WOOLPERT

MD/PA Sandy Supplemental Lidar

USGS/ Rolla, MO

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Section 1: Overview

Project Name: MD/PA Sandy Supplemental Lidar

Project: # 74333

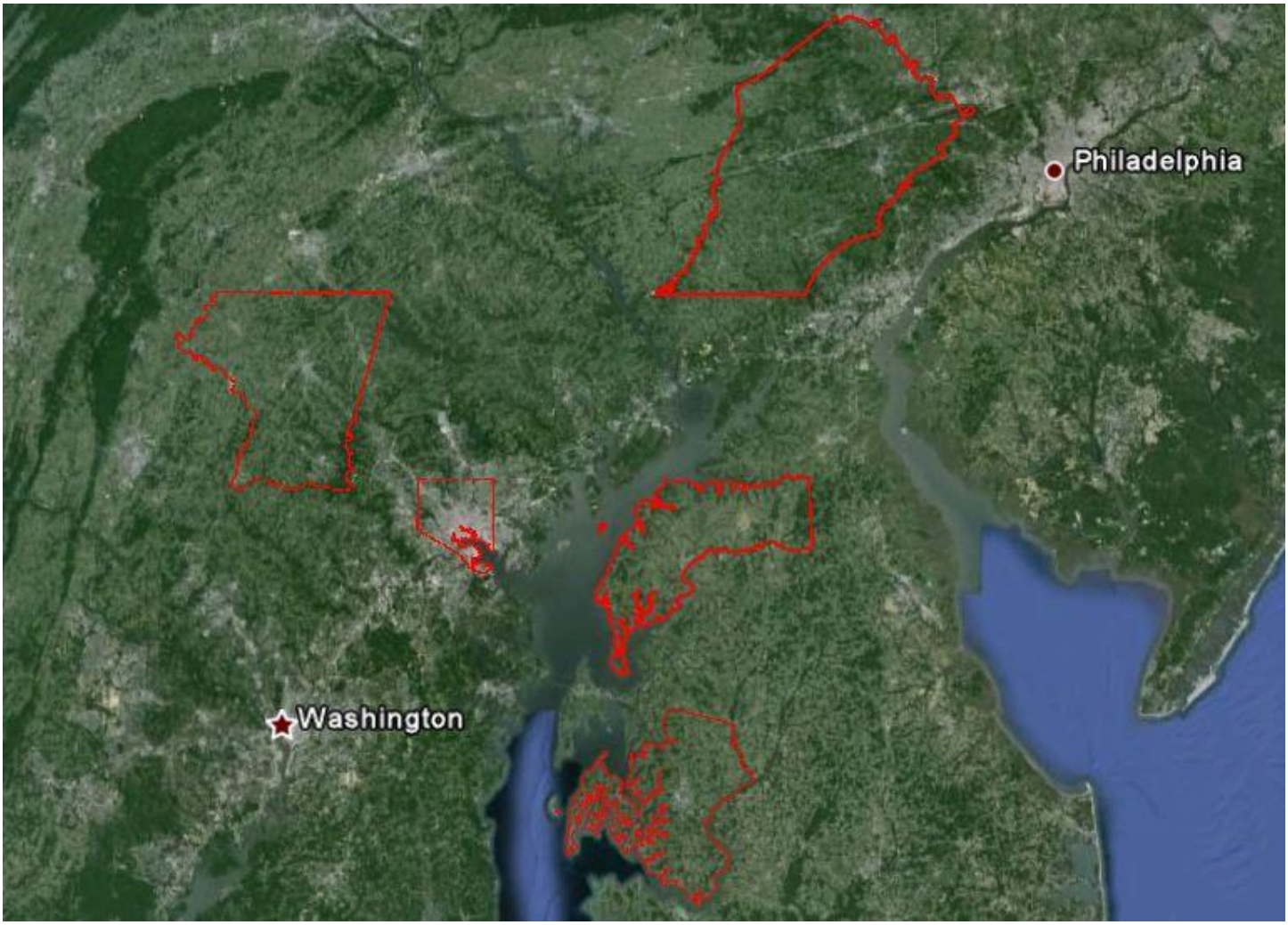
This report contains a comprehensive outline of the MD/PA Sandy Supplemental Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G14PD00397. This task order requires lidar data to be acquired over approximately 1,845 square miles of the MD/PA Sandy Supplemental Lidar. The lidar was collected and processed to meet a maximum Nominal Post Spacing (NPS) of 0.7 meter. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The data was collected using a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) lidar sensor. The ALS70 sensor collects up to four returns per pulse, as well as intensity data, for the first three returns. If a fourth return was captured, the system does not record an associated intensity value. The aerial lidar was collected at the following sensor specifications:

Table 1.1: ALS70 Specifications	**Kent & Talbot (MD)**	**Carroll & Baltimore (MD), Chester (PA)**
Post Spacing	2.3ft / 0.7 m	2.3ft / 0.7 m
AGL (Above Ground Level) average flying height	6,500 ft / 1,981 m	7,500 ft / 2,286 m
MSL (Mean Sea Level) average flying height	6,500 ft / 1,981 m	Varies
Average Ground Speed:	150 knots / 173 mph	150 knots / 173 mph
Field of View (full)	40 degrees	32 degrees
Pulse Rate	272 kHz	239 kHz
Scan Rate	41.5 Hz	40 Hz
Side Lap	25%	25%

The lidar data was processed and projected in NAD83(2011) UTM18, Meters, NAVD88 GEOID12A, in units of meter.

Figure 1.1: Lidar Task Order AOI



Section 2: Acquisition

The existing lidar data was acquired with a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar Sensor System, on board Woolpert Cessna aircraft. The ALS70 lidar system, developed by Leica Geosystems of Heerbrugg, Switzerland, includes the simultaneous first, intermediate and last pulse data capture module, the extended altitude range module, and the target signal intensity capture module. The system software is operated on an OC50 Operation Controller aboard the aircraft.

The ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar System has the following specifications:

Table 2.1: ALS Lidar System Specifications	
Operating Altitude	200 – 3,500 meters
Scan Angle	0 to 75° (variable)
Swath Width	0 to 1.5 X altitude (variable)
Scan Frequency	0 – 200 Hz (variable based on scan angle)
Maximum Pulse Rate	500 kHz (Effective)
Range Resolution	Better than 1 cm
Elevation Accuracy	7 - 16 cm single shot (one standard deviation)
Horizontal Accuracy	5 – 38 cm (one standard deviation)
Number of Returns per Pulse	7 (infinite)
Number of Intensities	3 (first, second, third)
Intensity Digitization	8 bit intensity + 8 bit AGC (Automatic Gain Control) level
MPiA (Multiple Pulses in Air)	8 bits @ 1nsec interval @ 50kHz
Laser Beam Divergence	0.22 mrad @ $1/e^2$ (~0.15 mrad @ 1/e)
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Roll Stabilization	Automatic adaptive, range = 75 degrees minus current FOV
Power Requirements	28 VDC @ 25A
Operating Temperature	0-40°C
Humidity	0-95% non-condensing
Supported GNSS Receivers	Ashtech Z12, Trimble 7400, Novatel Millenium

Prior to mobilizing to the project site, Woolpert flight crews coordinated with the necessary Air Traffic Control personnel to ensure airspace access.

Woolpert survey crews were onsite, operating a Global Navigation Satellite System (GNSS) Base Station for the airborne GPS support.

The lidar data was collected in seventeen (17) separate missions, flown as close together as the weather permitted, to ensure consistent ground conditions across the project area.

An initial quality control process was performed immediately on the lidar data to review the data coverage, airborne GPS data, and trajectory solution. Any gaps found in the lidar data were relayed to the flight crew, and the area was re-flown.

Figure 2.1: Lidar Flight Layout, MD/PA Sandy Supplemental Lidar

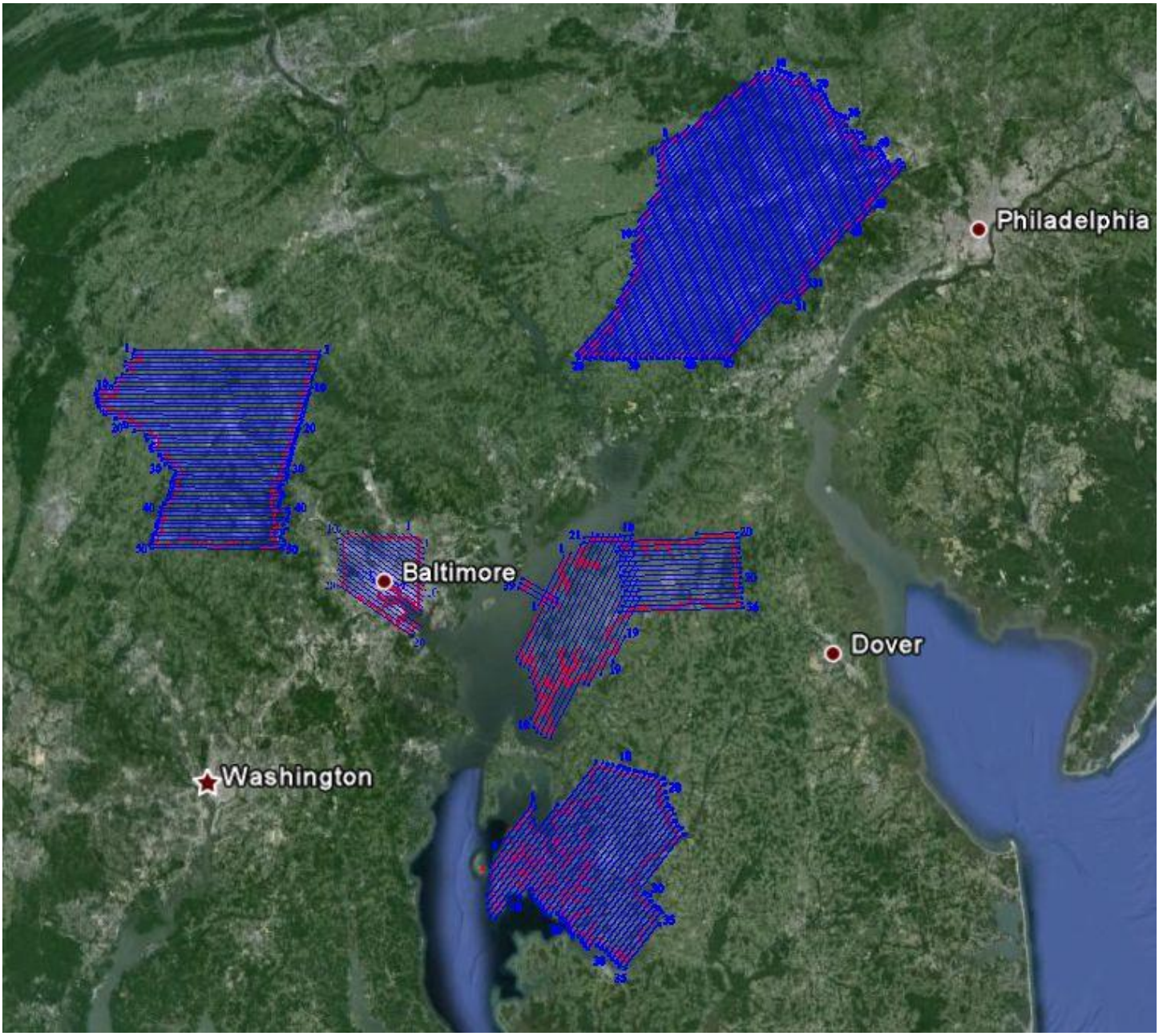


Table 2.2: Airborne Lidar Acquisition Flight Summary

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down	Mission Time (Local = EDT) Wheels Up/ Wheels Down
December 7, 2014 – Sensor ALS-7108	Chester (PA) 1-18	19:20 – 23:50	2:20 PM – 6:50 PM
December 15, 2014 – Sensor ALS-7108-A	Baltimore (MD) 1-22	22:05 – 2:40	5:05 PM – 9:40 PM
December 15, 2014 – Sensor ALS-7108-B	KENT (MD) 1-6, 37-39	22:05 – 2:40	5:05 PM – 9:40 PM
December 15, 2014 – Sensor ALS-7177	Carroll (MD)1-25	20:35 – 2:20	3:35 PM – 9:20 PM
December 17, 2014 – Sensor ALS-7108	KENT (MD) 7-8, 13-14, 34-36	13:36 – 16:30	8:36 AM – 11:30 AM
December 17, 2014 – Sensor ALS-7177	Carroll (MD)26-35, 50	23:05 – 2:10	6:05 PM – 9:10 PM
December 18, 2014 – Sensor ALS-7108	Talbot(MD) 1-7	12:20 – 14:03	07:20 AM – 09:03AM
December 19, 2014 – Sensor ALS-7108	KENT (MD) 26-33 Talbot(MD) 8-24	22:00 – 03:10	05:00 PM – 10:10PM
December 20, 2014 – Sensor ALS-7108	Talbot(MD) 25-29 KENT (MD) 9-11	13:50 – 16:15	08:50AM – 11:15AM
December 21, 2014 – Sensor ALS-7108-A	Talbot(MD) 30-35 KENT (MD) 9-12	14:00 – 16:05	09:00AM – 11:05AM
December 21, 2014 – Sensor ALS-7108-B	KENT (MD) 20-25	17:08 – 18:45	12:08AM – 13:45PM
December 26, 2014 – Sensor ALS-7108	CARROLL (MD) 26-29, 32-50	21:40 – 01:55	04:40PM – 08:55PM
December 27, 2014 – Sensor ALS-7108	Chester (PA) 19-28	14:20 – 18:37	08:20PM – 06:37PM
December 29, 2014 – Sensor ALS-7108	Chester (PA) 29-40	14:20 – 18:37	08:20PM – 06:37PM
December 30, 2014 – Sensor ALS-7108	Talbot(MD) 7-9	22:00-23:25	05:00PM -06:25PM
December 31, 2014 – Sensor ALS-7108	Chester (PA) 37, 40-51	13:05 – 17:06	08:05 AM – 05:06 PM
January 2, 2015 – Sensor ALS-7108	Chester (PA) 27	18:05 – 19:20	01:05PM – 02:20PM

Section 3: Lidar Data Processing

Applications and Work Flow Overview

1. Resolved kinematic corrections for three subsystems: inertial measurement unit (IMU), sensor orientation information and airborne GPS data. Developed a blending post-processed aircraft position with attitude data using Kalman filtering technology or the smoothed best estimate trajectory (SBET).
   Software: POSPac Software v. 5.3, IPAS Pro v.1.35.
2. Calculated laser point position by associating the SBET position to each laser point return time, scan angle, intensity, etc. Created raw laser point cloud data for the entire survey in LAS format. Automated line-to-line calibrations were then performed for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift.
   Software: ALS Post Processing Software v.2.75 build #25, Proprietary Software, TerraMatch v. 15.01.
3. Imported processed LAS point cloud data into the task order tiles. Resulting data were classified as ground and non-ground points with additional filters created to meet the task order classification specifications. Statistical absolute accuracy was assessed via direct comparisons of ground classified points to ground RTK survey data. Based on the statistical analysis, the lidar data was then adjusted to reduce the vertical bias when compared to the survey ground control.
   Software: TerraScan v.15.01.
4. The LAS files were evaluated through a series of manual QA/QC steps to eliminate remaining artifacts from the ground class.
   Software: TerraScan v.15.01.

Global Navigation Satellite System (GNSS) – Inertial Measurement Unit (IMU) Trajectory Processing

Equipment

Flight navigation during the lidar data acquisition mission is performed using IGI CCNS (Computer Controlled Navigation System). The pilots are skilled at maintaining their planned trajectory, while holding the aircraft steady and level. If atmospheric conditions are such that the trajectory, ground speed, roll, pitch and/or heading cannot be properly maintained, the mission is aborted until suitable conditions occur.

The aircraft are all configured with a NovAtel Millennium 12-channel, L1/L2 dual frequency Global Navigation Satellite System (GNSS) receivers collecting at 2 Hz.

All Woolpert aerial sensors are equipped with a Litton LN200 series Inertial Measurement Unit (IMU) operating at 200 Hz.

A base-station unit was mobilized for each acquisition mission where a CORS station was not utilized, and was operated by a member of the Woolpert acquisition team. Each base-station setup consisted of one Trimble 4000 – 5000 series dual frequency receiver, one Trimble Compact L1/L2 dual frequency antenna, one 2-meter fixed-height tripod, and essential battery power and cabling. Ground planes were used on the base-station antennas. Data was collected at 1 or 2 Hz.

The GNSS base station operated during the Lidar acquisition missions is listed below:

Table 3.1: GNSS Base Station

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
CHES CORS	39° 57' 05.91985"	75° 36' 01.15232"	109.495
KDMW Airport Base	39° 36' 20.64081"	77° 00' 09.26969"	206.254
KESN Airport Base	38° 48' 41.37160"	76° 03' 52.25387"	-13.807
NGS PID JV6476	39° 19' 57.88919"	76° 25' 38.50186"	-26.699
UMBC CORS	39° 15' 24.39056"	76° 42' 41.46818"	66.007

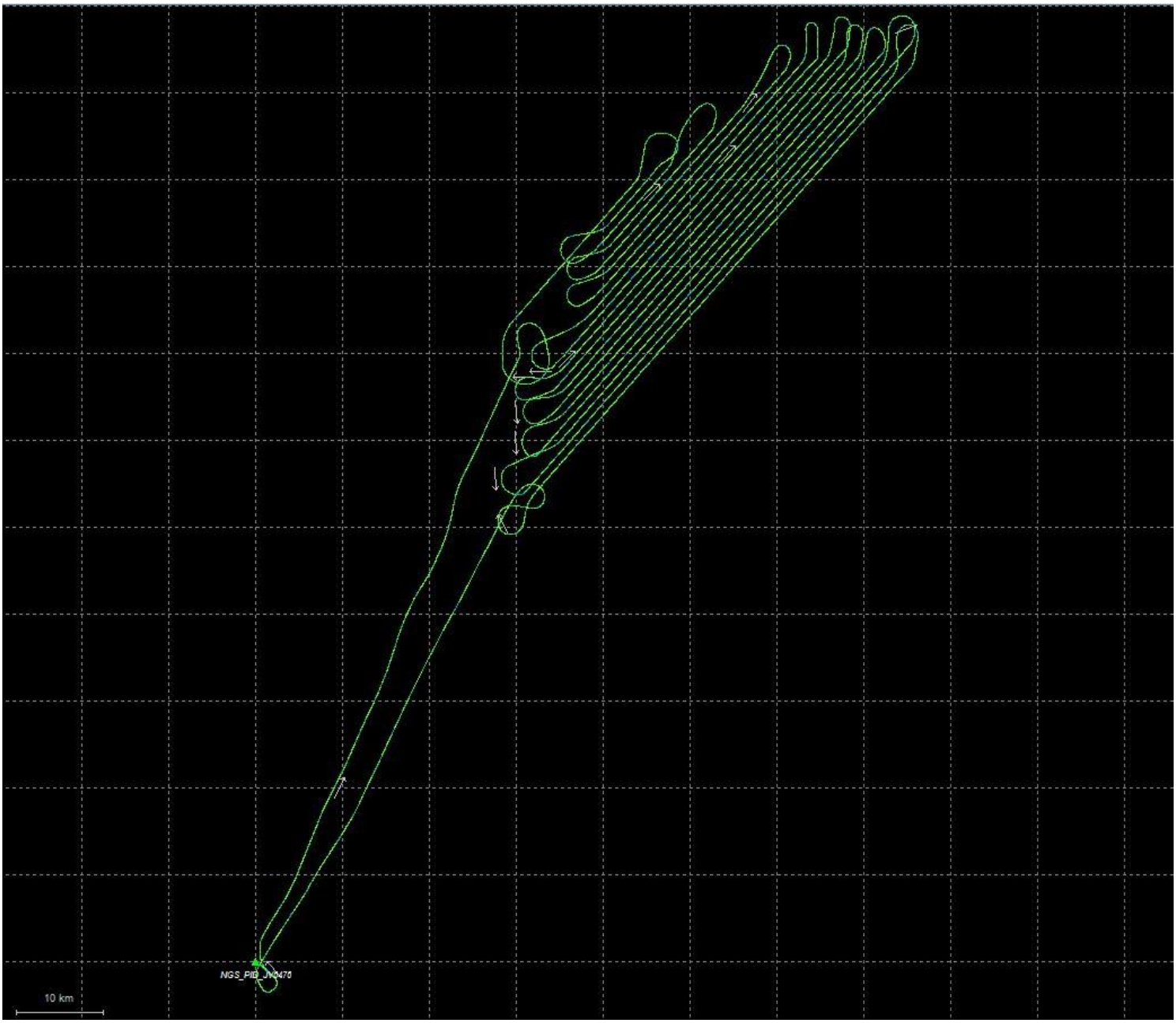
Data Processing

All airborne GNSS and IMU data was post-processed and quality controlled using Applanix MMS software. GNSS data was processed at a 1 and 2 Hz data capture rate and the IMU data was processed at 200 Hz.

Trajectory Quality

The GNSS Trajectory, along with high quality IMU data are key factors in determining the overall positional accuracy of the final sensor data. Within the trajectory processing, there are many factors that affect the overall quality, but the most indicative are the Combined Separation, the Estimated Positional Accuracy, and the Positional Dilution of Precision (PDOP).

Figure 3.1: Trajectory, Day34114_SH7108

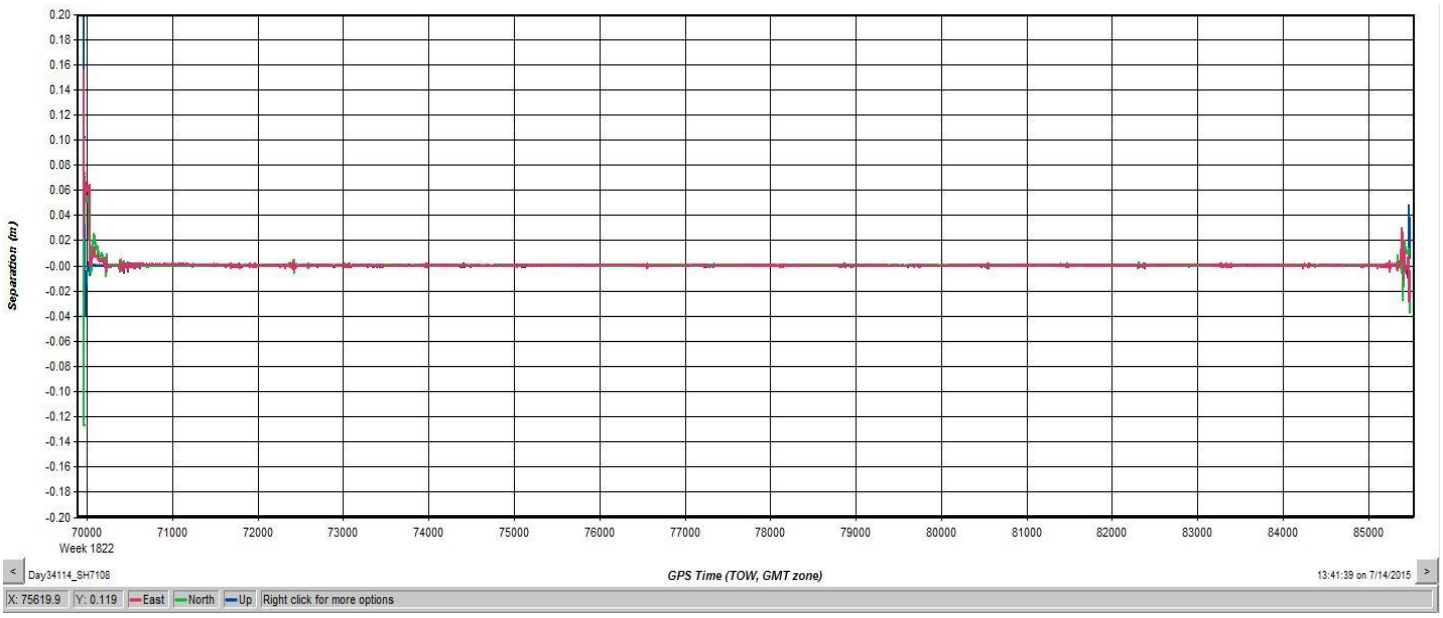


Combination Separation

The Combined Separation is a measure of the difference between the forward run and the backward run solution of the trajectory. The Kalman filter is processed in both directions to remove the combined directional anomalies. In general, when these two solutions match closely, an optimally accurate reliable solution is achieved.

Woolpert's goal is to maintain a Combined Separation Difference of less than ten (10) centimeters. In most cases we achieve results below this threshold.

Figure 3.2: Combined Separation, Day34114_SH7108

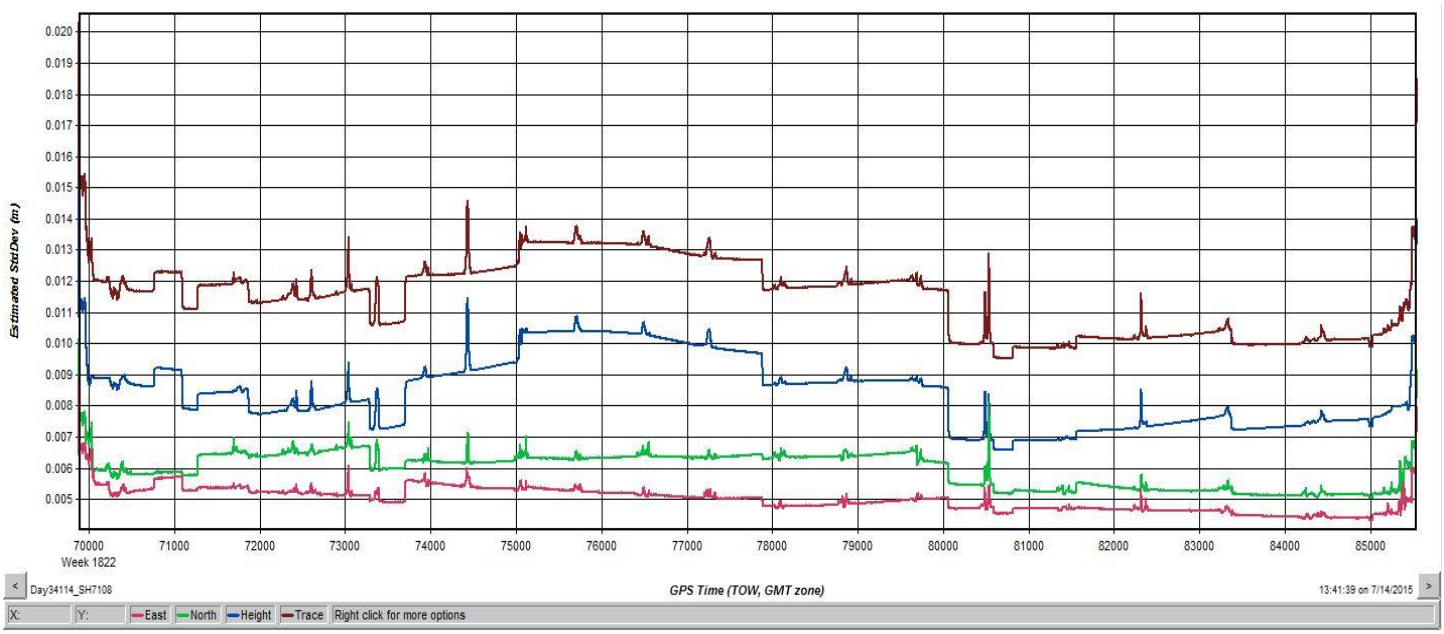


Estimated Positional Accuracy

The Estimated Positional Accuracy plots the standard deviations of the east, north, and vertical directions along a time scale of the trajectory. It illustrates loss of satellite lock issues, as well as issues arising from long baselines, noise, and/or other atmospheric interference.

Woolpert's goal is to maintain an Estimated Positional Accuracy of less than ten (10) centimeters, often achieving results well below this threshold.

Figure 3.3: Estimated Positional Accuracy, Day34114_SH7108

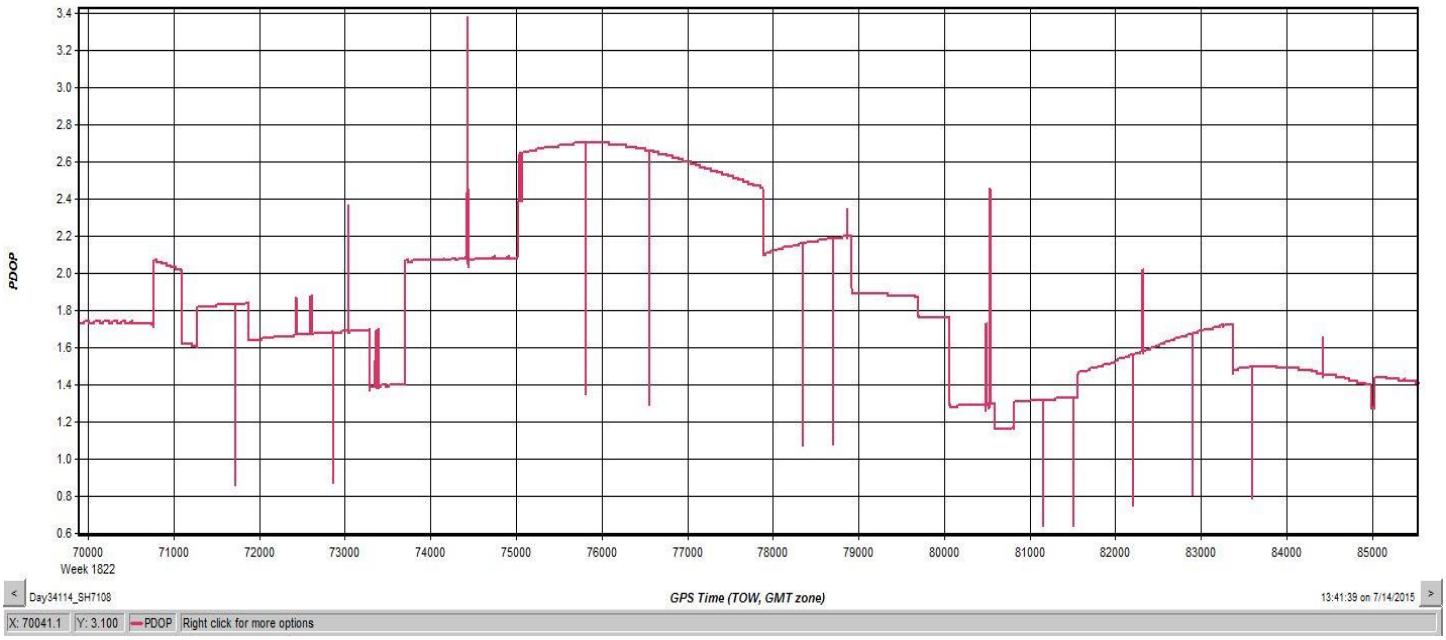


PDOP

The PDOP measures the precision of the GPS solution in regards to the geometry of the satellites acquired and used for the solution.

Woolpert's goal is to maintain an average PDOP value below 3.0. Brief periods of PDOP over 3.0 are acceptable due to the calibration and control process if other metrics are within specification.

Figure 3.4: PDOP, Day34114_SH7108



Lidar Data Processing

When the sensor calibration, data acquisition, and GPS processing phases were complete, the formal data reduction processes by Woolpert lidar specialists included:

- Processed individual flight lines to derive a raw “Point Cloud” LAS file. Matched overlapping flight lines, generated statistics for evaluation comparisons, and made the necessary adjustments to remove any residual systematic error.
- Calibrated LAS files were imported into the task order tiles and initially filtered to create a ground and non-ground class. Then additional classes were filtered as necessary to meet client specified classes.
- Once all project data was imported and classified, survey ground control data was imported and calculated for an accuracy assessment. As a QC measure, Woolpert has developed a routine to generate accuracy statistical reports by comparisons against the TIN and the DEM using surveyed ground control of higher accuracy. The lidar is adjusted accordingly to meet or exceed the vertical accuracy requirements.
- The lidar tiles were reviewed using a series of proprietary QA/QC procedures to ensure it fulfills the task order requirements. A portion of this requires a manual step to ensure anomalies have been removed from the ground class.
- The lidar LAS files are classified into the Default (Class 1), Ground (Class 2), Low Noise (Class 7), Water (Class 9), Ignored Ground (Class 10), Overlap Default (Class 17) and Overlap Ground (Class 18) classifications.
- FGDC Compliant metadata was developed for the task order in .xml format for the final data products.
- The horizontal datum used for the task order was referenced to NAD83(2011) UTM18, Meters. The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12A. Coordinate positions were specified in units of meters.
- Coastal tiles 18SVH065720 and 18SVH095690 contain no lidar points as they exist completely in water. A DEM IMG was generated for these two tiles as the digitized hydro breakline assumed the data extent in the area. As such only 2568 LAS and Intensity files will be delivered along with 2570 DEM IMG's.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

MD/PA Sandy Supplemental Lidar processing task order required the compilation of breaklines defining water bodies and rivers. The breaklines were used to perform the hydrologic flattening of water bodies, and gradient hydrologic flattening of double line streams and rivers. Lakes, reservoirs and ponds, at a minimum size of 2-acre or greater, were compiled as closed polygons. The closed water bodies were collected at a constant elevation. Rivers and streams, at a nominal minimum width of 30 meters (100 feet), were compiled in the direction of flow with both sides of the stream maintaining an equal gradient elevation.

LIDAR DATA REVIEW AND PROCESSING

Woolpert utilized the following steps to hydrologically flatten the water bodies and for gradient hydrologic flattening of the double line streams within the existing lidar data.

1. Woolpert used the newly acquired lidar data to manually draw the hydrologic features in a 2D environment using the lidar intensity and bare earth surface. Open Source imagery was used as reference when necessary.
2. Woolpert utilizes an integrated software approach to combine the lidar data and 2D breaklines. This process “drapes” the 2D breaklines onto the 3D lidar surface model to assign an elevation. A monotonic process is performed to ensure the streams are consistently flowing in a gradient manner. A secondary step within the program verifies an equally matching elevation of both stream edges. The breaklines that characterize the closed water bodies are draped onto the 3D lidar surface and assigned a constant elevation at or just below ground elevation.
3. The lakes, reservoirs and ponds, at a minimum size of 1-acre or greater and streams at a minimum size of 15 meters (50 feet) nominal width, were compiled to meet task order requirements. **Figure 4.1** illustrates an example of 15 meters (50 feet) nominal streams identified and defined with hydrologic breaklines. The breaklines defining rivers and streams, at a nominal minimum width of 15 meters (50 feet), were draped with both sides of the stream maintaining an equal gradient elevation.
4. All ground points were reclassified from inside the hydrologic feature polygons to water, class nine (9).
5. All ground points were reclassified from within a buffer along the hydrologic feature breaklines to buffered ground, class ten (10).
6. The lidar ground points and hydrologic feature breaklines were used to generate a new digital elevation model (DEM).

Figure 4.1: Example Hydrologic Breaklines

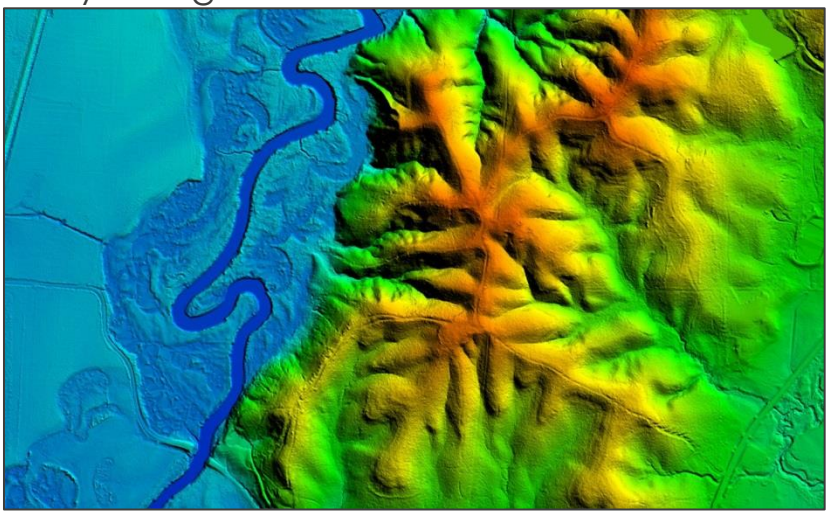


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

Figure 4.3 reflects a DEM generated from lidar with breaklines compiled to define the hydrologic features. This figure illustrates the results of adding the breaklines to hydrologically flatten the DEM data. Note the smooth appearance of the lake surface in the DEM.

Figure 4.2

Figure 4.3

Terrascan was used to add the hydrologic breakline vertices and export the lattice models. The hydrologically flattened DEM data was provided to USGS in ERDAS .IMG format.

The hydrologic breaklines compiled as part of the flattening process were provided to the USGS as an ESRI Shapefile The breaklines defining the water bodies greater than 2-acre and for the gradient flattening of all rivers and streams at a nominal minimum width of 30 meters (100 feet) were provided as a Polygon-Z feature class.

DATA QA/QC

Initial QA/QC for this task order was performed in Global Mapper v15, by reviewing the grids and hydrologic breakline features. Additionally, ESRI software and proprietary methods were used to review the overall connectivity of the hydrologic breaklines.

Edits and corrections were addressed individually by tile. If a water body breakline needed to be adjusted to improve the flattening of the DEM data, the area was cross referenced by tile number, corrected accordingly, a new DEM file was regenerated and reviewed.

Section 5: ACCURACY ASSESSMENT

Accuracy Assessment

The vertical accuracy statistics were calculated by comparison of the lidar bare earth points to the ground surveyed QA/QC points.

Table 5.1: Overall Vertical Accuracy Statistics,		
Average error	0.059	meter
Minimum error	-0.055	meter
Maximum error	0.186	meter
Average magnitude	0.073	meter
Root mean square	0.086	meter
Standard deviation	0.064	meter

Table 5.2: Raw Swath Quality Check Point Analysis FVA

Point ID	Easting (meter)	Northing (meter)	TIN Elevation (meter)	Dz (meter)
2001	310957.218	4398527.428	154.860	0.055
2002	339500.097	4395756.627	242.310	-0.046
2003	323348.217	4385756.099	195.420	-0.012
2004	335294.474	4376296.827	214.600	0.042
2005	324076.297	4368066.93	224.610	0.032
2006	334444.396	4362736.987	167.050	0.065
2007	423113.556	4438387.73	201.170	0.186
2008	455818.826	4441685.418	59.290	0.077
2009	443784.265	4454824.264	41.560	0.086
2010	455807.07	4433402.419	85.270	0.172
2011	448972.836	4424230.976	131.220	0.085
2012	412187.683	4398530.084	150.180	-0.024
2013	438095.792	4410141.536	83.540	-0.042
2014	427222.667	4346004.855	6.980	0.069
2015	410293.07	4399124.268	107.690	0.157
2016	407198.496	4341568.508	12.500	0.08
2017	406462.331	4338069.596	6.590	0.05
2018	393274.884	4333530.979	4.250	0.019
2019	393160.564	4332319.785	3.210	0.125
2020	408586.758	4357696.1	24.730	-0.055
2021	407853.195	4279229.246	16.050	0.094
2022	406906.508	4291125.984	10.960	0.145
2023	413573.654	4303804.77	15.840	0.093
2024	389156.591	4299570.915	3.220	0.104
2025	393371.221	4294432.281	3.210	0.021
2026	354270.247	4349071.004	48.180	-0.025
2027	356987.502	4357941.204	118.450	-0.017
2028	367471.51	4358672.896	100.570	0.065

2029	366811.893	4353618.911	26.890	0.118
2030	361226.822	4347857.236	15.090	-0.004
2031	318401.943	4364598.291	235.120	0.096
2032	364131.218	4358782.778	93.750	0.063
2035	407600.266	4341543.472	18.910	0.082

VERTICAL ACCURACY CONCLUSIONS

Raw LAS Swath Fundamental Vertical Accuracy (FVA) Tested 0.168 meters fundamental vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using 0.086 (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using all points.

LAS Swath Fundamental Vertical Accuracy (FVA) Tested 0.154 meters fundamental vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using 0.079 (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN.

Bare-Earth DEM Fundamental Vertical Accuracy (FVA) Tested 0.156 meters fundamental vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using 0.08 (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM.

SUPPLEMENTAL VERTICAL ACCURACY ASSESSMENTS

Table 5.3: Urban Land Cover Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
3001	310786.668	4398670.525	151.880	-0.031
3002	339311.229	4395272.922	241.010	-0.065
3003	329545.648	4382625.017	226.050	-0.009
3004	337163.211	4373378.551	171.530	0.07
3005	324145.724	4368110.894	227.200	-0.001
3006	334311.51	4362628.749	168.740	0.038
3007	423076.99	4438387.114	202.440	0.043
3008	455861.739	4441655.516	59.740	0.019
3009	443701.819	4454410.518	49.450	0.035
3010	455790.203	4433399.999	85.350	0.019
3011	448938.118	4424269.91	132.330	-0.035
3012	439707.135	4410861.095	91.850	-0.092
3013	437612.043	4410338.748	84.890	-0.07
3014	427505.735	4345893.942	7.590	0.013
3015	427882.533	4346160.347	8.970	-0.021
3016	407224.018	4341539.209	13.340	-0.019
3017	407915.672	4340138.976	1.300	0.075
3018	393230.734	4333577.266	4.060	-0.038

3019	393215.495	4332319.88	3.140	-0.018
3020	408508.645	4357660.586	25.150	-0.024
3021	407852.593	4279502.014	16.510	0.062
3022	407230.33	4291277.374	11.940	0.045
3023	407943.976	4292813.63	14.980	0.053
3024	393648.481	4293548.716	2.680	-0.067
3025	394393.623	4293411.414	1.830	-0.04
3026	354319.447	4349112.437	47.180	-0.056
3027	353042.17	4357927.223	142.630	0.036
3028	366783.081	4358979.9	98.760	0.023
3029	366688.973	4353700.116	28.960	0.065
3030	361266.855	4346747.138	3.110	-0.038
3031	328143.627	4385915.656	234.940	-0.056
3032	393212.394	4332338.701	3.420	-0.011
3033	443939.972	4434143.208	158.260	-0.041

VERTICAL ACCURACY CONCLUSIONS

Urban Land Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.072 meters supplemental vertical accuracy at the 95th percentile in the Urban supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. Urban Errors larger than 95th percentile include:
Point 3012, Easting 439707.135, Northing 4410861.095, Z-Error 0.092 meters
Point 3017, Easting 407915.672, Northing 4340138.976, Z-Error 0.075 meters

Table 5.4: Tall Weeds/Crops Land Cover Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
4001	310837.049	4398178.389	152.690	0.063
4002	338595.381	4394542.883	245.370	-0.021
4003	322853.325	4386105.054	201.580	0.023
4004	330952.629	4380938.222	267.060	0.033
4005	324018.725	4367853.611	215.740	0.114
4006	333539.88	4362994.677	183.860	0.094
4007	423108.171	4438341.165	201.170	0.209
4008	440718.821	4441618.792	204.130	0.097
4009	443417.319	4453413.752	87.680	0.134
4010	447397.836	4432197.728	100.920	0.092
4011	445223.945	4424384.786	104.450	-0.019
4012	420749.422	4412849.685	193.960	0.158
4013	410434.749	4399541.052	130.560	0.225
4014	433048.45	4358247.776	16.740	0.061
4015	424692.895	4353832.081	18.710	0.086
4016	423997.315	4345354.053	4.070	0.124
4017	407230.34	4338008.827	4.890	0.086

4018	393642.083	4338585.564	7.530	0.149
4019	396731.889	4329827.329	4.190	0.145
4020	408493.968	4355459.584	24.680	0.061
4021	412364.659	4273954.208	7.260	0.108
4022	406202.133	4288991.591	5.940	0.237
4023	414342.811	4304304.34	13.200	0.12
4024	406796.303	4307800.901	14.850	0.203
4025	389036.525	4299503.525	0.380	0.139
4026	322446.337	4368769.605	233.380	0.114
4027	445300.308	4424383.257	103.800	0.007
4028	430508.42	4398082.547	102.470	0.023
4029	423686.016	4345804.751	10.690	0.041
4030	405615.03	4288984.54	5.830	0.155
4031	312602.147	4394431.817	147.580	-0.017
4035	389604.026	4299028.237	5.040	0.061

VERTICAL ACCURACY CONCLUSIONS

Tall Weeds/Crops Land Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.216 meters supplemental vertical accuracy at the 95th percentile in the Tall Weeds/Crops supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. There were no Tall Weeds/Crops Errors exceeding the 95th percentile. Tall Weeds/Crops Errors at the 95th percentile include:
Point 4013, Easting 410434.749, Northing 4399541.052, Z-Error 0.225 meters
Point 4022, Easting 406202.133, Northing 4288991.591, Z-Error 0.237 meters

Table 5.5: Brushlands/Trees Land Cover Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
5001	339998.564	4387419.951	244.230	0.056
5002	338572.969	4394574.623	248.020	0.096
5003	323409.566	4385728.119	187.690	0.031
5004	334105.842	4378324.037	246.320	0.098
5005	330889.205	4381015.753	259.990	0.144
5006	334309.503	4363034.812	155.180	0.260
5007	443990.654	4454478.101	47.520	0.158
5008	427424.043	4436769.384	200.450	0.285
5009	426366.854	4354632.245	8.640	0.077
5010	449353.095	4432173.955	106.170	0.069
5012	455801.394	4425834.895	106.960	0.024
5013	430179.878	4406255.037	120.640	0.055
5014	433420.256	4348819.307	18.860	0.196
5015	423751.282	4345809.393	10.950	0.267

5016	404722.792	4344263.098	20.630	0.057
5018	390617.674	4337297.091	5.420	0.094
5019	396663.840	4329853.916	4.930	0.149
5020	408493.100	4355564.130	24.460	0.089
5021	411487.960	4274725.188	7.150	0.199
5022	410604.081	4296472.997	14.510	0.262
5023	413132.894	4299188.462	15.920	0.252
5024	407325.088	4308607.182	15.780	0.187
5025	389033.156	4299534.704	0.420	0.197
5027	422592.425	4415332.468	166.000	0.194
5029	399613.958	4330399.347	1.650	0.086
5030	425051.757	4346574.558	3.110	0.174
5031	391304.943	4296874.538	2.240	0.250
5032	421807.029	4408221.498	162.040	0.104
5035	394102.308	4292820.911	2.610	0.134

VERTICAL ACCURACY CONCLUSIONS

Brushlands/Trees Land Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.265 meters supplemental vertical accuracy at the 95th percentile in the Brushlands/Trees supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. Brushlands/Trees Errors larger than 95th percentile include:
Point 5008, Easting 427424.043, Northing 4436769.384, Z-Error 0.285 meters
Point 5015, Easting 423751.282, Northing 4345809.393, Z-Error 0.267 meters

Table 5.6: Forested and Fully Grown Land Cover Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
6016	427937.523	4356293.219	15.400	0.053
6017	405525.583	4341009.485	16.880	-0.043
6019	433681.534	4349110.963	17.370	0.118
6022	411683.054	4273830.285	7.450	0.078
6023	412317.637	4273948.885	7.140	0.039
6026	354150.646	4348325.345	57.350	0.041
6027	356096.441	4350116.245	56.620	0.018
6028	363359.333	4355673.717	70.650	0.042
6029	364022.369	4358750.812	96.550	0.082
6030	361080.559	4344932.773	3.640	0.065
6101	317679.805	4397256.560	151.400	-0.025
6102	327357.774	4391870.343	227.320	0.026
6103	335149.851	4394350.323	230.460	0.005
6104	341983.900	4384458.667	249.630	-0.002
6105	341609.523	4382972.584	244.830	-0.176
6106	327284.969	4366677.952	222.640	0.215

6107	317367.686	4363908.848	201.800	0.048
6108	423066.294	4438597.203	203.050	0.049
6109	433625.735	4447422.618	219.800	0.121
6110	461826.511	4436977.460	61.210	0.081
6111	408562.142	4357733.901	23.560	0.001
6112	446270.936	4418315.919	52.990	0.037
6113	453558.850	4422346.803	85.110	-0.034
6114	409514.941	4399681.290	94.120	0.101
6115	411988.595	4397832.633	147.620	0.034
6116	427953.500	4356333.043	16.190	0.027
6117	405573.897	4341050.451	17.350	-0.003
6119	433697.747	4349177.806	17.970	0.278
6122	411659.947	4273922.272	7.310	0.074
6123	412315.806	4273987.761	7.220	0.108
6126	354183.810	4348373.314	57.480	0.082
6127	356117.139	4350030.829	56.360	0.032
6128	363371.704	4355651.470	70.580	-0.015
6129	364039.134	4358733.863	96.030	0.091
6130	361074.502	4344895.261	4.120	0.064
6222	411633.947	4273885.625	7.220	0.057
6223	412371.869	4273912.609	7.110	0.011

VERTICAL ACCURACY CONCLUSIONS

Forested and Fully Grown Land Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.146 meters supplemental vertical accuracy at the 95th percentile in the Forested/Fully Grown supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. Forested/Fully Grown Errors larger than 95th percentile include:
Point 6105, Easting 341609.523, Northing 4382972.584, Z-Error 0.176 meters
Point 6106, Easting 327284.969, Northing 4366677.952, Z-Error 0.215 meters
Point 6119, Easting 433697.747, Northing 4349177.806, Z-Error 0.278 meters

CONSOLIDATED VERTICAL ACCURACY ASSESSMENT AND CONCLUSION

Consolidated Vertical Accuracy (CVA) Tested 0.216 meters consolidated vertical accuracy at the 95th percentile level; reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. CVA is based on the 95th percentile error in all land cover categories combined.
Point 4013, Easting 410434.749, Northing 4399541.052, Z-Error 0.225 meters
Point 4022, Easting 406202.133, Northing 4288991.591, Z-Error 0.237 meters
Point 5006, Easting 334309.503, Northing 4363034.812, Z-Error 0.260 meters
Point 5008, Easting 427424.043, Northing 4436769.384, Z-Error 0.285 meters
Point 5015, Easting 423751.282, Northing 4345809.393, Z-Error 0.267 meters
Point 5022, Easting 410604.081, Northing 4296472.997, Z-Error 0.262 meters
Point 5023, Easting 413132.894, Northing 4299188.462, Z-Error 0.252 meters
Point 5031, Easting 391304.943, Northing 4296874.538, Z-Error 0.250 meters
Point 6119, Easting 433697.747, Northing 4349177.806, Z-Error 0.278 meters

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		October 2015

Section 6: Flight Logs

Flight logs for the project are shown on the following pages:

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/7/2014	341	74333	2	USGS MD-PA Sandy

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
SIMMONS	N1107Q	2342.6	14:20:00	19:20:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN	ALS-7108	2346.7	18:50:00	23:50:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
			0					Departing	KMTN
								Arriving	KMTN

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
				Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi		B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
	Kts		Ft		Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	
		⇕Times entered are Zulu / GMT⇕						Verify S-Turns Before Mission	Yes X No
1	NE	20:03:00	20:04:00					FIGURE 8	
2	SW	20:07:00	20:09:00						
3	NE	20:12:00	20:14:00						
4	SW	20:17:00	20:21:00						
5	NE	20:24:00	20:29:00						
6	SW	20:33:00	20:38:00						
7	NE	20:41:00	20:49:00						
8	SW	20:52:00	20:59:00						
9	NE	21:03:00	21:13:00						
10	SW	21:16:00	21:25:00						
11	NE	21:29:00	21:39:00						
12	SW	21:42:00	21:52:00						
13	NE	21:55:00	22:06:00						
14	SW	22:09:00	22:20:00						
15	NE	22:23:00	22:34:00						
16	SW	22:38:00	22:50:00						
17	NE	22:53:00	23:06:00						
18	SW	23:10:00	23:22:00					FIGURE 8	
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ADS-80	DD/MM/YYYY	Day of Year	Mission Name / Job #
	15/12/2014	349	BALTIMORE/KENT 74333

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N3MZ [ ] N404CP [ ] N7079F [ ] N475CP [ ] N1107Q [X]	SH-81 [ ] SH-82 [ ]	2347.2	17:05:00	22:05:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2351.4	21:40:00	2:40:00

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PID
	Yes [ ] No [X]	GPS Base #1	Annen	KESN
		GPS Base #2	Operator	PID

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO / Arriving ICAO
140/3	10	18,000	70	9	4	30.11		

GSD	Bands to be Collected	"B" Band Turned On	MM80's
Ft	R [ ] G [ ] B [ ] IR [ ]	YES [ ] NO [ ]	#'s _____ & _____

Target Air Speed	Specified AGL	Terrain Height	Specified MSL	Capacity (Start)	Capacity (End)
150 Kts	7,500 Ft	Ft	Ft	_____	_____

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission	Yes [X]	No [ ]
1	N	22:42:00	22:43:00								Baltimore
2	S	22:46:00	22:47:00								
3	N	22:50:00	22:52:00								
4	S	22:55:00	22:57:00								
5	N	23:00:00	23:02:00								
6	S	23:05:00	23:08:00								
7	N	23:11:00	23:15:00								
8	S	23:18:00	23:22:00								
9	N	23:25:00	23:29:00								
10	S	23:33:00	23:37:00								
11	N	23:40:00	23:45:00								
12	S	23:48:00	23:52:00								
13	N	23:55:00	23:59:00								
14	S	0:03:00	0:08:00								
15	N	0:10:00	0:15:00								
16	S	0:18:00	0:22:00								
17	N	0:25:00	0:30:00								
18	S	0:33:00	0:37:00								
19	N	0:40:00	0:45:00								
20	S	0:48:00	0:52:00								
21	W	0:56:00	0:57:00								
22	E	0:59:00	1:00:00								
XX	XX	XX	MOVING	TO	KENT	CO.	WITH	A	CHANGE	IN	ALTITUDE
39	W	1:14:00	1:15:00								
38	E	1:18:00	1:20:00								
37	W	1:23:00	1:25:00								
		SEE PAGE	0:00:00								
↑ Times entered are Zulu / GMT ↑									Verify S-Turns After Mission	Yes [X]	No [ ]

Additional Comments:

WOOLPERT FLIGHT LOG SHEET #2

Leica ADS-80	DD/MM/YYYY	Day of Year	Mission Name / Job #
	15/12/2014	349	74333

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
1	N	1:29	1:32								
2	S	1:35	1:41								
3	N	1:44	1:50								
4	S	1:53	2:00								
5	N	2:04	2:11								
6	S	2:14	2:21								
		MISSION	END								

↑ Times entered are Zulu / GMT ↑ Verify S-Turns After Mission Yes ☐ No ☐

Additional Comments:

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/15/2014	349	074333_02	2	Carrol_MD

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3490.3	3:35:00	20:35:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
GEBHART	ALS-7177	3495.5	9:20:00	2:20:00	KDMW

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
Calm	10	clear	0	11	5	30.01		Departing	KDMW
								Arriving	KDMW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
32	40	239	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed	AGL	MSL	Waveform Used				Waveform Mode	Pre-Trigger Dist.
150 Kts	7500 Ft	7733 Ft	Yes		No	X	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 20:50:30
		⇩ Times entered are Zulu / GMT ⇩						Verify S-Turns Before Mission Yes X No
1	W	21:22:28	21:31:14	19:16:55	17	0.6	1.1	Takeoff: 21:04z
2	E	21:34:13	21:42:42	0:00:00	17	0.6	1.1	thick haze, cloudy like horzantally
3	W	21:46:00	21:54:36	0:00:00	17	0.6	1.2	clear vertically
4	E	21:57:48	22:06:33	0:00:00	16	0.6	1.1	
5	W	22:10:05	22:19:00	0:00:00	17	0.6	1	
6	E	22:21:52	22:30:40	0:00:00	17	0.7	1.1	
7	W	22:33:20	22:42:06	0:00:00	17	0.7	1.2	
8	E	22:45:18	22:54:20	0:00:00	17	0.7	1.3	
9	W	22:57:42	23:06:29	0:00:00	17	0.7	1.3	
10	E	23:09:23	23:18:00	0:00:00	17	0.7	1.3	
11	W	23:21:10	23:30:44	0:00:00	16	0.7	1.2	
12	E	23:33:33	23:42:37	0:00:00	16	0.7	1.3	
13	W	23:45:56	23:55:20	0:00:00	15	0.8	1.3	
14	E	23:57:46	0:07:55	0:00:00	14	0.7	1.3	
15	W	23:10:05	0:19:23	0:00:00	16	0.6	1.1	
16	E	0:22:08	0:31:00	0:00:00	17	0.6	1	
17	W	0:34:05	0:42:56	0:00:00	17	0.6	1	
18	E	0:45:45	0:54:28	0:00:00	17	0.7	1	
19	W	0:57:30	1:05:29	0:00:00	17	0.6	1.1	
20	E	1:08:15	1:15:56	0:00:00	17	0.7	1.1	
21	W	1:18:52	1:26:10	0:00:00	16	0.7	1.2	
22	E	1:28:44	1:35:41	0:00:00	16	0.7	1.3	
23	W	1:38:04	1:45:32	0:00:00	17	0.7	1.2	
24	E	1:48:12	1:54:31	0:00:00	17	0.7	1.3	
25	W	1:57:40	2:03:52	0:00:00	18	0.6	1.2	
				0:00:00				Landing: 0216z
				0:00:00				Static:02:17:45 - 02:19:45
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes X No

Additional Comments:	Drive #
	783516

WOOLPERT FLIGHT LOG SHEET #1

Leica ADS-80	DD/MM/YYYY	Day of Year	Mission Name / Job #
	17/12/2014	351	74333 Kent

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N3MZ [ ] N404CP [ ] N7079F [ ] N475CP [ ] N1107Q [X]	SH-81 [X] SH-82 [ ]	2351.4	8:36:00	13:36:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2353.7	11:30:00	16:30:00

Passengers	Using or Relying on CORS	GPS Base #1	Operator	Annen	PID	KESN
	Yes [ ] No [X]	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO
280/4	10	0	0	9	9	30		Arriving ICAO

GSD	Bands to be Collected	"B" Band Turned On	MM80's
Ft	R [ ] G [ ] B [ ] IR [ ]	YES [ ] NO [ ]	#'s _____ & _____

Target Air Speed	Specified AGL	Terrain Height	Specified MSL	Capacity (Start)	Capacity (End)
150 Kts	150 Ft	Ft	6,500 Ft	_____	_____

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission	Yes [X]	No [ ]
19	N	14:12:00	14:13:00								
18	S	14:17:00	14:21:00								
17	N	14:25:00	14:29:00								
16	S	14:32:00	14:38:00								
15	N	14:43:00	14:52:00								
14	S	14:55:00	15:03:00								
13	N	15:06:00	15:14:00								Moving due to tides
8	S	15:19:00	15:27:00								
7	N	15:29:00	15:37:00								
											Moving due to tides
36	E	15:42:00	15:46:00								
35	W	15:51:00	15:57:00								
34	E	16:00:00	16:05:00								
											Clouds moving into
											area-
↑ Times entered are Zulu / GMT ↑									Verify S-Turns After Mission	Yes [X]	No [ ]

Additional Comments:

1st Start up, failed laser temp diode. Correct start the 2nd time.

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/17/2014	351	074333_02	2	Carrol_MD

Operator	Aircraft	HOBBS Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3495.5	6:05:00	23:05:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
GEBHART	ALS-7177	3498.1	9:10:00	2:10:00	KDMW

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KDMW
300 10 pg 15	10	clr		3	-3	30		Arriving	KDMW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
32	40	239	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.	
150	Kts	7500	Ft	7733	Ft	Yes		No	x	@ NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	23:23:36
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission	Yes X No
26	E	23:46:40	23:52:37	0:00:11	16	0.7	1.1	Takeoff: 23:32/Too low/fast yo yo	
27	W	23:56:35	0:03:36	0:00:00	16	0.6	1	26 540 low at one point	
28	E	0:01:26	0:13:13	0:00:00	16	0.6	1.1	11-13 Cloud	
29	W	0:17:12	0:23:56	0:00:00	16	0.6	1.1	20-21 cloud	
30	E	0:27:38	0:32:47	0:00:00	16	0.6	1.1	mountian wave hard to maintain	
31	W	0:36:44	0:42:41	0:00:00	16	0.6	1.1	altitude and speed	
32	E	0:46:02	0:51:02	0:00:00	15	0.7	1.2		
33	W	0:55:00	1:00:53	0:00:00	15	0.7	1.1	4-6 cloud	
34	E	1:04:17	1:09:07	0:00:00	15	0.7	1.3	4-5 cloud 7-8	
35	W	1:12:31	1:18:04	0:00:00	16	0.6	1.2	REFLY ENTIRE LINE CLOUDS	
50	E	1:28:15	1:33:47	0:00:00	16	0.6	1.2	REFLY ENTIRE LINE CLOUDS	
28	W	1:42:19	1:43:54	0:00:00	16	0.7	1.4	PATCH-CLOUDS REFLY 11-13	
				0:00:00				clouds in the entire project area	
				0:00:00					
				0:00:00				Landing: 02:05	
				0:00:00				Static: 02:09:24 - 02:11:24	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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				0:00:00					
				0:00:00					
				0:00:00					
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #
	112

WOOLPERT FLIGHT LOG SHEET #1

Leica ADS-80	DD/MM/YYYY	Day of Year	Mission Name / Job #
	18/12/2014	352	Talbot 74333

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N3MZ ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-81 ☐ SH-82 ☐	2353.7	7:20:00	12:20:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2355.1	9:03:00	14:03:00
Passengers	**Using or Relying on CORS**		**GPS Base #1**	**Operator** Annen	**PID** KESN
	Yes ☐ No X		**GPS Base #2**	**Operator**	**PID**

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO / Arriving ICAO
330/12	10	9k	50	3	-6	30.15		

GSD	Bands to be Collected	"B" Band Turned On	MM80's
Ft	R ☐ G ☐ B ☐ IR ☐	YES ☐ NO ☐	#'s _____ & _____

Target Air Speed	Specified AGL	Terrain Height	Specified MSL	
150 Kts	6,500 Ft	Ft	Ft	Capacity (Start) _____ Capacity (End) _____

Line #	Dir.	Line Start Time	Line End Time	Int. Time	Speed	SV's	HDOP	PDOP	MSL	Sun Angle	Notes
Test	n/a			n/a	n/a				n/a	n/a	
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission	Yes X	No ☐
1	W	12:49:00	12:52:00								Talbot
2	E	12:56:00	12:59:00								
3	W	13:02:00	13:06:00								
4	E	13:09:00	13:12:00								
5	W	13:16:00	13:22:00								
6	E	13:24:00	13:33:00								
7	W	13:36:00	13:45:00								
											End of tide window
											No other areas due to
											clouds
↑ Times entered are Zulu / GMT ↑									Verify S-Turns After Mission	Yes ☐	No ☐

Additional Comments:

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/19/2014	353	74333

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2355.1	17:00	22:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2359.7	10:10	3:10

Passengers	Using or Relying on CORS	GPS Base #1	Operator	Annen	PID	KESN
	Yes ☐ No X	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO
310/5	10	0	0	3	-3	30.19		Arriving ICAO

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
40	41	272	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 22:04:00
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
26	E	22:36:00	22:41:00		17		1.3	Working fine
27	W	22:45:00	22:50:00					
28	E	22:53:00	22:58:00					
29	W	23:01:00	23:06:00					
30	E	23:09:00	23:15:00					
31	W	23:18:00	23:23:00					
32	E	23:26:00	23:21:00					
33	W	23:34:00	23:40:00					
xx		Talbot						Move to Talbot
8	S	23:47:00	23:56:00					
9	N	23:58:00	0:07:00					
10	S	0:10:00	0:18:00					
11	N	0:21:00	0:28:00					
12	S	0:31:00	0:38:00					
13	N	0:48:00	0:58:00					
14	S	0:52:00	0:59:00					
15	N	1:03:00	1:10:00					
16	S	1:13:00	1:21:00					
17	N	1:24:00	1:32:00					
18	S	1:35:00	1:43:00					
19	N	1:46:00	1:53:00					
20	S	1:57:00	2:04:00					
21	N	2:07:00	2:15:00					
22	S	2:18:00	2:25:00					
23	N	2:28:00	2:35:00					
24	S	2:39:00	2:46:00					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:

Systems worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/20/2014	354	Talbot Kent / 74333

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 ^	2355.1	8:50	13:50
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2361.7	11:15	16:15

Passengers	Using or Relying on CORS	GPS Base #1	Operator	Annen	PID	KESN
	Yes ☐ No ☐	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO
Calm	10	14000	90	-1	-3	30.34		Arriving ICAO

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
			100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	Ft	Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
25	N	14:18:00	14:25:00					
26	S	14:28:00	14:35:00					
27	N	14:37:00	14:44:00					
28	S	14:47:00	14:54:00					
29	N	14:56:00	15:00:00					
XX	XX	MOVE TO	KENT					
9	N	15:11:00	15:19:00					Cloud on very north end
10	S	15:22:00	15:30:00					Clouds on North end, will refly
11	N	15:33:00	15:44:00					Clouds now on northern 5 miles
		end	Clouds					Will refly above
↑ Times entered are Zulu / GMT ↑				0:00:00	Total Time On Line			Verify S-Turns After Mission Yes X No ☐

Additional Comments:

Had two false starts this morning to to cold temps of the machine

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/21/2014	354	74333 Kent Talbot Flt 1

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC N404CP N7079F N475CP N1107Q X	SH-7177 SH_6157 SH-7108 ^	2361.7	9:00	14:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2363.3	11:05	16:05

Passengers	Using or Relying on CORS	GPS Base #1	Operator	Annen	PID	KESN
	Yes ☐ No ☐	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO
Calm	8	7,500	90	2	-1	30.38		Arriving ICAO

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
			100	Course/Up ___ Fine/Down ___	Single ☐ 2+2 ☐ Multi ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	Ft	Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes XX No ☐
30	S	14:28:00	14:32:00					TALBOT
31	N	14:34:00	14:37:00					
32	S	14:41:00	14:44:00					
33	N	14:47:00	14:50:00					
34	S	14:53:00	14:56:00					
35	N	14:59:00	14:51:00					
		TALBOT	COMPLETE					
		MOVE TO	KENT					KENT
12	N	15:12:00	15:22:00					
11	S	15:25:00	15:28:00					PATCH TOP 7 FOR CLOUDS
10	N	15:31:00	15:34:00					PATCH TOP 7 FOR CLOUDS
9	S	15:36:00	15:39:00					PATCH TOP 7 FOR CLOUDS
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes XX No ☐

Additional Comments:

SYSTEM WORKING WELL

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/21/2014	355	74333 Kent Flt 2

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2363.3	12:08	17:08
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2364.6	13:45	18:45

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PID
	Yes ☐ No X		Annen	KESN
		GPS Base #2	Operator	PID

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO / Arriving ICAO
360/4	10	8k	70	4	-3	30.37		

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode	
			100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐	2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	Ft	Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
25	E	17:34:00	17:39:00					
24	W	17:43:00	17:49:00					
23	E	17:52:00	17:56:00					
22	W	17:59:00	18:08:00					
21	E	18:10:00	18:12:00					
20	E	18:15:00	18:17:00					
		KENT	COMPLETED					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments: SYSTEM WORKED WELL, NO ISSUES

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/26/2014	360	74333 Carroll County

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2365	16:40	21:40
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2368.8	20:55	1:55

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PID
	Yes ☐ No X	GPS Base #1	Annen	KDMW
		GPS Base #2	Operator	PID

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO / Arriving ICAO
240/4	10	9K	30	8	-1	30.22		

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
32	40	239	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	7,500 Ft	Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		↕Times entered are Zulu / GMT↕						Verify S-Turns Before Mission Yes X No ☐
26	E	22:08:00	22:14:00		15	0.8	1.2	
27	W	22:17:00	22:24:00					
28	E	22:27:00	22:32:00					
29	W	22:36:00	22:41:00					
32	E	22:45:00	22:50:00					
33	W	22:53:00	22:59:00					
34	E	23:02:00	23:07:00					
35	W	23:11:00	23:16:00					
36	E	23:19:00	23:24:00					
37	W	23:27:00	23:33:00					
38	E	23:36:00	23:41:00					
39	W	23:44:00	23:50:00					
40	E	23:53:00	23:59:00					
41	W	0:02:00	0:08:00					
42	E	0:11:00	0:17:00					
43	W	0:20:00	0:26:00					
44	E	0:29:00	0:35:00					
45	W	0:38:00	0:44:00					
46	E	0:48:00	0:53:00					
47	W	0:57:00	1:03:00					
48	E	1:06:00	1:11:00					
49	W	1:15:00	1:21:00					
50	E	1:24:00	1:30:00					
		↑Times entered are Zulu / GMT↑		0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments: System worked well

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/27/2014	361 FLT1	74333 Chester County

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2368.8	8:35	13:35
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2373.1	13:15	18:15

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PID	CHES
	Yes ☒ No ☐	GPS Base #2	Operator	PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KDMW
Calm	10	9k	40	4	1	30.26		Arriving ICAO	KDMW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
32	40	239	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	7,500 Ft	7,500 Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes ☒ No ☐
19	S	14:17:00	14:34:00		16	0.7	1.3	
20	N	14:37:00	14:52:00					
21	S	14:55:00	15:13:00					
22	N	15:16:00	15:31:00					
23	S	15:35:00	15:52:00					
24	N	15:55:00	16:10:00					
25	S	16:14:00	16:30:00					
26	N	16:34:00	16:48:00					
27	S	16:51:00	17:08:00					
28	N	17:11:00	17:25:00					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ No ☐

Additional Comments: System worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/29/2014	363	74333

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2379.4	8:05	13:05
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2383.9	13:00	18:00
Passengers	**Using or Relying on CORS**		**GPS Base #1**	**Operator**	**PID** CHES
	Yes X No ☐		**GPS Base #2**	**Operator**	**PID**

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
Calm	10	12k	80	2	-4	30.18		KDMW	KDMW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode	
32	40	239	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐	2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	7,500 Ft	Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
29	S	13:57:00	14:13:00		17	0.8	1.3	
30	N	14:15:00	14:29:00					
31	S	14:33:00	14:48:00					
32	N	14:51:00	15:04:00					
33	S	15:07:00	15:22:00					
34	N	15:25:00	15:38:00					
35	S	15:41:00	15:55:00					
36	N	15:59:00	16:11:00					
37	S	16:15:00	16:28:00					Small Fuzzy 2 FSE
38	N	16:32:00	16:44:00					
39	S	16:47:00	17:00:00					
40	N	17:04:00	17:16:00					Small cloud 2.2 FSE
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments: System worked well

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/30/2014	364	74333 Talbot County

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2385.1	17:00	22:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2386.1	18:25	23:25

Passengers	Using or Relying on CORS	GPS Base #1	Operator	Annen	PID	KESN
	Yes ☐ No X	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KESN
Calm	10	Clr	0	7	-4	30.42		Arriving ICAO	KESN

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode	
40	41	272	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐	2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	6,500 Ft	6,500 Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
		Talbot	Re-flight		16	0.7	1.1	
7	N	22:32:00	22:41:00					
8	S	22:44:00	22:53:00					
9	N	22:56:00	23:04:00					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:

System worked fine, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	12/31/2014	365	74333 Chester County

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2386.5	8:05	13:05
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2390.1	12:06	17:06

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PA	PID	CHES
	Yes X No ☐	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KDMW
330/15	10	0	0	-5	-13	30.4		Arriving ICAO	KDMW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
32	40	239	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	7,500	7,500 Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No ☐
41	S	13:56:00	14:08:00					
42	N	14:11:00	14:24:00					
43	S	14:26:00	14:39:00					
44	N	14:42:00	14:55:00					
45	S	14:57:00	15:09:00					
46	N	15:12:00	15:25:00					
47	S	15:27:00	15:39:00					
48	N	15:44:00	15:53:00					
49	S	15:56:00	15:57:00					
50	S	16:00:00	16:01:00					
51	N	16:05:00	16:05:00					
40	S	16:11:00	16:14:00					CLOUD PATCH
37	N	16:17:00	16:19:00					CLOUD PATH
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:

SYSTEM WORKED WELL, NO ISSUES.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	1/2/2015	2	74333 Chester County

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2390.1	13:05	18:05
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Larocque			2391.2	14:20	19:20

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PA	PID	CHES
	Yes X No ☐	GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KDMW
280/8	10	18,000	80	4	-7	30.26		Arriving ICAO	KTTA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode
32	40	239	100	Course/Up ___ Fine/Down ___	Single ☐ Multi ☐ 2+2 ☐ 4+3 ☐

Air Speed	AGL	MSL	Threshold	Waveform Mode	Pre-Trigger Dist.
150 Kts	7,500 Ft	7,800 Ft	/	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
↕Times entered are Zulu / GMT↕								Verify S-Turns Before Mission Yes X No ☐
27	S	18:52:00	19:01:00		18	0.8	1.1	One patch flight
								Relocating to KTTA
								In flight shut down
↑Times entered are Zulu / GMT↑				0:00:00	Total Time On Line			Verify S-Turns After Mission Yes X No ☐

Additional Comments:

System worked well. Unable to do a full 360 at start of line. Playing, 'Beat the Clouds'. No time for the complete beginning turns.

Drive #

Section 7: Final Deliverables

The final lidar deliverables are listed below.

- LAS v1.2 classified point cloud
- LAS v1.2 raw unclassified point cloud flight line strips.
- Hydro Breaklines as ESRI shapefile
- Digital Elevation Model in ERDAS .IMG format
- 8-bit intensity images in .TIF format
- Tile Index and data extent provided as ESRI shapefile
- Control Points provided as ESRI shapefile
- FGDC compliant metadata per product in XML format
- Lidar processing report
- Survey report in pdf format