384.35	4146911.108	733.402
UR026	420984.9	4198201.753	747.833
UR027	449872.553	4193623.518	695.546
UR028	440159.51	4188716.598	731.498

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

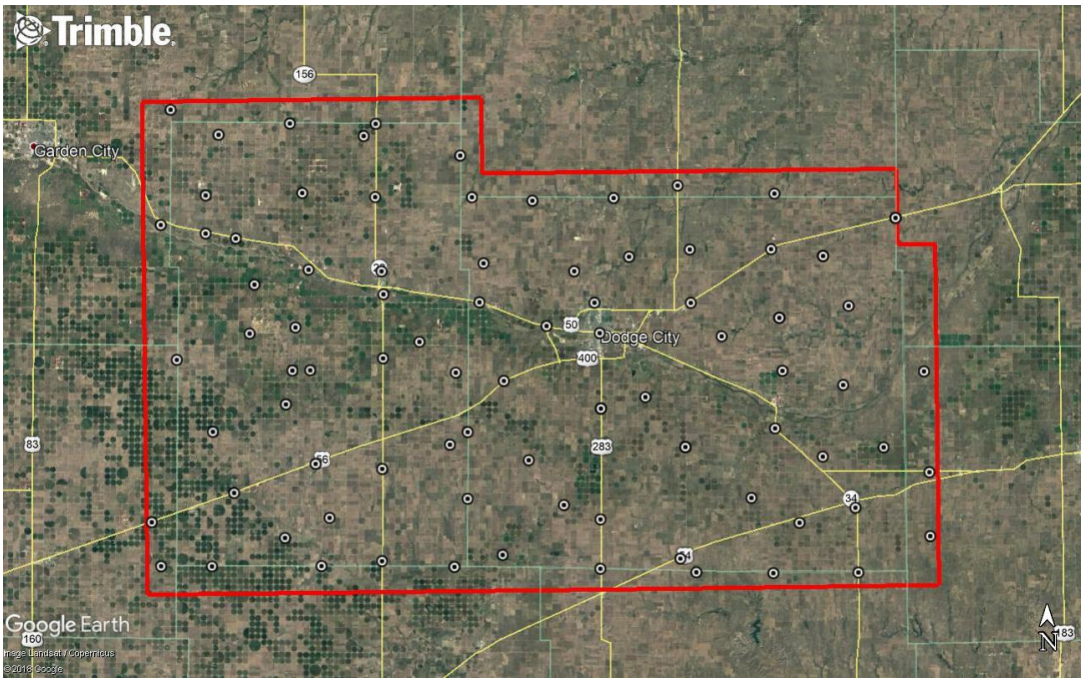


Figure 4: Non-Vegetated Vertical Accuracy (NVA) Point Distribution

ID	Easting	Northing	Elevation
BR001	446605.956	4191275.61	701.712
BR002	401706.725	4196435.447	790.47
BR003	433894.437	4161010.771	756.99
BR004	366253.149	4191029.324	820.627
BR005	450689.725	4178126.008	690.897
BR006	383735.495	4156440.242	823.891
BR007	399398.077	4181259.793	775.314
BR008	427329.809	4157629.405	774.342
BR009	404005.528	4170166.963	808.497
BR010	383238.96	4197144.583	825.412
BR011	374417.944	4195633.029	839.364
BR012	440006.681	4193190.26	724.96
BR013	447618.977	4147751.102	746.548
BR014	416809.084	4167804.645	772.384
BR015	418940.301	4155951.984	778.382
BR016	427439.141	4181560.54	753.716
BR017	381843.739	4184353.789	794.691
BR018	417667.365	4155480.31	774.002

ID	Easting	Northing	Elevation
BR019	452293.481	4186410.402	683.019
BR020	381656.078	4187364.386	837.038
BR021	422541.296	4182713.244	770.199
BR022	434414.378	4178226.273	720.652
BR023	364099.531	4179344.731	839.449
BR024	380890.101	4197118.194	833.18
HG001	450786.502	4155082.39	731.912
HG002	354263.889	4171058.183	863.021
HG003	379479.94	4205239.585	834.142
HG004	390883.702	4151473.028	789.901
HG005	363373.307	4200823.112	862.228
HG006	365505.534	4164790.407	855.927
HG007	375897.56	4179200.483	822.279
HG008	369679.5	4174446.416	835.846
HG009	381684.075	4171075.574	837.228
HG010	360407.436	4155189.611	849.752
HG011	362531.707	4182609.093	843.766
HG012	395259.011	4193718.744	811.134
HG013	369793.169	4156617.935	832.044
HG014	390777.524	4159633.069	827.044
HG015	439438.702	4173327.221	732.779
HG016	441141.605	4185813.275	725.338
HG017	437895.934	4157241.535	747.199
HG018	395178.385	4188250.564	810.173
HG019	400819.939	4162249.925	806.667
HG020	420981.593	4198217.025	746.8
HG021	361694.219	4158381.337	836.359
HG022	362387.744	4191911.448	826.81
TR001	402203.625	4149714.953	775.673
TR002	419024.451	4186731.745	752.3
TR003	427406.768	4198972.164	696.252
TR004	354503.214	4181984.236	858.22
TR005	383483.539	4192216.231	829.488
TR006	434414.76	4178206.886	720.802
TR007	447474.848	4171480.387	701.087
TR008	391317.313	4173913.495	823.565

ID	Easting	Northing	Elevation
TR009	420100.762	4176012.828	770.579
TR010	358878.328	4204038.438	866.791
TR011	408743.042	4179070.024	762.48
TR012	351904.602	4148855.929	867.112
TR013	376767.565	4169429.25	837.679
TR014	392428.685	4145055.653	770.13
TR015	427316.401	4190014.979	746.925
TR016	422864.791	4147235.368	780.406
TR017	428092.95	4169936.038	730.678
TR018	358363.188	4192647.221	835.021
TR019	427316.408	4190014.995	746.92
TR020	427316.4	4190014.989	746.925
TR021	403450.381	4179899.091	772.862
TR022	433546.538	4166051.048	728.054
TR023	433546.543	4166051.053	728.032

Table 74: Vegetated Vertical Accuracy (VVA) Point Coordinates

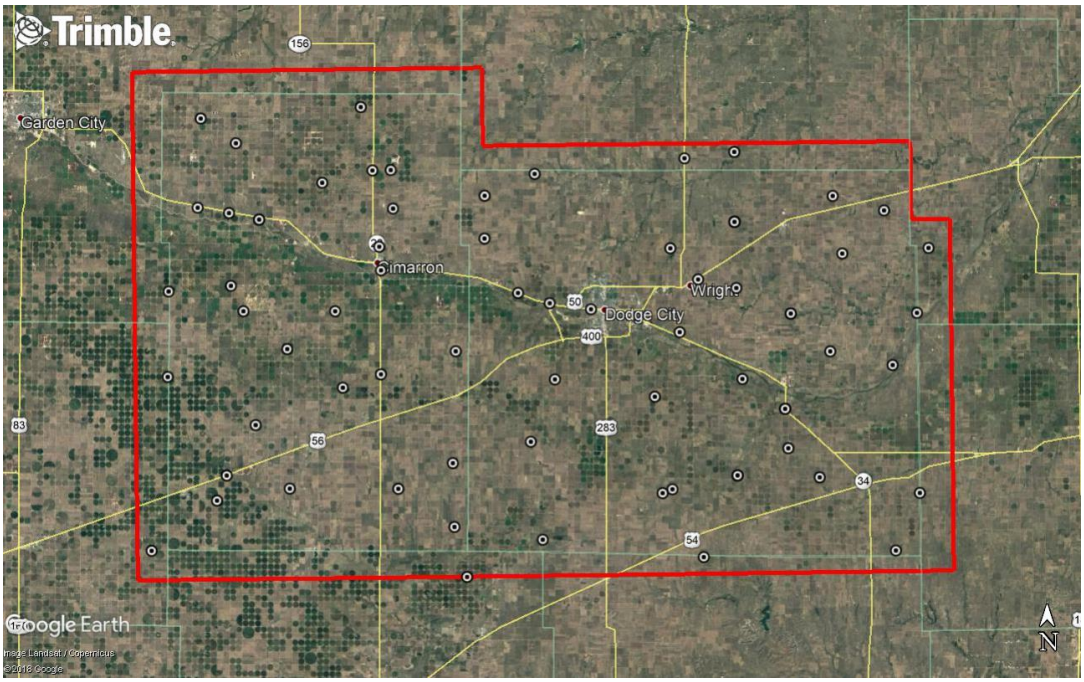


Figure 5: Vegetated Vertical Accuracy (VVA) Point Distribution

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
Horizontal Datum	NAD83(ITRF96)
Coordinate System	UTM, 14N
Vertical Datum	NAVD88
Geoid Model	12B
EPSG Code	3744
Units of Reference	Meter

Table 5: Coordinate Reference System

3.1.3 LiDAR Point Cloud Statistics

Category	Value
Total Points (Nominal)	76,458,875,674
Nominal Pulse Spacing (M)	0.3291
Nominal Pulse Density (PLS/M^2)	9.2349
Total Points (Aggregate)	77,388,020,337
Aggregate Pulse Spacing (M)	0.2823
Aggregate Pulse Density (PLS/M^2)	12.5474

Table 6: 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. The following figure depicts a sample of the assessment.

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 ≤2cm. 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
7	Low Noise
9	Water
10	Ignored Ground (Breakline Proximity)
17	Bridges
18	High Noise

Table 7: 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 0.5-meter cell size. Intensity images were cut to match the tile index and its corresponding tile names and delivered in .img 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 0.5-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.

3.1.10 Surface – Digital Elevation Model (DSM)

Surface digital elevation models (DSMs) were derived using all first return LiDAR points, excluding LiDAR points classified as high or low noise. All DSMs were created with a grid spacing of 0.5- meter. DSMs 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 10: 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)	69	0.0986	0.1933	0.2428
NVA (DEM)	69	0.0982	0.1924	0.2357
VVA (Point Cloud)	68	0.1730	0.3392	0.3549
VVA (DEM)	68	0.1639	0.3212	0.3198

Table 11: NVA/VVA Accuracies

SECTION 5: CERTIFICATION STATEMENTS

5.1 Aerial LiDAR Project

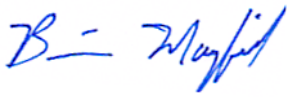
This accuracy assessment confirms that the data may be used for the intended applications stated in Section I of this document. This dataset may also be used as a topographic input for other applications, but the user should be aware that this LiDAR dataset was designed with a specific purpose and was 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.



Brian J. Mayfield, ASPRS Certified Photogrammetrist #R1276

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
BE002	373220.7860	4148627.4230	820.6140	820.6720	0.0580	NVA
BE003	372037.9940	4174442.6660	833.7470	833.7690	0.0220	NVA
BE004	426578.5190	4178274.6630	750.9030	750.9190	0.0160	NVA
BE005	416379.8920	4170385.9180	772.3850	772.4710	0.0860	NVA
BE006	358683.4760	4148740.4090	848.4860	848.5330	0.0470	NVA
BE007	358438.0960	4197649.5080	870.5390	870.6290	0.0900	NVA
BE008	412485.5920	4196657.8840	743.7400	743.8310	0.0910	NVA
BE010	392796.4210	4166060.6070	823.6380	823.6370	-0.0007	NVA
BE011	392236.4950	4202483.4930	798.1530	798.3740	0.2210	NVA
BE012	364067.3910	4179373.8680	838.9340	838.9750	0.0410	NVA
BE013	359037.7790	4166493.1050	854.5860	854.6820	0.0960	NVA
BE014	390428.7510	4164435.7980	832.6090	832.6730	0.0640	NVA
BE015	360239.6850	4205619.4810	863.1370	863.3880	0.2510	NVA
BE016	393721.0990	4196974.3080	805.8650	805.8280	-0.0370	NVA
BE017	397235.5280	4149820.7110	765.7400	765.8580	0.1180	NVA
BE018	430274.9690	4156936.2980	772.2360	772.3330	0.0970	NVA
BE022	407151.8800	4187070.0560	785.3050	785.3210	0.0160	NVA
BE023	405422.8310	4156303.5670	791.8370	791.9770	0.1400	NVA
BE024	422491.4130	4189757.5440	746.6910	746.6470	-0.0440	NVA
BE025	401717.6060	4196421.0400	790.3480	790.4170	0.0690	NVA
BE026	391317.0570	4173900.5730	823.3590	823.3870	0.0280	NVA
BE027	422862.9180	4147226.6510	780.4690	780.5940	0.1250	NVA
BE028	381857.1930	4184336.5080	794.8490	794.8460	-0.0029	NVA
BE030	421596.3480	4163747.3450	781.9620	782.0150	0.0530	NVA
BE031	369679.0440	4174432.5280	835.9620	836.0820	0.1200	NVA
BE032	351927.9030	4148830.6250	867.0840	867.1540	0.0700	NVA
BE033	379481.4020	4205210.2430	834.3740	834.5550	0.1800	NVA
BE034	358370.3070	4192624.4220	834.5930	834.5720	-0.0210	NVA
BR001	446605.9560	4191275.6100	701.7120	702.0630	0.3510	VVA
BR002	401706.7250	4196435.4470	790.4700	790.5910	0.1210	VVA
BR003	433894.4370	4161010.7710	756.9900	757.2200	0.2300	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
BR004	366253.1490	4191029.3240	820.6270	820.6360	0.0085	VVA
BR005	450689.7250	4178126.0080	690.8970	691.2560	0.3590	VVA
BR006	383735.4950	4156440.2420	823.8910	823.9560	0.0650	VVA
BR007	399398.0770	4181259.7930	775.3140	775.2920	-0.0220	VVA
BR008	427329.8090	4157629.4050	774.3420	774.3710	0.0290	VVA
BR009	404005.5280	4170166.9630	808.4970	808.6510	0.1540	VVA
BR010	383238.9600	4197144.5830	825.4120	825.5340	0.1220	VVA
BR011	374417.9440	4195633.0290	839.3640	839.3720	0.0082	VVA
BR012	440006.6810	4193190.2600	724.9600	725.2760	0.3160	VVA
BR013	447618.9770	4147751.1020	746.5480	746.8350	0.2870	VVA
BR014	416809.0840	4167804.6450	772.3840	772.4850	0.1010	VVA
BR015	418940.3010	4155951.9840	778.3820	778.4520	0.0700	VVA
BR016	427439.1410	4181560.5400	753.7160	753.7580	0.0420	VVA
BR017	381843.7390	4184353.7890	794.6910	794.7360	0.0450	VVA
BR018	417667.3650	4155480.3100	774.0020	773.9920	-0.0097	VVA
BR019	452293.4810	4186410.4020	683.0190	683.3380	0.3190	VVA
BR020	381656.0780	4187364.3860	837.0380	837.0450	0.0069	VVA
BR021	422541.2960	4182713.2440	770.1990	770.2730	0.0740	VVA
BR022	434414.3780	4178226.2730	720.6520	721.0090	0.3570	VVA
BR023	364099.5310	4179344.7310	839.4490	839.5530	0.1040	VVA
BR024	380890.1010	4197118.1940	833.1800	833.2330	0.0530	VVA
HG001	450786.5020	4155082.3900	731.9120	732.2730	0.3610	VVA
HG002	354263.8890	4171058.1830	863.0210	863.0130	-0.0085	VVA
HG003	379479.9400	4205239.5850	834.1420	834.3830	0.2410	VVA
HG004	390883.7020	4151473.0280	789.9010	790.0110	0.1100	VVA
HG005	363373.3070	4200823.1120	862.2280	862.5150	0.2870	VVA
HG006	365505.5340	4164790.4070	855.9270	855.9070	-0.0200	VVA
HG007	375897.5600	4179200.4830	822.2790	822.4190	0.1400	VVA
HG008	369679.5000	4174446.4160	835.8460	835.8870	0.0410	VVA
HG009	381684.0750	4171075.5740	837.2280	837.3320	0.1040	VVA
HG010	360407.4360	4155189.6110	849.7520	849.7810	0.0290	VVA
HG011	362531.7070	4182609.0930	843.7660	843.9360	0.1700	VVA
HG012	395259.0110	4193718.7440	811.1340	811.1180	-0.0160	VVA
HG013	369793.1690	4156617.9350	832.0440	832.0940	0.0500	VVA
HG014	390777.5240	4159633.0690	827.0440	827.1420	0.0980	VVA
HG015	439438.7020	4173327.2210	732.7790	733.0250	0.2460	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
HG016	441141.6050	4185813.2750	725.3380	725.5530	0.2150	VVA
HG017	437895.9340	4157241.5350	747.1990	747.5330	0.3340	VVA
HG018	395178.3850	4188250.5640	810.1730	810.1560	-0.0170	VVA
HG019	400819.9390	4162249.9250	806.6670	806.7040	0.0370	VVA
HG020	420981.5930	4198217.0250	746.8000	747.0100	0.2100	VVA
HG021	361694.2190	4158381.3370	836.3590	836.4440	0.0850	VVA
HG022	362387.7440	4191911.4480	826.8100	826.8020	-0.0077	VVA
OT001	392685.3120	4157288.6630	807.8260	807.8830	0.0570	NVA
OT002	421591.2440	4163759.0700	781.8180	781.8560	0.0380	NVA
OT003	381642.6160	4187354.2710	837.0440	837.0880	0.0440	NVA
OT004	380917.0310	4197147.5540	832.9200	832.9880	0.0680	NVA
OT006	353893.7510	4209008.6320	873.4250	873.6710	0.2460	NVA
OT007	354359.6970	4176021.9010	850.7420	850.7850	0.0430	NVA
OT008	395156.3170	4188256.7580	810.0380	810.0760	0.0380	NVA
OT009	386553.0860	4178014.1330	805.4570	805.4850	0.0280	NVA
OT010	374369.1690	4154973.5250	833.0740	832.9900	-0.0840	NVA
OT011	442641.5890	4171665.5850	724.4970	724.7500	0.2530	NVA
OT013	370151.5760	4180103.3120	831.1500	831.1430	-0.0068	NVA
OT014	371252.9530	4197803.8130	844.6710	844.7540	0.0830	NVA
OT015	364779.4250	4185807.9500	840.1070	840.0990	-0.0078	NVA
OT016	368766.9250	4169987.9330	838.5240	838.5760	0.0520	NVA
OT017	368419.9470	4152389.1700	833.0220	833.0620	0.0400	NVA
OT018	390830.6890	4148314.8600	778.7900	778.9190	0.1300	NVA
OT019	400834.1130	4162270.5490	806.9940	807.0540	0.0600	NVA
OT020	403401.2920	4179905.4630	772.7290	772.7580	0.0290	NVA
OT021	414432.6880	4188895.0750	751.6150	751.6390	0.0240	NVA
OT026	436628.1060	4153575.3270	758.5450	758.7830	0.2380	NVA
TR001	402203.6250	4149714.9530	775.6730	775.7280	0.0550	VVA
TR002	419024.4510	4186731.7450	752.3000	752.3310	0.0310	VVA
TR003	427406.7680	4198972.1640	696.2520	696.1790	-0.0730	VVA
TR004	354503.2140	4181984.2360	858.2200	858.0740	-0.1460	VVA
TR005	383483.5390	4192216.2310	829.4880	829.3860	-0.1020	VVA
TR006	434414.7600	4178206.8860	720.8020	721.2080	0.4060	VVA
TR007	447474.8480	4171480.3870	701.0870	701.3890	0.3020	VVA
TR008	391317.3130	4173913.4950	823.5650	823.6070	0.0420	VVA
TR009	420100.7620	4176012.8280	770.5790	770.6550	0.0760	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	Laser (Z)	Delta (Z)	Report Point Type
TR010	358878.3280	4204038.4380	866.7910	867.0470	0.2560	VVA
TR012	351904.6020	4148855.9290	867.1120	867.1620	0.0500	VVA
TR013	376767.5650	4169429.2500	837.6790	837.6850	0.0058	VVA
TR014	392428.6850	4145055.6530	770.1300	770.2480	0.1180	VVA
TR015	427316.4010	4190014.9790	746.9250	746.9190	-0.0063	VVA
TR016	422864.7910	4147235.3680	780.4060	780.5840	0.1780	VVA
TR017	428092.9500	4169936.0380	730.6780	730.6450	-0.0330	VVA
TR018	358363.1880	4192647.2210	835.0210	835.0580	0.0370	VVA
TR019	427316.4080	4190014.9950	746.9200	746.9200	-0.0004	VVA
TR020	427316.4000	4190014.9890	746.9250	746.9190	-0.0061	VVA
TR021	403450.3810	4179899.0910	772.8620	772.8920	0.0300	VVA
TR022	433546.5380	4166051.0480	728.0540	728.3360	0.2820	VVA
TR023	433546.5430	4166051.0530	728.0320	728.3360	0.3040	VVA
UR001	381425.9310	4161346.5800	845.6240	845.6810	0.0570	NVA
UR002	371977.0860	4187693.3500	813.7630	813.7780	0.0150	NVA
UR003	410427.5430	4178876.9630	759.9200	759.9830	0.0630	NVA
UR004	433273.4010	4189681.2460	748.8900	749.0990	0.2090	NVA
UR007	350768.1130	4154658.7000	871.4310	871.4380	0.0068	NVA
UR008	372615.6570	4162107.8060	847.3570	847.3880	0.0310	NVA
UR009	410161.6810	4147845.9300	787.3330	787.4150	0.0820	NVA
UR011	420769.2400	4149061.3350	787.5640	787.5610	-0.0029	NVA
UR012	352422.3740	4193826.1640	838.6940	838.7750	0.0810	NVA
UR013	361748.3290	4158400.2570	836.8210	836.8680	0.0470	NVA
UR014	381249.0250	4149184.6430	810.6830	810.7770	0.0940	NVA
UR015	397664.8740	4172738.6080	812.9030	812.9190	0.0160	NVA
UR016	394554.6110	4183126.5760	794.1630	794.1640	0.0009	NVA
UR017	381084.6240	4206798.4070	830.3250	830.5720	0.2470	NVA
UR018	362366.4160	4191916.9180	827.3570	827.3280	-0.0290	NVA
UR020	409788.8230	4182898.2530	785.8660	785.9160	0.0500	NVA
UR021	410465.1880	4168952.3840	794.2730	794.2860	0.0130	NVA
UR022	410247.2670	4154354.0670	803.1970	803.1670	-0.0300	NVA
UR023	381707.5740	4175898.7440	817.5890	817.5990	0.0096	NVA
UR024	422537.9640	4182727.7850	770.4100	770.3660	-0.0440	NVA
UR026	420984.9000	4198201.7530	747.8330	747.9350	0.1020	NVA

Table 12: 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
BE002	373220.7860	4148627.4230	820.6140	820.6175	0.0035	NVA
BE003	372037.9940	4174442.6660	833.7470	833.7457	-0.0013	NVA
BE004	426578.5190	4178274.6630	750.9030	750.9474	0.0444	NVA
BE005	416379.8920	4170385.9180	772.3850	772.4360	0.0510	NVA
BE006	358683.4760	4148740.4090	848.4860	848.5621	0.0761	NVA
BE007	358438.0960	4197649.5080	870.5390	870.6026	0.0636	NVA
BE008	412485.5920	4196657.8840	743.7400	743.8126	0.0726	NVA
BE010	392796.4210	4166060.6070	823.6380	823.6713	0.0333	NVA
BE011	392236.4950	4202483.4930	798.1530	798.3394	0.1864	NVA
BE012	364067.3910	4179373.8680	838.9340	838.9918	0.0578	NVA
BE013	359037.7790	4166493.1050	854.5860	854.6955	0.1095	NVA
BE014	390428.7510	4164435.7980	832.6090	832.6557	0.0467	NVA
BE015	360239.6850	4205619.4810	863.1370	863.4446	0.3076	NVA
BE016	393721.0990	4196974.3080	805.8650	805.8716	0.0066	NVA
BE017	397235.5280	4149820.7110	765.7400	765.8482	0.1082	NVA
BE018	430274.9690	4156936.2980	772.2360	772.3289	0.0929	NVA
BE022	407151.8800	4187070.0560	785.3050	785.3144	0.0094	NVA
BE023	405422.8310	4156303.5670	791.8370	791.9566	0.1196	NVA
BE024	422491.4130	4189757.5440	746.6910	746.6796	-0.0114	NVA
BE025	401717.6060	4196421.0400	790.3480	790.4011	0.0531	NVA
BE026	391317.0570	4173900.5730	823.3590	823.3723	0.0133	NVA
BE027	422862.9180	4147226.6510	780.4690	780.5828	0.1138	NVA
BE028	381857.1930	4184336.5080	794.8490	794.8622	0.0132	NVA
BE030	421596.3480	4163747.3450	781.9620	781.9885	0.0265	NVA
BE031	369679.0440	4174432.5280	835.9620	836.0115	0.0495	NVA
BE032	351927.9030	4148830.6250	867.0840	867.1242	0.0402	NVA
BE033	379481.4020	4205210.2430	834.3740	834.5646	0.1906	NVA
BE034	358370.3070	4192624.4220	834.5930	834.5636	-0.0294	NVA
OT001	392685.3120	4157288.6630	807.8260	807.8771	0.0511	NVA
OT002	421591.2440	4163759.0700	781.8180	781.8738	0.0558	NVA
OT003	381642.6160	4187354.2710	837.0440	837.0956	0.0516	NVA
OT004	380917.0310	4197147.5540	832.9200	832.9779	0.0579	NVA
OT006	353893.7510	4209008.6320	873.4250	873.7074	0.2824	NVA
OT007	354359.6970	4176021.9010	850.7420	850.7843	0.0423	NVA
OT008	395156.3170	4188256.7580	810.0380	810.0566	0.0186	NVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
OT009	386553.0860	4178014.1330	805.4570	805.4733	0.0163	NVA
OT010	374369.1690	4154973.5250	833.0740	832.9696	-0.1044	NVA
OT011	442641.5890	4171665.5850	724.4970	724.7300	0.2330	NVA
OT013	370151.5760	4180103.3120	831.1500	831.1294	-0.0206	NVA
OT014	371252.9530	4197803.8130	844.6710	844.7498	0.0788	NVA
OT015	364779.4250	4185807.9500	840.1070	840.0723	-0.0347	NVA
OT016	368766.9250	4169987.9330	838.5240	838.5975	0.0735	NVA
OT017	368419.9470	4152389.1700	833.0220	833.0573	0.0353	NVA
OT018	390830.6890	4148314.8600	778.7900	778.8973	0.1073	NVA
OT019	400834.1130	4162270.5490	806.9940	807.0513	0.0573	NVA
OT020	403401.2920	4179905.4630	772.7290	772.7319	0.0029	NVA
OT021	414432.6880	4188895.0750	751.6150	751.6008	-0.0142	NVA
OT026	436628.1060	4153575.3270	758.5450	758.8065	0.2615	NVA
UR001	381425.9310	4161346.5800	845.6240	845.6787	0.0547	NVA
UR002	371977.0860	4187693.3500	813.7630	813.7846	0.0216	NVA
UR003	410427.5430	4178876.9630	759.9200	759.9609	0.0409	NVA
UR004	433273.4010	4189681.2460	748.8900	749.0847	0.1947	NVA
UR007	350768.1130	4154658.7000	871.4310	871.4600	0.0290	NVA
UR008	372615.6570	4162107.8060	847.3570	847.3732	0.0162	NVA
UR009	410161.6810	4147845.9300	787.3330	787.3851	0.0521	NVA
UR011	420769.2400	4149061.3350	787.5640	787.5460	-0.0180	NVA
UR012	352422.3740	4193826.1640	838.6940	838.7776	0.0836	NVA
UR013	361748.3290	4158400.2570	836.8210	836.8703	0.0493	NVA
UR014	381249.0250	4149184.6430	810.6830	810.7887	0.1057	NVA
UR015	397664.8740	4172738.6080	812.9030	812.9661	0.0631	NVA
UR016	394554.6110	4183126.5760	794.1630	794.1680	0.0050	NVA
UR017	381084.6240	4206798.4070	830.3250	830.5626	0.2376	NVA
UR018	362366.4160	4191916.9180	827.3570	827.3519	-0.0051	NVA
UR020	409788.8230	4182898.2530	785.8660	785.9256	0.0596	NVA
UR021	410465.1880	4168952.3840	794.2730	794.2619	-0.0111	NVA
UR022	410247.2670	4154354.0670	803.1970	803.1845	-0.0125	NVA
UR023	381707.5740	4175898.7440	817.5890	817.5614	-0.0276	NVA
UR024	422537.9640	4182727.7850	770.4100	770.3278	-0.0822	NVA
UR026	420984.9000	4198201.7530	747.8330	747.9204	0.0874	NVA
Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR001	446605.9560	4191275.6100	701.7120	702.0387	0.3267	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR002	401706.7250	4196435.4470	790.4700	790.5722	0.1022	VVA
BR003	433894.4370	4161010.7710	756.9900	757.1974	0.2074	VVA
BR004	366253.1490	4191029.3240	820.6270	820.6270	0.0000	VVA
BR005	450689.7250	4178126.0080	690.8970	691.2961	0.3991	VVA
BR006	383735.4950	4156440.2420	823.8910	823.9300	0.0390	VVA
BR007	399398.0770	4181259.7930	775.3140	775.3292	0.0152	VVA
BR008	427329.8090	4157629.4050	774.3420	774.3435	0.0015	VVA
BR009	404005.5280	4170166.9630	808.4970	808.6017	0.1047	VVA
BR010	383238.9600	4197144.5830	825.4120	825.5244	0.1124	VVA
BR011	374417.9440	4195633.0290	839.3640	839.4189	0.0549	VVA
BR012	440006.6810	4193190.2600	724.9600	725.2669	0.3069	VVA
BR013	447618.9770	4147751.1020	746.5480	746.8518	0.3038	VVA
BR014	416809.0840	4167804.6450	772.3840	772.4537	0.0697	VVA
BR015	418940.3010	4155951.9840	778.3820	778.4295	0.0475	VVA
BR016	427439.1410	4181560.5400	753.7160	753.7138	-0.0022	VVA
BR017	381843.7390	4184353.7890	794.6910	794.7187	0.0277	VVA
BR018	417667.3650	4155480.3100	774.0020	774.0134	0.0114	VVA
BR019	452293.4810	4186410.4020	683.0190	683.3207	0.3017	VVA
BR020	381656.0780	4187364.3860	837.0380	837.0377	-0.0003	VVA
BR021	422541.2960	4182713.2440	770.1990	770.2012	0.0022	VVA
BR022	434414.3780	4178226.2730	720.6520	720.9553	0.3033	VVA
BR023	364099.5310	4179344.7310	839.4490	839.5255	0.0765	VVA
BR024	380890.1010	4197118.1940	833.1800	833.2745	0.0945	VVA
HG001	450786.5020	4155082.3900	731.9120	732.2530	0.3410	VVA
HG002	354263.8890	4171058.1830	863.0210	863.0340	0.0130	VVA
HG003	379479.9400	4205239.5850	834.1420	834.3774	0.2354	VVA
HG004	390883.7020	4151473.0280	789.9010	790.0077	0.1067	VVA
HG005	363373.3070	4200823.1120	862.2280	862.4808	0.2528	VVA
HG006	365505.5340	4164790.4070	855.9270	855.9193	-0.0077	VVA
HG007	375897.5600	4179200.4830	822.2790	822.3860	0.1070	VVA
HG008	369679.5000	4174446.4160	835.8460	835.9022	0.0562	VVA
HG009	381684.0750	4171075.5740	837.2280	837.2708	0.0428	VVA
HG010	360407.4360	4155189.6110	849.7520	849.7468	-0.0052	VVA
HG011	362531.7070	4182609.0930	843.7660	843.9132	0.1472	VVA
HG012	395259.0110	4193718.7440	811.1340	811.1407	0.0067	VVA
HG013	369793.1690	4156617.9350	832.0440	832.0418	-0.0022	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
HG014	390777.5240	4159633.0690	827.0440	827.1026	0.0586	VVA
HG015	439438.7020	4173327.2210	732.7790	733.0461	0.2671	VVA
HG016	441141.6050	4185813.2750	725.3380	725.5769	0.2389	VVA
HG017	437895.9340	4157241.5350	747.1990	747.4998	0.3008	VVA
HG018	395178.3850	4188250.5640	810.1730	810.1733	0.0003	VVA
HG019	400819.9390	4162249.9250	806.6670	806.6912	0.0242	VVA
HG020	420981.5930	4198217.0250	746.8000	747.0137	0.2137	VVA
HG021	361694.2190	4158381.3370	836.3590	836.4221	0.0631	VVA
HG022	362387.7440	4191911.4480	826.8100	826.8396	0.0296	VVA
TR001	402203.6250	4149714.9530	775.6730	775.7675	0.0945	VVA
TR002	419024.4510	4186731.7450	752.3000	752.3554	0.0554	VVA
TR003	427406.7680	4198972.1640	696.2520	696.1647	-0.0873	VVA
TR004	354503.2140	4181984.2360	858.2200	858.1940	-0.0260	VVA
TR005	383483.5390	4192216.2310	829.4880	829.3849	-0.1031	VVA
TR006	434414.7600	4178206.8860	720.8020	721.1766	0.3746	VVA
TR007	447474.8480	4171480.3870	701.0870	701.3783	0.2913	VVA
TR008	391317.3130	4173913.4950	823.5650	823.5525	-0.0125	VVA
TR009	420100.7620	4176012.8280	770.5790	770.6052	0.0262	VVA
TR010	358878.3280	4204038.4380	866.7910	867.0519	0.2609	VVA
TR012	351904.6020	4148855.9290	867.1120	867.1664	0.0544	VVA
TR013	376767.5650	4169429.2500	837.6790	837.6511	-0.0279	VVA
TR014	392428.6850	4145055.6530	770.1300	770.2002	0.0702	VVA
TR015	427316.4010	4190014.9790	746.9250	747.0237	0.0987	VVA
TR016	422864.7910	4147235.3680	780.4060	780.5922	0.1862	VVA
TR017	428092.9500	4169936.0380	730.6780	730.7365	0.0585	VVA
TR018	358363.1880	4192647.2210	835.0210	835.0367	0.0157	VVA
TR019	427316.4080	4190014.9950	746.9200	747.0239	0.1039	VVA
TR020	427316.4000	4190014.9890	746.9250	747.0233	0.0983	VVA
TR021	403450.3810	4179899.0910	772.8620	772.8665	0.0045	VVA
TR022	433546.5380	4166051.0480	728.0540	728.2930	0.2390	VVA
TR023	433546.5430	4166051.0530	728.0320	728.2928	0.2608	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR001	446605.9560	4191275.6100	701.7120	702.0387	0.3267	VVA
BR002	401706.7250	4196435.4470	790.4700	790.5722	0.1022	VVA
BR003	433894.4370	4161010.7710	756.9900	757.1974	0.2074	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
BR004	366253.1490	4191029.3240	820.6270	820.6270	0.0000	VVA
BR005	450689.7250	4178126.0080	690.8970	691.2961	0.3991	VVA
BR006	383735.4950	4156440.2420	823.8910	823.9300	0.0390	VVA
BR007	399398.0770	4181259.7930	775.3140	775.3292	0.0152	VVA
BR008	427329.8090	4157629.4050	774.3420	774.3435	0.0015	VVA
BR009	404005.5280	4170166.9630	808.4970	808.6017	0.1047	VVA
BR010	383238.9600	4197144.5830	825.4120	825.5244	0.1124	VVA
BR011	374417.9440	4195633.0290	839.3640	839.4189	0.0549	VVA
BR012	440006.6810	4193190.2600	724.9600	725.2669	0.3069	VVA
BR013	447618.9770	4147751.1020	746.5480	746.8518	0.3038	VVA
BR014	416809.0840	4167804.6450	772.3840	772.4537	0.0697	VVA
BR015	418940.3010	4155951.9840	778.3820	778.4295	0.0475	VVA
BR016	427439.1410	4181560.5400	753.7160	753.7138	-0.0022	VVA
BR017	381843.7390	4184353.7890	794.6910	794.7187	0.0277	VVA
BR018	417667.3650	4155480.3100	774.0020	774.0134	0.0114	VVA
BR019	452293.4810	4186410.4020	683.0190	683.3207	0.3017	VVA
BR020	381656.0780	4187364.3860	837.0380	837.0377	-0.0003	VVA
BR021	422541.2960	4182713.2440	770.1990	770.2012	0.0022	VVA
BR022	434414.3780	4178226.2730	720.6520	720.9553	0.3033	VVA
BR023	364099.5310	4179344.7310	839.4490	839.5255	0.0765	VVA
BR024	380890.1010	4197118.1940	833.1800	833.2745	0.0945	VVA
HG001	450786.5020	4155082.3900	731.9120	732.2530	0.3410	VVA
HG002	354263.8890	4171058.1830	863.0210	863.0340	0.0130	VVA
HG003	379479.9400	4205239.5850	834.1420	834.3774	0.2354	VVA
HG004	390883.7020	4151473.0280	789.9010	790.0077	0.1067	VVA
HG005	363373.3070	4200823.1120	862.2280	862.4808	0.2528	VVA
HG006	365505.5340	4164790.4070	855.9270	855.9193	-0.0077	VVA
HG007	375897.5600	4179200.4830	822.2790	822.3860	0.1070	VVA
HG008	369679.5000	4174446.4160	835.8460	835.9022	0.0562	VVA
HG009	381684.0750	4171075.5740	837.2280	837.2708	0.0428	VVA
HG010	360407.4360	4155189.6110	849.7520	849.7468	-0.0052	VVA
HG011	362531.7070	4182609.0930	843.7660	843.9132	0.1472	VVA
HG012	395259.0110	4193718.7440	811.1340	811.1407	0.0067	VVA
HG013	369793.1690	4156617.9350	832.0440	832.0418	-0.0022	VVA
HG014	390777.5240	4159633.0690	827.0440	827.1026	0.0586	VVA
HG015	439438.7020	4173327.2210	732.7790	733.0461	0.2671	VVA

Point ID	Given (X)	Given (Y)	Given (Z)	DEM (Z)	DEM (DZ)	Report Point Type
HG016	441141.6050	4185813.2750	725.3380	725.5769	0.2389	VVA
HG017	437895.9340	4157241.5350	747.1990	747.4998	0.3008	VVA
HG018	395178.3850	4188250.5640	810.1730	810.1733	0.0003	VVA
HG019	400819.9390	4162249.9250	806.6670	806.6912	0.0242	VVA
HG020	420981.5930	4198217.0250	746.8000	747.0137	0.2137	VVA
HG021	361694.2190	4158381.3370	836.3590	836.4221	0.0631	VVA
HG022	362387.7440	4191911.4480	826.8100	826.8396	0.0296	VVA
TR001	402203.6250	4149714.9530	775.6730	775.7675	0.0945	VVA
TR002	419024.4510	4186731.7450	752.3000	752.3554	0.0554	VVA
TR003	427406.7680	4198972.1640	696.2520	696.1647	-0.0873	VVA
TR004	354503.2140	4181984.2360	858.2200	858.1940	-0.0260	VVA
TR005	383483.5390	4192216.2310	829.4880	829.3849	-0.1031	VVA
TR006	434414.7600	4178206.8860	720.8020	721.1766	0.3746	VVA
TR007	447474.8480	4171480.3870	701.0870	701.3783	0.2913	VVA
TR008	391317.3130	4173913.4950	823.5650	823.5525	-0.0125	VVA
TR009	420100.7620	4176012.8280	770.5790	770.6052	0.0262	VVA
TR010	358878.3280	4204038.4380	866.7910	867.0519	0.2609	VVA
TR012	351904.6020	4148855.9290	867.1120	867.1664	0.0544	VVA
TR013	376767.5650	4169429.2500	837.6790	837.6511	-0.0279	VVA
TR014	392428.6850	4145055.6530	770.1300	770.2002	0.0702	VVA
TR015	427316.4010	4190014.9790	746.9250	747.0237	0.0987	VVA
TR016	422864.7910	4147235.3680	780.4060	780.5922	0.1862	VVA
TR017	428092.9500	4169936.0380	730.6780	730.7365	0.0585	VVA
TR018	358363.1880	4192647.2210	835.0210	835.0367	0.0157	VVA
TR019	427316.4080	4190014.9950	746.9200	747.0239	0.1039	VVA
TR020	427316.4000	4190014.9890	746.9250	747.0233	0.0983	VVA
TR021	403450.3810	4179899.0910	772.8620	772.8665	0.0045	VVA
TR022	433546.5380	4166051.0480	728.0540	728.2930	0.2390	VVA
TR023	433546.5430	4166051.0530	728.0320	728.2928	0.2608	VVA

Table 13: DEM Check Point Assessment