Aerial Lidar Report

Kansas Manhattan Lidar (AOI 2)

15115

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August 2015

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Section 1: Lidar Acquisition

1.1 Acquisition

The Atlantic Group, LLC (Atlantic) has successfully completed lidar acquisition for the Kansas Manhattan Lidar (AOI 2). Lidar for this AOI was acquired in one (1) flight lift completed on March 7th, 2015. The project area encompasses 135 square miles or 350 square kilometers.

1.2 Acquisition Status Report

Upon notification to proceed, the flight crew loaded the flight plans and validated the flight parameters. The Acquisition Manager contacted air traffic control and coordinated flight pattern requirements. Lidar acquisition began immediately upon notification that control base stations were in place. During flight operations, the flight crew monitored weather and atmospheric conditions. Lidar missions were flown only when no condition existed below the sensor that would affect the collection of data. The pilot constantly monitored the aircraft course, position, pitch, roll, and yaw of the aircraft. The sensor operator monitored the sensor, the status of PDOPs, and performed the first Q/C review during acquisition. The flight crew constantly reviewed weather and cloud locations. Any flight lines impacted by unfavorable conditions were marked as invalid and re-flown immediately or at an optimal time.

1.3 Acquisition Details

Atlantic acquired nineteen (19) passes of the AOI as a series of perpendicular and/or adjacent flight lines. The flight plan included zigzag flight line collection as a result of the inherent IMU drift associated with all IMU systems. At least two (2) GPS reference stations were in operation during all missions, sampling positions at 1 Hz or higher frequently. Differential GPS baseline lengths did not exceed 40 km, unless otherwise approved. Differential GPS unit in aircraft recorded sample positions at 2 Hz or more frequently. Lidar data was only acquired when GPS PDOP was ≤ 4 and at least 6 satellites were in view.

Atlantic monitored weather and atmospheric conditions and conducted lidar missions only when conditions existed that would not degrade sensor ability in the collection of data. These conditions included no snow, rain, fog, smoke, mist and/or low clouds. Lidar systems are active sensors, not requiring light, thus missions may be conducted during night hours when weather restrictions do not prevent collection. Atlantic accessed reliable weather sites and indicators (webcams) to establish the highest probability for successful collection in order to position our sensor to maximize successful data acquisition.

Within 72-hours prior to the planned day(s) of acquisition, Atlantic closely monitored the weather, checking all sources for forecasts at least twice daily. As soon as weather conditions were conducive to acquisition, our aircraft mobilized to the project site to begin data collection. Once on site, the acquisition team took responsibility for weather analysis. Atlantic lidar sensors are calibrated at a designated site located at the Fayetteville Municipal Airport (FYM) in Fayetteville, TN and are periodically checked and adjusted to minimize corrections at project sites.

1.4 Lidar Flightline Orientation

The following graphic represents the alignment of the project area of interest (AOI) and the flight-lines executed to provide AOI coverage.

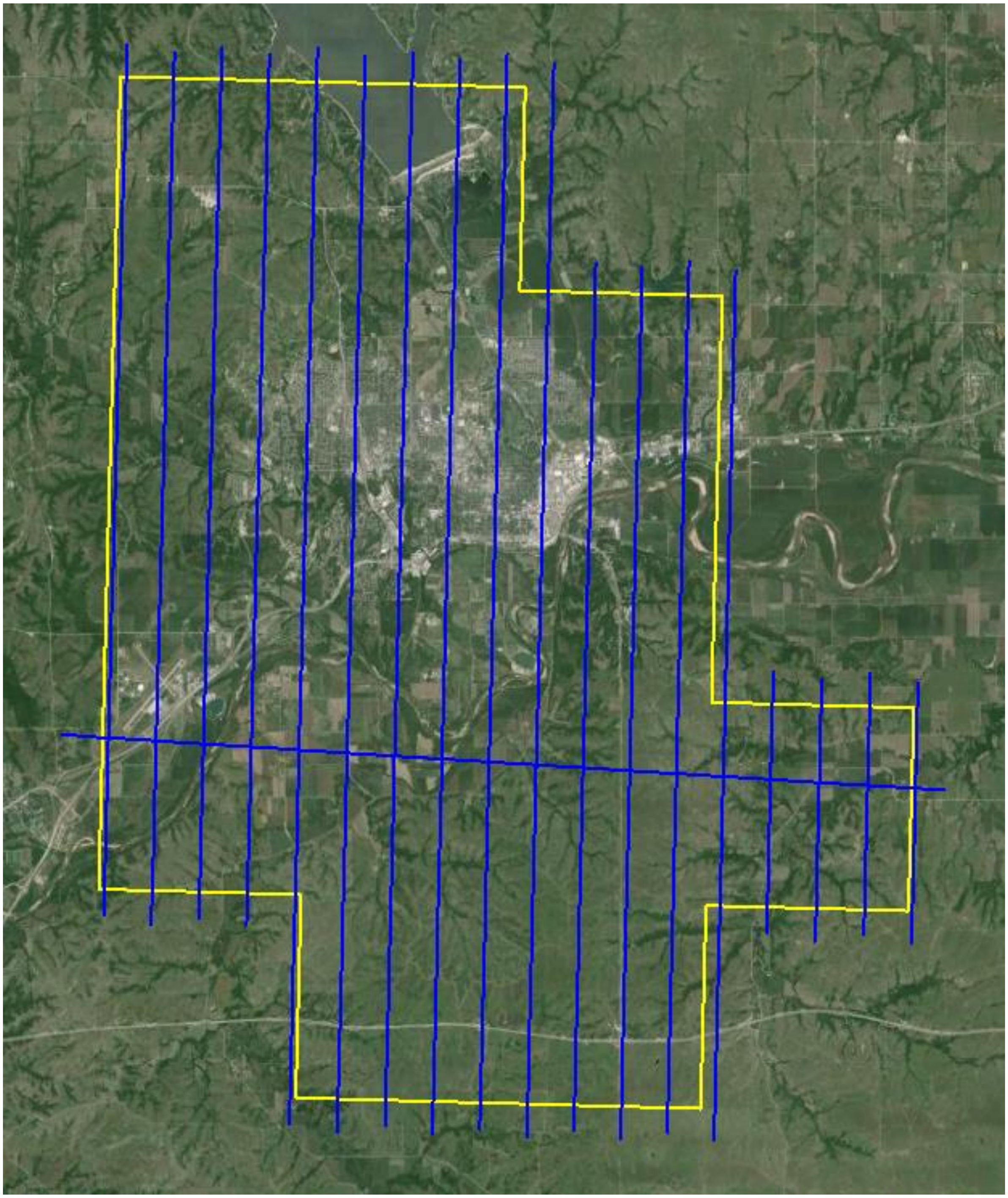


Figure 1: Trajectories as flown by Atlantic

1.5 Acquisition Equipment

Atlantic operated a Partenavia S.P.A. P 68 C/TC (N775MW) outfitted with Leica ALS70-HP lidar system during the collection of the project area. Table 1 represents a list of the features and characteristics for the Leica ALS70-HP lidar system:

Atlantic's Sensor Characteristics		
Leica ALS70-HP		
Manufacturer	Leica	
Model	ALS70 - HP	
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
Operating Temperature	0 - 40 °C	
Flight Management	FCMS	
Power Consumption	927 @ 22.0 - 30.3 VDC	

Table 1: Atlantic Sensor Characteristics

1.6 Lidar System Acquisition Parameters

Table 2 illustrates Atlantic's system parameters for lidar acquisition on this project.

Lidar System Acquisition Parameters	
Item	**Parameter**
System	Leica ALS-70 HP
Nominal Pulse Spacing (m)	0.6
Nominal Pulse Density (pls/m²)	2.5
Nominal Flight Height (AGL meters)	2318
Nominal Flight Speed (kts)	130
Pass Heading (degree)	90
Sensor Scan Angle (degree)	40
Scan Frequency (Hz)	35.8
Pulse Rate of Scanner (kHz)	256.8
Line Spacing (m)	286
Pulse Duration of Scanner (ns)	4
Pulse Width of Scanner (m)	0.46
Central Wavelength of Sensor Laser (nm)	1064
Sensor Operated with Multiple Pulses	Yes
Beam Divergence (mrad)	0.15
Nominal Swath With (m)	1536
Nominal Swath Overlap (%)	20
Scan Pattern	Triangle

Table 2: Atlantic Lidar System Acquisition Parameters

1.7 GPS Reference Stations

One (1) CORS station and one (1) dedicated station set by Atlantic were used to control the lidar acquisition for the project area. The coordinates provided in Table 3 below are in NAD83 (2011), Geographic Coordinate System, Ellipsoid, Meters.

GPS Reference Station Coordinates				
Designation	**PID**	**Latitude (N)**	**Longitude (W)**	**Height**
KSU1	DI3428	39°06'02.67733"	096°36'34.09360"	326.625
MHK SET	n/a	39°08'18.21276"	096°40'12.34584"	287.360

Table 3: GPS Reference Station Coordinates

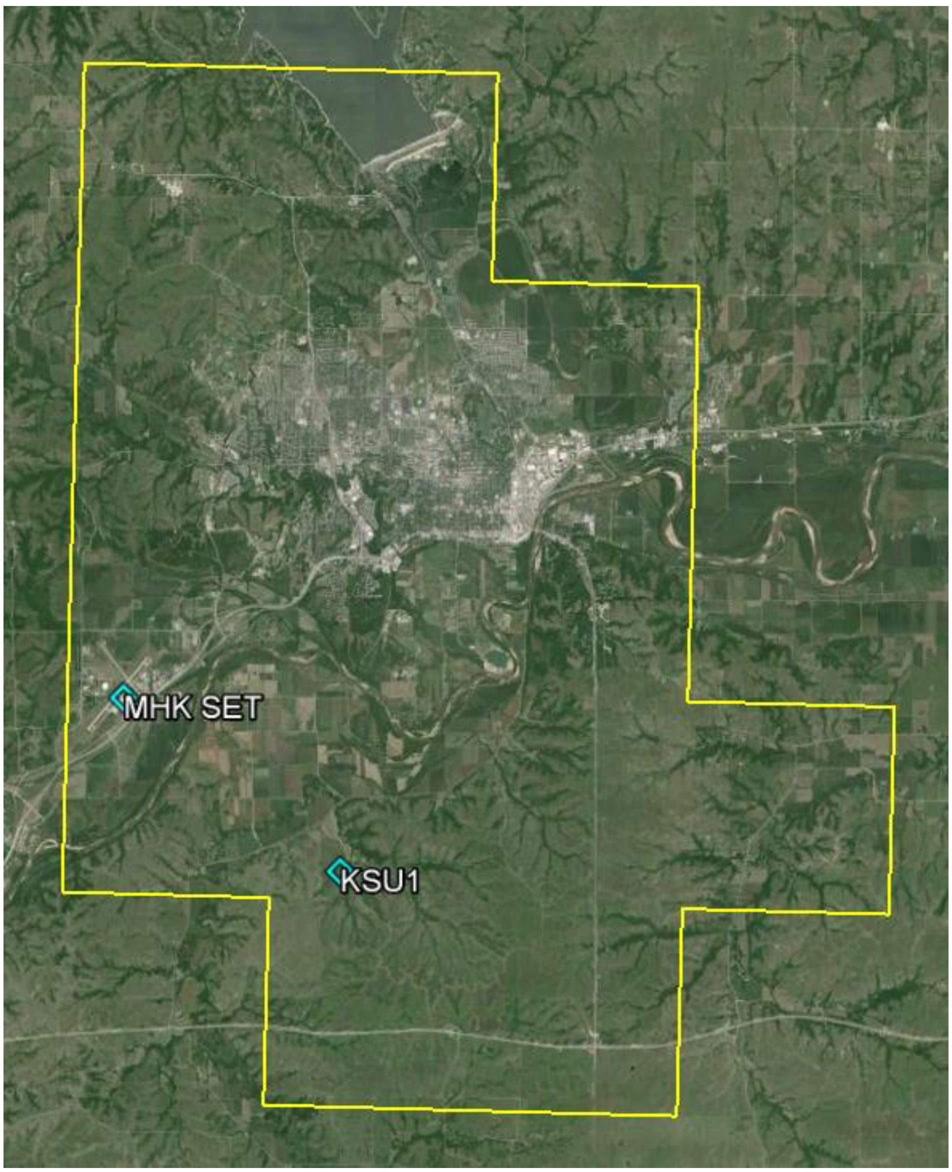


Figure 2: GPS Reference Station(s)

1.8 Airborne GPS Kinematic

Differential GPS unit in aircraft collected positions at 2 Hz. Airborne GPS data was processed using the Inertial Explorer (version 8.5.4320) software. Flights were flown with a minimum of 6 satellites in view (10° above the horizon) and with a PDOP of ≤4 when laser online. Distances from base station to aircraft were kept to a maximum of 40km.

For all flights, the GPS data can be classified as good, with GPS residuals of 3cm average or better but none larger than 10cm being recorded.

Data collected by the lidar unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

GPS processing results for each lift are included in **Section 5: GPS Processing**.

Section 2: Lidar Processing

2.1 Generation and Calibration of Laser Points

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete. Subsequently, the mission points are output using Leica's CloudPro post processor with the most recent boresight values. The initial point generation for each mission calibration is verified within TerraScan using distance colored points to identify errors. If a calibration error greater than specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. Once validated each output mission is imported into the GeoCue software package. Here a project level supplementary coverage check is carried out to ensure no data voids unreported by Field Operations are present.

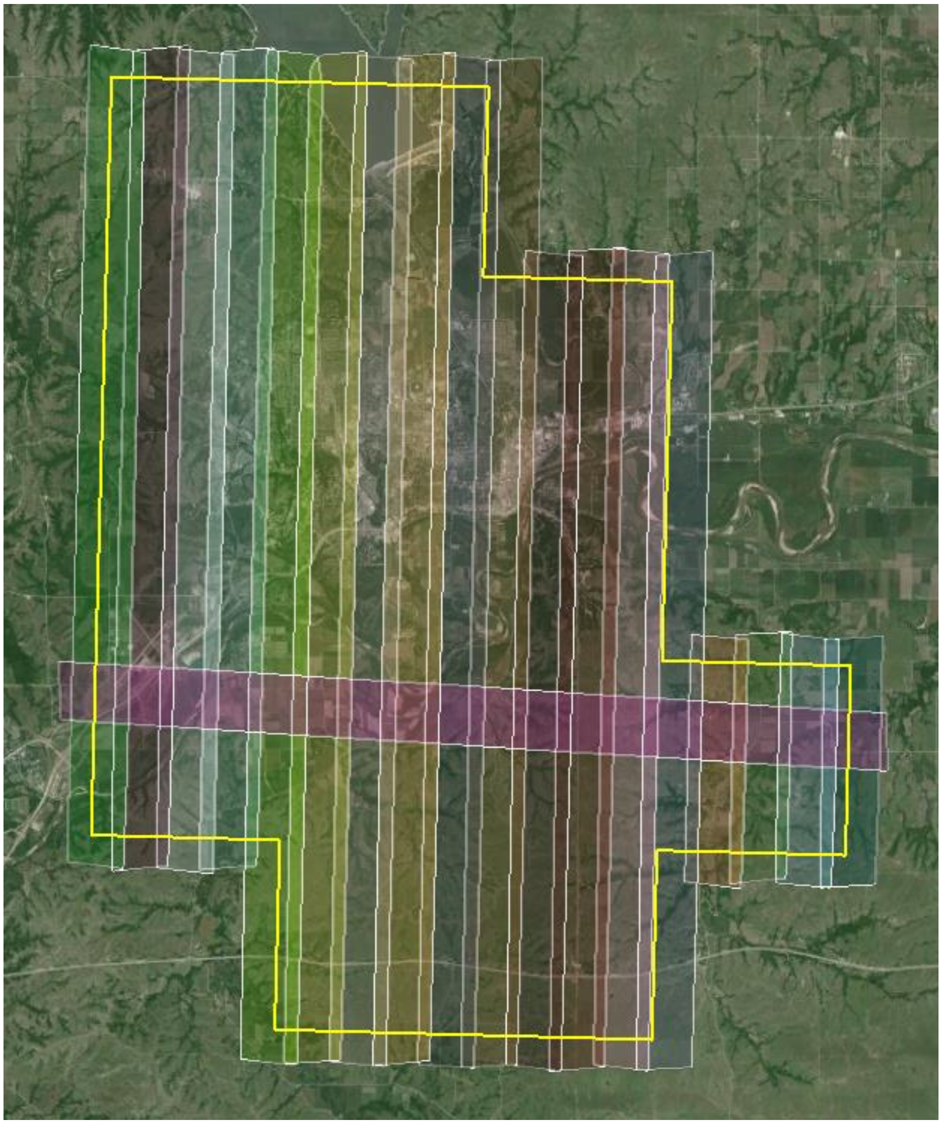


Figure 3: Lidar swath data showing complete coverage

2.2 Reference Systems

Horizontal Datum: North American Datum of 1983 (HARN)
Coordinate System: Universal Transverse Mercator Northern Zone 14
Vertical Datum: North American Vertical Datum of 1988
Geoid Model: Geoid12A
Units: Meters

2.3 Lidar Point Cloud Statistics

Table 4 illustrates the overall lidar point cloud statistics for this project.

Point Cloud Statistics	
Category	**Value**
Total Points	1,531,679,524
Aggregate Nominal Pulse Spacing (m)	0.6042
Aggregate Nominal Pulse Density (pls/m²)	2.7

Table 4: Lidar Point Cloud Statistics

2.4 Relative Accuracy

For effective data management, each imported mission is tiled out in GeoCue to a project specific tile scheme or index. Relative accuracy and internal quality are then checked using a number of carefully selected tiles in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed by the generation of Z-Difference colored intensity orthos in GeoCue. The color scale of these orthos are adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flight line to flight line and mission to mission alignment. When available, surveyed control points are used to supplement and verify the calibration of the data.

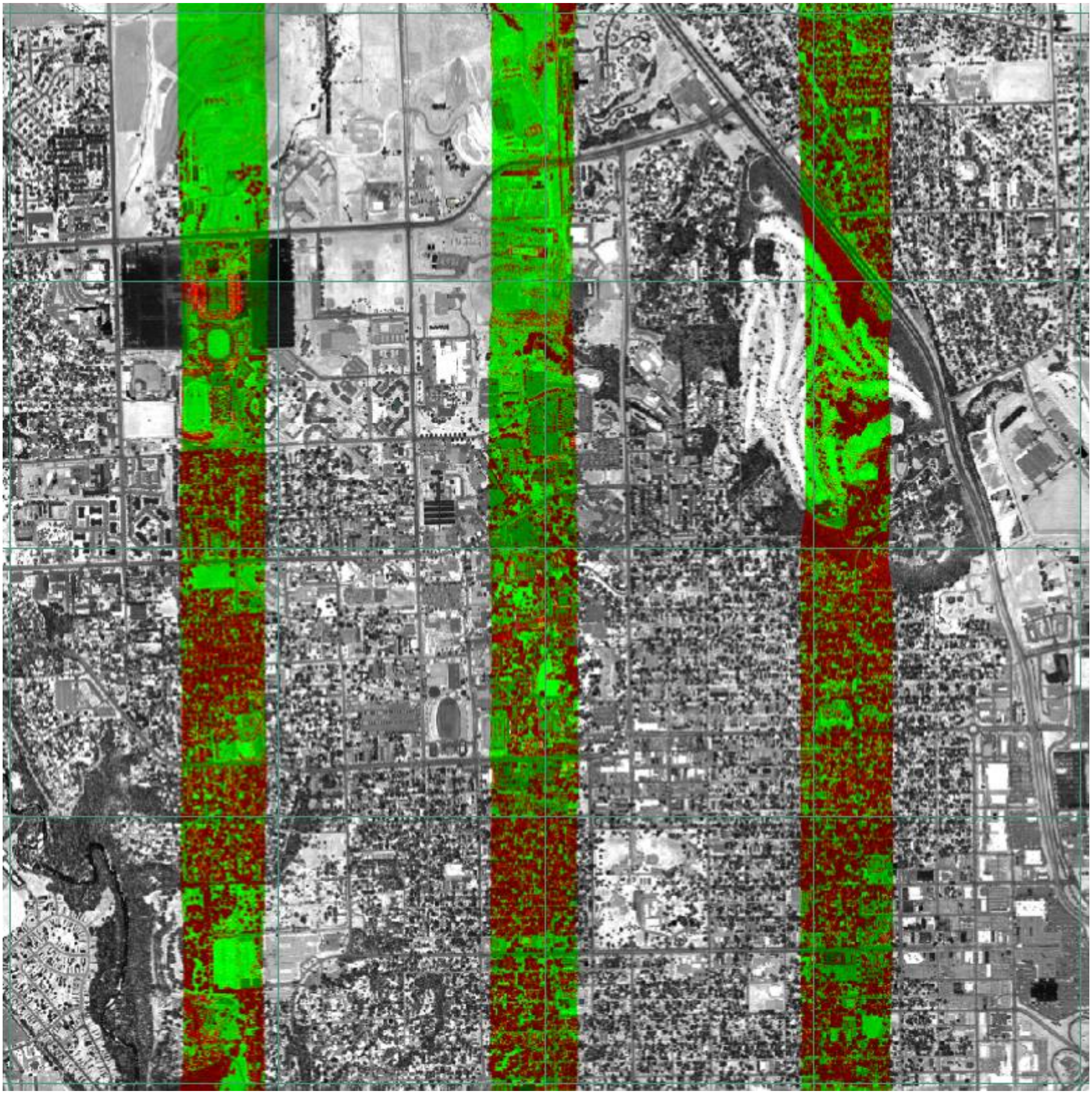


Figure 4: dZ ortho sub-sample

2.5 Relative Accuracy Results

An overall statistical assessment of the relative accuracy using TerraMatch Tie Line Report between lidar swaths can be found in Tables 5, 6, 7, and 8 below. The values provided are in meters.

Average Magnitudes Per Line											
Line	**X**	**Y**	**Z**	**Line**	**X**	**Y**	**Z**	**Line**	**X**	**Y**	**Z**
1	0.001	0.005	0.010	**7**	0.038	0.025	0.013	**13**	0.011	0.012	0.011
2	0.001	0.005	0.013	**8**	0.026	0.031	0.013	**14**	0.012	0.012	0.012
3	0.002	0.017	0.013	**9**	0.019	0.020	0.012	**15**	0.014	0.012	0.013
4	0.031	0.036	0.014	**10**	0.018	0.013	0.012	**16**	0.017	0.011	0.013
5	0.012	0.015	0.012	**11**	0.018	0.012	0.012	**17**	0.028	0.018	0.015
6	0.013	0.016	0.011	**12**	0.014	0.012	0.011	**18**	0.011	0.018	0.012

Table 5: Average Tie Line Magnitudes per Line

Internal Observation Statistics			
Category	**X**	**Y**	**Z**
Average Magnitude	0.016	0.014	0.012
RMS Values	0.024	0.025	0.016
Maximum Values	0.148	0.141	0.141
Observation Weight	9164.0	9164.0	44876.0

Table 6: Tie Line Observation Statistics

Overall Relative Accuracy	
Category	**Mismatch**
Average 3D Mismatch	0.01649
Average XY Mismatch	0.02651
Average Z Mismatch	0.01217

Table 7: Relative Accuracy Results

TerraMatch Tie Lines	
Category	**Observations**
Section Lines	16,191
Roof Lines	4,582

Table 8: Total Tie Line

2.6 Project Purpose

The primary purpose of the lidar survey was to establish measurements of the bare earth surface, as well as top surface feature data for providing geometric inputs for modeling, other numerical modeling and economic related assessments.

2.7 Lidar Classification

The calibrated point cloud data from the laser sensor was merged to produce processed (*.las) file(s) including but not limited to 3D position, intensity, and time-stamp. A filtering methodology was utilized to produce a multi-return surface elevation model dataset with bare-earth conditions. GeoCue, TerraScan, and TerraModel software was used for the initial batch processing and manual editing of the (*.las) point clouds. Atlantic utilized collected breakline data to preform classification for classes' 9-Water and 10-Rail (breakline buffer). Outlined in Table 9 are the classification codes utilized for this project.

ASPRS Standard Lidar Point Classes		
Code	**Description**	**Utilized**
0	Created, never classified	
1	Unclassified[3]	X
2	Ground	X
3	Low Vegetation	
4	Medium Vegetation	
5	High Vegetation	
6	Building	
7	Low Point (noise)	X
8	Reserved	
9	Water	X
10	Rail (breakline buffer)	X
11	Road Surface	
12	Reserved	
13	Wire – Guard (Shield)	
14	Wire – Conductor (Phase)	
15	Transmission Tower	
16	Wire-structure Connector (e.g. Insulator)	
17	Bridge Deck	X
18	High Noise	X
19-63	Reserved	
64-255	User Definable	

Table 9: Point Cloud Classification Scheme

Section 3: Vertical Accuracy Assessment

3.1 Ground Surveyed Check Points

Atlantic established a total of thirty two (32) checkpoints for this project (26 NVA + 6 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 5 times the NPS exists with less than 1/3 of the $RMSE_Z$ deviation from a low-slope plane. Slopes that exceed 10 percent were avoided. Each land cover type representing 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 45 degrees above the horizon to ensure a sufficient 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 & VVA) are required to be well-distributed throughout the land cover type, for the entire project area.

3.2 Vertical Accuracy

Below are the vertical accuracy reporting requirements for this project:

Vertical Accuracy Reporting Requirements in Meters:

$RMSE_Z$ ≤ 10.0cm (Non-Vegetated Swath, DEM)
NVA ≤ 19.6cm 95% Confidence Level (Swath, DEM)
VVA ≤ 29.4cm 95^{th} Percentile (DEM)

Vertical Accuracy Reporting Requirements in Feet:

$RMSE_Z$ ≤ 0.328ft (Non-Vegetated Swath, DEM)
NVA ≤ 0.643ft 95% Confidence Level (Swath, DEM)
VVA ≤ 0.965ft 95^{th} Percentile (DEM)

*The terms FVA (Fundamental Vertical Accuracy), SVA (Supplemental Vertical Accuracy) and CVA (Consolidated Vertical Accuracy) are from the National Digital Elevation Program (NDEP) Guidelines for Digital Elevation Data (2004). The term FVA refers to open terrain, urban and levee classes; the term SVA refers to classes tested that are in addition or supplemental to the open terrain; the term CVA refers to the consolidated accuracy of the data from all classes (FVA + SVA).

*The terms NVA (Non-vegetated Vertical Accuracy) and VVA (Vegetated Vertical Accuracy) are from the 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).

3.3 Check Point Distribution

The following graphics depict the locations and distribution of NVA and VVA Check Points established for this project.

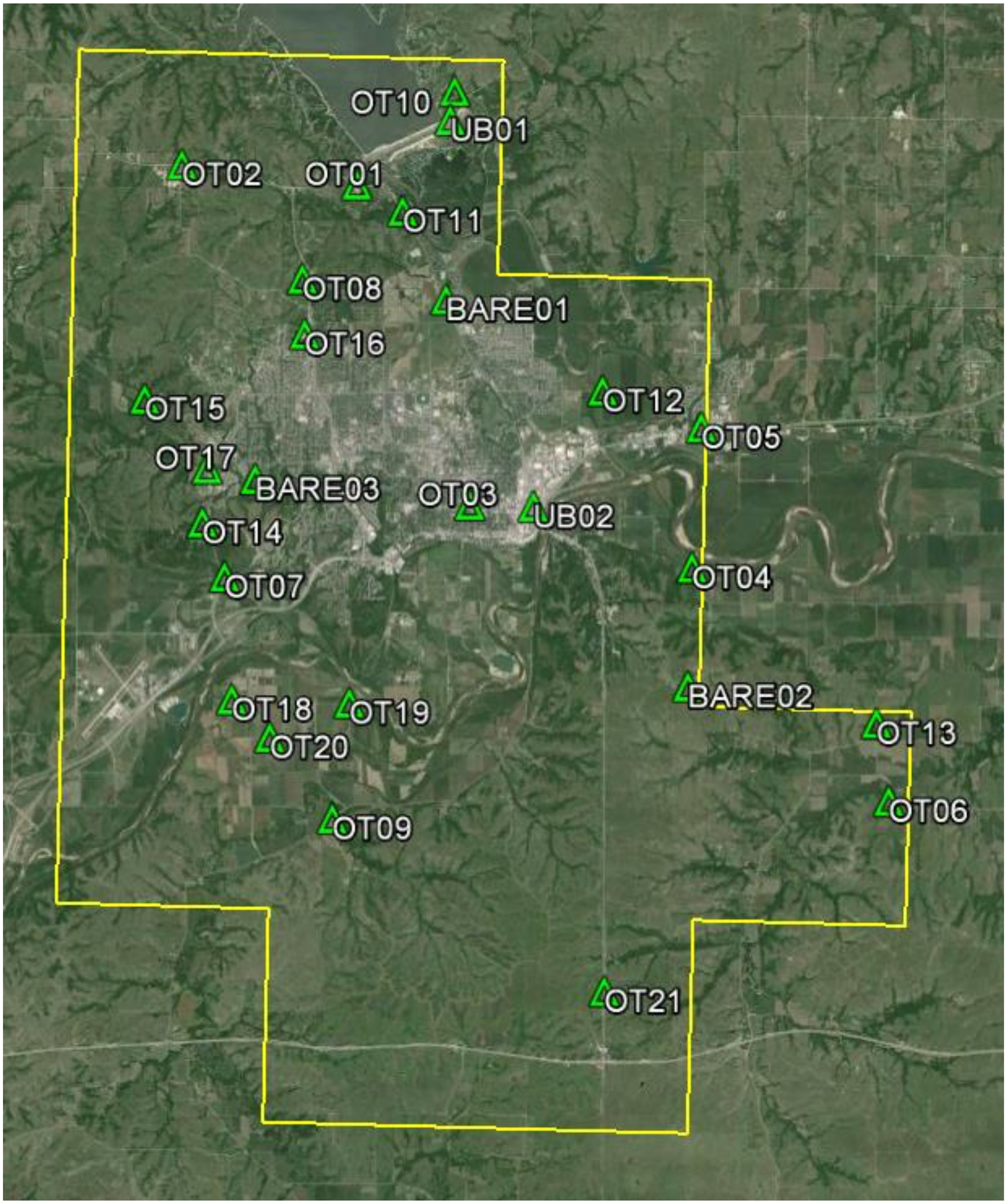


Figure 5: Non-vegetated Vertical Accuracy (NVA) Check Point Distribution

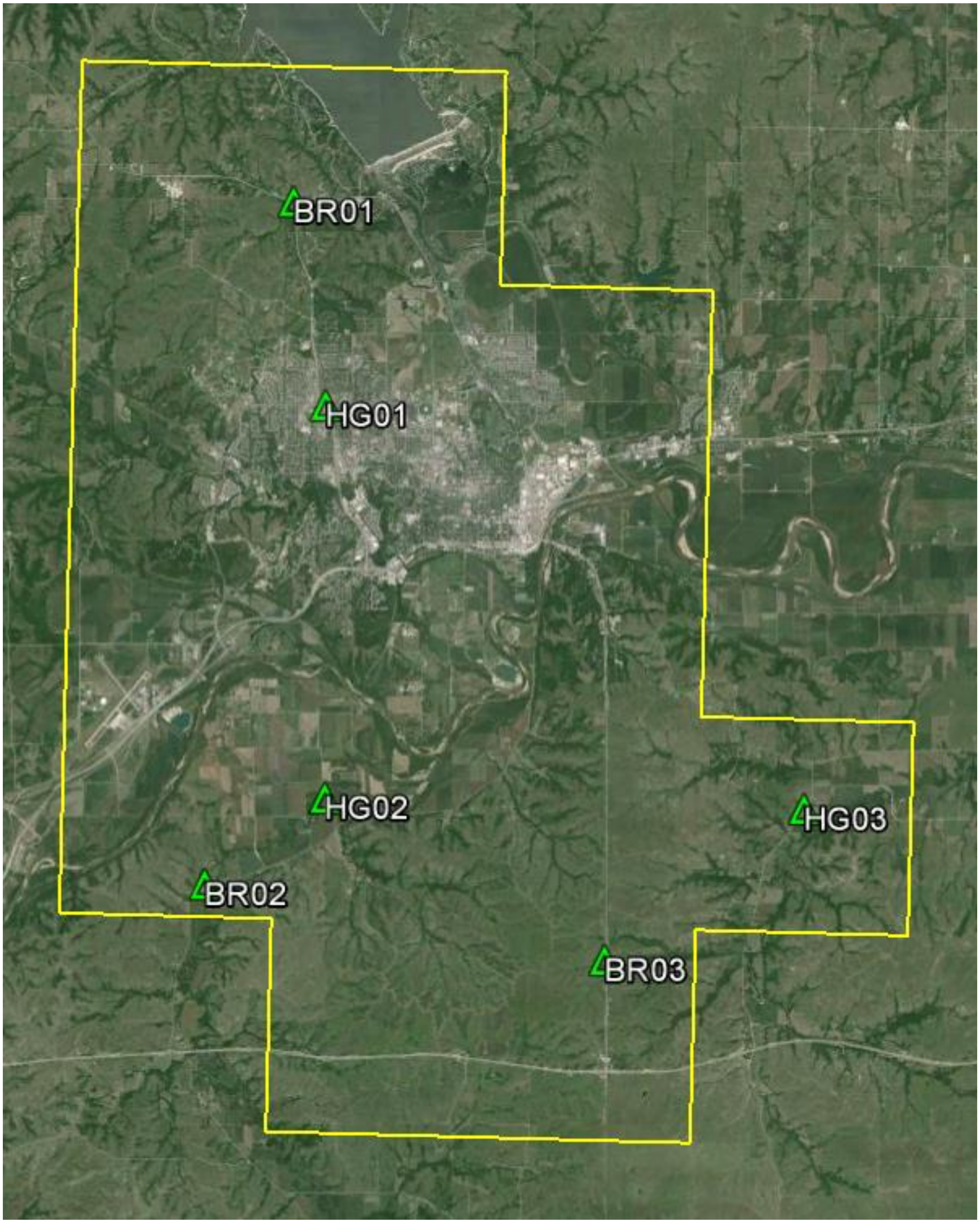


Figure 6: Vegetated Vertical Accuracy (VVA) Check Point Distribution

3.4 Check Point Assessment

A vertical accuracy assessment of the NVA & VVA checkpoints against the lidar point cloud swath data and bare-earth surface DEM's can be found in Tables 10, 11, and 12 below. The coordinates provided are in NAD83 (HARN), UTM Zone 14N, NAVD88 (Geoid12A), Meters.

Non-vegetated Vertical Accuracy (NVA) Check Point Assessment (Swath)						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
BARE01	708801.996	4344370.019	323.459	323.442	Bare Earth	-0.017
BARE02	714739.591	4335457.884	421.233	421.202	Bare Earth	-0.031
BARE03	704428.047	4340041.839	321.360	321.342	Bare Earth	-0.018
OT01	706633.786	4346999.905	335.921	335.847	Open Terrain	-0.074
OT02	702502.221	4347366.609	411.366	411.342	Open Terrain	-0.024
OT03	709492.439	4339570.128	312.281	312.322	Open Terrain	0.041
OT04	714762.644	4338244.150	305.924	305.999	Open Terrain	0.075
OT05	714892.888	4341531.417	309.758	309.823	Open Terrain	0.065
OT06	719538.866	4332902.758	330.783	330.788	Open Terrain	0.005
OT07	703765.807	4337738.093	330.274	330.309	Open Terrain	0.035
OT08	705411.659	4344760.998	414.148	414.178	Open Terrain	0.030
OT09	706453.909	4332146.388	320.104	320.075	Open Terrain	-0.029
OT10	708877.890	4349253.445	367.702	367.677	Open Terrain	-0.025
OT11	707727.765	4346412.453	331.009	331.057	Open Terrain	0.048
OT12	712546.425	4342327.996	308.646	308.737	Open Terrain	0.091
OT13	719199.057	4334716.922	334.750	334.706	Open Terrain	-0.044
OT14	703209.368	4338991.726	380.760	380.767	Open Terrain	0.007
OT15	701774.165	4341847.739	336.249	336.251	Open Terrain	0.002
OT16	705499.211	4343472.494	365.043	365.030	Open Terrain	-0.012
OT17	703290.918	4340257.009	325.118	325.139	Open Terrain	0.022
OT18	704013.076	4334868.605	315.561	315.527	Open Terrain	-0.034
OT19	706780.901	4334861.787	312.176	312.112	Open Terrain	-0.064
OT20	704930.735	4334007.433	316.104	316.091	Open Terrain	-0.013
OT21	712962.130	4328272.496	419.982	420.011	Open Terrain	0.029
UB01	708789.580	4348573.064	353.201	353.201	Urban Terrain	0.000
UB02	710990.292	4339573.727	308.269	308.311	Urban Terrain	0.042

Table 10: Lidar Point Cloud Swath Data Assessment

Non-vegetated Vertical Accuracy (NVA) Check Point Assessment (DEM)						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
BARE01	708801.996	4344370.019	323.459	323.436	Bare Earth	-0.023
BARE02	714739.591	4335457.884	421.233	421.202	Bare Earth	-0.031
BARE03	704428.047	4340041.839	321.360	321.294	Bare Earth	-0.066
OT01	706633.786	4346999.905	335.921	335.847	Open Terrain	-0.074

OT02	702502.221	4347366.609	411.366	411.340	Open Terrain	-0.026
OT03	709492.439	4339570.128	312.281	312.322	Open Terrain	0.041
OT04	714762.644	4338244.150	305.924	305.982	Open Terrain	0.058
OT05	714892.888	4341531.417	309.758	309.773	Open Terrain	0.015
OT06	719538.866	4332902.758	330.783	330.716	Open Terrain	-0.067
OT07	703765.807	4337738.093	330.274	330.274	Open Terrain	0.000
OT08	705411.659	4344760.998	414.148	414.178	Open Terrain	0.030
OT09	706453.909	4332146.388	320.104	320.070	Open Terrain	-0.034
OT10	708877.890	4349253.445	367.702	367.664	Open Terrain	-0.038
OT11	707727.765	4346412.453	331.009	331.035	Open Terrain	0.026
OT12	712546.425	4342327.996	308.646	308.699	Open Terrain	0.053
OT13	719199.057	4334716.922	334.750	334.704	Open Terrain	-0.046
OT14	703209.368	4338991.726	380.760	380.771	Open Terrain	0.011
OT15	701774.165	4341847.739	336.249	336.203	Open Terrain	-0.046
OT16	705499.211	4343472.494	365.043	365.022	Open Terrain	-0.021
OT17	703290.918	4340257.009	325.118	325.129	Open Terrain	0.012
OT18	704013.076	4334868.605	315.561	315.501	Open Terrain	-0.060
OT19	706780.901	4334861.787	312.176	312.112	Open Terrain	-0.064
OT20	704930.735	4334007.433	316.104	316.076	Open Terrain	-0.028
OT21	712962.130	4328272.496	419.982	420.007	Open Terrain	0.025
UB01	708789.580	4348573.064	353.201	353.179	Urban Terrain	-0.022
UB02	710990.292	4339573.727	308.269	308.256	Urban Terrain	-0.013

Table 11: Bare-Earth Surface NVA Assessment

Vegetated Vertical Accuracy (VVA) Check Point Assessment (DEM)						
PointID	**Easting**	**Northing**	**KnownZ**	**LaserZ**	**Description**	**DeltaZ**
BR01	705081.758	4346817.424	356.872	356.979	Brush	0.107
BR02	703414.757	4330752.004	327.890	328.045	Brush	0.155
BR03	712879.292	4329226.661	404.674	404.777	Brush	0.103
HG01	705964.110	4342056.796	337.253	337.259	High Grass	0.006
HG02	706191.699	4332851.567	316.397	316.441	High Grass	0.045
HG03	717485.123	4332891.969	334.345	334.442	High Grass	0.097

Table 12: Bare-Earth Surface VVA Assessment

3.5 Vertical Accuracy Results

An overall statistical assessment of the check points can be found in Tables 13, 14, 15, and 16 below. The values provided are in meters.

Check Points Error Statistics								
Category	**# of**	**Min**	**Max**	**Mean**	**Median**	**Skew**	**Std Dev**	**$RMSE_Z$**
Open Terrain	21	-0.074	0.058	-0.011	-0.021	0.101	0.041	0.042
Urban Terrain	2	-0.022	-0.013	-0.018	-0.018	n/a	0.006	0.018
Bare Earth	3	-0.066	-0.023	-0.040	-0.031	-1.497	0.023	0.044
High Grass	3	0.006	0.097	0.049	0.045	0.423	0.046	0.062
Brush	3	0.103	0.155	0.122	0.107	1.695	0.029	0.124
Consolidated	32	-0.074	0.155	0.004	-0.007	0.835	0.057	0.056

Table 13: Check Points Error Statistics

Check Points Vertical Accuracy Assessment				
Land Cover Category	**# of Points**	**FVA — Fundamental Vertical Accuracy ($RMSE_Z$ x 1.9600)**	**CVA — Consolidated Vertical Accuracy (95th Percentile)**	**SVA — Supplemental Vertical Accuracy (95th Percentile)**
Open Terrain	21	0.082		
Urban Terrain	2			-0.013
Bare Earth	3			-0.024
High Grass	3			0.092
Brush	3			0.150
Consolidated	32		0.105	

Table 14: Check Points Vertical Accuracy Assessment

Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA)				
Broad Land Cover Type	**# of Points**	**$RMSE_Z$ (m)**	**95% Confidence Level (m)**	**95th Percentile (m)**
NVA of Point Cloud	26	0.041	0.081	
NVA of DEM	26	0.041	0.080	
VVA of DEM	6	0.098		0.143

Table 15: Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA)

Comparison of NSSDA, NDEP, and ASPRS Statistics					
Land Cover Category	NSSDA $Accuracy_Z$ at 95% confidence level based on $RMSE_Z$ * 1.9600 (m)	NDEP FVA, plus SVAs and CVA based on 95th Percentile (m)	NDEP Accuracy Term	ASPRS Vertical Accuracy (m)	ASPRS Accuracy Term
Open Terrain	0.082	0.053	FVA	0.080	NVA
Urban Terrain	0.035	-0.013	SVA		
Bare Earth	0.087	-0.024	SVA		
High Grass	0.121	0.092	SVA	0.143	VVA
Brush	0.243	0.150	SVA		
Consolidated	0.110	0.105	CVA	n/a	n/a

Table 16: Comparison of NSSDA, NDEP, and ASPRS Statistics

3.6 Limitations of Use

The accuracy assessment confirms that the data may be used for the intended applications stated in the **Project Purpose** section of this document. The 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 Kansas Department of Agriculture.

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 that 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.

Section 4: Certification

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

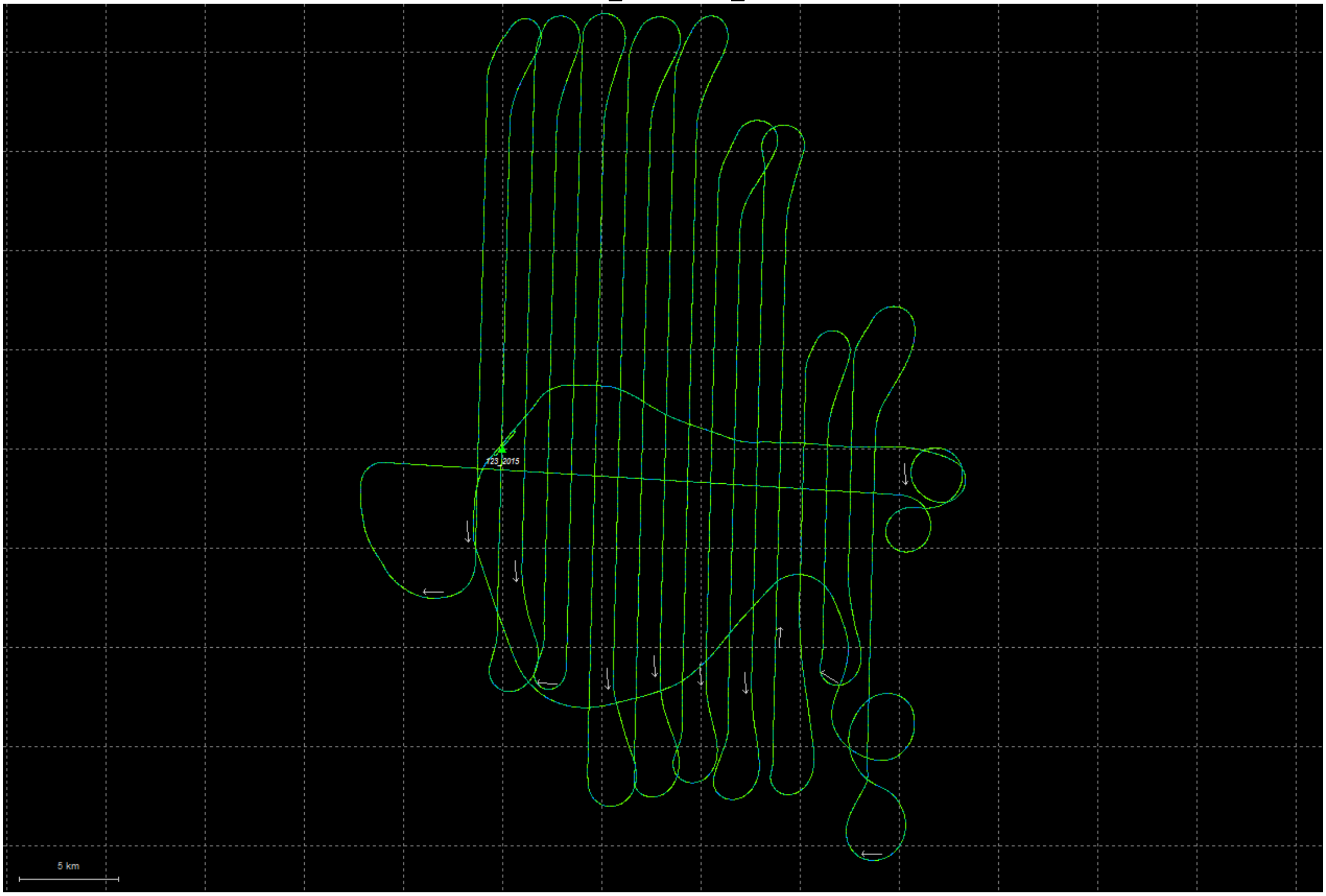
Brian J. Mayfield, ASPRS Certified Photogrammetrist #R1276

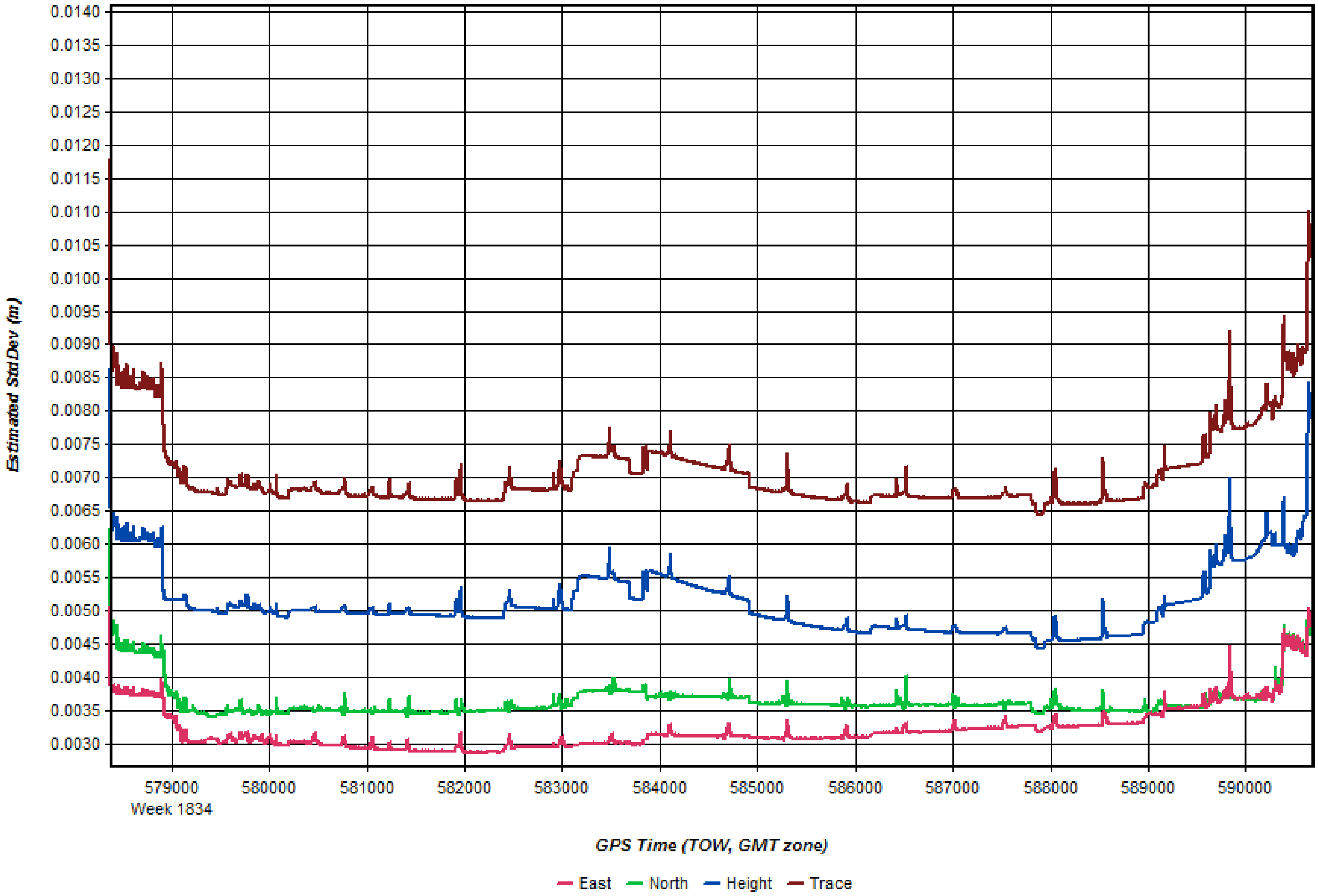
Section 5: GPS Processing

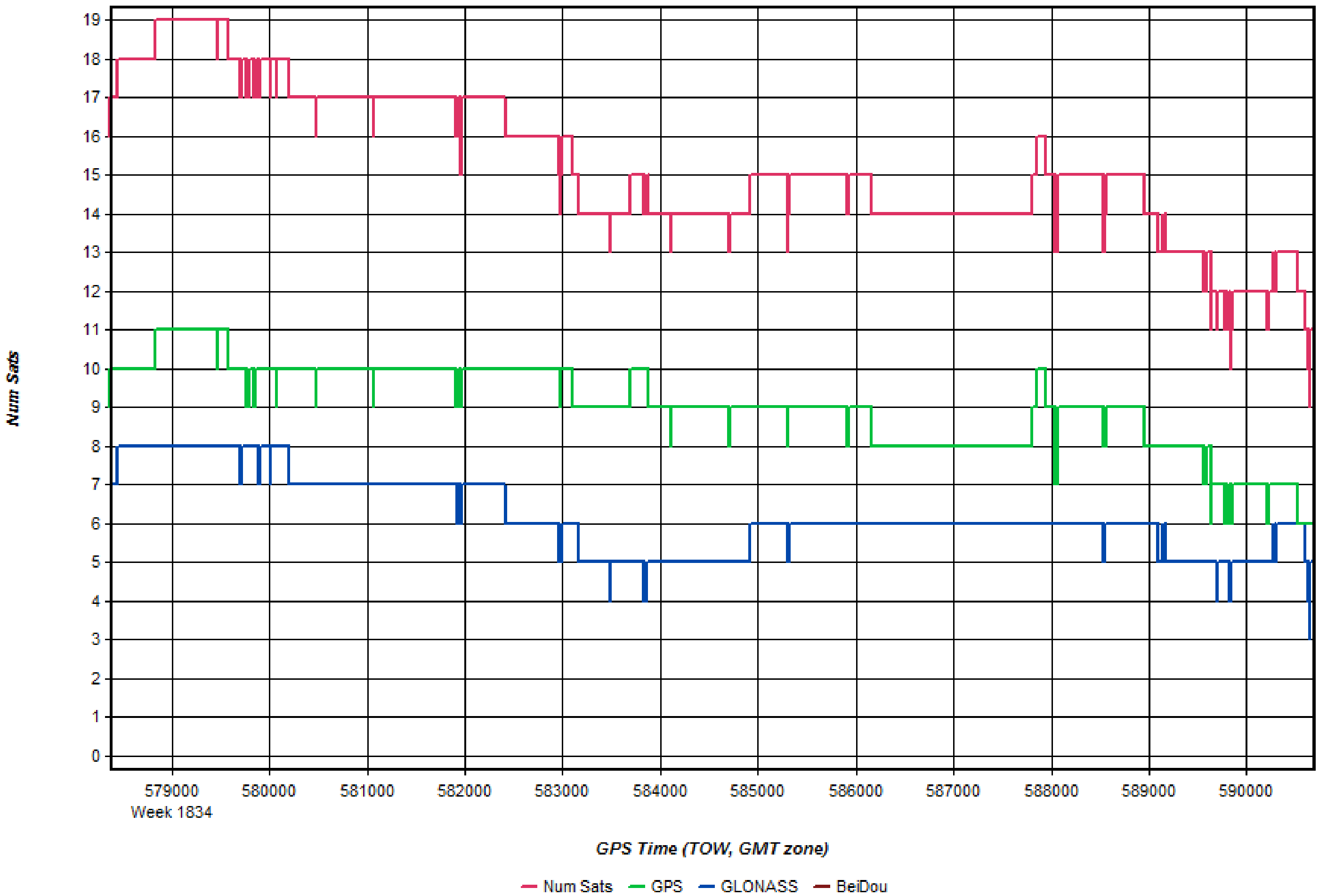
Inertial Explorer Version 8.50.4320

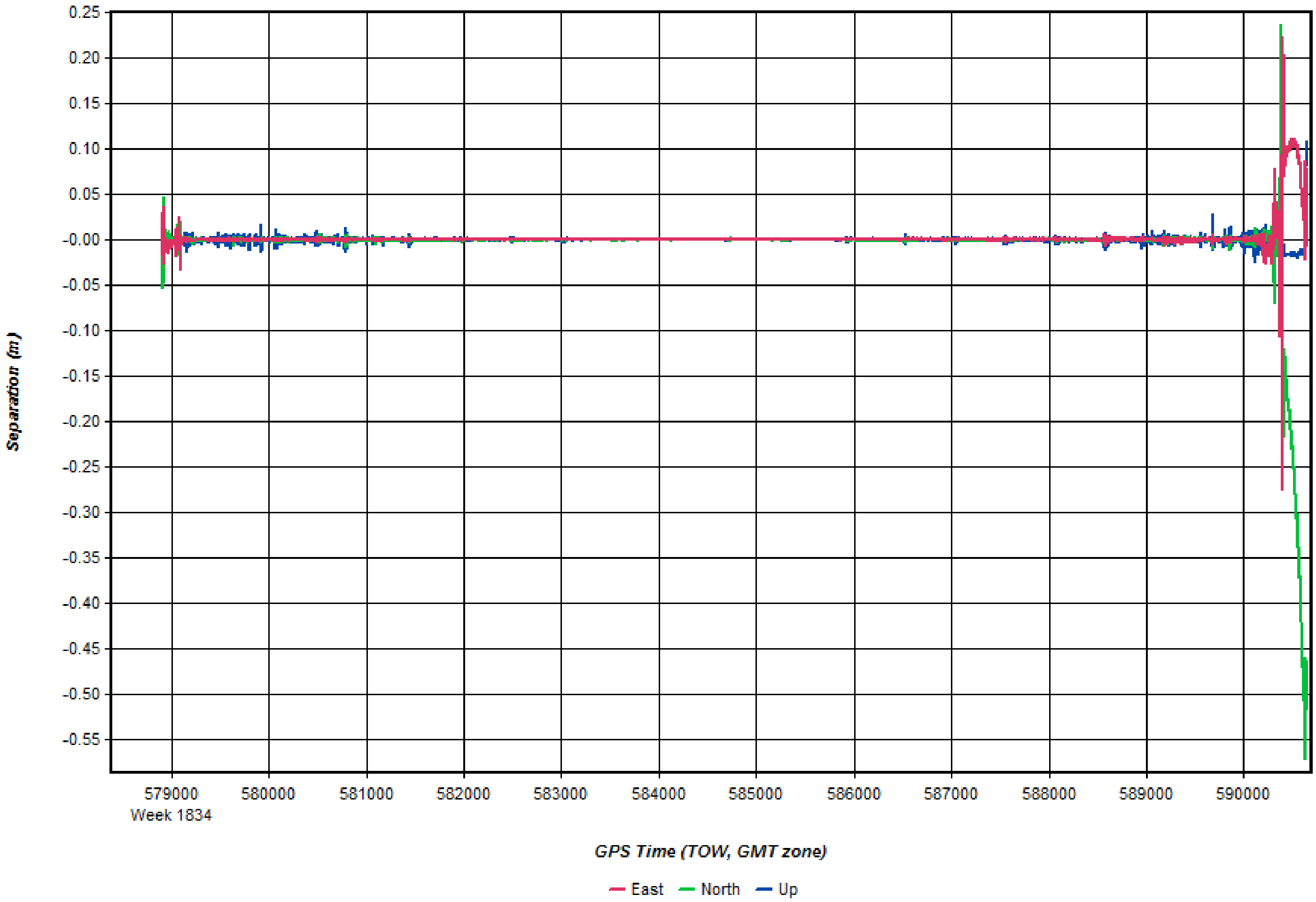
Plots by lift of the Coverage Map, Estimated Position Accuracy, Number of Satellites, Combined Separation, and PDOP.

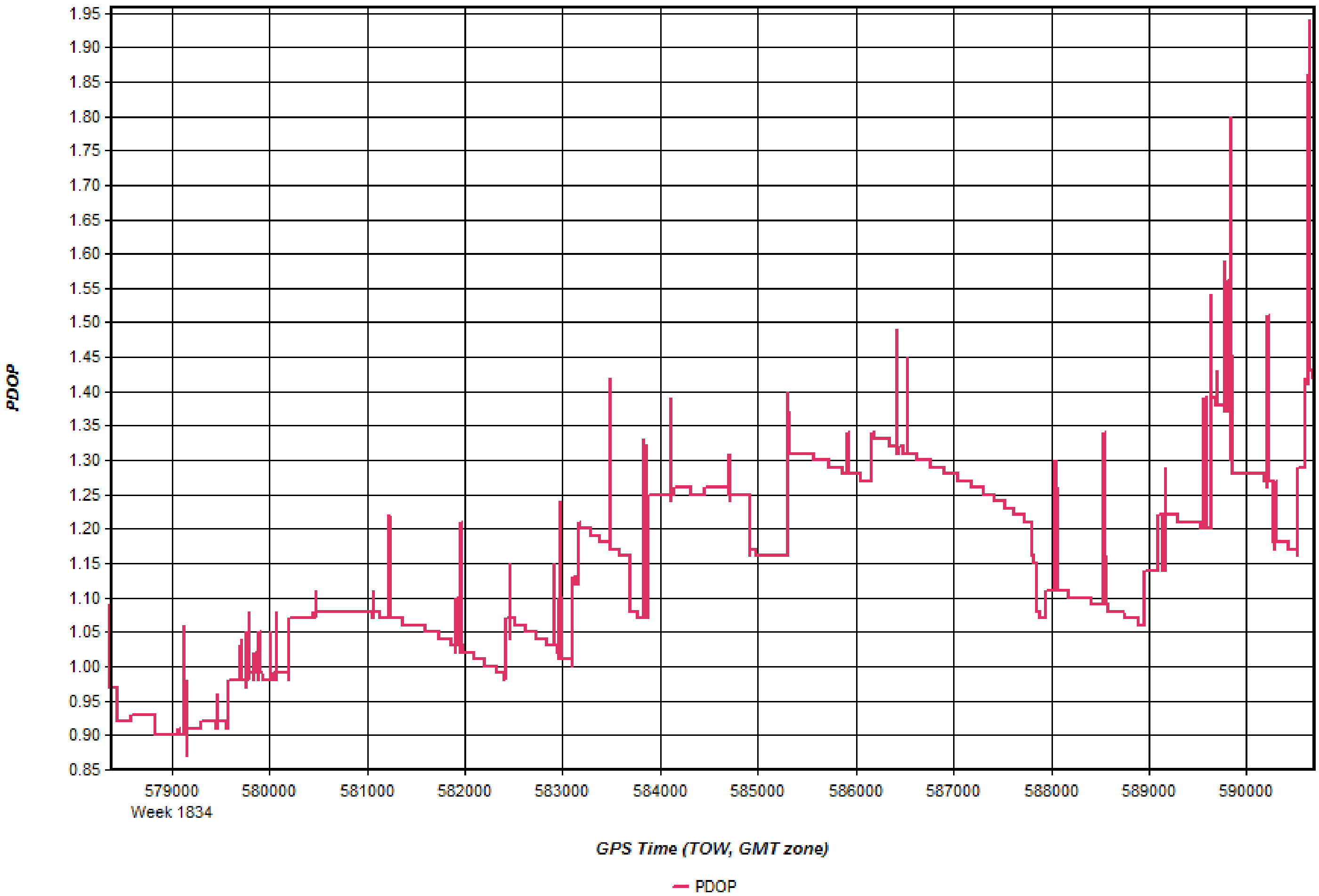
123_20150307_1




Estimated StdDev (m)
0.0140
0.0135
0.0130
0.0125
0.0120
0.0115
0.0110
0.0105
0.0100
0.0095
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
579000
Week 1834
580000
581000
582000
583000
584000
585000
586000
587000
588000
589000
590000
GPS Time (TOW, GMT zone)
East
North
Height
Trace


Num Sats
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
579000
Week 1834
580000
581000
582000
583000
584000
585000
586000
587000
588000
589000
590000
GPS Time (TOW, GMT zone)
Num Sats
GPS
GLONASS
BeiDou


Separation (m)
0.25
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
-0.40
-0.45
-0.50
-0.55
579000
Week 1834
580000
581000
582000
583000
584000
585000
586000
587000
588000
589000
590000
GPS Time (TOW, GMT zone)
East
North
Up


PDOP
1.95
1.90
1.85
1.80
1.75
1.70
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
579000
Week 1834
580000
581000
582000
583000
584000
585000
586000
587000
588000
589000
590000
GPS Time (TOW, GMT zone)
PDOP